Abhay Rane · Burak Turna
Riccardo Autorino · Jens J. Rassweiler
Editors

Practical Tips in Urology

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To Our Families and Friends

In Memoriam

Viorel Bucuras suffered from a severe heart attack with subsequent cerebral ischemia just two weeks before the ESUT-Brainstroming Meeting 2015, he had organized for us. During this Meeting we finalized the outline of this book. Viorel, we will miss your input, friendship and hospitality.

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Foreword by Evangelos Liatsikos

Science and technology are continuously progressing at a quick pace. We endourologists are obliged to follow this never-ending technological evolution. ESUT is always in the forefront of any kind of scientific and or clinical development in the field of endoscopic urology. The need to create a comprehensive book that focuses mostly on practical issues of endourology in everyday life was evident to us. After all, we all know that ESUT has always been a family for all endourologists and continuously tries to satisfy their scientific needs. But when does the research end? As far as I am concerned, never! We will always continue our efforts in order to offer a better quality of life to our patients.

This book contains important developments conducted during the recent years in the field of endourology and urotechnology. Because of this, it constitutes an excellent work and a very useful tool for all urologists. The authors as well as the editors have focused on important theoretical and practical issues. We thus really need to congratulate them for the contribution in the production of this interesting work.

Patras, Greece
May 2016

Evangelos Liatsikos

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Part I
General Urology

Chapter 1
Diagnostic Algorithms for Hematuria

Joanne Creswell

Abstract Visible hematuria yields a urological diagnosis in 15–20 % of cases, whereas non-visible hematuria has poor specificity and a urological diagnosis is found in fewer than 5 % of referrals. Herein, a practical guidelines-based diagnostic approach for these two clinical scenarios is provided.

Keywords Cystoscopy • Diagnosis • Hematuria

Introduction

In practice, local guidance should be followed as many protocols and algorithms are already in place. In some countries, for example, the UK, there will be targets in place to ensure prompt referral and investigation. There are a few suggestions, however, that can improve the service for the patient, clinician and institution whilst remaining compliant with guidelines [1, 2].

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Definitions

- Visible hematuria (VH) – indicates blood that can be seen by the patient or care giver. Also termed frank or macroscopic or gross hematuria
- Non-visible hematuria (NVH) – invisible to the naked eye. Picked up by urinalysis or microscopy. Also termed dipstick or microscopic hematuria

Triaging Referrals

Visible hematuria yields a urological diagnosis in 15–20 % of cases, increasing with age and risk factors, such as smoking. Non-visible hematuria has poor specificity and a urological diagnosis is found in fewer than 5 % of referrals. Many protocols therefore recommend only investigating those over 40 years of age.

If there is any opportunity to triage patients, visible hematuria should be prioritized as pathology is more likely.

Caution A note of caution is required for those with intermittent hematuria – investigate even if there has been only one episode. Also the increasing cohort of patients taking oral anticoagulants should be investigated as many will have an underlying pathology, such as a bladder tumor. Due to common risk factors and age, one might argue that the patient taking anticoagulants is even more likely to have urinary tract pathology.

Rapid Diagnosis/One-Stop Clinics

The use of direct-to-test allocation of patients is relatively straightforward in this group of patients. This facilitates rapid diagnosis and reassurance, and it reduces the need for review appointments. It is slightly complicated by the requirement for imaging and cystoscopy. The sequence in which these tests occur can be helpful in reducing the need for procedures. For example, if a bladder tumor is identified on imaging the patient can be listed directly for endoscopic resection of tumor, rather than first undergoing flexible cystoscopy. On the other hand, if a bladder tumor is diagnosed first with cystoscopy, the ultrasound scan can be avoided and CT scan performed for staging and upper tract imaging.

Ideally, the cystoscopy and imaging should be performed in the same location, which facilitates patient convenience. Bear in mind that imaging may be most useful with a full bladder and that the patient is likely to need to void after cystoscopy and may then arrive at the ultrasound scanner with an empty bladder.

Patient Information

As investigations are protocol driven, it is relatively easy to prepare a patient information sheet. Well-informed patients will be prepared for tests and the process will run more smoothly.

Personnel Required

Essential requirements are someone trained in flexible cystoscopy, with an assistant to prepare patients and act as chaperone.

The cystoscopist may be a nurse-practitioner, junior doctor or senior doctor. Following protocols facilitates the involvement of clinicians in training, however, the involvement of a senior clinician will tend to limit over-investigation and missed diagnoses.

A hematuria clinic proforma with standardized questions allows rapid recording of history and risk factors. This increases the speed of the history taking for less experienced practitioners and facilitates audit.

Equipment

Provision of video capture allows cystoscopists to record findings where there is doubt about the diagnosis. This reduces the tendency to schedule unnecessary investigations, by sharing images with a more experienced colleague who can often reassure.

Many modern cystoscopy stacks and scopes have image enhancing technology such as narrow-band imaging (NBI) as standard. This can be helpful in recognizing more subtle lesions, and requires no additional instillation, therefore is of particular utility in this setting.

The ability to perform biopsy and cautery is very helpful, to avoid further general anesthetic procedures. A red patch can be sampled in this manner without the need for separate hospital/clinic admission.

Specific Tests

The use of cystoscopy is universal and requires little debate at this time.

However, significant discussion has centered on the imaging test to be used and the use of urine tests such as cytology. Practice varies and the jury is still out regarding best practice and use of resources.

One suggested algorithm is given in Fig. 1.1. This incorporates the use of ultrasound scanning of kidneys and bladder for NVH, and CT Urogram for visible hematuria. There may be specific patients where a cause for has not been found, but there is persistent NVH and risk factors such as age, cigarette smoking such that CT urogram is desirable.

The use of urine cytology has been vigorously debated. Economic evaluation suggests that yield is relatively low in the presence of normal imaging and cystoscopy. Additionally, this test requires lab processing and therefore cannot be applied in the one-stop setting. Very few patients will have primary carcinoma in situ (cis) without abnormality on cystoscopy or imaging. Similarly the isolated finding of upper

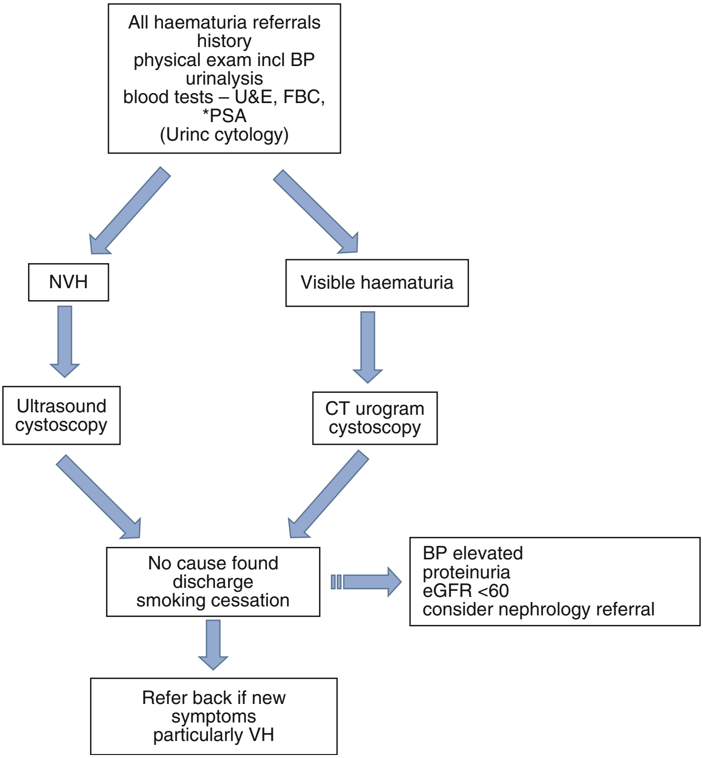

Figure 1.1 An example of an algorithm for hematuria assessment

tract transitional cell carcinoma (TCC) in NVH with a normal ultrasound is unusual. However, photodynamic diagnosis (PDD) has highlighted a few patients who have been identified with cis on the basis of suspicious cytology with normal white light cystoscopy.

Bear in mind also, that urine cytology can be helpful in planning management of disease. For example, suspicious cytology indicates high-risk disease, which may affect strategy for endoscopic management of both lower and upper tract TCC. One approach would be to reserve cytology for those with a diagnosis of bladder tumor, or only for those with negative investigations. There are test kits available for urine markers which offer greater sensitivity compared to cytology, however, these have not proven effective enough to replace cystoscopy and specificity remains a concern.

Recommendations

When discharging the patient with negative investigations from the clinic, it is helpful to specify the criteria for referral again. For example, with NVH and negative investigations it is reasonable to suggest that the patient only be referred back if new symptoms, particularly VH develop in the future.

The opportunity for health education should not be missed. The patient who has just spent 2 weeks worrying about a possible urological cancer may be more susceptible to your advice about stopping smoking.

Don't forget to consider referral to nephrology for NVH with negative investigations and proteinuria, hypertension and impaired renal function.

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Chapter 2
Hydronephrosis in Pregnancy

Alessio Zordani, Luigi Bevilacqua, and Salvatore Micali

Abstract In this chapter we provide a critical and practical overview of the clinical management of hydronephrosis during pregnancy, which represents a very common and sometimes problematic scenario for the practising urologist.

Keywords Hydronephrosis • Management • Pregnancy

Introduction

Hydronephrosis appears approximately in more than 80 % of pregnant women [1]. This is considered as a para-physiological phenomenon that occurs during the second – third trimester of pregnancy, and it disappears a few weeks after birth (usually within the first month) [2]. Hydronephrosis may initially manifest in the first trimester, then, it increasingly develops throughout pregnancy [3]. This progression was also reported in a large prospective study by Faundes and colleagues, who found that hydronephrosis was present

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in 15 %, 20 %, and 50 % of women during the first, second, and third trimesters, respectively [4]. Dilatation is usually more pronounced on the right kidney [5, 6] and in primigravidas [7], and it does not occur below the pelvic brim. Serial measurements by ultrasonography report that the maximal incidence of hydronephrosis develops during the 28th week [2].

Etiology

The mechanism inducing the dilatation of kidney pelvis, caliceal systems and ureter is ascribed to obstructive and hormonal causes [1]. The main factor is the mechanical obstruction of the ureter due to the compression of pregnant uterus against the pelvic brim. This event explains why the ureter dilatation appears only above the *linea terminalis* (terminal line). The dextrorotation of the uterus and the relative protection of the left ureter provided by the sigmoid colon most likely justifies the right side prevalence of hydronephrosis (Fig. 2.1) [5, 6].

There are elevated baseline ureteral pressures in resting during pregnancy. Ureteral pressure has been recorded above the pelvic brim also during positional changes, and the resulting pressures were decreased. This reflect the displacement of the uterus from the ureter, which allows the reduction of the dilatation. Hydronephrosis of pregnancy usually does not occur in quadrupeds, whose uterus hangs away from the ureters [8].

Hormonal effects on the ureters have also been implicated, in order to explain the kidney dilatation during pregnancy. About 10–15 % of incidence of ureteral dilatation observed in the first-trimester, occurring before the uterus reaches the pelvic brim, supports a non-mechanical mechanism (Faundes 1989). This hypothesis may be endorsed by high levels of progesterone during pregnancy, which reduce ureter's smooth muscle tone, peristalsis and contraction pressure. Progesterone has been proven to increase the degree of hydronephrosis during pregnancy, and to delay the rate of disappearance after birth [2], however it is not able by itself to cause ureteral dilatation. As a matter of fact, in women with pelvic kidney or ureteral diversion, in which the ureter enters the conduit above the pelvic brim, hydronephrosis is not observed. The significantly lower incidence of left-sided hydronephrosis also supports such hypothesis [5]. Schneider et al. showed that administration of progesterone in non-pregnant women fails to cause hydronephrosis, hence there is no correlation between hormones and dilatation [9].

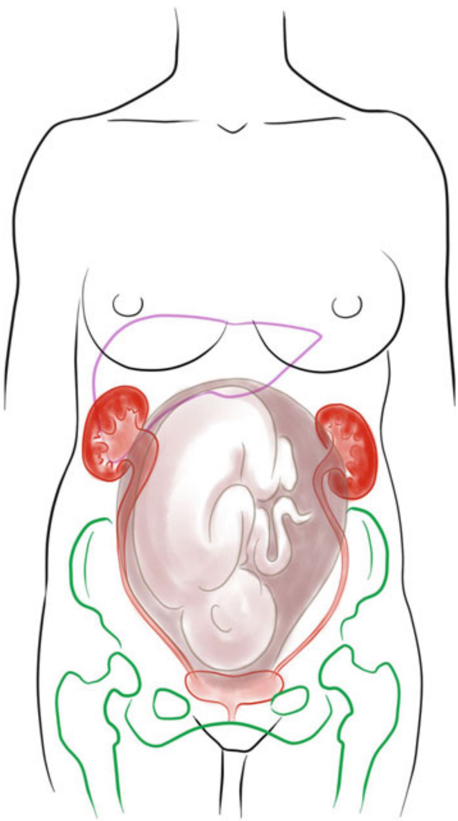

FIGURE 2.1 This picture shows the physiological dilatation of the right ureter, in the middle third, compressed between the gravid uterus and the pelvic brim (Courtesy of Massimo Borri)

Therefore, obstruction is the primary factor in the etiology of hydronephrosis during pregnancy and hormonal factors may be involved [3]. Increased diuresis, small stones or other unrecognized factors may cause decompensation of ureteral function, progressing to symptomatic acute hydronephrosis [10]. Nephrolithiasis is a relatively uncommon event in pregnancy, with frequency of 0.05 % [11].

Clinic and Imaging

Hydronephrosis of pregnancy is usually clinically silent. Renal colic is the most common non-gynecologic cause for abdominal pain and hospitalization during pregnancy and clinical presentation could vary from nausea, emesis, urgency, frequency, dysuria, hematuria and fever [12]. Acute urinary stasis can lead to flank pain until pyelonephritis, renal failure, pre-eclampsia and pre-term labor. A normal curve of dilatation was proposed to define the upper limits of caliceal diameter during gestational weeks [4].

Ultrasonography is the imaging tool of choice for evaluation of hydronephrosis in pregnancy woman due to its relatively low cost, extensive results, real-time capability, safety [13, 14]. Typical ultrasonographic framework is hydroureteronephrosis extending to the pelvic brim. When ureteral dilation extends below it, a different etiology of obstruction, such as a ureteral stone, should be considered. In case the ultrasonography findings are questionable, Magnetic Resonance Imaging (MRI) will allow to make a distinction. On high-resolution T2 sequences, physiological dilatation will show the ureter in the middle third compressed between the gravid uterus and the pelvic brim (Fig. 2.2). Obstruction due to calculi causes renal enlargement and perinephric edema. When a stone is lodged in the lower ureter, a standing column of dilated ureter will be seen below the physiological constriction. The stone itself may be shown [15]. In addition, MRI is useful to show also other causes of acute flank or abdominal pain, including appendicitis, ovarian torsion, and adrenal hemorrhage. The administration

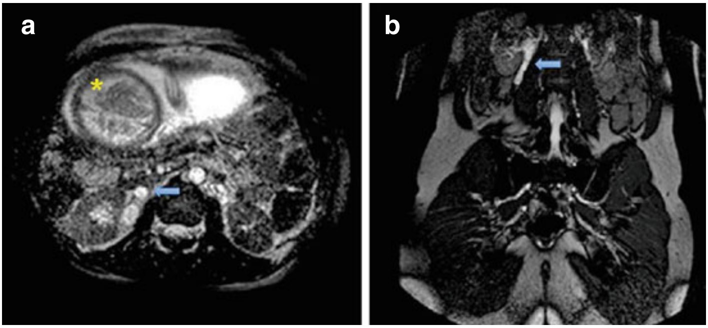

FIGURE 2.2 MRI sequence shows a right hydroureteronephrosis with a regular left kidney in a 30 weeks pregnancy woman. (**a**) T2 weight axial sequence (*blue arrow* shows right ureter dilatation,* shows fetal head). (**b**) T2 weight coronal sequence (Courtesy of Dr.ssa Federica Fiocchi, University of Modena and Reggio Emilia, Policlinico di Modena)

of gadolinium contrast should be avoided in pregnant patients because it is known to cross the placental barrier. Computed tomography (CT) is an acceptable alternative if there is a contraindication to MRI, but even low-dose regimes imply the use of ionizing radiation [16].

Therapy

Management options are based on the coexisting stone disease, pyelonephritis and renal disease [6]. The first line therapy in symptomatic women is conservative management (analgesia, bed rest, hydration and antibiotics when clinically indicated) unless the symptoms persist [10].

The EAU guideline recommends the use of the combination of NSAID and Dipyrone, as first line treatment option during severe renal colic pain. In order to prevent decreased fetal urine production and oligohydramnios, administration of paracetamol is recommended [17]. In conservative management, a close follow-up with urine analysis, urine culture, renal function tests and ultrasound is very important. However, placement of ureteral stent (under ultrasound guidance) or percutaneous nephrostomy is needed when sepsis signs and renal failure arises.

The initial management of nephrolithiasis should be conservative since spontaneous expulsion rates of up to 84 %. Studies have reported ureteroscopy to be a safe procedure in stone disease during pregnancy (free rate 70–100 %), though, in accordance with a normal standard of care, the treatment of stones should be delayed to the post-partum period [11].

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Chapter 3
Practical Interpretation and Application of Urodynamic Findings

Leah Chiles and Eric S. Rovner

Abstract Proper reading and interpretation of a pressure flow urodynamic tracing should be performed in a systematic fashion. Unfortunately, there is no universally agreed upon approach to the interpretation of a pressure flow urodynamic study. Using the functional classification of voiding dysfunction as a framework, the pressure-flow tracing can be dissected into a filling/storage portion and an emptying portion. Important aspects of the urodynamic study can sub-classified within each of these phases. Conveniently, each of these aspects can be titled with a "C" thus providing the 9 "C's" of pressure-flow urodynamics interpretation and reporting. Such a scheme allows a complete and uniform approach to the interpretation of the urodynamic tracing. This chapter will provide a framework with which the practitioner can approach and interpret the pressure-flow urodynamic (PFUD) study.

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Keywords Urodynamics • Voiding dysfunction • Bladder outlet obstruction • Incontinence • Neurogenic bladder

Introduction

Urodynamics (UDS) are the dynamic study of the transport, storage and evacuation of urine [1]. UDS consists of a number of studies including uroflowmetry, post void residual measurement, filling and voiding cystometry, and sometimes urethral pressure measurement. Fluoroscopy is sometimes used concurrently to evaluate the dynamic anatomy of urinary tract in which case the study is termed "video-urodynamics". These tests measure and assess various processes, intrinsic and extrinsic to the lower urinary tract. UDS can assist in the diagnosis, prognosis, and treatment regimens related to a variety of lower urinary tract conditions. The term "urodynamics" was first coined by Dr. David Davis in 1954 [16]. Since then, there has been an exponential increase in the utilization of UDS by healthcare practitioners including urologists.

The amount of information produced during a routine PFUD study can be imposing to fully comprehend, understand and properly interpret. For a given study, the modern electronic multichannel pressure flow urodynamic machine produces a large amount of data in a graphical display usually supplemented with other information. The format varies depending on the type of urodynamic equipment, the specific study, and the end-user customization. Nevertheless, in most instances, the various channels on the graph represent a set of continuous variables over time including vesical and abdominal pressure recordings, urine flow rate and volume, infused volume and potentially other signals as well. An event summary, annotations, nomograms and other features now commonly found on commercially available urodynamics equipment add to the tremendous set of data available from a routine pressure-flow urodynamic (PFUD) study.

In the same manner in which radiologists interpret their imaging studies, it is crucial to be systematic and organized in approaching the PFUD tracing in order to properly and completely distil the optimal amount of information from the study. It is quite possible to overlook salient and relevant features of a PFUD tracing especially in those cases where there exists one single overwhelming abnormality. Like the astute radiologist, the expert urodynamicist will not be dissuaded from completely interpreting the study even in the setting of a distracting feature so that other, subtler findings can be noted as well. Such nuances can be crucial in formulating an accurate interpretation of the study and should not be overlooked.

The 9 "C's" of PFUD are a method of organizing and interpreting the PFUD study in a simple, reliable and practical manner [19]. In doing so, this system minimizes the potential for "missing" an important and relevant finding on the tracing. This framework is easy to understand, remember, and applicable to all PFUD studies for virtually all lower urinary conditions.

The "9 C's" of Urodynamics

In the functional classification as popularized by Wein the micturition cycle consists of two phases: (1) bladder filling/urinary storage, and (2) bladder emptying. All voiding dysfunctions therefore can be categorized as abnormalities of one or both of these phases. This classification system also provides a useful framework for organizing the 9 "C's".

The 9 "C's" represent the nine essential features of the PFUDs tracing that represent a minimum interpretive data set. Each of the features begins with the letter "C." (Table 3.1):

- in the filling phase, the "C's" consist of contractions (involuntary), compliance, continence, capacity and coarse sensation.
- in the emptying phase contractility, complete emptying, coordination and clinical obstruction are evaluated.

The "C's" are not specific for all types urinary dysfunction nor all urodynamic abnormalities. Nevertheless, by organizing and interpreting a study within this framework, it provides an

Table 3.1 9 "C's" of PFUD

Filling and storage	Emptying
Coarse sensation	Contractility
Compliance	Coordination
Contractions (involuntary detrusor)	Complete emptying
Continence	Clinical obstruction
Cystometric capacity	

organizing thread from which to formulate a diagnosis and begin to assemble a management plan.

Of course all PFUD tracings should be interpreted in the context of the patient's history, physical examination and other relevant studies. Additionally, reproducing the patient's symptoms or at least notating whether this was achieved during the study is also important in order to properly interpret the tracing and any abnormalities seen. Notwithstanding these limitations, it remains that a systematic and organized approach to interpretation of the PFUD tracing is likely to yield the most useful and complete set of data and optimize clinical care and outcomes.

Simply reviewing a UDS tracing is not sufficient to generate an accurate interpretation. The filling and voiding phases of the study are dynamic processes that are influenced by patient understanding of testing instructions (i.e. waiting for permission to void), and artifact (i.e. movement of uroflow detector during the test). Therefore, it is important that the person interpreting the UDS tracing is involved with the actual UDS study as knowledge of the testing environment will help differentiate artifacts from true findings.

Filling and Storage Phase

The filling phase starts with the initiation of instillation of saline (or contrast if a video urodynamic study is being performed) and ends with the instruction to void or "permission to void". Prior to giving permission to void the provider performing the UDS needs to ensure that all questions regarding the filling and storage phase have been addressed. Once permission to void has been given, the emptying phase begins. It is helpful to have a recent voiding diary available prior to the UDS. The voiding diary will help assess how the UDS tracing reflects their voided volumes in a non-clinical environment.

Coarse Sensation

The sensation of bladder filling experienced by the patient is variable but absence of normal sensation, or delayed sensation of bladder may be indicative of neurological abnormalities. Furthermore, hypersensitivity, lack of sensation during detrusor overactivity, sensation of extreme pain, or low bladder capacity overall due to sensation of fullness may be indicative of other lower urinary tract pathology.

It is important to begin the study with an empty bladder. Thus, most often patients are catheterized prior to the start of the study. This will help ensure that the infused volumes at which sensations are recorded are accurate. It is also important to ensure that the recorded infused amount accurately reflects the actual infused amount. Such calibrations should be done regularly and periodically as routine maintenance of the urodynamic equipment. Bladder coarse sensation can be delayed in patients with poorly controlled diabetes and HIV. Sensation can be absent in patients with spinal cord injuries. Hypersensitivity at low volumes may be indicative of interstitial cystitis (Painful bladder syndrome), UTI or other disorders.

Patients should be informed of the study objectives prior to beginning testing and this is especially relevant when assessing sensation. They should be prompted to inform the person performing the study of several events in the study [1]:

1. first sensation of bladder filling (during filling cystometry, the sensation when he/she first becomes aware of bladder filling)

2. first desire to void (the feeling, during filling cystometry, that the patient would desire to pass urine and the next convenient moment, but voiding can be delayed if necessary),
3. strong desire to void (during filling cystometry, as a persistent desire to void without the fear of leakage),
4. maximum cystometric capacity (in patients with normal sensation, is the volume at which the patient feels he/she can no longer delay micturition (has a strong desire to void)).
5. Urgency (during filling cystometry, the sudden compelling desire to void) at any time during the UDS.

Filling sensations are very subjective and as such there are not a universally accepted set of normative values hence the term "coarse sensation" is utilized. Typical ranges are: first sensation ~170–200 mL, first desire to void ~250 mL, strong desire to void ~400 mL and Maximum capacity ~480 mL [17]. Reviewing a recent voiding diary may be helpful. Sensation is affected by the placement of a catheter in the bladder, which may cause irritation, and/or pain, which may be erroneously interpreted as a sensation to void. Overly warm, cold, or too rapidly infused fluid can also affect bladder sensation. When documenting the interpretation of the UDS tracing coarse sensation is usually reported as absent, reduced or increased [9].

Compliance

Compliance reflects the passive viscoelastic properties of the bladder and is defined as the relationship between change in bladder volume and change in detrusor pressure [1]. Compliance is calculated by mathematically dividing the volume change of the bladder just prior to volitional micturition or the first involuntary bladder contraction by the detrusor pressure at that same point [1]. In a normally compliant bladder and in the absence of detrusor overactivity, the detrusor pressure should remain essentially unchanged during filling.

Decreased bladder compliance is generally acknowledged as a risk factor for upper tract deterioration.

Despite the importance of this data point, there exists no universally accepted normative value. Compliance of less than 20 mL/cm H_2O is commonly used as the threshold below which is considered abnormal [22]. Occasionally, a prolonged involuntary bladder contraction (detrusor overactivity or DO) can be confused with true abnormal compliance. One way to differentiate between these is to stop infusing fluid and observe for a few minutes. Typically, pressures will return to baseline after a few minutes with DO whereas pressures will remain high in abnormal compliance. Video urodynamics/VCUG can be helpful as high-grade reflux and large bladder diverticulum can act as a "pop off" masking underlying abnormal compliance.

Testing of the detrusor leak point pressure (DLPP) in patients with abnormal compliance can be helpful in risk assessment of future upper tract deterioration. DLPP is defined as "lowest value of the detrusor pressure at which leakage is observed in the absence of abdominal strain or detrusor contraction" [12]. A DLPP of greater than 40 is considered deleterious to the upper tracts [13]. However, in certain individuals; a DLPP of less than 40 may also put the upper tracts at risk (Fig. 3.1).

Pelvic radiation, denervation from radical pelvic surgery, neurogenic bladder and chronically indwelling Foley catheters are common etiologies of abnormal bladder compliance. Patients, who have abnormal compliance with a chronic indwelling Foley, should be converted to a short period of CIC to allow for bladder cycling if feasible. Often, in these patients without a high suspicion of true poor compliance, normal compliance will be noted after a short period of CIC and/or bladder cycling.

When documenting the interpretation of the UDS tracing, compliance is usually reported as normal or abnormal or can be listed as a calculated value as noted previously. It is important to recognize that an artifactual decrease in the P_{abd} (P_2) transducer can misinterpreted as decreased compliance, but in fact this is due to artifact or repositioning of the abdominal pressure transducer during the study (Fig. 3.2).

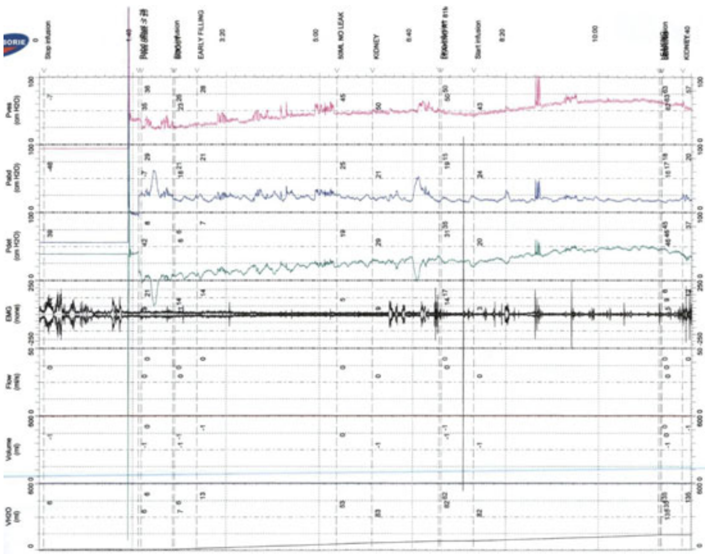

FIGURE 3.1 Decreased compliance. Note the change in detrusor pressure of 6–46 cm H_2O during instillation of 135 ml of fluid volume. Change in P_{det} is 46–6 = 40 cm H_2O with a change in volume of 135 mL. Compliance = (ΔVolume/ΔP_{det}) = 135 mL/40 cm = 3.375 mL/cm H_2O

Contractions, Involuntary (Detrusor Overactivity)

Detrusor overactivity (DO) is defined as a urodynamic observation characterized by involuntary detrusor contractions (IDC) during the filling phase which may be spontaneous or provoked. If there is a relevant neurologic lesion it is deemed neurogenic DO. If there is no relevant neurologic lesion it is deemed idiopathic DO [1]. It is important to ensure than any suspected detrusor overactivity is in fact accurate and not artifact. True detrusor overactivity is noted as a wavelike form on the P_{det} tracing along with a similar wave like form on P_{ves} in the absence of "permission to void". Additionally, the interpreter must ensure that there is not drop out from the rectal/abdominal catheter (P_{abd}) that may artificially simulate a rise in detrusor pressure.

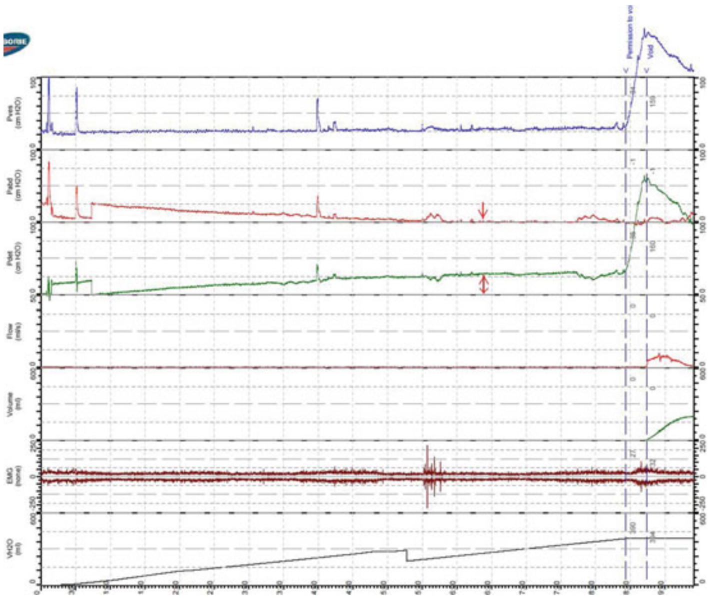

FIGURE 3.2 The apparent rise in P_{det} is artifactual and secondary to a change in position and signal drop out of P_{abd} which can be mistaken for decreased compliance

Often, patients will report an unintended or sudden urge to urinate, which may or may not correlate with an IDC. It is key for the interpreter of the UDS tracing to be involved in the study as this helps identify artifact from true detrusor overactivity and can confirm if the DO replicates the patients presenting symptoms. Additionally, DO can be "stress induced" by strain or cough so it is important to be aware of potential precipitating events both during the study and at home.

When documenting the interpretation of the UDS tracing, detrusor contractions during the filling phase are usually reported as absent ("stable filling"), present and suppressible, present with resulting detrusor overactivity incontinence, or terminal DO (DO related incontinence resulting in emptying of the bladder) (Fig. 3.3). DO which occurs at cystometric

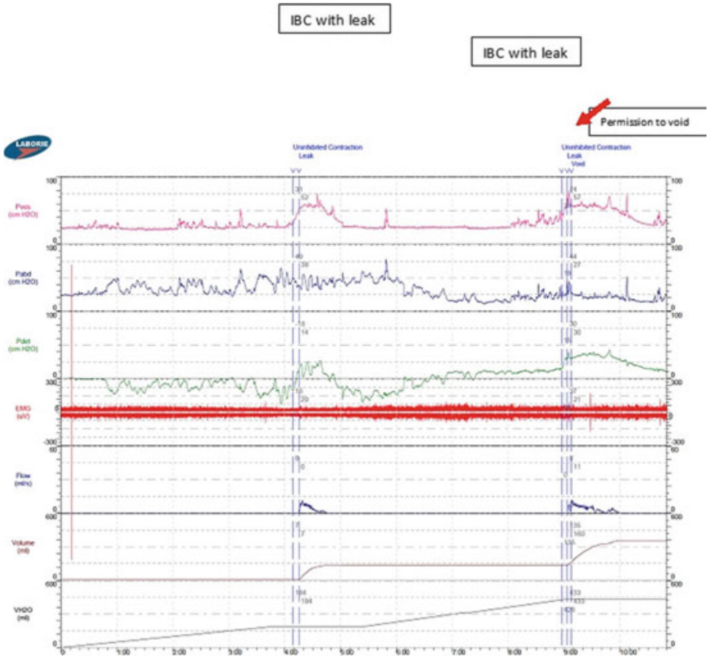

FIGURE 3.3 Detrusor overactivity with associated urinary urge incontinence. Note while there is some artifact from $P_{abd,}$ the waveform of P_{ves} correlates to P_{det}. In both sequences there is an involuntary detrusor contraction (IDC) followed by involuntary flow of urine. During the second IDC the patient is give permission to void (3rd mark). It is important to notate events in real time as this tracing could be mistaken for a normal voiding pattern if patient were given permission to void prior to increased detrusor pressure

capacity and results in bladder emptying is referred to as "terminal detrusor overactivity". An after-contraction (Fig. 3.4) is a large amplitude rise in P_{det} occurring after the cessation of voiding. The clinical significance of this finding is unclear as it may represent catheter artifact or a true abnormality. While there is no defined high/low limit of rise in P_{det} to be considered DO, the definitive interpretation of low amplitude DO (less than 5 cm H_2O) requires a high quality UDS study [1].

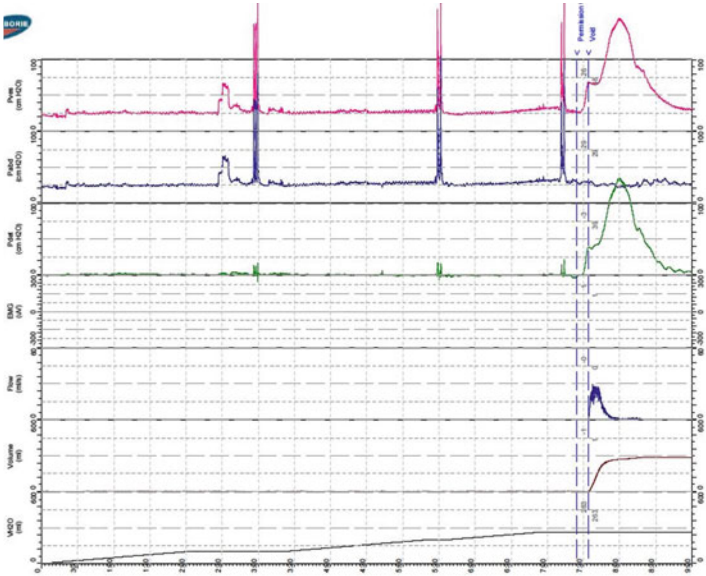

FIGURE 3.4 Normal detrusor contractility. This is a female patient with complaints of mixed urinary incontinence. Stress incontinence was tested multiple times throughout study at increasing bladder volumes. Filling was stable with no evidence of detrusor overactivity. Note the rise in detrusor pressure with permission to void followed by an aftercontraction of the detrusor muscle denoted by the arrow (See section "Contractility (Detrusor Overactivity)")

Cystometric Capacity

Cystometric capacity is the volume in which "patients with *normal* sensation can no longer delay micturition" [1]. Cystometric capacity should not be confused with functional bladder capacity, which is obtained from a voiding diary in conjunction with a post void residual. Cystometric capacity is typically less than the functional bladder capacity. There is no universally defined normal cystometric capacity, but typical values range from 370 to 540 mL ± 100 cc [18]. Of note, the provider performing the UDS should ensure the patient is not experiencing an involuntary detrusor contraction which is generating the sensation such that they cannot delay micturition. Extremely large bladder capacity, due to impaired sensation of bladder filling, may result from peripheral or central (spinal) neurological disease. Small bladder capacity may be secondary to sensory disorders of the lower urinary tract such as painful bladder syndrome.

The filling rate of the bladder can also affect the cystometric capacity. Generally, a filling rate of 50–70 mL/min is used in adults [3]. This filling range allows for the test to be completed in a reasonable amount of time, yet minimizes the artifacts related to overly rapid bladder filling [20]. A voiding diary suggestive of large/small bladder capacity can assist in determining if a faster/slower fill rate is more appropriate. When documenting the interpretation of the UDS tracing, cystometric capacity is usually reported in cc or mL.

Continence

Continence refers to the presence or absence of urinary leakage during the UDS. The abdominal leak point pressure (ALPP), also performed as cough leak point pressure or Valsalva leak point pressure is defined as the lowest intravesical pressure at which urine leakage occurs because of increased abdominal pressure in the absence of a detrusor contraction [1]. While there is no universally accepted method to test ALPP it is important to ensure that the leakage of urine reproduces the patient's symptoms and that the test is performed in the same manner in the urodynamics laboratory for each patient allowing for consistent interpretation of results.

If unable to reproduce a patient's symptomatic stress incontinence, provocative maneuvers (i.e., moving from sitting to standing) can be attempted. UDS can help differentiate stress induced detrusor overactivity (Fig. 3.5) from true stress incontinence (Fig. 3.6). Having the patient cough or Valsalva may demonstrate stress induced DO as their true

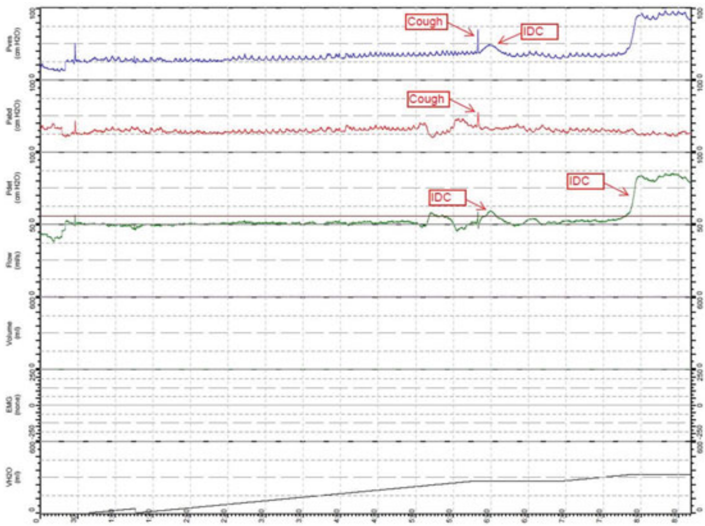

FIGURE 3.5 Stress induced detrusor overactivity. Notice the patient's cough which is recorded as an increase in P_{abd} and P_{ves} followed by a rise in detrusor pressure (IDC) recorded on P_{ves} and P_{det}

etiology of incontinence. ALPP testing should not be performed during an involuntary detrusor contraction.

It is important to note that despite the small size of the urethral catheter it can obstruct the bladder outlet masking clinical urinary incontinence. In patients with suspected stress urinary incontinence that is unable to be reproduced during the UDS study it has been suggested that the urethral catheter be removed and stress maneuvers repeated [11, 21]. Patients with advanced prolapse may have their prolapse reduced to rule out occult stress urinary incontinence, which may be masked by urethral kinking from prolapsed [5]. Lastly, it should be noted whether the urinary incontinence on the study reproduced the patients presenting symptoms as the artificial circumstances of the UDS laboratory may result in spurious findings and thus erroneous interventions. When documenting the interpretation of

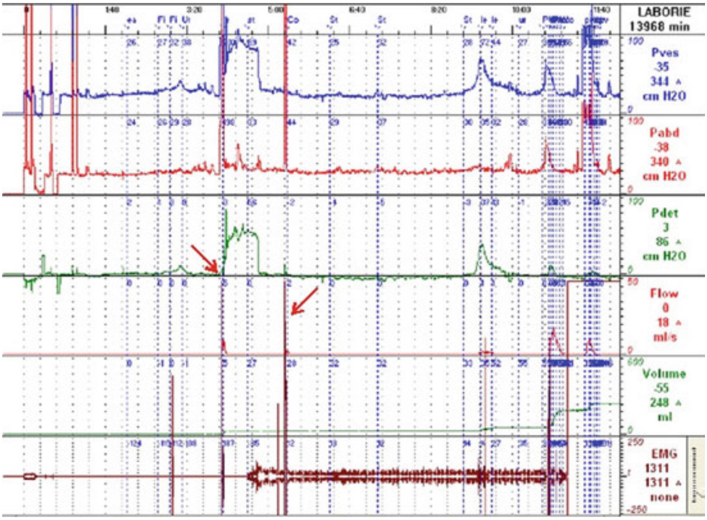

FIGURE 3.6 Stress urinary incontinence and stress induced detrusor overactivity. Note the two cough and strain provocative maneuvers with resultant urinary incontinence (*arrows*). The first arrow is cough followed by an IDC with incontinence representing stress induced detrusor overactivity. The second arrow marks leakage of urine with cough without associated IDC and represents a true leak point pressure

the UDS tracing incontinence is usually reported as absent (normal), present- stress incontinence, present – detrusor over activity incontinence.

Emptying Phase

The emptying phase begins when the bladder is filled to cystometric capacity and in the absence of detrusor overactivity the patient is given permission to void. Ideally, all questions regarding the patients filling phase should be addressed prior to initiating the emptying phase of the study.

Contractility

Once the instruction to void or "permission to void" is given to the patient, they should, to the extent possible, initiate a volitional void. In the setting of normal voiding, urine flow should occur once the pressure generated by the detrusor overcomes the total bladder outlet resistance as the urethra closure forces diminish. There are no defined normative values for P_{det} during volitional voiding. In normal, unobstructed women, a detrusor contraction of 10–30 cm/H_2O is general considered normal. In normal, unobstructed men, a detrusor contraction of 30–50 cm/H_2O is common [6, 15]. When considering "normal" it is important to assess both the magnitude and duration of the detrusor contraction in the context of the ability empty the bladder (Fig. 3.4). It is important to note that some women will normally void via pelvic floor relaxation without generating a measurable detrusor contraction [23]. The lack of a detrusor contraction is not inherently abnormal as long as there is neither a neurologic etiology identified nor abnormal bladder emptying. While nomograms and calculations have been established to more objectively describe contractility in both men and women, these nomograms must be utilized in conjunction with clinical observations [2, 14].

Not infrequently, patients have a "shy bladder" or psychogenic inhibition and are unable to void during the emptying phase of the procedure. Allowing a faucet to run or giving the patient privacy in the UDS suite can often create a suitable environment for initiation of micturition. If the patient is still unable to void, performing the voiding phase on a non-invasive uroflow can still provide some valuable information. When documenting the interpretation of the UDS tracing contractility is usually reported as normal, absent or underactive. There is no defined threshold for underactivity, but rather contractility is assessed in the context of the bladder's ability to empty appropriately, and in

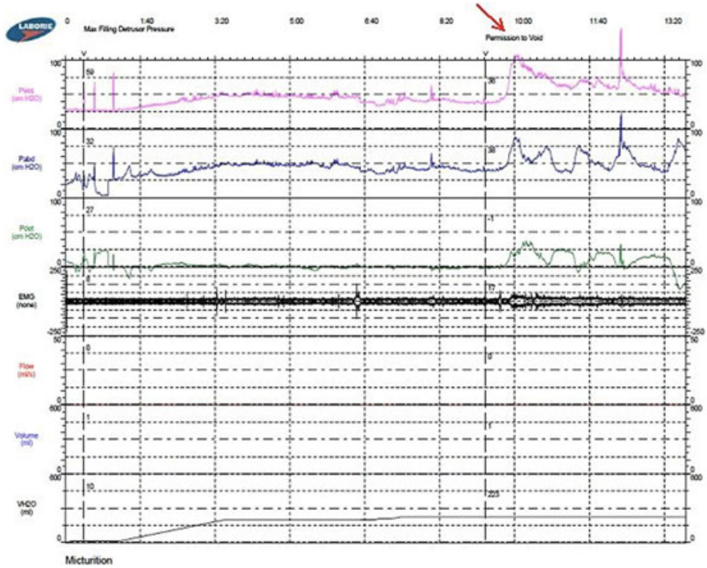

FIGURE 3.7 Detrusor underactivity. Note there is some artifact from P_{abd}, but the waveform of P_{ves} after permission to void command is given demonstrates a poorly sustained, detrusor contraction (*arrows*) that reaches approximately 25 cm H_2O and is inadequate to generate a urine flow

most cases is related to the residual outlet resistance during the void (Fig. 3.7).

Coordination

The first recordable event in micturition is electrical silence of the pelvic floor EMG. Thus, coordination of voiding requires that the smooth and striated sphincters relax and open just prior to the onset of the detrusor contraction. During a normal void the bladder neck and sphincter should remain open for the duration of the entire void. When increased EMG activity is seen or a lack of opening of the bladder outlet is noted on video urodynamics, a pathologic condition may exist.

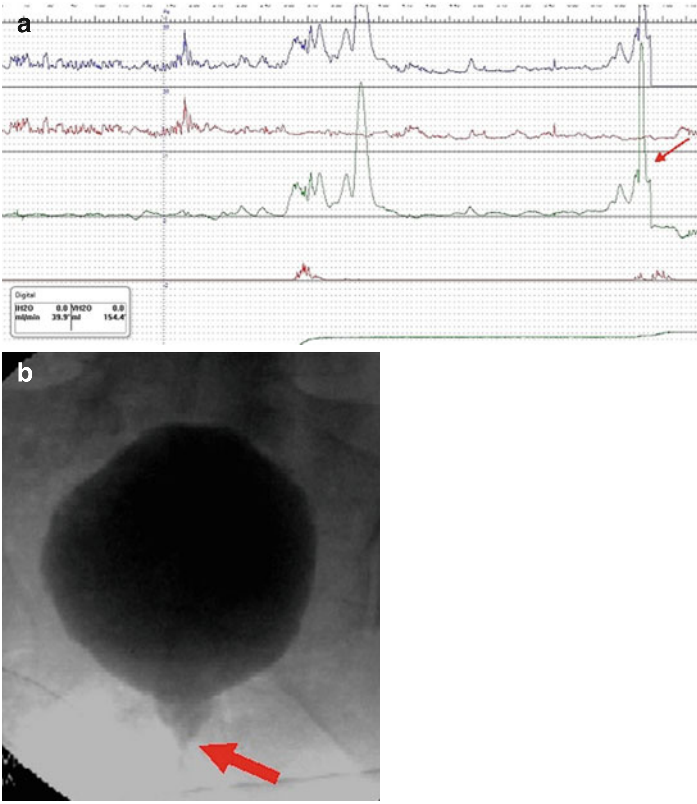

FIGURE 3.8 Dysfunctional voiding. This tracing is from a neurologically normal female. She voided P_{ves} out (*thin arrow*), but note the increased detrusor pressure and low urine flow rate consistent with BOO. Voiding images reveal a dilated proximal urethra and bladder neck with a narrowed midurethra (*thick arrow*). (**a**) Urodynamic Tracing. (**b**) Fluoroscopic Voiding Image

If there is a lack of coordination in a patient without a known neurologic condition consideration of a spinal condition may warrant referral to a neurologist. Lack of coordination in voiding may be seen in conditions such as detrusor external sphincter dyssynergia (DESD) and dysfunctional voiding (Fig. 3.8). However, apparent but artifactual uncoordinated voiding may be seen in patients with pain related to the urethral catheterization for the UDS study. In such suspected cases, it is important to review the non-invasive (unintubated) uroflowmetry flow pattern to rule out catheter related pain artifact resulting in an aberrant uroflow [10]. When documenting the interpretation of the UDS tracing, coordination is usually reported as coordinated, or uncoordinated.

Complete Emptying

As noted previously, just prior to beginning the UDS study the patient is catheterized for a PVR. At the conclusion of the study a second PVR is calculated by subtracting the voided volume in the uroflow transducer from the infused volume. Emptying can be one of the more difficult parameters to accurately reproduce during urodynamics. Micturition is typically a private event, which can be hard to replicate in a urodynamics lab. Urodynamics requires multiple transducers to be placed, two of which are invasive (urethrovesical and rectal) and may result in pain and thus suppression of the micturition reflex. Additionally, the other individuals in the UDS laboratory (there is often a technician performing the study as well as a fluoroscopy technician in the room) may induce psychogenic inhibition due to voiding in front of others.

Complete emptying is defined by the lack of a significant post void residual (PVR). However, there is no universally accepted cut off for a normal/abnormal PVR in either men or women. Typically, in men a PVR less than 50–100 mL is considered adequate bladder emptying, while a PVR greater than 200 mL is considered abnormal [4]. When documenting the interpretation of the UDS tracing complete emptying is usually reported as normal or abnormal. Typically, the PVR is also reported in ml.

Clinical Obstruction

Clinical obstruction, also referred to as bladder outlet obstruction (BOO), is defined by the relationship between

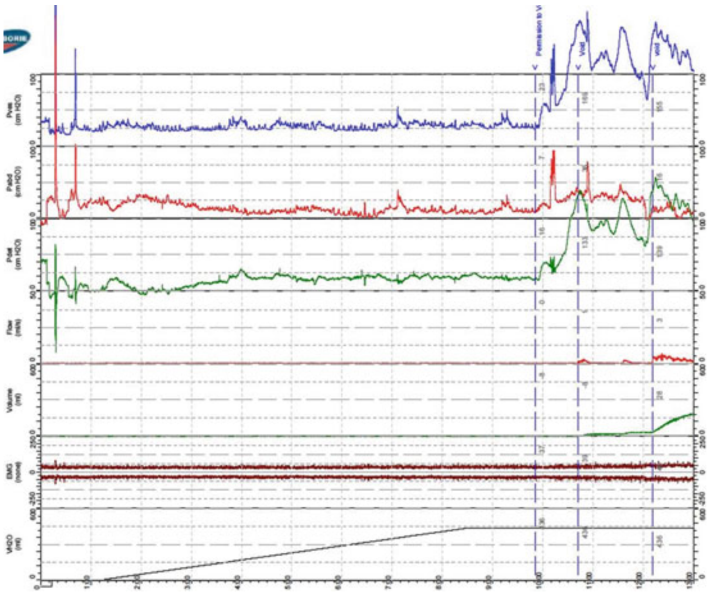

FIGURE 3.9 Benign prostatic obstruction. During voiding there is an elevated detrusor pressure with a weak urinary flow rate consistent with bladder outlet obstruction. BOO Index = P_{det} @ Qmax − 2 × Qmax. BOOI = 125 − 2(5) = 115 is consistent with bladder outlet obstruction

bladder pressure during voiding and urine flow. BOO is generally defined as high voiding pressure and low urine flow but may also occur in the setting of detrusor underactivity in which the voiding pressure may be attenuated. BOO can result from a variety of causes. In men prostatic obstruction (Fig. 3.9), urethral stricture and bladder neck contractures are common etiologies. In women, the most common cause is probably iatrogenic due to prior SUI surgery or vaginal prolapse (Fig. 3.10). Other less common causes include primary bladder neck obstruction (Fig. 3.11), and dysfunctional voiding. While there are multiple nomograms to assess bladder outlet obstruction, there is no accepted definition of obstruction, nor dominate nomogram to establish the diagnosis [7, 8]. While nomograms

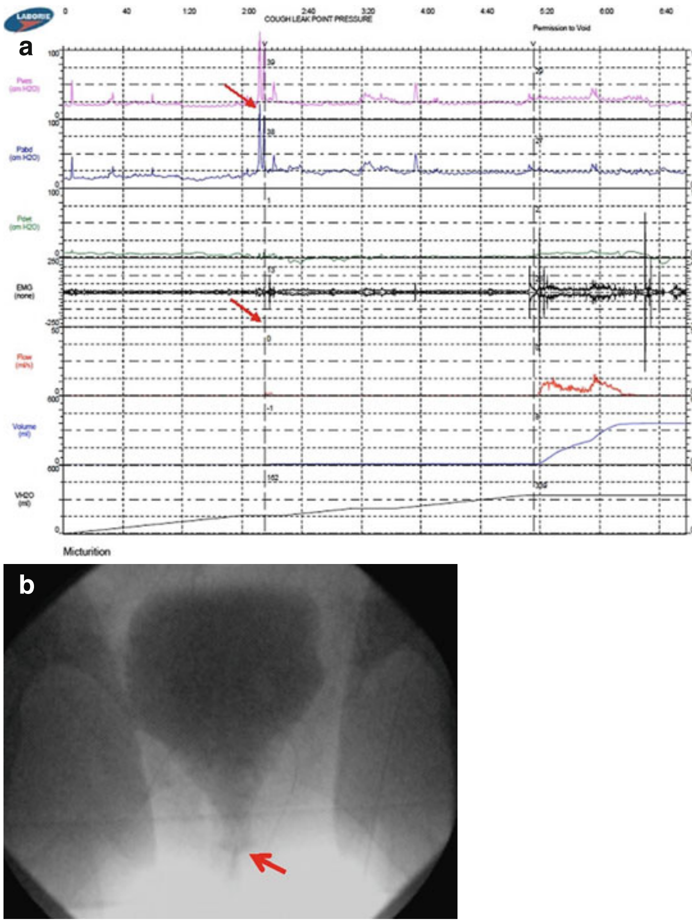

Figure 3.10 (**a**) Obstructing midurethral sling. Valsalva demonstrates SUI (*thin arrows*) and during volitional voiding there was a low urinary flow rate and detrusor underactivity. Voiding images below reveals an abrupt cutoff of contrast at an obstructing midurethral sling (*thick arrow*) with dilation of the proximal urethra. (**b**) Obstructing Midurethral Sling. Abrupt cutoff of contrast at an obstructing midurethral sling (*thick arrow*) with dilation of the proximal urethra

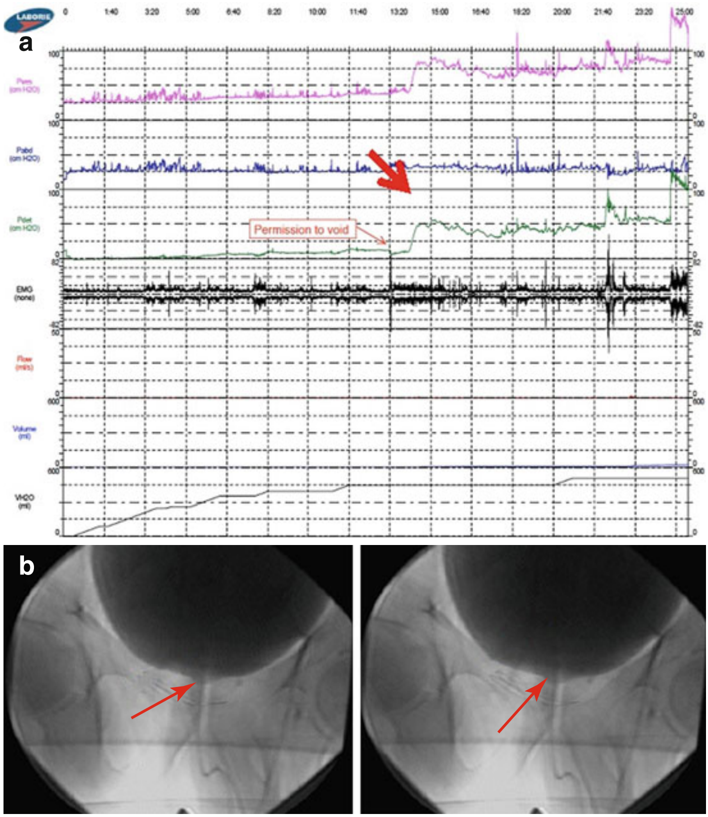

FIGURE 3.11 Primary bladder neck obstruction. The *thick arrow* denotes a strong detrusor contraction without flow. The *thin arrows* on video images demonstrate a closed bladder neck during attempt to void. (**a**) Urodynamic Tracing. (**b**) Fluoroscopic Voiding Image

have been established to more objectively describe obstruction, these nomograms must be utilized in conjunction with clinical observations [2, 14]. When documenting the interpretation of the UDS tracing clinical obstruction is usually reported as unobstructed, equivocal, or obstructed.

Conclusions

UDS plays an important role in evaluating lower urinary tract function. Over the course of the last few decades as urodynamicists gained an evolving understanding of the lower urinary tract great efforts were undertaken to develop standardized testing formats and terminology to allow for reproducible results that can be communicated to other health care providers. As part of this, we feel that the use of the "9 C's" provides a simple and concise means to evaluate and report upon the large amount data generated by urodynamics testing.

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Chapter 4
Practical Interpretation of CT Findings for the Urologist

Minh Tran and Simon Bariol

Abstract This chapter improves interpretation of CT scans by explaining first principles of CT scanning. The ideal type of CT scan for a patient varies with indication. Radiation safety principles must be considered, especially in recurring conditions such as urolithiasis and in tumor surveillance and follow up.

Keywords CT • Urolithiasis • Renal masses • Urogenital trauma

Introduction

Computed Tomography (CT) has revolutionized the diagnosis of a number of common urological diseases. Before acquiring a CT for a patient, we need to consider what type of CT is best for the clinical question being asked and what findings on CT will be useful to assist in diagnosis and/or treatment. This chapter will provide a practical guide rather

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than a comprehensive review in assessing CT scans for common urological conditions.

Understanding the basics of CT is crucial to its interpretation. Two important concepts to understand include attenuation values (Hounsfield Unit) and phases of a CT.

- Density [23]: each pixel on a CT slice is assigned a numerical value compared to the attenuation value of water and is displayed on a scale of arbitrary units called Hounsfield units (HU). As water is assigned an attenuation value or HU of 0, values >0 increase in white and values <0 increase in black (Table 4.1). Thus tissues denser than water have a HU >0 and appear whiter on CT whilst tissues less dense than water have a HU <0 and are more black.
- Phases of a CT: Administration of intravenous contrast provides functional information and gives rise to various "phases" determined by time, as contrast material passes through the vascular system and into the renal collecting system (Table 4.2).

Urolithiasis

Non-contrast CT scans have an extremely high sensitivity (94–97 %) and specificity (96–100 %) in detecting urinary calculi [20, 21]. As a result, any suspicion of renal colic

Table 4.1 Hounsfield units of varying tissues

Tissue	HU
Bone	400–1000
Soft tissue	40–80
Water	0
Fat	−60 to −100
Lung	−400 to −600
Air	−1000

Table 4.2 CT phases and their objective

Phase	Time post injection	Description
Pre-contrast	–	Identification of calculi, baseline soft tissue density measurement
Arterial (corticomedullary)	25–75 s	Enhancement of arterial vessels
Venous (nephrogenic)	~80 s	Enhancement of venous vessels, soft tissue density measurement (assess for contrast enhancement)
Delayed (excretory)	>240 s	Enhancement of collecting system

should be assessed with a non-contrast scan, even if other diagnoses are more probable [21].

Although, strictly speaking, a non-contrast CT scan is not a dynamic study, and therefore it lacks functional information, it will demonstrate secondary signs of obstruction, including ureterohydronephrosis and perinephric stranding [7, 17, 22]. This may influence the urgency of treatment, particularly in the context of fever or impaired renal function [17].

The non-contrast scan is preferable as contrast obscures accurate identification of the stone in the excretory phase, and requires significantly less radiation [4]. Stone size and location is accurately determined by non-contrast CT scanning, and will have the greatest influence on management. Comprehensive anatomical information and alternative diagnoses may require a contrast scan [4].

It is helpful to track the ureters on axial slices in a craniocaudal direction, paying particular attention to the areas where stones are likely to impact (pyeloureteric junction and intramural ureter). The authors prefer to use a workstation to facilitate this, however hard copy films are equally easy to interpret. Coronal reconstructions may be helpful.

Tips in Assessing CT for Urolithiasis

1. Assess kidneys for hydronephrosis, perinephric stranding, and anatomical abnormalities
2. Check for co-existing renal stones, ipsi- or contralateral
3. Track ureters proximal to distal
4. Assess bladder for stones & other pathology

Stone density can be assessed to determine stone type preoperatively, which may also influence management. The density of common stone types have been described and are presented in Table 4.3 [5, 8, 14–16, 18].

Renal Masses

Urological indications for a CT include micro- or macroscopic hematuria, flank pain, recurrent urinary tract infections or constitutional symptoms (fatigue, unintentional weight loss, pyrexia of unknown origin). However, most renal masses are discovered incidentally. A four phase CT is required to assist in the diagnosis, staging, treatment planning, and surveillance of renal masses. The non-contrast phase provides a baseline density measurement. The cortico-medullary phase (25–75 s delay) results in renal cortex enhancement with limited medullary enhancement providing information regarding renal vasculature that is important for surgical planning and also helps differentiates pseudo-tumors from neoplasms. The cortico-medullary phase is not the ideal phase for evaluating a renal mass however, as a small renal mass may enhance similar to that of renal medulla during this phase and hypovascular

Table 4.3 Stone types and approximate density

Stone type	Density (HU)
Calcium	400–1000+
Cystine	600–800
Struvite	600–800
Uric acid	400–500

neoplasms such as papillary lesions may not be readily identifiable during this phase [3, 9, 11]. The nephrogenic phase (>80 s delay) is important for the evaluation of a renal mass as it provides maximal homogenous parenchymal enhancement [10]. The delayed or excretory phase (3–5min delay) allows contrast excretion into the collecting system aiding in identification of calyceal or renal pelvis involvement and detection of urothelial tumors [10, 19].

Tips in Assessing CT for Renal Mass

A contrast enhancing lesion is a renal cell carcinoma (RCC) until proven otherwise [1]. A change of 20 HU or greater is strong evidence of enhancement [10]. A change of 10–20 HU is indeterminate and it may require further imaging (USS or MRI) [10, 24]. One needs to be mindful of the standard deviation measurements when interpreting contrast enhancement. RCC may be homogenous or heterogeneously solid enhancing, and it may appear cystic or solid. If a suspicious lesion is seen, there is a need to systematically check for [10]:

(i) Direction extension – venous (renal vein ± IVC) or into adjacent soft tissue
(ii) Lymphatic involvement (para-aortic)
(iii) Distant Metastases – from most common to least: lung, liver, bone, adrenal, contralateral kidney, brain. Further staging with CT chest and bone scan is recommended.

Differentials for solid or cystic renal masses must be considered. Oncocytomas cannot be distinguished from RCC on any imaging modality although the classic finding is that of a central stellate scar [10, 24]. Angiomyolipoma (AML) contains fat and so appears hyperechoic on ultrasound but low density on CT. Lipid-poor AMLs are difficult to distinguish from RCC and further imaging with ultrasound and MRI is necessary. If cystic lesions show equivocal contrast enhancement characteristics then further assessment with ultrasound or MRI is worthwhile.

Trauma of Urogenital Tract

Urinary tract injuries occur in about 10 % of abdominal trauma patients with the kidneys being the most commonly injured organ. However, most isolated renal injuries are minor and can be managed conservatively [12, 13].

If CT is indicated, and the patient is stable, a four-phase scan provides the most relevant anatomical and functional information and will identify the presence of any active hemorrhage or urinary extravasation [6, 12]. A CT cystogram can also be performed if there is suspicion of a bladder injury, via an IDC once the urethra has been cleared of injury.

Tips in Assessing CT for Urogenital Trauma

1. Look for renal parenchymal defects (areas of non-enhancement) with perinephric hemorrhage ± extravasation (of blood or urine) from collecting system
2. Segmental areas of non-enhancement are usually well defined and wedge shaped indicating a segmental infarction [2].
3. Global non-enhancement of a kidney indicates global infarction and should prompt investigation of a renal artery injury (CT angiography) and urgent endovascular repair [12].
4. "Contrast blush" during arterial phase indicating hemorrhage.
5. Extravasation of contrast on delayed phase indicating collecting system injury

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Chapter 5
What Should Urologists Ask the Radiologist?

Ardeshir R. Rastinehad and Arthur D. Smith

Abstract As urologists incorporate new advances in imaging technology, our field has become increasingly dependent on our diagnostic and interventional radiology colleagues. One of the most important aspects of these collaborations is managing communication and expectations. As new technologies enter the armamentarium, it is important to develop a mutual understanding of workflow management and the key concepts utilized to foster a beneficial working environment. Herein we will discuss topic of optimizing communication between the radiologist and the urologist.

Keywords Communication • Imaging • Interventional radiology • Technology

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Introduction

Diagnostic radiology has an integral role in the diagnosis and treatment of the urologic patient. The initial diagnosis for multiple urologic conditions depends highly on the radiologist's report. There are many key factors that can help the urologist then develop a treatment plan. For example, stones are commonly diagnosed and assessed using computerized tomography (CT) scans. Key details a urologist needs for the treatment of their patients include stone size in three dimensions, Hounsfield units (HU), stone composition, associated hydronephrosis, and forniceal rupture location for all stones, not just the largest stone. The use of all three dimensions for stones can help avoid the under-representation of stone burden, which can occur when a ureteral stone is measured in the axial plane and fails to convey the significance of the length of the stone. For instance, a 6 mm ureteral stone is present within the proximal ureter. The report failed to mention that the stone is approximately 1.2 cm in length on the coronal image. Therefore the probability of the patient passing the stone is less and may warrant a different management plan.

Oncology is another subspecialty where imaging plays a major role in the care pathway for patients. The use of new imaging techniques in magnetic resonance imaging has improved the differentiation of multiple types of renal masses. The radiologist is now able to quantify imaging characteristics of different types of renal cell carcinoma using peak enhancement, chemical shift imaging, diffusion weighted imaging and other sequences [1–5].

Therefore, it is important to have detailed reports, which include three-dimensional measurements and the specific findings from the different sequences. For example, the presence of intra-cytoplasmic lipid, hemosiderin deposition, peak enhancement characteristics, apparent diffusion co-efficient maps and macroscopic fat can be key factors in the differentiation of the multiple types of renal masses. Similarly, adrenal masses have unique imaging characteristics on CT scans and MRIs, indispensable information helpful in treatment planning. These are important examples of details that radiologist should include in their reports, this shared understanding of critical diagnostic information that can impact the treatment plan.

Diagnostic radiology reports should include recommendations for follow up imaging and any ordering of imaging studies by urologists should be based on national or regional guidelines. Adherence to guidelines could decrease the over utilization of imaging in the treatment of the urologic patient [6].

Interventional Radiology

As new imaging techniques and therapeutic interventions progress to minimally invasive methods, interventional radiologists have an increasing role in the care of a urologic patient. Hybrid trained physicians, trained in both urology and interventional radiology, are emerging, and leading to improved referral patterns and the ability to create collaborative studies without conflict (e.g., prostate embolization for BPH). The decision on who should do a particular procedure should be based on training, and consequently it is important for the endourologist to become familiar with many interventional techniques. Urologists, if capable, should perform access for percutaneous stone procedures; if not, they should inform the interventional radiologist the preferable site of access to ensure adequate stone clearance. Similarly urologist should perform ultrasound guided prostate biopsy, and a target biopsy with prior MRI planning. Essentially procedures that can be performed under ultrasound or with C-arm fluoroscopically can be managed by the urologist. The CT and MRI machines, are under the control of the interventional radiologist and procedures requiring this equipment is best done by them.

Recent AUA guidelines have included the use of renal biopsy in the assessment of small renal masses, as well as recommending the use of renal biopsies prior to renal mass ablation as the standard of care for small renal masses. Previously, interventional radiologists were treated as technicians by urologists, however this old model no longer exists. Interventional radiologists now have office practices and can evaluate and treat patients according to their practice patterns. It is important to have open lines of communication to discuss and review recent changes to urologic guidelines in order to keep our radiology colleagues up to date on changes to the standards of care.

Renal embolization is utilized to treat angiomyolipomas, as well as in the maintenance of hemostasis after a percutaneous stone extraction or partial nephrectomy. For post-operative bleeding patients, the urologist should communicate the exact location of access or surgical resection to help the radiologist evaluate and treat these patients.

Conclusions

It is imperative for the urologist to include the radiologist (and vice-versa) for the overall management of their mutual patients. These examples discussed are not meant to be all inclusive, but to re-enforce the need for a close working relationship with your radiology team. This close collaboration benefits the patients as well as the physician; a close partnership will aid in the integration of new techniques and technologies into the workflow for our patients.

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Chapter 6
Tips for Managing Acute Iatrogenic Ureteric Injury

Celi Varol and A.S. Goolam

Abstract Traditionally, ureteric injuries during minimally invasive procedures have meant that conversion to an open operation was required. With the popularity of the Da Vinci robot, vision and access within the pelvis has improved and suturing in particular has become much easier when compared to laparoscopy. This has facilitated the completion of repair of injuries in a minimally invasive manner on a more regular basis. High index of suspicion and early definitive repair assist in reducing morbidity and further associated complications.

Keywords Iatrogenic ureteric injury • Management

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Introduction

Iatrogenic injury of the ureter is best repaired at the time of injury and thus requires a high index of suspicion intra-operatively [1, 2, 6]. Failure to recognize an intra-operative ureteric injury may lead to preventable sequelae and morbidity (typically as a result of an open procedure required for delayed repairs) [4]. Ureteric injury can be encountered during endoscopic, laparoscopic, robotic and open procedures. All repairs, if possible should be attempted in the same surgical approach the injury occurred. The least to most reconstructive surgical repair that is necessary, without compromising the success of outcome should be the aim. It is important to protect the renal unit and allow adequate urine drainage

When approaching an iatrogenic ureteric injury, several pertinent factors need to be taken into account. The best type of repair and approach can be determined via the following salient points:

1. Mechanism of the injury (avulsion, transection, ligation, laceration, crush or thermal)
2. Location of the injury (lower, mid or upper ureter)
3. Resection of ureter – where ureteric length has been lost

Basic Principles

Irrespective of surgical repair approach that is intended, the basic principles must be applied at all times when repairing an iatrogenic ureteric injury [1, 3]. All anastomotic repairs must adhere to the following:

- Vascularized healthy tissue
- Spatulated, tension free and watertight anastomosis
- Absorbable suture material – (4-0 or 5-0)
- Stented internally
- Drained externally
- Bladder must be catheterized
- Omental or vascularized tissue wrap (if deemed necessary)

Mechanism of Injury

Endoscopic Injury

This is usually encountered during ureteroscopic stone surgery:

1. Minor – perforation/laceration: of the ureter at any level can be managed with internal stenting of the ureter.
2. Avulsion of the uretero-pelvic junction: a retrograde pyelogram and internal stent is required. Assessment of the disruption is usually difficult and a delayed ureteropyelostomy repair will be necessary. Most injuries are partial disruptions and stent placements may be adequate.
3. Avulsion of the lower/mid ureter (ureteroscopic basket stone retrieval)

Stenting is the simplest means of achieving immediate urine drainage. This may not be possible for long segment avulsions. Immediate repair with end-to-end anastomosis or bladder flap reconstruction should be considered if ureteric vascularity is compromised. A transuretero-ureterostomy may also be an option in this case

Tips: To assist in placing an internal stent:

- Retrograde X-Ray visualization of ureter is essential and use of dilute (half strength saline/contrast mix) contrast will increase visibility in the presence of extravasation.
- The first attempt should be to place a wire into the proximal ureter with a thin diameter (4.5 fr) rigid ureteroscope.
- A ureteric access sheath could stabilize the distal, but caution should be exercised as it could change the angle of the ureter when assisting in placing the wire.
- A combination of straight and angled tip wires should be used.

Transection

A transection injury can be repaired with primary uretero-ureterostomy anastomosis. Both ureteric ends will need to be freshened, spatulated and mobilized to allow a tension free, open anastomosis. Ureteroureterostomy can be performed at all levels of the ureter. However, at the distal ureteric end, anastomosis to the bladder (ureteroneocystostomy) is recommended due to inadequate access to the distal ureteric stump and difficulty in repair. Similarly, close to the UPJ an uretero-pyelostomy repair is preferred.

Thermal/Crush Injury

These should be managed like a transection injury with debridement of the injured ends. The ureteric ends need to be debrided to allow healing with minimal scar formation. Active bleeding from the ureteric ends is a sign of good vascular integrity. Internal stenting alone may result in stricture formation requiring a delayed repair.

Ligation/Kinking

The suture tie needs to be removed and an internal stent placed.

Laceration

The extent of the injury can be assessed by a retrograde pyelogram. Minor injuries can be salvaged by internal stenting, but more extensive tears will in addition need repair with interrupted 5-0 absorbable sutures

Distal Ureteric Injuries

General Tips: Preparing for the Bladder Re-implant

- Fill the bladder via an IDC to capacity with sterile saline to facilitate dissection of the bladder, identify the volume and allow marking of the bladder prior to undertaking the dissection for a simple implant, Psoas Hitch or Boari Flap.

- Dissect the bladder off its peritoneal attachment including the Urachal ligaments anterior-lateral down to the pelvic floor. Divide the superior vesicle artery on the contralateral side to the ureteric injury to increase bladder mobilization.

Laparoscopic Re-implant

- Place the patient in a steep Trendelenburg position (>20°) to allow the bowel to fall out of the pelvis in distal ureteric injuries.
- If there is potential tension on the anastomosis, stitch the bladder first to the Psoas tendon for a Psoas hitch or Boari flap repair. This will fix the bladder and allow an easier ureteric anastomosis.

Robotic Re-implant

- Un-docking the robot and placing the patient in a steep Trendelenburg position (>25°) prior to Re-docking will allow the bowel to drop out of the pelvis
- An extra laparoscopic port with a fan retractor or bowel grasping forceps for the assistant can increase exposure.
- Robotic assisted and laparoscopic dissection of the distal ureteric stump may allow for a primary uretero-ureterostomy to be performed. A primary bladder implant is generally preferred due to visibility and access issues to the distal ureteric stump [5].

Proximal or Short Mid Ureteric Injuries

General tips:

- The ureter should be mobilized distally and proximally to allow for a tension free anastomosis. Ensure that the peri-ureteric adventia is retained for vascular integrity.

- The kidney may need to be dissected free form its surrounding peri-nephric fat and "hanging off" its hilum, to allow caudal mobilization of the proximal ureter.
- A vascular pedicle (Omentum/mesentery) can be wrapped around the repair site

Resection of Ureter (Where Ureteric Length Has Been Lost)

General tips:

- A long Boari Flap may reach the mid to proximal ureter in large capacity bladders. This should be considered in segmental loss of ureter.
- A transuretero-ureterostomy should be considered if a primary ureteroureterostomy is not possible and the bladder capacity is insufficient for a Boari Flap.
- An interposition of bowel is a salvage situation rather than an acute repair option.

Conclusions

Managing a complication minimally invasively depends on the skill and technical ability of the surgeon. Traditionally, ureteric injuries during minimally invasive procedures have meant that conversion to an open operation was required. With the popularity of the Da Vinci robot, vision and access within the pelvis has improved and suturing in particular has become much easier when compared to laparoscopy. This has facilitated the completion of repair of injuries in a minimally invasive manner on a more regular basis.

Moreover, prompt identification of ureteric injuries, a high index of suspicion and early definitive repair assist in reducing morbidity and further associated complications.

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Chapter 7
Chronic Prostatitis: A Practical Approach to Treatment

Christopher Netsch and Andreas Johannes Gross

Abstract While diagnosing an acute prostatitis is usually no problem for the physician, the symptomatic of chronic forms of prostatitis allows no clear differential diagnosis between them. Only in 5 % of the patients with chronic prostatitis uropathogenic bacterias can be found. The most frequent treatment strategies in patients with chronic prostatitis/chronic pelvic pain syndrome are antibiotics, alphablockers, and antiphlogistics.

Keywords Chronic pelvic pain • Acute prostatitis • Chronic prostatitis

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Acute Bacterial Prostatitis

Acute bacterial prostatitis is a severe infection and normally caused by E. coli bacteriae and Enterobacteriae, while the role of Gram positive coccus in the pathogenesis of acute bacterial prostatitis is controversial. Patients with acute bacterial prostatitis usually complain lower urinary tract symptoms (LUTS) like urgency, frequency, dysuria and pain in the lower abdomen or perineum. Signs of systemic inflammation like fever and chills can be found. The most frequent complications were acute urinary retention, prostate abscess, and epididymitis.

Diagnosis of an acute bacterial prostatitis is made by digital rectal examination (tenderness of the prostate to palpation) and urinalysis of mid-stream urine (leucocytes, bacteria). An ultrasound of the bladder and the prostate should be performed to estimate the post-void residual urine and to exclude an abscess of the prostate.

The most effective antibiotics during acute prostatitis are fluorochinolones, which might be changed according to antibiotic susceptibility testing. The antibiotic therapy of acute prostatitis should be performed a minimum of 2–4 weeks. In patients with acute urinary retention in addition to the acute bacterial prostatitis, a suprapubic tube should be inserted, while transurethral foley catheters are contraindicated. In patients with an abscess of the prostate a drainage of the abscess (transperineal, transrectal, transurethral) might be necessary.

Chronic Prostatitis and Chronic Pelvic Pain Syndrome (CP/CPPS)

There are two types of chronic prostatitis: a bacterial type (category II) and a non-bacterial type (category III) (Table 7.1). The bacterial type is defined by the detection of uropathogen bacteria. However, only in 5 % of the chronic forms uropathogen bacteria can be found. On the other hand, in 95 % of the cases, no bacteria can be found despite carrying out a wide array of examinations. In these cases, this is called

TABLE 7.1 Classification of the prostatitis syndrome according to NIH

Category	Name	Description
I	Acute bacterial prostatitis	Acute infection of the prostate
II	Chronic bacterial prostatitis/chronic pelvic pain syndrome (CPPS)	Chronic infection of the prostate with recurrent urinary tract infections
IIIa	Inflammatory CPPS	Leucocytes in ejaculate, prostate fluid or urine after prostate massage
IIIb	Non-inflammatory CPPS	No leucocytes in ejaculate, prostate fluid or urine after massage of the prostate
IV	Asymptomatic inflammatory prostatitis	No symptoms, incidentally detected during prostate biopsies, leucocytes in ejaculate/prostatic fluid

NIH National Institutes of Health, USA

chronic pelvic pain syndrome (CPPS). However, the symptoms are similar in both types.

The patients indicate a wide array of complaints in chronic prostatitis. They may have distinct pain in the pelvis or perineum, that can be forwarded to the back, the penis, the testicles or the thigh. Most patients indicate more or less LUTS like urgency, frequency, dysuria, nocturia, or reduction of the urine stream. Up to 70 % of the patients may have an erectile dysfunction. The symptoms may occur slow-growing and have typically a characteristic undulated course.

In patients with chronic prostatitis (CP), the etiology of urinary tract infections mainly E. coli is undisputable, while the role of Chlamydia Trachomatis and Mycoplasms are less clear. Other infectious causes are only found in rare cases. One known pathogenetic factor in chronic bacterial prostatitis is the reflux of infected urine into the prostatic ducts. However, in CPPS a lot of etiologic aspects have been discussed (e.g. postinfectious, physical mechanisms, autoimmune, psychogenic, neurogenic, infravesical obstruction) (Table 7.2).

Basic Diagnostics in CP/CPPS

Standardized questionnaires have been established to specify symptoms of prostatitis. One of these questionnaires is the National Institutes of Health Chronic Prostatitis Symptom Index (NIH-CPSI). Urinalysis before and after a prostate massage plays another major role in the diagnostics of CP/CPPS. In chronic bacterial prostatitis (NIH II, IIIa), the concentration of leucocytes is tenfold higher after prostate massage in the urine and in chronic bacterial prostatitis (NIH II) the concentration of typical pathogens for urinary tract infections is tenfold higher, respectively.

To verify an infravesical obstruction due to functional or anatomic genesis, a standardized questionnaire (IPSS, International

Table 7.2 Pathogenetic factors for chronic pelvic pain syndrome (CPPS)

Pathogenetic factor	**Comment**
Postinfectious	Bacterial genoma in prostatic tissue
Analogue to interstitial cystitis	Disturbance of the epithelial layer of the bladder
Physical	Reflux of urine into the prostatic ducts
(Auto)immune	Cytokine, auto-antibodies
Psychogenic	Stress-prostatitis
Functional/morphologic infravesical obstruction	Bladder neck obstruction
Neurogenic	Hyperesthesia
Morphologic changes in anal area	Anogenital syndrome, hemorrhoids, anal fissure

Prostate Symptom Score) a post-void residual volume measurement and uroflowmetry should be performed. According to the NIH-classification, an examination of the ejaculate should be performed to differentiate the prostatitis types. However, an examination of the ejaculate is mainly performed only in specialized centers.

Since 50 % of all asymptomatic men have a bacterial colonization of the anterior urethra, a microbiologic analysis of the ejaculate alone is misleading. In addition, the analysis of the ejaculate is not adequate to localize the origin of the infection in the urinary tract.

Therapy of Chronic Pelvic Pain Syndrome

Since the cause of chronic pelvic pain syndrome (CPPS) is not known in most of the cases, the treatment is very demanding. The most frequent treatment strategies include antibiotics, alphablockers, and antiphlogistic treatment.

Antibiotics are the most common medications used, although bacterial infections can only be found in 5 % of the patients. Since in men with CPPS the possibility of an non-detectable infection is discussed, an attempt with an antibiotic, normally with fluorochinolones, is recommended. This is based on the observation that 40 % of the patients benefit from antibiotic regimen despite missing bacteria in urine cultures. However, if there is no symptom improvement after a maximum of 4-week antibiotic therapy, the antibiotic treatment should be ceased.

The combination of CP/CPPS with LUTS has made the application of alphablockers a viable option. Randomized controlled studies have shown significant effects of alphablockers like terazosin, alfuzosin, and tamsulosin. The application of non-steroidal anti-inflammatory drugs (NSAID) is widely-used, although the evidence for this regimen is sparse. NSAIDs have no impact on pathogenetic mechanisms of CPPS but play an important role in symptomatic, analgetic therapy of CPPS.

Due to the limited success of the aforementioned treatment strategies a wide array of therapeutic concepts have been developed: drug therapies, physical therapies, pain modulation, behavioral therapy, surgical, minimally-invasive and multimodal concepts, respectively.

In conclusion, therapy of CPPS/CP is characterized by a high percentage of therapy resistant patients which were treated by non-standardized therapies, which have been evaluated only in few randomized controlled studies.

Chapter 8
How Do I Manage the Septic Urologic Patient?

Francesco Sanguedolce

Abstract Urosepsis is a life-threatening condition with a 20–30 % risk of mortality associated. Urologists play a major role in the diagnostic process and in the eventual interventional procedures; however, successful management of uroseptic patients involves coordination with intensive care physicians in a Intensive Care Unit. Causes of urosepsis need to be addressed in the post-acute septic process and their eventual surgical managements may be significantly challenging for practitioners.

Keywords Urosepsis • Urology • Intensive care

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Introduction

The term sepsis was first introduced by Hippocrates in the fourth century to define the putrefaction process of organic tissues and organs. On the contrary, Galen referred to sepsis as healing processes of human body in response to wounds.

In modern era, sepsis was considered a lethal process due to the massive infiltration of infective organisms to organs and systems, and to the spread of their toxins in the bloodstream; it was only few decades ago that it was suggested that the pathogenesis of sepsis involved a systemic inflammatory response generated by the host in response to an infective insult that could persist and progress even in the case of a successful eradication of the pathogen [5].

Standardization of current definition of sepsis has been adopted even more recently; the International Sepsis Definition Conference in 1992 and later in 2003 defined sepsis as a clinical condition where both infection and systemic inflammatory response are present. Diagnostic criteria are shown in Table 8.1 [8]; it is noteworthy to highlight that the Consensus listed these criteria as factors to consider at the bedside by the team of physicians involved rather than considering them as proper entry criteria. However, in some Countries this list has been adapted by expressively reporting which and/or how many of the criteria need to be present to define a septic condition; e.g., the German Sepsis Society identified a sepsis in the case of a clinically/microbiologically proven infection plus at least one criterion suggestive of an acute organ dysfunction [4].

Incidence of severe sepsis has been observed to be higher in male, black ethnicity and young patients [1, 10]. Other risk factors are listed in Box 8.1.

Urosepsis or urogenital sepsis is among the most common type of sepsis ranging from 8.6 to 30.6 % of the septic patients [9]. It is the most frightening complication of urogenital tract infections which prevalently are carried out by Gram negative bacteria; E. Coli is the most common infective agent being detected in even more than 50 % of cases on either

Table 8.1 Diagnostic criteria for sepsis

Infection, documented or suspected, and some[a] of the following:
General variables
Fever (core temperature >38.3 °C)
Hypothermia (core temperature <36 °C)
Heart rate >90 min^{-1} or >2 SD above the normal value for age
Tachypnea
Altered mental status
Significant oedema or positive fluid balance (>20 mL/kg over 24 h)
Hyperglycemia (plasma glucose >120 mg/dL or 7.7 mmol/L) in the absence of diabetes
Inflammatory variables
Leukocytosis (WBC count >12,000 μL^{-1})
Leukopenia (WBC count <4000 μL^{-1})
Normal WBC count with >10 % immature forms
Plasma C-reactive protein >2 SD above the normal value
Plasma procalcitonin >2 SD above the normal value
Hemodynamic variables
Arterial hypotension (SBP <90 mmHg, MAP <70, or an SBP decrease >40 mmHg in adults or <2 SD below normal for age)
$Sv\ O_2$ >70 %
Cardiac index >3.5 $L\cdot min^{-1\cdot M-23}$
Organ dysfunction variables
Arterial hypoxemia (PaO_2/FIO_2 <300)
Acute oliguria (urine output <0.5 $mL\cdot kg^{-1}\cdot h^{-1}$ or 45 mmol/L for at least 2 h)
Creatinine increase >0.5 mg/dL

(continued)

Table 8.1 (continued)

Coagulation abnormalities (INR >1.5 or aPTT >60 s)
Ileus (absent bowel sounds)
Thrombocytopenia (platelet count <100,000 μL^{-1})
Hyperbilirubinemia (plasma total bilirubin >4 mg/dL or 70 mmol/L)
Tissue perfusion variables
Hyperlactatemia (>1 mmol/L)
Decreased capillary refill or mottling

Adapted from Levy et al. [1]
WBC white blood cell, *SBP* systolic blood pressure, *MAP* mean arterial blood pressure, *SvO2* mixed venous oxygen saturation, *INR* international normalized ratio, *aPTT* activated partial thromboplastin time
[a]The authors specify in the text that the term "some" reflects the need to diagnose patients' septic condition at the bedside and the list of the above criteria are a guidance of the factors to consider rather than a proper entry list criteria

urine or blood cultures, followed by other bacteria of the Enterobacteriaceae family in different proportion according to different cohorts [4, 15].

Gram positive bacteria account to a 5 % of the cases; fungal urosepsis are less common.

Diagnosis and Early Management of Urosepsis

Time is the most important factor in treating effectively any sepsis.

Urologists have the crucial role to recognize quickly the clinical signs and symptoms that may indicate a diagnosis of urosepsis: they may variably involve flank pain, low urinary tract symptoms, acute urinary retention, perineal pain, hematuria, etc., according to the source of the infection (s. Box 8.2).

Urine and blood tests are mandatory to confirm urine infection and uroseptic condition; blood test should include Full Blood Count, C-Reactive Protein, serum Procalcitonin, Coagulation profile comprising INR and aPTT, Creatinine and Electrolytes, and Lactate (s. Table 8.1).

Imaging is necessary to detect abdominal-pelvic collections or dilatation of the urinary tracts; CT scan is the preferred option, and if not available Ultrasound Scan (US) and X-ray should be performed instead.

Patients with a presumed or established diagnosis of urosepsis need to be admitted to a Intensive Care Unit in the last three decades it has been observed that mortality for sepsis has dropped from 80 to 20–30 % thanks to the advances achieved in the management of septic patients with the introduction of standardized protocols in intensive care [5].

A state-of-the art intensive care should provide real-time monitoring of patients' condition, optimal hemodynamic control, ideal respiratory and metabolic support, appropriate antimicrobial coverage and medical management of any organ-specific impairment.

Urological Intervention

All septic patients need to be catheterized, also in absence of urinary retention, in order to monitor fluid balance.

Urgent derivation of urinary tract is likely to be necessary in case of obstructive uropathy: in a recent series it was shown that urgent urinary tract decompression with either nephrostomy tube or retrograde stent could halve mortality in uroseptic patient with obstructive stones respect to patients non receiving decompressive intervention (8.82 % vs 19.2 %, respectively; $p < 0.001$) [2].

However, evidence in literature is lacking with respect to which approach should be preferred between retrograde stenting or percutaneous nephrostomy; a recent systematic review was inconclusive on this regard as only two small randomized controlled trials could be retrieved from literature search with contrasting results [11–13].

Main advantages of ureteral stents include a less invasiveness procedure in a closed and less contaminated system; on the other side, nephrostomy tube may reduce renal compression more quickly, allow a direct control of quality/quantity of urine and eventual wash-out of kidney, and it is not limited by further obstructions of lower urinary tract (urethral stenosis and enlarged prostate) or of the ureter (ab extrinseco obstruction, pelvic masses, ureteral stenosis).

Any retroperitoneal and pelvic collections should be considered for drainage, with large size and non-response to medical treatment as trigger factors for intervention. Usually, insertion of a drain requires the aid of interventional radiologists, in order to guide the procedure under CT or US imaging. In rare occasions urgent surgical exploration is required which is associated to a higher risk of mortality and complications.

A more aggressive approach is needed in the case of Fournier's gangrene where urgent scrotal debridement is mandatory with the removal of the all necrotic tissue. State-of-art intensive care, adequate antimicrobial treatment and repeated debridement (3.5 in average, every 48 h) are necessary to assure effective treatment and reduce mortality for uroseptic complications [3, 16].

Post-septic Urological Management

Patients with past medical history of sepsis have a higher risk of mortality even after having survived to the acute event [5].

Once patients' condition are stabilized and uroseptic condition is resolved, urologists may be face the problem of when and how to treat the cause of the infection, if not addressed during the acute phase.

If a surgical intervention is needed, a general rule consists in planning the procedure as soon as general conditions of post-septic patients are stable; the longer is the time passed from the acute infective process the higher is the risk that fibrotic tissue can develop in the interested area making more challenging the procedure indicated.

This may be the case for example of staghorn stones which require a Percutaneous Nephrolithotomy (PCNL) or of non-functioning kidneys which need to be removed with a nephrectomy. In the first case, major problems may be encountered in the percutaneous tract formation: in these cases, Alken dilators are probably the most likely effective tool with the balloon dilators the least one. However, evidence in literature is scarce on this regard.

If a nephrectomy is indicated in a post uroseptic patient with the source of sepsis in the interested kidney (e.g., pyelonephritis, pyonephrosis), a local chronicization of the inflammatory process may develop in a xanthogranulomatous pyelonephritis (XGP). As well known, XGP is the most challenging urological surgical condition to be approached laparoscopically; actually, initial series contraindicated laparoscopic approach in these rare condition due to the high risk of complications and conversion recorded [7, 14]. However, recent improvement in technique and technology have allowed some skilled urologists to publish small series demonstrating feasibility of laparoscopic approach, even if risks for complication and conversion to open approach are still relatively present. Main benefits of laparoscopic nephrectomy for XGP of course are less hospital stay, quicker recovery and less pain [6]. Correct case selection is fundamental and if pre-operative CT scans are suggestive of significant involvement of surrounding organs with severe distorted anatomy, an open approach should be warranted.

Patients' safe first!

Box 8.1 Risk Factors for Urosepsis

AIDS
Type 2 DM
Use of immunosuppressive agents
Transplanted patients
Pts receiving chemotherapy
Pts receiving chronic steroidal therapy

Box 8.2 Urosepsis Classification According to Most Frequent Causes

Acute pyelonephritis
Pyonephrosis
Anatomical abnormalities
Urinary stones
Tumors
Urological fistula
Fournier's gangrene
Transrectal/Transperineal prostate biopsy
Urological intervention
Urological trauma

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Chapter 9
Practical Functional Evaluation of Adrenal Mass

Francesco Porpiglia, Riccardo Autorino, and Cristian Fiori

Abstract Over the past few decades the widespread application of non-invasive, high resolution imaging techniques such as MRI and CT has led to the incidental discovery of asymptomatic adrenal masses with increasing frequency. These masses, named "adrenal incidentalomas" (AIs), raise challenging questions for physicians and their patients. The diagnostic approach has to be focused on distinguishing benign and non-secreting from malignant or hormone secreting adrenal masses, and this approach combines radiological and functional evaluations. The aim of this chapter is to review the main techniques for the functional evaluation of AIs.

Keywords Adrenal mass • Adrenal incidentaloma • Assessment • Diagnostic test

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Introduction

Over the past few decades the widespread application of non-invasive, high resolution imaging techniques such as MRI and CT has led to the incidental discovery of asymptomatic adrenal masses with increasing frequency. These masses, named "adrenal incidentalomas" (AI), raise challenging questions for physicians and their patients. The diagnostic approach has to be focused on distinguishing benign and non-secreting from malignant or hormone secreting adrenal masses, and this approach combines radiological and functional evaluations. The aim of this chapter is to review the main techniques for the functional evaluation of AI.

Prevalence

In autopsy studies, the mean prevalence of clinically inapparent adrenal masses is about 2.0 %, ranging from 1.0 to 8.7 % [1]. In radiological studies, the frequency of AI was estimated at 4 % in middle age and increases up to more than 10 % in the elderly, peaking around the fifth and seventh decade [2]. AIs are slightly more frequent in women probably as a result of a referral bias.

On the contrary, the frequency of AIs is very low in childhood and adolescence accounting for 0.3–0.4 % of all tumors in children [2, 10].

Etiology

AIs do not represent a single clinical entity but they include a broad spectrum of diseases. Most AIs are benign adenomas that they account for 80 % of all tumors, even if a precise estimate is impossible because adrenal adenomas are rarely excised. The remaining 20 % of these lesions is represented by pheochromocytoma, primary adrenocortical carcinoma, myelolipomas, cysts and various rare benign tumors [3, 10]. Table 9.1 summarizes prevalence and etiology of AIs.

TABLE 9.1 Prevalence of adrenal incidentalomas: overview based on published series

Etiology	Prevalence (%)
Adrenal cortical tumors	
Benign non functional adenoma	70–84
Subclinical Cushing syndrome	1–29
“Aldosteronoma”	1–3
Adrenocortical Carcinoma (ACC)	1–10
Adrenal medullary tumors	
Pheochromocytoma	1.5–10
Ganglioneuroma	<1
Neuroblastoma, Carcinoma	<1
Other adrenal tumors	
Myelolipoma	7–15
Lipoma	0–11
Cysts and pseudocysts	4–10
Hematoma and hemorrhage	0–4
Metastases	0–20
Pseudoadrenal lesions (stomach, pancreas, kidney vascular lesions)	0–10

Clinical Presentation

As the vast majority of AIs is represented by cortical, non-secreting masses, these tumors are generally asymptomatic. In case of secreting tumors too, the patient if often asymptomatic; nevertheless when analyzed retrospectively and thoroughly, symptoms due to adrenal hormone hyper-secretion are found many cases, thus a careful medical history taking is basic for the identification of a secreting tumor. Herein we briefly summarize the possible clinical patterns of different AIs.

- ***Cortisol Secreting Adenoma – Subclinical Cushing's Syndrome (SCS).*** These lesions are characterized by autonomous glucocorticoid production without specific signs and symptoms of Cushing's syndrome (CS), a condition termed subclinical hypercortisolism (SCS). This syndrome is the most frequent endocrine dysfunction detected in patients with adrenal incidentalomas, accounting from 5 to 20 % of all cases. Clinical signs and symptoms range from small increment of diurnal cortisol rhythm to occurrence of complications. This syndrome is reported to be closely associated with cardiologic and metabolic diseases such as hypertension, insulin resistance, glucose and lipid metabolic disorders, obesity (cluster metabolic syndrome), and osteoporosis [8].
- ***Aldosteronoma***. Aldosterone secreting adenoma manifests as Conn's disease. The possible clinical manifestation that may be found in AI Conn's disease is mild hypertension, even if hypokalemia, nocturia, polyuria, muscle cramps, palpitations may occur. In some cases patients with Conn's disease on adrenal incidentaloma are totally asymptomatic even when hormonal tests are positive [4].
- ***Sex hormone secreting cortical adrenal tumor***. Sex hormone secreting tumors are rare. In the vast majority of cases, mainly in female patients, symptoms may include light and atypical hyperandrogenism: deepening of the voice, acne, hirsutism.
- ***Primary adrenocortical carcinoma***. Primary adrenocortical carcinoma (ACC) is rare and extremely malignant tumor. Among patients with AI, its prevalence is estimated to be about 4 %: with increasing risk in case of large tumors. As an example, ACC represents 2 % of all AIs ≤ 4 cm in size, 6 % of those 4–6 cm and up to 25 % of tumors > 6 cm [3, 8]. Primary adrenocortical carcinoma can be functional (about two/third of the cases) or non-functional. The clinical manifestation involves light symptoms related to adrenal hypersecretion, such as hypercortisolism (more common), as well as high sex hormones or aldosterone hypersecretion. Hormonally inactive masses (usually the larger ones) may present with abdominal discomfort or back pain.

- ***Pheochromocytoma***. Classically, clinicians report that only a quarter of pheochromocytomas are detected ante mortem, the remnant are found on post mortem as most patients die due to cardiovascular complication even before pheochromocytoma was diagnosed. Clinically, symptoms include history of hypertension with pathognomonic pheochromocytoma triad, including headache, perspiration, and palpitation, which make it possible to be detected. On the other side, such triad symptoms rarely noticed and it is missed by the clinicians due to its paroxysmal quality and considered as a common discomfort. Approximately 10–40 % of pheochromocytoma on adrenal incidentaloma is asymptomatic and it is called sub clinical pheochromocytoma. Whilst the vast majority of them are sporadic (about 86 %), the remainder are associated with familial syndromes, such as neurofibromatosis type 1, von Hippel-Lindau syndrome, multiple endocrine neoplasia type 1 (MEN1) and 2 (MEN2) and the pheo/paraganglioma syndromes. This should be kept in mind when a relative of a patient with one of these syndromes is evaluated for an adrenal mass. Finally, the risk to have a malignant pheo is not trivial (10 %) and distant metastases can be found during radiological evaluations [6, 8].
- ***Other adrenal masses***. These include myelolipoma, cyst and ganglioneuroma; however, they are rare and no typical or characteristic symptom is found. Adrenal is a common site of metastases, mainly due to breast, lung and kidney cancer, melanoma and lymphoma. These lesions, when incidentally found, are generally asymptomatic.

Radiological Evaluation

In general the main aim of radiologic evaluation is the characterization of an adrenal mass and the differentiation between benignant and malignant lesions.

- ***Ultrasonography***. The reliability of ultrasonography (US) depends largely on operator skill, patient habitus and adrenal lesion size: obesity and overlying gas are frequent obstacles for visualization of the adrenal glands, moreover lesions < 3 cm are not visible with US. Ultrasonography is not able to differentiate benignant and malignant lesions but has a good reliability in evaluating mass size and its growth during follow up [8, 9].

- ***CT***. Most abdominal and chest CT scans leading to the unexpected discovery of an adrenal mass are obtained without the use of current technical recommendations for an optimal CT study of the adrenal glands, i.e. analysis on contiguous 3–5 mm-thick CT slices, preferentially on multiple sections using multidetector row protocols. In those cases, it may be helpful to perform an additional CT scan specifically aimed for the study of the adrenal glands. The size and radiological features of an adrenal mass on unenhanced CT may lead to a differentiation between benign and malignant lesions. Four cm cut off seems to be the most reliable one to diagnose malignancy but it has a very low specificity (Fig. 9.1). Inhomogeneous lesion with irregular border and presence of necrotic area generally illustrate a malignancy whilst infiltration of the neighbour tissues clearly indicates a malignant lesion. Density of the lesion may distinguish benign from malignant lesion as mass with density < 10 HU are more likely benignant, tumor with density >10 HU on unenhanced CT are considered indeterminate and required further for characterization. Enhanced CT may further help in characterization of adrenal mass. The percentage washout on delayed images contributes to the differentiation between adenomas and malignant adrenal masses. The 'washout'– decreases more quickly in adenomas than malignant masses. A 10–15 min delay after administration of contrast medium was shared by several authors. Loss of 50 % or more of the attenuation value on delayed CT is specific for adenoma, whereas less than 50 % washout is indicative of malignant lesions or atypical adenoma. Others suggest a threshold washout of 60 % [1, 3, 8].
- ***MRI***. The differentiation between benign and malignant masses was based both on the findings from chemical shift

both on the signal intensities of conventional techniques. Chemical shift imaging relies on the different resonance frequencies of protons in water and triglyceride molecules and, therefore, may permit a more specific diagnosis of adrenal adenomas that contain abundant lipids (Fig. 9.2) [3, 8]. Today there is no evidence about the superiority of MRI on CT in the characterization of the adrenal masses, and in the clinical practice MRI studies are indicated after a CT study only in very selected cases.

- ***PET scans***. This has emerged as helpful tool in the characterization of adrenal masses. The rational of 18 F-FDG PET is based on an increased glucose uptake by malignant

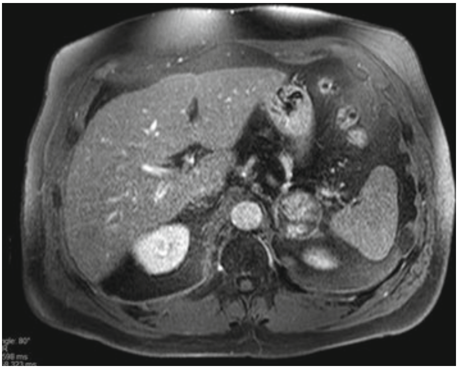

FIGURE 9.1 CT scan shows a left, round, 5 cm adrenal lesion with regular shape. Pathological evaluation after adrenalectomy revealed a benign cortical adenoma

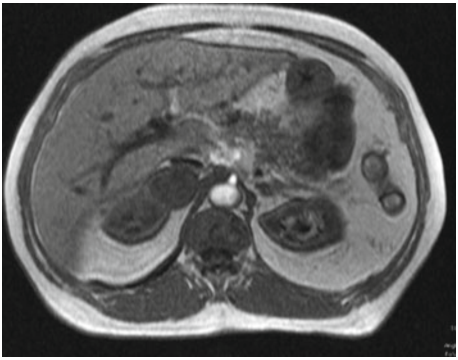

FIGURE 9.2 MRI shows a right, 4 cm well defined adrenal mass. In this case MRI was indicated for gastro-intestinal disease and documented (incidentally) the adrenal tumor

lesions. The sensitivity of FDG-PET in identifying malignant lesions is about 95 % with a specificity of 80–100 %. False negative are caused by the presence of intralesional necrotic or hemorrhagic areas that can result in poor FDG uptake. Moreover PET imaging is not reliable for small (<1 cm) lesions. The use of PET/CT may offer advantages over PET alone as the radiological characteristics of the lesion can be clearly determined. In clinical practice F-FDG PET should be used for distinguishing potentially malignant lesions from benign tumors only in radiologically (CT or MRI) indeterminate adrenal lesions [8].

- ***Scintigraphy***. The role of scintigraphy has progressively decreased during the last years thanks to the improvement of other radiological investigations. Two radiocholesterol derivatives have been proposed: 131 I-6-b -iodomethyl-norcholesterol (NP-59) and 75 Se-selenomethyl- 19- nor-cholesterol. In general, a concordant scintigraphic pattern, defined as a unilateral adrenal visualization or increased radiotracer uptake at the side of the detected mass, has been proposed as a typical pattern of benign cortical adenoma or nodular hyperplasia. In contrast, a discordant pattern with absent, decreased, or distorted uptake by the adrenal mass indicate more likely an ACC. Low reliability of scintigraphy for lesions <2 cm, lack of widespread expertise, limited availability of the tracer, and length of the procedure which requires serial scanning over a 1 week period limit the use of this tool [8].

Fine Needle Aspiration (FNA)

The need for FNA has been reduced by the accuracy of adrenal imaging techniques and its use is very rare. Nowadays FNA may be useful only in patients with a history of an extra-adrenal malignancy and inconclusive results of imaging tests, or when a rare tumor is suspected.

Pheocromocytoma should be excluded by using functional evaluation before embarking in an adrenal FNA to limit the risk of complications [8–10].

Functional Evaluation

In general, all subjects (even when totally asymptomatic) with an incidentally discovered adrenal mass should be screened for both catecholamine overproduction and hypercortisolism, with the exception of patients with adrenal masses whose imaging characteristics are typical for benign non secreting masses such as myelolipoma or adrenal cyst. Hyperaldosteronism should be considered in hypertensive and/or hypokalemic patients (Fig. 9.3) [3, 8].

- ***SCS***. The mainstay of hormonal screening for SCS is 1 mg dexamethasone-suppression test (DST) as suggested by available Literature data. The DST has widely been employed to diagnose subtle abnormalities of cortisol secretion in patients with adrenal incidentalomas and many clinicians use the overnight 1 mg DST, which is easy to perform in every-day practice. The rational of this test is that low doses of dexamethasone inhibit cortisol secretion in healthy patients but does not in patients with SCS. Nevertheless, there is a never-ending debate on the cut-off values to consider the test as positive. In the past a NIH conference panel recommended the 1 mg DST with the traditional threshold of 5 µg/dl (138 nmol/l) to define adequate suppression. In other words, cortisol levels after

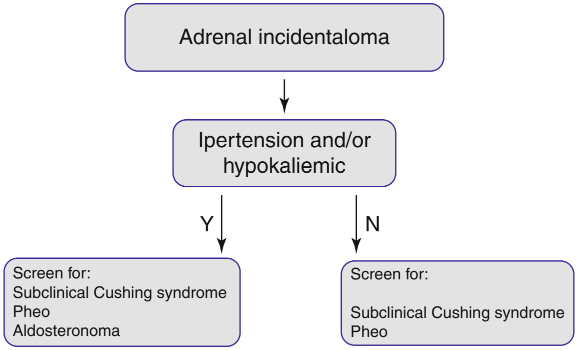

FIGURE 9.3 Flow chart: hormonal evaluation of adrenal mass

DST have to be lower than this value in healthy patients. This cut of has been confirmed by AACE/AAES Medical Guidelines for the management of adrenal incidentalomas. More recently French Society of Endocrinology recommended a cut-off for the 1 mg DST at 1.8 μg/dl g/dl (50 nmol/l) in the screening for SCS. Other authors have suggested the standard 2-day low-dose DST or high-dose DST as the first step of SCS investigation. Up to now, there is no direct head-to-head comparison of the different DSTs, or different thresholds after the 1 mg DST. In general, false positive results of DST may occur as a consequence of decreased dexamethasone absorption, use of drugs that increase hepatic dexamethasone metabolism (as barbiturates, anticonvulsant and rifampicin), increase estrogens, pregnancy or alcohol abuse. Markers of adrenal autonomy such as 24 h Urinary Free Cortisol (UFC) excretion, midnight serum cortisol, plasma ACTH, salivary cortisol levels, or repeat DST after 3–6 months to confirm lack of suppression are possible alternatives. However, the high-dose DSTs have not been extensively used in clinical setting, and recent studies have shown that normal late-night salivary cortisol levels do not rule out SCS among patients with adrenal incidentalomas. Thus, the late-night salivary cortisol data are not solid enough to be included in the "first step" screening procedures for SCS. Despite some technical problems, 24 h Urinary Free Cortisol (UFC) excretion and plasma ACTH levels represent helpful tools to confirm the diagnosis in case of doubts and represent the second step for the diagnosis of SCS rather than the first screening test. As far 24 h UFC is concerned, the upper normal limit in the majority of essays ranges from 80 to 120 μg/24 h (220–230 mmol/24 h), the sensitivity of this test is increased when it is repeated (usually × 3). ACTH plasma levels <10 pg/ml (2 pmol/L) suggest ACTH suppression and confirm the diagnosis of SCS. In summary, the recent conclusion drawn by the AME position statement of adrenal incidentalomas can be shared: it seems biologically plausible to consider that cortisol levels lower than 1.8 μg/dl (50 nmol/l) after 1 mg DST *clearly* exclude autonomous (ACTH-independent) cortisol secretion, whereas cortisol levels higher than 5 m g/dl (138 nmol/l) *likely* indicate SCS. Cortisol values after dexamethasone between 1.8 (50 nmol/l) and 5 μg/dl (138 nmol/l) may be considered as "gray-zone" and in these cases further evaluations (ACTH and UFC) are required (Fig. 9.4) [8].

- ***Aldosteronoma***. According to the Endocrine Society's Clinical Guidelines for management of primary aldosteronism all patients with an incidentally discovered adrenal mass and hypertension should be tested for hyperaldosteronism. Recent data showed that aldosteronoma may cause hypokalemia without hypertension thus specific hormonal tests also in these patients (hypokalemic normotensive). The first step analysis is represented by the measurement of plasma aldosterone (ALD) and plasma renin activity (PRA). Special instructions should be keep in

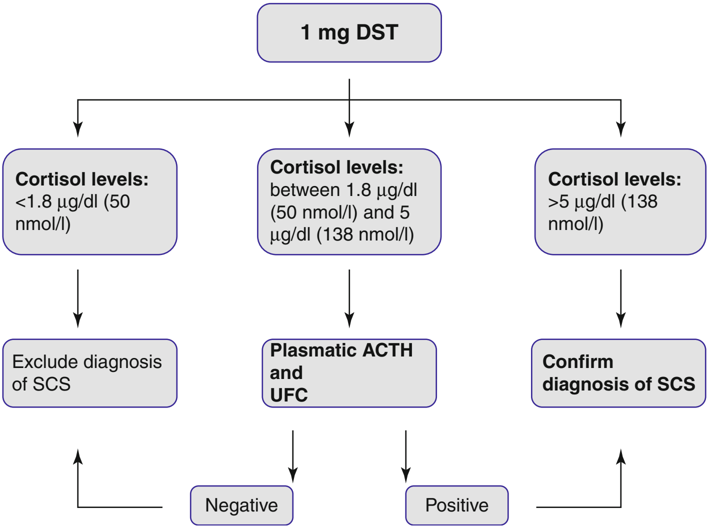

FIGURE 9.4 Flow chart: hormonal evaluations for the diagnosis of SCS

mind to prepare this test as many factors may interfere with ALD/PRA levels. Angiotensin converting enzyme inhibitors, angiotensin receptor blockers, dihydropyridine calcium channel antagonists, b-blockers, clonidine, non-steroidal anti-inflammatory drugs, potassium-wasting diuretics, amiloride, licorice, and chewing tobacco must be discontinued at least for 4 weeks before the test, whilst spironolactone must be discontinued at least for 6 weeks. In hypertensive patients non-interfering medication, such as doxazosin should be administered. A ratio of 20 or greater, when ALD is expressed in ng/dl and PRA in ng/ml/h, aldosterone secreting mass should be suspected. Other Authors have adopted a threshold of ALD/PRA ratio of 30 or 50 and until now no specific head to head comparison has identified the best cut off for the diagnosis of hyperaldosteronism. In some essays plasma aldosterone is indicated as ng/dl and direct renin concentration as ng/l, in these cases the threshold value of ALD/PRA is 3.7. Confirmation procedures are mainly oral sodium loading test and intravenous infusion test. Rational of both tests is the lack of aldosterone suppression with intravascular volume expansion that can indicate autonomous aldosterone production. For the first test, high sodium diet (about 12.8 g sodium chloride per day) is administered for 3 days. Urinary ALD levels >27.7 nmol/d (or >33.3 nmol/d for others) confirm diagnosis of aldosterone secreting mass. For the second one a 4 h infusion of 2 L of saline solution is administered (caveat: left ventricular and/or renal dysfunction). Post-infusion aldosterone levels >277.4 pmol/l (or >10 ng/dl) confirm the autonomous aldosterone production. Nowadays, a third confirmatory test (fludrocortisone suppression test) is less used that in the past. Finally one should remember that in very selected case (i.e. in case of doubts or to differentiate unilateral from bilateral disease), the reference standard test is adrenal venous sampling (Fig. 9.5). Nevertheless one should note that this approach is invasive, has high costs and strictly depends on radiologist's skill [4].

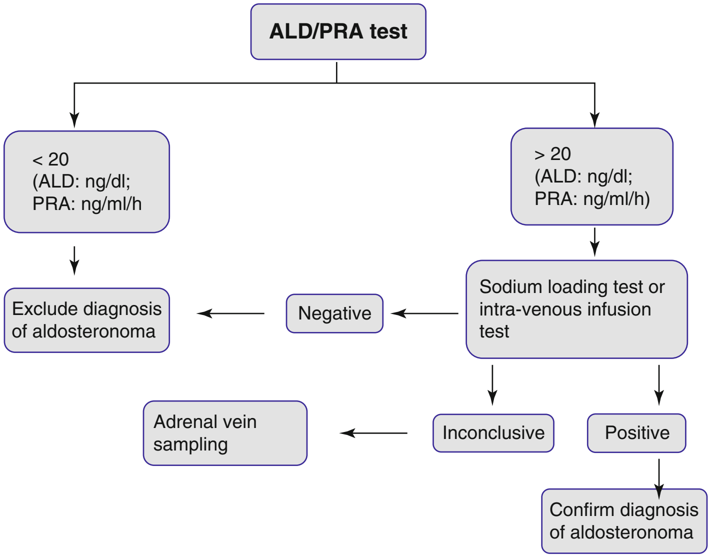

FIGURE 9.5 Flow chart: hormonal evaluations for the diagnosis aldosteronoma

- ***Pheochromocytoma***. Screening for pheochromocytoma should also be done in normotensive patients. In all patients with adrenal incidentalomas, fractionated metanephrines should be measured in urine (sensitivity 97 %) or free metanephrines in plasma (sensitivity 99 %). The rational of metanephrines measurement is that they are continuously produced and released by the tumor, in contrast to catecholamine that are often secreted intermittently or in low amounts. Therefore, in terms of hormonal evaluation of an incidentaloma, the assessment of catecholamine, is not generally recommended because this method has poor sensitivity and specificity often leading to false positive results. Conventionally, an elevation of fractionated metanephrines of more than fourfold above the reference interval establishes the diagnosis. False-positive results should be considered in various clinical situations (acute cardiovascular or cerebrovascular events, congestive heart failure, acute alcohol or clonidine withdrawal, cocaine abuse), drugs (tricyclic antidepressants, phenoxybenzamine, α1-adrenoreceptor blockers, clonidine, methyldopa, bromocriptine, labetalol, acetaminophen) and sampling conditions. In these subjects, measurements should be repeated in the absence of possible interfering conditions. Unfortunately, notwithstanding it was generally agreed that further biochemical testing is needed in case of doubt, there was no specific recommendation on what form this should take [6].

- ***Other functional investigations.*** Some authors proposed the measurement of dehydroepiandrosterone sulfate (DHEAS) as marker of ACC. Specifically, it has been reported as being low in benign adrenocortical lesions and high in primary adrenocortical carcinoma with sensitivity of 100 % and specificity of 47 %. Other Authors found any correlations between DHEAS levels and ACC, so no recommendations can be given to the reader [9]. Nevertheless, based on our positive experience with DHEAS in ACC scenario, we currently use it in evaluating an AI in our every day clinical practice.

Management of AIs

Indications to surgery and follow up of AIs are still matter of debate and their discussion is beyond the aims of this chapter. We would like to briefly review the recommendations in the management of AI as emerged by the analysis of the literature.

In general, surgery is recommended for:

- Any adrenal mass with radiological aspects of malignancy compatible with malignancy (including mass size >4–6 cm, no ideal cut off has been clearly identified until now)
- All functional adrenal tumors causing overt steroid hormone or catecholamine excess.

Literature data are still insufficient to make any recommendation for or against surgery in patients with subclinical Cushing's syndrome and indication to surgery should be shared with the patients and based on a careful clinical monitoring of patients at high cardiovascular risk (i.e. hypertension, diabetes). In these patients adrenalectomy seems to be reasonable when medical therapy does not treat the diseases potentially linked to hypercortisolism [8]. Similarly, indications to surgery in patients with Conn syndrome should be evaluated on a case by case basis [4].

In all patients with presumably benign tumors that are submitted to the surgery, laparoscopy is indicated [5]. No data support the best approach (transperitoneal versus retroperitoneal) for this kind of surgery. The mainstay for the treatment of a malignant lesion is open surgery even if recent data demonstrated that laparoscopic adrenalectomy in selected patients (no infiltration of neighbour tissues, respect of oncologic surgery principles) with stage I and II ACC seems to be an adequate treatment [7, 11]. For the patients in which "watchful waiting" approach has been chosen the literature data are not enough to make firm recommendations on endocrine and radiologic follow-up. Repeat imaging (CT or MRI) 3–6 months after discovery of an adrenal incidentaloma to recognize a rapidly growing mass seems to be reasonable with the only exception of adrenal mass that has clear features of myelolipoma or cyst; in these cases no additional follow-up is needed [8, 9].

During the follow up period, adrenalectomy should be considered if the mass enlarges by 1 cm or more and/or changes its appearance during observation [8].

Acknowledgments and Conflict of Interest

None

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Chapter 10
Interstitial Cystitis: Practical Recommendations for Treatment

Rashad Sholan Mammadov

Abstract Interstitial cystitis remains a challenging condition to define and to manage. Practical tips in the diagnosis and treatment of interstitial cystitis are provided in the chapter based on the current evidence as well as the author's own clinical experience.

Keywords Interstitial cystitis • Treatment

Introduction

Interstitial cystitis (IC) remains as a disease that is insufficiently defined. The reason for this can be evidenced in an insufficient amount of research into the etiology of the disease. The term "interstitial cystitis" was first used by Skene in 1887 in a book referencing the female urethra and bladder

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diseases [5]. The ulcer that can be seen at the time of interstitial cystitis was defined by Hunner in a literature report that has become a milestone for interstitial cystitis [4].

Diagnosis of IC

Despite a quite large number of studies, the diagnosis of the disease fully depends on awareness and skepticism of the physician establishing the diagnosis. There is a little pathognomonic evidence for IC disease. Exclusion criteria developed by “The National Institute of Health” for the diagnosis of the disease have been reported. Diagnostic criteria have been recognized by “The American Urological Association” and by the “Society for Urodynamics and Female Urology” - pain, pressure, and discomfort in the bladder due to the lower urinary tract symptoms without any urinary tract infection and other identifiable reasons for a period of 6 weeks [2].

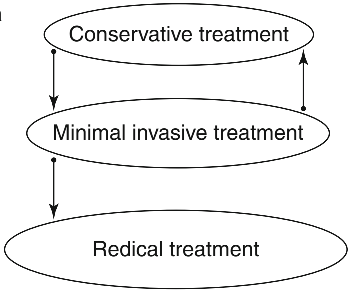
These are also the clinical criteria that we use at our Institution in daily clinical practice. This ensures a timely diagnosis, and a more effective treatment. We perform analyses for urinary culture, serum creatinine, and radiological imaging of the urinary tract when a patient meeting the diagnostic criteria is admitted to our clinic [1].

Most of the times, we only perform basic examinations, and consider further tests, such as urodynamics and cystoscopy with possible biopsy, in selected cases. We recommend cystoscopy as the first examination for patients with more severe, long-term symptoms. The purpose in such cases is also to perform a therapeutic hydro-distension in the same session, while obtaining information about the prognosis of the disease (for example – the presence of “Hunner” ulcers that can be considered pathognomonic and it indicates a poor prognosis).

Treatment of IC

General principles of current guidelines should be adopted in the treatment of IC, as illustrated in Fig. 10.1.

Figure 10.1 Treatment algorithm in the management of IC



The following drugs can be used: amitriptyline, an oral tricyclic antidepressant, (75 mg per day before sleep, for a period of at least 8 weeks) in conservative treatment; anticholinergic for patients with severe impingement symptoms; pentosan polysulfate (400 mg 2 per day, times a day) for patients with a long history of the disease. We do combine intravesical diluted heparin with lidocaine solution (lidocaine solution of 2 % is diluted with 10 000 IU heparin solution 50 cc NaCl %) for patients with more severe pain. We have observed that symptoms are relieved after this treatment, even for a short period of time. As mentioned above, sometimes we do combine the first and second line treatment options in selected cases. In our experience, the combination is more effective in these cases.

We proceed with cystoscopy and hydro-distension under general anesthesia as a minimally invasive treatment. As shown in the literature, hydro-distension is useful in many cases [3]. In our practice, we do not use hydro-distension alone, but we combine it with medical conservative treatment as necessary. Efficiency takes an average of 3 months.

A more radical treatment can be considered for patients who are unresponsive to any treatment, whose quality of life is severely impaired and whose anesthetic bladder capacity has seriously contracted organically. In these cases cystectomy and urinary diversion represents a treatment modality. Despite being quite aggressive, it can ultimately result improvement of the quality of life, as symptoms can disappeared in selected patients and those in the "terminal" stage.

It is known that diet is also of great importance in patients with interstitial cystitis [6]. We recommend to avoid dark tea, coffee, soft drinks, alcoholic beverages, citrus fruits, artificial sweeteners, and hot pepper(s) in their daily lives.

Last, we believe that the treatment strategy may become more effective by carefully listening to the patients with IC and paying great attention to their medical history.

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Chapter 11
Optimal Use of Antibiotics in Urology

Mete Çek

Abstract Urinary tract infections (UTI) are one of the most frequent infections and consequently one of the most frequent indications of prescribing antibiotics. Optimal use of antibiotics in these infections is necessary to successfully treat patients as well as combat with increasing resistance. This requires individualization of treatment based on various features of UTIs. Bacterial spectrum, local resistance patterns, key features of urological infections have to be considered in the selection of antimicrobial agents for the treatment of UTIs. Recommendations based on major guidelines and clinical tips will be discussed in this chapter.

Introduction

Urological infections include urinary tract infections (UTI), prostatitis, epididymo-orchitis, sexually transmitted diseases, infections of male accessory glands and urosepsis. The management of septic urologic patient will be discussed elsewhere in this book. Optimal use of antibiotics in these infections

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requires individualization of choices based on allergy, local resistance profile of microorganisms, compliance of the patient, local practice patterns, availability and cost of drugs [5]. Collateral damage, i.e., ecological adverse effects of antibiotic therapy should also be considered when prescribing antibiotics [7].

UTIs are one of the most frequent infections both in the community setting and in healthcare-associated situations. Consequently, one of the most common indications for prescribing antimicrobial agents is UTIs, particularly acute uncomplicated cystitis. An association between antibiotic use and resistance has been shown both on individual and population levels [3]. Antibiotic resistance leads to treatment failures and increases length of hospital stay. Clinicians should experience caution in the selection of antibiotics to prevent or at least delay the development of resistance.

Bacterial Spectrum of UTIs

An important aspect of antibiotic preference is the knowledge of bacterial spectrum of infections. More than 80 % of the microorganisms causing uncomplicated UTIs are *E. coli* whereas bacterial spectrum of complicated UTIs is more heterogeneous compared to uncomplicated UTIs. Although *E. coli* is still the most frequent one, bacteria like *Enterococcus spp*., *Klebsiella spp., Pseudomonas spp., Proteus mirabilis* and *Enterobacter spp.,* are isolated in many cases of complicated UTIs [10].

Resistance of Microorganisms

Increasing rate of resistance is a major concern in the treatment of UTIs. Various studies have documented high resistance rates of *E. coli* to ampicillin, sulfonamides and to trimetoprim. More recent increase of resistance to fluoroquinolones and cephalosporins is of concern [6, 8, 13].

Antibiotics for the Treatment of Uncomplicated Cystitis

Uncomplicated UTIs are infections occurring in otherwise healthy premenopausal women. As urine culture is usually not performed in these patients, treatment is empirical and should be based on the local or national surveillance data. Fosfomycin, nitrofurantoin and pivmecillinam are suggested for the treatment of uncomplicated cystitis both by the EAU and IDSA Guidelines (Table 11.1).

Table 11.1 EAU and IDSA recommendations for antimicrobial therapy in acute uncomplicated cystitis in otherwise healthy premenopausal women [4]

EAU	**IDSA**
Fosfomycin trometamol 3 g single dose	Fosfomycin trometamol 3 g single dose
Nitrofurantoin 50 mg q6h × 7 days	Nitrofurantoin monohydrate/ macrocrystals 100 mg bid × 5 days
Nitrofurantoin macrocrystal 100 mg bid × 5–7 days	
Pivmecillinam 400 mg bid × 3 days	Pivmecillinam 400 mg bid × 5 days
Pivmecillinam 200 mg bid × 7 days	
	Trimethoprim-sulfamethoxazole 160/800 mg (one DS tablet) bid × 3 days (if resistance prevalence is <20 %)
Alternatives	
(If local resistance of E. coli is <20 %) Trimethoprim- sulphamethoxazole 160/800 mg bid 3 days	

(continued)

Table 11.1 (continued)

EAU	IDSA
Ciprofloxacin 250 mg bid × 3 days	
Levofloxacin 250 mg qd × 3 days	
Norfloxacin 400 mg bid × 3 days	
Ofloxacin 200 mg bid × 3 days	
Cefpodoxime proxetil 100 mg bid × 3 days	
Trimetoprim 200 mg bid × 5 days	

Treatment of Uncomplicated Pyelonephritis

Oral antibiotics can be effective in mild and moderate cases. Treatment should last for 5–10 days preferably with one of the following agents: Ciprofloxacin (500–750 mg bid 7–10 days), Levofloxacin (250–500 mg qd 7–10 days), Levofloxacin (750 mg qd 5 days) [8].

Parenteral administration of antimicrobial agents is indicated for the treatment of severe pyelonephritis. After improvement, oral treatment should be instituted with one of the above-mentioned antibacterials. Initial empiric parenteral treatment should be started with one of the following agents: Ciprofloxacin (400 mg bid), Levofloxacin (250–500 mg qd), Levofloxacin (750 mg qd).

Tip If a fluoroquinolone, TMP-SMX or a beta-lactam for oral treatment is preferred for the treatment of acute pyelonephritis and the local susceptibility of microorganisms is not known, an initial IV dose of ceftriaxone or 24 dose or aminoglycoside is recommended [5].

Treatment of Pregnant Women with UTI

Tip Pregnant women should be screened for asymptomatic bacteriuria during the first trimester. Asymptomatic bacteriuria in pregnancy should be treated same as cystitis (Table 11.2).

Tip Avoid nitrofurantoin in G6PD deficiency, trimethoprim in first trimester and at term, tetracyclines, chloramphenicol and aminoglycosides.

Table 11.2 Treatment regimens for ABU and pyelonephritis in pregnancy [4]

Asymptomatic bacteriuria in pregnancy	Pyelonephritis in pregnancy
Nitrofurantoin (Macrobid®) 100 mg q12 h, 3–5 days	Ceftriaxone 1–2 g IV or IM q24 h
Amoxicillin 500 mg q8 h, 3–5 days	Aztreonam 1 g IV q8-12 h
Co-amoxicillin/clavulanate 500 mg q12 h, 3 t-5 days	Piperacillin-tazobactam 3.375–4.5 g IV q6 h
Cephalexin (Keflex®) 500 mg q8 h, 3–5 days	Cefepime 1 g IV q12 h
Fosfomycin 3 g Single dose	Imipenem-cilastatin 500 mg IV q6 h
Trimethoprim-sulfamethoxazole q12 h, 3–5 days	Ampicillin 2 g IV q6 h
	Gentamicin 3–5 mg/kg/day IV in 3 divided doses

Antibiotics for the Treatment of Complicated UTIs

Complicated UTIs are infections associated with an anatomical or functional abnormality of the genitourinary tract. Therefore, treatment should aim to treat the infection while managing the underlying pathology simultaneously. Guiding the treatment with urine culture is a general and useful recommendation. However, it may be necessary to start with empirical treatment while waiting for urine culture results. In this case, a broad bacterial spectrum has to be considered. A fluoroquinolone with mainly renal excretion, an aminopenicillin plus a β-lactamase inhibitor (BLI), a cephalosporin, carbapenems, aminoglycosides are recommended alternatives [4, 5].

Tip (EAU): Antibiotics with nephrotoxic features (e.g., aminoglycosides) should be used cautiously in patients with renal impairment. Because of the wide therapeutic index of most antibiotics, adjustment of dose would not be considered unless GFR < 20 mL/min. Nitrofurantoin and tetracyclines are contraindicated, but not doxycycline.

Tip Asymptomatic bacteriuria with and without the presence of urinary catheters should not be treated except in special circumstances [3].

Tip Pyuria accompanying asymptomatic bacteriuria is not an indication for antimicrobial treatment [5].

Management of Patients with Catheters

Although various antibiotics and antiseptic substances have been tested, none of them have proved to be efficient. For patients with urinary catheters, the only indication for antibiotics is symptomatic UTI [4].

Tip Prophylactic antimicrobials should not be administered routinely to patients at the time of catheter placement to reduce catheter associated UTIs CAUTI at the time of catheter removal or replacement to reduce bacteriuria.

Antibiotic Prophylaxis in Urology

Prophylactic antibiotics are used in urology for certain indications: Prophylaxis for recurrent UTI, prophylaxis before urological interventions, including transrectal ultrasound-guided biopsy (TRUS-Bx) of the prostate.

Tip UTI should be treated before commencing antibiotic to prevent infective complications.

In women who experience recurrent cystitis, continuous antimicrobial prophylaxis regimens can be applied with one of the following agents: TMP-SMX, nitrofurantoin, cefaclor, cephalexin, norfloxacin, ciprofloxacin (all once daily) or fosfomycin (every 10 days) [4].

Perioperative Prophylaxis

Which Operations Require Perioperative Antimicrobial Prophylaxis?

There is high level of evidence only for the use of antibiotic prophylaxis before transurethral resection of prostate (TURP) and prostate biopsy [1].

Current evidence does not support the routine use of antibiotic prophylaxis in cystoscopy, urodynamic investigation, transurethral resection of bladder tumor, and extracorporeal shock-wave lithotripsy [1]. However, antibiotic prophylaxis is supported for therapeutic ureterorenoscopy and percutaneous nephrolithotomy, even though level of evidence is low.

Antibiotic prophylaxis is not advised in clean surgery, but is advised in clean-contaminated and prosthetic surgery [1].

Tip The optimal administration of IV first or second-generation cephalosporins for surgical prophylaxis is within 60 min before incision [12]. A single dose is sufficient for most surgical interventions; antibiotics should be discontinued within 24 h after the intervention [12].

Antibiotic Prophylaxis Before Transrectal Prostate Biopsy

Almost universal use of fluoroquinolones for prophylaxis before TRUS-Bx of the prostate has led to an increasing prevalence of fecal carriage of fluoroquinolone-resistant E coli strains [11]. To overcome risk of infections caused by these resistant microorganisms, modified prophylaxis regimes are suggested:

- Augmented prophylaxis: This is the addition of another antibiotic (e.g., gentamycin, cefazolin) to the routine use of fluoroquinolones. Existence of co-resistance and the potential of creating an increase in antibiotic resistance are drawbacks.
- Targeted antimicrobial prophylaxis can be applied when pre-biopsy rectal swabs are cultured for sensitivity test and prophylaxis is designed accordingly. This method is associated with a decrease in infective complications caused by fluoroquinolone resistant microorganisms [9].

Sexually Transmitted Diseases: Urethritis [2, 4]

(Gonococcal urethritis) Gonorrhea: 1 g im Ceftriaxone; Azithromycin 1 g orally as a single dose)

(Non-gonococcal urethritis) Chlamydia: (Azithromycin 1 g orally as a single dose, Doxycycline 100 mg orally for 7 days)

Tip As gonococcal infections are often accompanied by chlamydial infection, an antichlamydial active therapy should be added.

Epididymo-orchitis

Male genital bacterial infections can be caused by the same bacterial spectrum as complicated UTI or by sexually transmitted bacterial pathogens, such as N. gonorrhea, C. trachomatis or Mycoplasmata. While both epididymitis and orchitis are preferably treated with fluoroquinolones active against C. trachomatis (ofloxacin, levofloxacin), treatment of partners should be considered, depending upon the history of the patient.

Tip Chronic epididymitis can be a manifestation of urogenital tuberculosis [4].

Acute and Chronic Bacterial Prostatitis

Acute bacterial prostatitis Antibiotics penetrate well into the prostatic tissue in acutely inflamed prostatic tissue. Parenteral administration of high doses of bactericidal antibiotics may be necessary in severe prostatitis. These antibiotics are fluoroquinolones, third-generation cephalosporins with or without gentamycin or broad spectrum penicillin derivatives [4]. An oral fluoroquinolone would be appropriate in moderate cases.

Chronic bacterial prostatitis Penetration of antibiotics into the prostatic tissue in chronic bacterial prostatitis is not as good as it is in acute prostatitis. Fluoroquinolones are the drugs of choice, because of their antibacterial activity against Gram-negative bacteria as well as their excellent penetration into the prostate. Duration of treatment should be 4–6 weeks.

Tip There is not enough data to support the application of intraprostatic injection of antibiotics.

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Chapter 12
Difficult Urethral Catheterization

Carlos Villanueva

Abstract A difficult urethral catheterization (DUC) occurs when a urethral catheter cannot be advanced into the bladder after one or more attempts. Depending on the practice setting, using a 16–18 F Coudè catheter followed by a 12 F silicone catheter can solve most DUC cases. When catheterizing by an experienced practitioner fails, it is recommended to attempt placing a glidewire blindly. If urethral dilation is needed, using small (<14Fr) ureteral access sheaths is usually all is needed. Cystoscopy will be necessary for a small percentage of cases.

Keywords Difficult urethral catheterization • Difficult foley • Urethral stricture • Urethral dilation

Introduction

A difficult urethral catheterization (DUC) occurs when a urethral catheter cannot be advanced into the bladder after one or more attempts. Depending on the practice setting,

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either a nurse or a physician attempts the first catheterization. If unsuccessful, he/she may resort to a more experienced nurse/physician or may request a urology consult for catheter placement. Some practices (i.e. Mayo Clinic) have designated catheter teams with experienced technicians who can handle most situations, but they also end up referring some cases to urologists. This chapter only focuses on male DUC.

Type of Catheter

The first decision to make when approaching a DUC patient is whether another attempt at urethral catheterization using a catheter is warranted before resorting to flexible cystoscopy or blind insertion of glidewires.

In 82 consecutive DUC cases at both a university and community hospital in Omaha, Nebraska (complete series has not yet been published), where most initial catheterizations are attempted by nurses, we found that a 16–18 Fr coude catheter was successful in close to half (38/82) of the DUC consults. Copious lubrication (>10 ml of 2 % viscous lidocaine) was used in every catheterization.

Pooled data from several DUC studies showed that the most common causes of DUC are either strictures or bladder neck contractures [7] (Fig. 12.1). Because of this fact, we recommend attempting the use of a 12 F foley catheter when the 16–18 Fr catheter is unsuccessful. In our series, 27 % (12/44) of patients were successfully catheterized using a 12 Fr silicone catheter after a failed attempt with the 16–18 Fr coude. In the laboratory we demonstrated that silicone catheters are twice as stiff as latex catheters and because of this might be better at passing through tight strictures [8]. We recommend always using small silicone catheters in cases of DUC.

Blind Passage of Glidewire

After failed attempts at catheterization by the urologist or experienced technician, we recommend trying to pass a glidewire blindly next. It is imperative to avoid any stiff glidewires

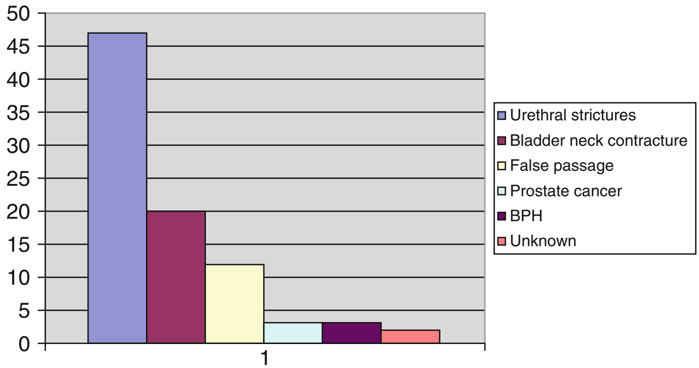

FIGURE 12.1 Most common causes of difficult urethral catheterization. *Pooled cases from Beaghler's et al [2], Freid's et al [4] and Mistry's et al [6] series. Included are the 54 patient from Beaghler's series all of which underwent flexible cystoscopy, and the 13 patient in Mistry's series that underwent flexible cystoscopy. Twenty patient from Freid's series were included too, but it was not mentioned in the article how the cause of difficult urethral catheterization was found in these patient

because of the potential for bladder or urethral perforation. Several authors have demonstrated the safety and efficacy of glidewires [1, 3–5, 9].

In our consecutive series of DUC, after failed attempts at catheterization, 75 % (24/32) of patients were successfully catheterized after the blind placement of a glidewire. We used both straight and angled tip glidewires. Sometimes when either the straight or angled tip did not go through we tried the other type.

Glidewires are usually 150 cm in length. The glidewire should be advanced gently into the bladder and coiled inside the bladder until <40 cm of glidewire stick out of the urethra. This assures proper placement in the bladder since advancing this much glidewire into a false passage or urethral perforation would encounter much more resistance and be almost impossible to do with a regular glidewire (but possible with a stiff glidewire). As one advances the wire, effort is made to "feel" the obstructive area to try to maneuver the glidewire past it. This may be facilitated by grasping the glidewire with a hemostat or moist gauze.

Once the bladder is secured, a 16 Fr council tip catheter is attempted (successful in 8/24), or a 12 Fr silicone catheter using the Blitz technique (Fig. 12.2) (successful in 13/24). If neither catheter will go in, dilating with a ureteral access sheath is safer due to the tapered tip and the hydrophilic

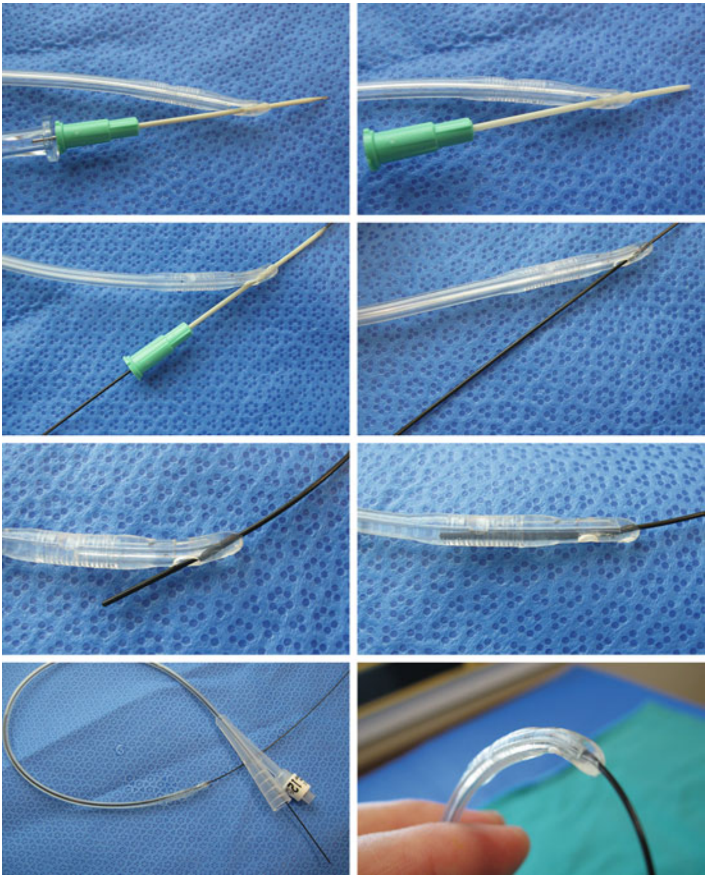

Fig. 12.2 The Blitz technique

nature. This is enough to be able to subsequently pass the 12 F silicone catheter. In our series, only 3 patients had to be dilated with a 12 F ureteral access sheath.

Flexible Cystoscopy

If unable to pass the glidewire blindly, cystoscopy may be of help [2]. Eight patients in our series underwent flexible cystoscopy. The etiology in these cases is usually false passage or a pinpoint stricture.

False passages are usually ventral and so the true lumen is found dorsally. The trick when advancing the cystoscope is to point the tip towards the ceiling directly facing the urethral mucosa and following the mucosa into the bladder. No attempt to find the center of the urethral lumen is made as when doing routine cystoscopies.

Cystoscopy in this scenario is not easy since the patient is in pain, visualization is poor because of blood coming from the false passages, and the equipment available might not be what you are used to. If able to maneuver a false passage into the bladder, the glidewire is then placed in the bladder and the same steps as when placing a glidewire blindly described above are followed.

Occasionally a pinpoint stricture is found and with the use of the cystoscope a glidewire can be directed through the stricture into the bladder. Mild dilatation with a ureteral access sheath followed by a 12 Fr silicone catheter is usually all that is needed to temporize the situation.

Suprapubic Catheterization

In our consecutive DUC series, no patients required suprapubic catheter insertion. However, it is expected that some patients might need this option after other techniques have failed. The technique for SP catheterization is beyond the scope of this chapter.

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Chapter 13
Management of Acute Urinary Retention

Susan Willis

Abstract Acute urinary retention (AUR) is a common urological emergency. The immediate management consists of urethral catheterization and documentation of the retention volume. The cause must be determined so that the patient can be investigated and managed appropriately.

Keywords Acute urinary retention • Catheter • Benign prostatic enlargement

Introduction

Acute urinary retention (AUR) is the sudden inability to pass urine, and is usually associated with supra-pubic pain. The retention volume should be recorded and is typically 800 ml or less; a greater volume is suggestive of acute-on-chronic urinary retention, the management of which may differ from AUR.

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Initial Management

On presentation and after taking a brief history from the patient, a urethral catheter must be placed without delay in order to alleviate the patient's distress. For difficult urethral catheterization see Chap. 10. If a urethral catheter cannot be placed, then a supra-pubic catheter must be inserted, preferably with ultra-sound guidance.

It is vital to take a careful history from the patient (usually once catheterized and comfortable) in order to elucidate the cause of the AUR, as this will determine your management strategy. There may be a history of worsening lower urinary tract symptoms (LUTS) or of the episode being precipitated by consuming a large quantity of alcohol. The common causes of acute urinary retention and their initial management are described in Table 13.1.

Often there is more than one factor contributing to the AUR. In these cases, all appropriate management strategies will need to be addressed simultaneously.

All patients presenting with AUR should have a serum creatinine check – if this is elevated then a renal ultra-sound scan should be performed to make sure that a case of high-pressure chronic retention is not missed. These patients can have a significant post-obstructive diuresis and will require hospital admission for monitoring of their fluid balance and renal function.

Do not measure the prostate-specific antigen (PSA) during an episode of acute urinary retention, as it is likely to be elevated above baseline during this period. This can lead to considerable anxiety for the patient in what is already a stressful time. The exception is where a metastatic prostate cancer is suspected clinically and when the immediate management will be altered by this finding (in the case of a spinal cord compression).

Most patients with AUR will not require hospital admission. They will need to be shown how to care for their catheter and given the appropriate supplies. If the patient is able and there is no evidence of infection, then they can be given a catheter valve so that they can cycle their bladder in a physiological manner. They must be discharged with a clear plan for follow-up so that their catheter is not forgotten about.

Table 13.1 Causes of acute urinary retention

Cause of AUR	Initial management, following catheterization
Benign prostatic enlargement	Alpha-blockers for a minimum of 3 days, then trial without catheter (TWOC)
Urethral stricture	Ascending and descending urethrogram
Urinary tract infection	Antibiotics for a minimum of 48 h, then TWOC
Constipation	Laxitives/suppositories/enema, then TWOC
Drugs (e.g. opiate analgesia, anticholinergics, sympathomimetics)	Stop causative agent if possible for >48 h, then TWOC
Spinal cord injury/ neurological cause	Leave catheter on free drainage until fully assessed and pathology stable
Post-operative	TWOC when mobile/recovered
Diuresis causing over-distension (medically-induced or secondary to alcohol)	TWOC after 24–48 h

Most cases of AUR will be seen in men. This condition is uncommon in women, but may arise from neurological causes or pelvic pathology.

Management of AUR Due to Benign Prostatatic Enlargement

The commonest cause of AUR is benign prostatic enlargement (BPE) resulting in bladder outflow obstruction (BOO). If the history is suggestive of this diagnosis (including slow stream, incomplete emptying, hesitancy, intermittency, frequency, urgency and nocturia), then the patient should be started on an alpha-blocker (e.g. alfuzosin, tamsulosin, doxazosin).

These drugs reduce the dynamic element of obstruction by reducing the smooth muscle tone in the bladder neck and prostate.

In the ALFAUR trial [1], 360 patients with AUR were randomized to either alfuzosin 10 mg once daily or placebo. They showed that by giving alfuzosin for 3 days prior to catheter removal, the chances of a successful TWOC were increased from 48 to 63 %.

A meta-analysis of five randomized-controlled trials of alpha-blockers versus placebo prior to removal of catheter for AUR favors alpha-blockers was also reported [2]. This appears to be a class effect, with all alpha-blockers giving a statistically significant result.

Generally if patients fail one TWOC, and there are no contra-indications, then a second TWOC should be performed 1–2 weeks later. If a second TWOC fails, then surgical management should be considered (usually transurethral prostatic surgery). An algorithm for the immediate management of AUR is presented in Fig. 13.1.

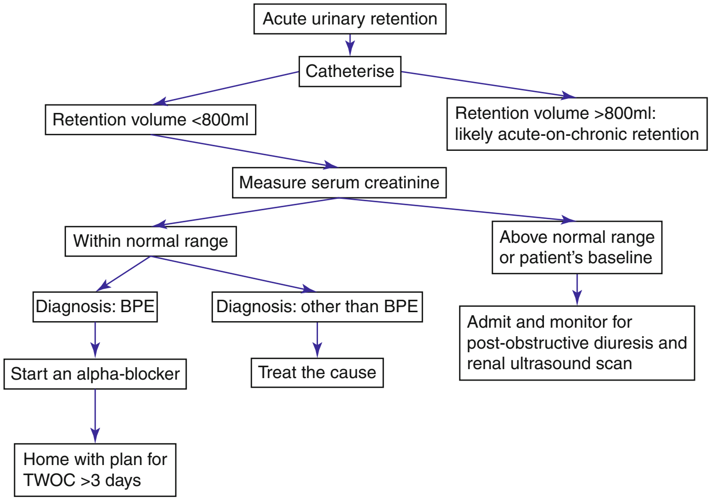

Figure 13.1 Algorithm for the management of acute urinary retention (*BPE* benign prostatic enlargement)

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Chapter 14
Congenital Anomalies in Adults: Diagnosis and Management Considerations

Sarel Halachmi

Abstract Diagnosis of a congenital urological anomaly in an adult is not a rare event. Management considerations in the adult patient are sometimes different compared to the pediatric age group. In adults, more emphasis is given to symptoms, patient age and additional co-morbidities. The adult age group may benefit from a wider choice of surgical techniques that cannot be applied in children such as endoscopic procedures. Despite utilizing similar operational skills and techniques, surgical outcome in adults may be different from that in children. In general, there is a relatively large arsenal of available therapeutic solutions to offer to adult patients with congenital urological anomalies.

Keywords Adults • Diagnosis • Management • Ureteropelvic junction obstruction • Cryptorchidism • Ureterocele • Hypospadias • Vesico-Ueteral Reflux • Obstructing megaureter

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Adult Ureteropelvic Junction Obstruction (UPJO)

Incidence

The incidence of UPJO in the pediatric age group is well defined, affecting around 60 % of all newborns with hydronephrosis. The exact incidence of primary congenital UPJO in adults is unknown, although estimated as "not uncommon"[20].

Symptoms

In contrast to prenatal screening, adult UPJO may be discovered in several ways: (a) evaluation following symptoms such as chronic back pain, acute renal colic, especially after fluid overload, hematuria, UTI and pyelonephritis; and (b) incidentally during diagnostic imaging of the abdomen or spinal area for other problems such as abdominal or back pain.

Diagnosis

Diagnosis of adult UPJO does not differ from that of the pediatric age group, using nuclear medicine static and dynamic renal scans, CT urography or MR urography, and intravenous pyelography. Unfortunately, there is no consensus regarding which is the optimal imaging modality to determine obstruction. Moreover, there are no uniform standards for how to perform the above-mentioned diagnostic tests, and various protocols exist.

Management

Management decisions in the adult are different. In children, the main goal is to eliminate the obstruction in order to restore maximal renal function and to allow maximal growth of the kidney. In adults, the ability to restore renal function or to allow neo-compensatory renal growth following surgery is limited, as chronic obstruction may have caused irreversible changes in the renal parenchyma and vasculature, and the maximal growth potential has already been achieved. Factors that should guide the physician regarding the management of adult UPJO are: side effects such as recurrent infections and stone formation, symptoms, function, age and co-morbidities.

Symptomatic patients with UPJO should be treated when the UPJO endanger the patient: recurrent pyelonephritis or hypertension can be life threatening, especially in elderly patients with other co-morbidities. Non-life-threatening symptoms such as chronic pain that interfere with a patient's quality of life may also be an indication for definitive treatment.

Definitive treatment includes reconstructive surgery to eliminate the obstruction or nephrectomy. In order to choose the most suitable treatment for the patient, several factors should be taken into consideration: the function of the obstructed kidney, function of the other kidney, patient's age and co-morbidities.

A non-functioning symptomatic kidney in the presence of a normal functioning contralateral kidney should be removed. In patients with a single kidney or those with overall poor renal function, reconstructive surgery should be offered.

Nephrectomy in adults is a well-established operation. The decision between open and laparoscopic/robotic routes should be made by the patient and the urologist based on individual circumstances. Both can achieve the surgical goal successfully, with the advantage of a shorter recovery period with less analgesic consumption in patients who undergo laparoscopic nephrectomy [46]. Surgeon should bear in mind that post infection nephrectomy could be more complex due to tissue reaction and adhesions [25].

Reconstructive surgery in adults can be performed by a wider range of surgical techniques than in children. The open surgical approach – open pyelopasty – is still considered the gold standard in adults, with a 91 % success rate overall and 100 % success rate for grade 1–3/4 hydronephrosis [19]. Laparoscopic and laparoscopic robotic pyeloplasty already show similar success rates to open surgery. Bauer et al. compared 42 laparoscopic pyeloplasties to 35 patients who underwent open surgery, and the overall success rates were comparable (98 % and 94 %, respectively) [5]. Robot-assisted laparoscopic pyelopasty also showed comparable success rates with minimal complications and short recovery time [31]. In contrast to the pediatric age group, adult patient may choose to undergo endoscopic correction of the UPJO. Endoscopic endopyelotomy is a minimally invasive procedure that may be performed as ambulatory or day-care surgery, with short recovery time and rapid return to normal activity. The ability to perform the procedure under regional anesthesia, endoscopic endopyelotomy is more suitable to patients with co-morbidities. It was originally described by Wickham, using an endoscopic urethrotome via an antegrade approach, performed a full-thickness incision of the upper ureter and UPJ. Among the three initially treated patients, two achieved improved drainage [51]. Danuser et al. assessed the results of 212 consecutive antegrade endopyelotomies over a period of 8 years and showed overall 85 % success [13]. With the introduction of smaller endoscopes with better visual imaging and the use of laser energy antegrade and later on retrograde, endopyelotomies became even easier to perform. Today, endopyelotomy for UPJO in adults is considered as first-line treatment in various urological centers. Recent reviews with longer-term follow up show that success rates are worse than previously reported. Dimarco et al. assessed the long-term results of antegrade endopyelotomy (182 patients) and open pyeloplasty (175 patients) [14]. The estimated 3-, 5-, and 10-year recurrence-free survival rates for the endopyelotomy group were only 63 %, 55 % and 41 %, respectively, compared to 85 %, 80 % and 75 % for the pyeloplasty group ($p < 0.001$). Additional crucial information arising from this study is the fact that failures continue to appear after 5 and 10 years, and patients should be followed accordingly. Rassweiler et al. showed similar results comparing the success rates of laser endopyelotomy (113 patients) and laparoscopic pyelopasty (143 patients). The laparoscopic procedure showed a superior overall success rate of 94.4 % versus 72.6 % [37].

Take Home Message
Adult UPJ may be symptomatic or discovered incidentally. Management depends on symptoms renal function and comorbidities. Various optional treatment modalities are available: open laparoscopic\robotic nephrectomy for non-functioning units. Reconstructive procedure for functioning units varies from endoscopic to open\laparoscopic\robotic pyeloplasty. Although minimally invasive endoscopic techniques considered primary option, recent reports show disappointing results and late appearance failure. Patients should be followed beyond 10 years, and given advice regarding the higher success rate of formal pyeloplasty.

Adult Cryptorchidism (Undescended Testis, UDT)

Incidence

Cryptorchidism is noted in 1–4 % of full term newborns and up to 45 % in preterm babies. The exact incidence of UDT in adulthood is not defined in the literature.

Symptoms

Acute pain due to torsion, or pain following blunt trauma, or pain related to abdominal content herniation may lead to the discovery of UDT [33].

Diagnosis

As in the pediatric age group, physical examination is the key tool for the diagnosis of UDT. In contrast to children, older man may have different body habitus, hence physical examination may be less informative mandating inguinal sonography. There are no guidelines what is the proper diagnostic algorithm for non-palpable testis in adults.

Management

In the pediatric age group, orchidopexy at an early age is guided by the need to preserve functions, and to prevent complications (torsion, susceptibility to blunt trauma and hernia). Orchidopexy may facilitate earlier detection of cancer. Regarding adult UDT, unfortunately, spermatogenesis decays with time and after the age of 2 the rate of germ-cell aplasia irreversibly accelerates. Fertility potential is better if the UDT is unilateral and if surgery was performed at earliest age possible [45]. Rogers et al. analyzed the histology of 52 resected UDTs. Patients' mean age at surgery was 26 years, and among the 52 specimens only one (1.9 %) testis showed normal spermatogenesis. The remaining testicles showed: Sertoli cells only, in 30 (58 %) patients, maturation arrest in 15 (28.5 %), and testicular agenesis in six (11.5 %). The authors concluded that the majority of UDTs cannot contribute to fertility [38]. Grasso et al. found similar results by performing testicular biopsies in 22 patients who had post-pubertal orchidopexy for cryptorchidism. More than 83 % of the biopsies showed azoospermia and severe oligospermia [21]. Although Leydig cells are less vulnerable to damage, endocrine function is also impaired in the adult UDT [22].

From fertility point of view, adult orchidopexy will not improve spermatogenesis. Concerning malignancy, it has already been shown that orchidopexy does not prevent or change the rate of testicular cancer [34]. Moreover, high percentage of UDT related cancer are at a high stage at diagnosis [39]. Orchidopexy may only improve the ability to palpate the testicle. For these reasons a unilateral orchiectomy in a presence of normal contralateral testicle is a valid option. If orchidopexy is chosen, lifelong follow up should be established.

Due to its abnormal location, UDT may cause discomfort and undergo torsion. Zilberman et al. showed that the rate of salvaging UDT torsion is lower than for normally positioned testes. Among 11 patients with torsion of UDT only two testicles (18 %) remained viable; five had massive necrosis during surgery and had to be resected and four vanished post orchidopexy [48].

Summary

The majority of adult UDTs have very low fertility potential, impairment of endocrine function and increased risk of testicular cancer. In patients with a normal contralateral testicle, UDT orchiectomy should be offered. In patients with a single testis or bilateral UDT, preservative management may be considered mandating awareness of the possible complications and close follow up with monthly self-examination and periodical physical examination [9].

Adult Ureterocele

Incidence

In the pediatric age group ureterocele may be related to a wide variety of complex anomalies, such as duplex kidney, ectopic ureter, bladder outlet obstruction, incontinence and reflux. In adults most of the ureteroceles are related to a single system. They are intravesically located and the degree of obstruction is less severe, however exception exist.

The exact incidence is not reported in the literature. Most of the cases are reported in women (4:1 female to male ratio), however most cases of stone formation in ureteroceles were reported in males. Stone formation in ureterocele was reported up to 40 % [40].

Symptoms

Presentation in an adult could be either by flank/back pain and recurrent UTI, or asymptomatic hydronephrosis detected incidentally. Stasis at the ureteral meatus due to the partial obstruction by the ureterocele, may induce stone formation inside the ureterocele, causing renal colic and/or UTI. A single case report in the English medical literature described a patient who deteriorated to renal failure due to bilateral ureterocele [47]. Rarely, prolapsed ureterocele may cause acute urinary retention in adults [49].

Diagnosis

Ultrasound will demonstrate a cystic mass within the bladder. Doppler mode can demonstrate a urine jet at the meatus of the ureterocele with volume changes during urine expulsion from the meatus. Evaluation of renal parenchyma, degree of hydronephrosis and jet sign combined with the advantage of no radiation energy exposure, ultrasound may be a sufficient tool to diagnose and follow up adult patients with ureterocele [28]. In cases where the anatomy is unclear, CT or MRI urography may give an accurate delineation of the anatomy, renal function, excretion delay and the degree of hydronephrosis. Renal function could also be assessed using nuclear medicine studies.

Management

Management should be based on symptoms and renal function. Symptomatic patients should be treated. In the case of no or poorly functioning kidney with normal contralateral kidney and normal GFR, nephrectomy should be offered. In case of duplex kidney, only the non-functioning pole should be removed, and the functioning pole should be preserved. Open, laparoscopic and robotic laparoscopic procedure can be safely performed according to patient's condition and surgeon capabilities [32].

For symptomatic patients with functioning kidney, endoscopic incision puncture or resection of the ureterocele and stone fragmentation when present will lead to symptom elimination with minimal morbidity. The main complication of these procedures is secondary vesico-ureteral reflux (VUR). Although it seems logical that puncture may less lead to VUR, prospective comparison has not been performed. The significance of post incision reflux has not completely clarified in adults.

Chtourou et al. described 20 patients (mean age 48 years) with ureterocele diagnosed due to chronic back pain; 16 had a single system and four duplex. All had an endoscopic incision, and in the presence of stones, fragmentation. Elimination of pain was successfully achieved in all patients. In a single patient the procedure was complicated with sepsis and one patient developed transient vesico ureteral reflux [10]. Vasu et al. described a rare case of bilateral ureterocele causing progressive renal failure that reversed following bilateral incision. Although these are single case reports, such complications should be taken in management considerations [47].

Take Home Message

Adult ureteroceles are usually intravesical related to single system and usually do not affect renal function. Treatment is directed to alleviate symptoms, avoid further complications and preserve renal function. Puncture or incision may be the best option for functioning symptomatic ureterocele. In the presence of stones Incision and stone fragmentation is the treatment of choice. For symptomatic nonfunctioning kidney or pole, nephrectomy or heminephrectomy should be offered. VUR is the main complication following ureterocele incision and resection but its clinical role in adults has not clearly been defined yet.

Adult Hypospadias

Distal hypospadias in itself poses only a cosmetic problem, and sometimes may cause deviation of the urinary stream. Erectile function is fully preserved and is not related to the anomaly. Ejaculation and fertility are not impaired, especially today in the era of assist reproduction. There is very little data regarding hypospadias correction in adults.

Adayener reviewed the results of primary distal hypospadias repair in 80 adults and secondary repair in additional 17 [1]. The location of the meatus was glanular in six, coronal in 35 and subcoronal in 56. Operative technique used was meatal advancement in 42, Mathieu in 41 and tubularized incised plate in 14. Overall success rate was 91.3 %. However, the meatal position-related success rate was slightly different with 91 % success for glanular and coronal hypospadias and only 85 % success rate for subcoronal hypospadias. This rate is low compared to the pediatric age group. Senkul et al. achieved a 89.9 % success rate operating on 59 adults with a mean age of 22 years, among whom 48 had distal, nine midshaft and two proximal hypospadias [41]. Operating on secondary hypospadias yields much lower success rates, with no differences in complications and failure rates noted whether the failed primary correction was performed in childhood or in adulthood. Barbagli et al. assessed 60 adults with complications following pediatric hypospadias surgery; 36 % of the patients had one complication and 64 % had two or more [3]. Complications included stricture 34, residual hypospadias 26, fistula 18, meatal stenosis 11, penile curvature nine, hair four, diverticula two and stone in one. Twenty-nine patients had one-stage repair with buccal or skin grafts or direct repair, and 31 underwent multistage repairs with buccal or skin grafts. Forty-five (75 %) patients had a final successful outcome, 15 (25 %) failed. One-stage repair provided 24 (82.7 %) successes and five (17.3 %) failures. Multistage repair provided 21 (67.7 %) successes and 10 (32.3 %) failures. The authors concluded that adults with complications following childhood hypospadias repair are still a difficult population to treat with a high failure rate for re-operative surgery.

Senkul et al. showed a 27 % complication rate for second attempt hypospadias correction in patients operated in adulthood [41].

For comparison we review results from the experience in the pediatric age group. Snodgrass and Yucel reported about fistulae rate of 10 % and an additional complication of 6 % [43]. Cheng et al. reported about 514 pediatric patients operated for distal (414) and mid-shaft (100) hypospadias [11]. For the distal repair no fistulae were reported and only a single case (0.2 %) of stenosis, in the mid-shaft group three (3 %) fistulae were noticed and one (1 %) case of urethral stenosis. Combining both groups overall complications were less than 1 %. Wilcox reviewing 26 articles comprising around 2035 pediatric patients operated for distal hypospadias revealed an average complication rate of only 9 % [50].

Take Home Message
Primary and secondary hypospadias correction in adults is feasible. Surgical success rates are lower and there is a high complication rate compared to the pediatric age group. Patients should be informed regarding this data [36].

Adult Vesico-Ureteral Reflux (VUR)

Incidence

Pinthus et al. showed a rate of 28 % of VUR in 47 female patients investigated following acute pyelonephritis. VUR was detected by indirect cystography. Later formal retrograde cystography in the same group demonstrated a steep drop to 9 % VUR rate only [35]. Choi et al. assessed 86 adult females with pyelonephritis for the significance of VUR. All patients underwent voiding cystourethrogram (VCUG), 31 of them at the 3rd treatment day and 55 at the seventh day. Only two patients (2.3 %) had low-grade reflux [12]. Today as the rate of endoscopic injection for VUR in children increases, similarly the rate of long term VUR relapse will increase too even after a short term negative cystography. Recent articles demonstrated a 50 % long term relapse [23]. The true incidence of VUR in adults has not been defined correctly yet; however we should anticipate elevation of relapsing symptomatic VUR in adult patients who were endoscopically treated.

Symptoms

Recurrent urinary tract infection, severe pyelonephritis, unexplained hypertension or renal function deterioration in the adult may lead to the diagnosis of VUR during patient workup. Koheler et al. studied retrospectively a group of 115 adults (median age 28) with known VUR and found that 87 % complained about symptomatic UTI, 34 % had hypertension, 42 % back pain and 18 % had nephrolithiasis [26].

Diagnosis

As in the pediatric age group the only way to diagnose reflux is by VCUG. Currently there are no strict guidelines when to perform VCUG in an adult patient.

Management

The treatment of pediatric reflux underwent tremendous changes in the past decade. Open surgery was replaced with conservative medical treatment and minimally invasive endoscopic procedures. Although a high percentage of patients with reflux will resolve spontaneously, in 10–40 % reflux will persist (depending mainly on grade and patient age). Symptomatic reflux, causing new renal scars, and deterioration of renal function should be treated [30]. However, the proper management for asymptomatic persistent reflux in the adult is yet to be determined.

Symptomatic patients and patients with progressive nephron loss, active treatment is recommended. There is no consensus regarding asymptomatic persistent reflux. The indications for treatment in children are not applicable in adults. The adult kidney is more resistant to infection, less prone to develop new scars, and the total kidney growth potential has already been achieved. Consideration of increased risk in the adult patient with reflux may arise for several reasons. The chance of spontaneous resolution of the reflux in adulthood is low. In females, adulthood may be related to an increased rate of bacterial UTI during sexual activity and at menopause. Pregnancy is related to overall urinary tract dysfunction, bacteriuria and UTI. The question whether reflux can impair pregnancy outcome was studied in several works: el-Khatib et al. studied the outcome of 345 pregnancies in 137 women with reflux nephropathy. Overall fetal loss was 48 (14 %) of which only six (2 %) were therapeutic abortions. Fifty-two pregnancies took place in women with plasma creatinine >0.11 mmol/l prior to conception. Fetal loss after 12 weeks' gestation (excluding therapeutic abortions) was 18 % compared to 8 % in the 104 pregnancies where maternal plasma creatinine was lower than 0.11 mmol/l ($p<0.05$). Maternal complications were also more common in the impaired renal function group ($p<0.001$). Comparison of pregnancies in women with unilateral versus bilateral renal scarring revealed no significant difference in fetal loss but an increased incidence of maternal complications in the bilateral renal scar group ($p<0.01$). Persistent VUR was not associated with increased fetal loss or maternal risk; however, impaired renal function prior to conception is associated with increased fetal loss and maternal complications in pregnancy [16]. Bukowski et al. also noticed that female patients with renal scars related to VUR may experience severe complications of pregnancy, including preeclampsia, premature birth and acute renal failure. He recommends correction of reflux prior to conception [7]. Mansfeld et al. did found higher rate urinary tract infection in pregnant female who had reflux correction but not increased rate of miscarriage [29].

For symptomatic patients endoscopic treatment is a valid option in adults, in the presence of high grade reflux and duplex systems too. Moore treated 27 adults with 93 % success rate. Complications were hydronephrosis and obstruction in 1 patient and injection failure in 3 [30].

Open surgery, laparoscopic [42] or robotic surgery [8], are also valid successful options, however surgeons should be aware that reflux operation in adults is more complex. Leissner et al. showed that following puberty, the female pelvis widens and deepens and the trigone is in a deeper retropubic location which makes the mobilization of the ureters more difficult [27]. Additionally, the plexus of vein running across the surface of the bladder enlarge and are more prone to bleeding.

Take Home Message
There are no strict guidelines when to perform VCUG in adults to detect reflux. Symptomatic reflux should be corrected. Endoscopic and surgical anti reflux surgery can be done in adults with high success rate. Asymptomatic reflux in adult is still an enigma, however in patients with renal scars and reflux the fear from pregnancy related complication might promote reflux correction prior to conception.

Adult Primary Obstructing Megaureter (POM)

Incidence

There is no solid date about the true incidence in adult however the reported series are small.

Symptoms

Urinary tract infection and flank pain are the prominent symptoms in adults with POM. Hemal et al. described a series of 55 adult patients treated over a period of 12 years: 52/55 (94 %) were symptomatic presenting with flank pain, 20/55 (36 %) had calculi, and one (1.8 %) had obstructive jaundice due to a huge hydronephrotic kidney [24]. Tatlisen described five patients with POM who all suffered from flank pain [44]. Dorairajan et al. reported a series of 37 adult patients with POM: 26 (70 %) had flank pain, 15 (40 %) UTI, 17 (46 %) urinary calculi, and five (13.5 %) presented with azotemia [15].

Diagnosis

Diagnostic imaging included ultrasound, intravenous pyelography, diuretic renogram and VCUG as in the pediatric age group. Ghersin et al. used antegrade injection of contrast material and multi-detector CT to diagnose urinary tract obstruction including megaureters without the need for intravenous contrast material injection, for the evaluation of patients with impaired renal function [18].

Management

In contrast to the pediatric age group, the medical literature uniformly recommends active treatment in adults with POM [4, 15, 17, 24]. Surgical management for functioning renal units includes ureteral neocystostomy (open or laparoscopic\laparoscopic robotic) and endoscopic endoureterotomy (electrocautery or laser), and nephrectomy for non-functioning units. Hemal et al. operated 41 patients for POM: 38 patients underwent reimplantation (21 with tailoring and 17 without) and three endoscopic ureteral meatotomy [24]. Forty three of the 47 (%) showed improvement in collecting system dilatation, and the mean follow-up time was 7 years. In this series five (12 %) patients with bilateral POM suffered already from renal failure on diagnosis, despite surgical treatment only one patient improved, and two died of renal failure. Tatlisen performed direct nipple ureteroneocystostomy in five adult patients in order to avoid ureteral tailoring [44]. Ansari et al. successfully performed three laparoscopic ureteroneocystostomies for POM; ureteral tailoring was done extracorporeally followed by Lich-Gregoir reimplantation [2]. Biyani performed four endoscopic laser ureterotomies for adult POM; a full-thickness 2.5 cm long incision was performed on the intramural and juxtavesical part of the ureter followed by internal stent diversion. In a 24-month follow-up period all patients improved; a single female patient developed reflux [6]. Bapat et al. used a cutting current to treat six POM. Follow up of 1–4 years showed reduction of hydronephrosis and elimination of symptoms [4].

Take Home Message
Adult POM in contrast to children is usually symptomatic. Due to symptoms complications such as infections, stones and reduced renal function, and low spontaneous resolution active management is advocated. For functioning units, reconstructive surgery is advised; for poorly functioning units' nephrectomy would be a better option. Ureteral reimplantation with or without tailoring is an established procedure. Endoscopic endoureterotomy showed good results, but should be evaluated for a longer term with higher numbers of patients.

Conclusions

Diagnosis of a congenital urological anomaly in an adult is not a rare event. Management considerations in the adult patient are sometimes different compared to the pediatric age group. In adults, more emphasis is given to symptoms, patient age and additional co-morbidities. The adult age group may benefit from a wider choice of surgical techniques that cannot be applied in children such as endoscopic procedures. Despite utilizing similar operational skills and techniques, surgical outcome in adults may be different from that in children. In general, there is a relatively large arsenal of available therapeutic solutions to offer to adult patients with congenital urological anomalies.

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Chapter 15
How Do I Get a Perfect Cosmetic Result After Circumcision?

İbrahim Ulman and Ali Tekin

Abstract Circumcision is not an essential surgery and poor cosmesis is an underrecognized complication of it. Factors leading to poor cosmesis following circumcision are; impertinent tissue handling, insufficient hemostasis, using thick heavy sutures with long absorption time, failing to recognize anatomical diversities or abnormalities, excessive resection of prepuce, and too tight dressing.

Keywords Cosmesis • Circumcision • Hypospadias • Prepuce • Frenulum

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Introduction

Cosmesis, by definition, means preservation, restoration, or bestowing of bodily beauty. Circumcision, which leaves a permanent change of the natal characteristics of a body part, will ever be subject to dispute particularly from the cosmetic point of view, besides function and other health related issues. Complications related to circumcision are mostly iatrogenic, imminent and need correction at diagnosis. "Bad" cosmesis is different and most people involuntarily or unwarily live with it. Since circumcision is not performed in the same manner in different communities, a "normal" looking circumcised penis in a country may seem ugly and unacceptable for people from other parts of the world. In this paper, we tried to outline basic features that will make a circumcised penis acceptable in most communities where it is performed routinely.

There are certain factors leading to poor cosmesis following circumcision:

- Impertinent tissue handling
- Insufficient hemostasis
- Using thick heavy sutures with long absorption time
- Failing to recognize anatomical diversities or abnormalities
- Excessive resection of prepuce
- Too tight dressing

Below, these points are reviewed in detail:

- The circumcision line should be close to the glans as possible (Fig. 15.1). Inner prepuce, covering the glans and designed to be wet, is more sensitive and delicate than outer preputial skin. It is prone to irritation and skin reaction left open following circumcision. Edema as a reaction to any irritant is more amplified in inner preputial skin. Limiting the width of inner prepuce up to 5–6 mm in newborns, and 7–8 mm in older boys does not only help in this issue, but it also prevents so-called "entrapped penis" by making it impossible for the circumcision line to move distal to the glans and retract (Fig. 15.2). Leaving short

FIGURE 15.1 Ideal circumcision line should be close to the glans as possible as shown in the figure

FIGURE 15.2 "Entrapped penis". The circumcision line has moved distal to the glans and retracted

inner prepuce is achievable in open sleeve and clamp techniques (Gomco and others). But, it is not possible in the traditional Guillotine-type circumcision, which leaves a very long inner prepuce with a circumcision line placed in almost the middle of the penile shaft (Figs. 15.3 and 15.4). Unfortunately, this is still the most common technique performed by non-medical personnel in large parts of the world.

FIGURES 15.3 AND 15.4 In the traditional Guillotine-type circumcision, circumcision line is almost in the middle of the penile shaft

- Another important matter is the amount of excision of the prepuce. Too much excision may cause painful erections and premature ejaculation after puberty. Proximal line of excision should be marked while the penis is stretched. Besides, suprapubic fat tissue, to which penis is embedded, may cause difficulty to determine the amount of prepuce to be excised. By simply pressing suprapubic area, the length of the penis under erection may be estimated and proximal line is marked accordingly. Distal incision is made after stripping prepuce as described above. Starting with distal incision is preferred.
- Besides enhancing cosmesis, frenulum of prepuce of penis is believed to be one of the most two sensitive specific locations of the penis. However, the frenulum is cut in 26–33 % of circumcised normal patients without any short frenulum or frenular chordee [1, 2]. Frenulum is frequently cut in Gomco clamp type circumcisions, and many surgeons approximate and suture cut sides of proximal frenulum to reconstruct it. Ignoring this small detail leads to loss of circumferential inner preputial collar on the ventral side of the penis as an adverse cosmetic effect. It may also create glandular tilt or chordee on erection if ventral skin is tight. Frenulum is usually untouched in Guillotine-type circumcisions, but this is not a reason to defend that insecure technique. Nevertheless, the open sleeve technique is the best way to preserve frenulum.
- Ample time should be given to bleeding control, particularly in older boys. Using bipolar cautery for hemostasis is safer and easier. Postoperative bleeding or hematoma is one of the most common complications of circumcision.
- Skin closure should be done with most delicate sutures. Thick and slowly absorbable materials cause permanent suture tracts, sinuses or cysts. The inner foreskin of newborns and infants is fragile. 6/0 or 7/0 quickly absorbed materials like polyglactin or polyglicaprone can be used. For the older kids and adults, 5/0 quickly absorbed materials may be used. Medical cyanoacrylate is a good alternative to stitching. It avoids permanent suture marks and suture tunnels that may be problematic. Meticulous hemostasis is vital before cyanoacrylate application. Subcuticular

(separate or continuous) suturing, which has similar advantages can also be used by giving some more time and effort.

- The aim of dressing following circumcision is to cover sensitive areas of circumcised penis until the initial stages of wound healing are complete, which is usually 2–3 days. It also prevents excessive edema, which is common after circumcision. It is never a substitute for a careful bleeding control before suturing. Spending enough time for hemostasis is a better choice rather than a pressure dressing which is unsafe. Different kinds of dressings give similar results. The most important thing for the boy and the parents is that should be easily removed.
- Circumcision is performed most commonly in the newborn period where inner foreskin is strictly adhered to glans in most normal babies. Stripping the prepuce out of the glans leads to partial loss of epithelium over the glans. This heals secondarily, and results in a different color than the rest of the glans. Another complication specific to circumcision in the neonatal or infant period is adhesion of the inner preputial skin to the corona or glans. Most of those are benign and separates in time, but rarely they form strong attachments like skin bridges requiring excision (Fig. 15.5).
- There are some potential dangers of circumcision in some tricky cases that may lead to significant complications if unrecognized and the technique is not modified accordingly. The scope of this chapter is not enough to give detailed management of these particular problems, but they are listed below in an attempt to caution the reader to appreciate these challenging cases of circumcision which requires expertise.

  – Abundant suprapubic fat around penis particularly in obese boys
  – Penoscrotal fusion (webbed penis)
  – Congenital penile curvature
  – Hypospadias with megameatus and intact prepuce (Fig. 15.6)
  – Penile torsion or rotation
  – Micropenis

FIGURE 15.5 Skin bridges due to neonatal circumcision requiring excision

FIGURE 15.6 Ignoring hypospadias with megameatus and intact prepuce during circumcision is a malpractice issue

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Chapter 16
Technical Tips for Varicocelectomy

Mehmet İlker Gökçe and Önder Yaman

Abstract Successful varicocele repair is of utmost importance for infertile couples with varicocele as a cause of male factor infertility. In this chapter, technical tips to increase quality of varicocele repair will be given. For varicocele repair, sub inguinal, inguinal, and retroperitoneal approaches can be used.

Keywords Varicocele repair • Surgical technique • Infertility

Introduction

The role of varicocele repair on maintaining spontaneous pregnancies has been a subject of debate and still controversy exists on its superiority over observation. However, recent randomized controlled trials on population of clinical varicocele and impaired semen analysis and meta-analysis of these trials clearly shown the advantage of varicocele repair [1,2,6]. Therefore successful varicocele repair is of utmost importance for infertile couples with varicocele as a cause of male factor infertility. In this chapter, technical tips to increase

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quality of varicocele repair will be given. For varicocele repair, sub inguinal, inguinal, and retroperitoneal approaches can be used. Currently sub inguinal approach with aid of operating microscope is the most commonly used, as in our center, technique with high success and low complication rates [3–5]. In the following sections technical tips for sub inguinal approach will be given.

Sub Inguinal Microscopic Varicocelectomy

Patient Position and Incision

The patient must be positioned supine and mild Trandelenburg position maintains distention of the spermatic cord. Standard perioperative precautions such as padding, deep venous thromboembolism prophylaxis, and intravenous antibiotics for prophylaxis against gram-positive skin organisms should be applied. The incision must be at the level of external inguinal ring. To maintain the correct level of incision, external inguinal ring must be identified digitally by invaginating the scrotum. Generally a 2–3 cm transverse skin incision along the lines of Langerhans is performed to maintain adequate space to reach the spermatic cord. After passing through the Camper' s and Scarpa's fascia, the surgeon should be aware of the inferior epigastric vein.

Identification of the Cord and Ligation of External Spermatic Veins

Spermatic cord should be identified at the level of external inguinal ring and it should be grasped with a Babcock clamp and drawn gently through the incision. Ilioinguinal nerve must be identified at the level of external inguinal ring where it exits from the inguinal canal. It should be dissected gently and should be spared (Fig. 16.1). Spermatic cord must be dissected bluntly and cremasteric attachments must be divided. At this level perforating external spermatic vessels should be

Figure 16.1 Subinguinal varicocelectomy: ilioinguinal nerve must be identified at the level of external inguinal ring where it exits from the inguinal canal. It should be dissected gently and should be spared

identified and carefully ligated (Fig. 16.2). Spermatic cord should be positioned on a tongue depressor and the operating microscope should be brought into the field and the cord should be examined under 8–15 power magnification. The most important point is the spermatic cord should be hold at a level as proximal as possible even from the inner portion of inguinal canal to perform high ligation of the vessels. External and internal spermatic fascia should be opened and spermatic cord is inspected carefully.

Identification and Preservation of Internal Spermatic Artery

Identification and protection of testicular artery is of upmost importance. Pulsations of the artery should be inspected but it is not always possible to observe. To aid identification of artery and separation of it from the adjacent veins, micro-Doppler should be introduced before fine dissection of the spermatic cord (Fig. 16.3). Internal spermatic artery may be

Figure 16.2 Spermatic cord must be dissected bluntly and cremasteric attachments must be divided. At this level perforating external spermatic vessels should be identified and carefully ligated

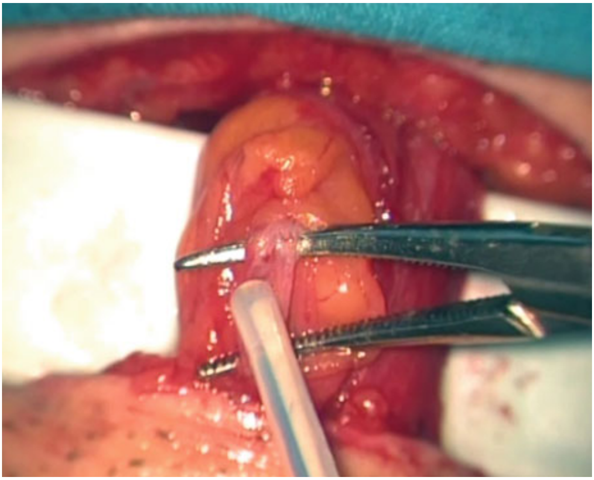

Figure 16.3 Identification and protection of testicular artery: to aid identification of artery and separation of it from the adjacent veins, micro-Doppler should be introduced before fine dissection of the spermatic cord

small in diameter or it may get smaller in diameter due to manipulations of the spermatic cord. In this case irrigation of the field with lidocaine 1 % solution or papaverine (30 mg/mL) diluted in a 1:5 ratio with saline helps to dilate the artery. Systemic hypotension due to anesthesia may also complicate identification of the artery. In this case the anesthesiologist should be requested to increase the systolic blood pressure over 100 mmHg. After identification of the artery, care the surgeon should take care of it throughout the surgery to protect and should be identified several times while performing fine dissection of the other structures.

Ligation of the Veins and Preservation of the Lymphatics

After identification of the artery, internal spermatic veins should be ligated and divided. For ligation 3–0 or 4–0 silk is generally used. However we use titanium surgical clips for venous occlusion. While dividing the veins, special care for preservation of lymphatic vessels should be given. Optical magnification aids in identification of the lymphatics and it is responsible for decreased rates of hydrocele following sub inguinal varicocelectomy. After ligation of all veins, dissection of the cremasteric fibers should be performed and any cremasteric arteries identified should also be preserved.

Completion of the Surgery

At the end of the procedure, to ensure completion of the surgery, the surgeon should check out the patency of testicular and cremasteric arteries, lymphatics, and vas deferens with its associated vessels, while there are no other veins (other than those preserved in the vas deferens packet) are visualized. If the operation is performed under local anesthesia the patient may be asked for a Valsalva maneuver to observe filling of any missed veins. Careful hemostasis should be performed first at the level of spermatic cord and than hemostasis of the adjacent tissues should be performed especially in case of ligation of external spermatic veins. The spermatic cord than should be returned to its original position. For postoperative pain relief, proximal spermatic cord may be infiltrated with local anesthetics (0.25 % bupivacaine).

For completion of the surgery, Scarpa and Camper fascia should be closed with fine absorbable sutures, and the subcutaneous tissue should be infiltrated with a local anesthetic. The skin should be closed with running subcuticular closure and Steri-strips must be used to diminish the tenderness of the edges.

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Chapter 17
Optimum Use of Second Line Treatment Options for Erectile Dysfunction

Davide Arcaniolo, Riccardo Autorino, Raffaele Balsamo, and Marco De Sio

Abstract About 30 % of patients receiving PDE5-Inhibitors for the treatment of erectile dysfunction do not respond to oral drug. It could depend on lack of correct information for drug use, lack of appropriate follow-up, presence of comorbidities, unrealistic patient expectations, incorrect diagnosis, performance anxiety and problematic relationships. So, before

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prescribing to patients a second line therapy, it is mandatory to carefully check if patient is taking PDE5-inhibitors in the right way and with an adequate sexual stimulation, if the medication taken is a licensed one, if patient is affected by hypogonadism and therefore needs a testosterone replacement therapy or if patient could benefit from the treatment of comorbidities. In addition, switching to another PDE5-inhibitor or a combination therapy with long-acting and short-acting PDE5-inhibitors could be effective strategies in non-responders. If patients are still not-responders, a second line therapy could be suggested. Intracavernosal injections (ICI) with vasoactive agents (prostaglandins, papaverine, phentolamine, vasoactive intestinal polypeptide) are the most widely used second line therapy and their effectiveness is high (>70 %). Nevertheless, the drop-out rate of these therapy is still high due to willing of a definitive and permanent therapy, discomfort in self-injection, lack of spontaneity in sexual relationship and stop of sexual activity. Use of vacuum device is a valid treatment too for erectile dysfunction with a success rate of more than 90 % and could be an alternative method in older patients in a stable relationship. Treatment with alprostadil cream with a permeation enhancer in patients affected by erectile dysfunction of all etiology and physical therapy with low-intensity shockwave in patients affected by vasculogenic erectile dysfunction are very promising strategies but to date no specific recommendation could be given for their use. Combination of different second line therapies or combination between a second line treatment and a PDE5-inhibitor could be tried before proposing a penile prosthesis implant.

Keywords Erectile dysfunction • Second line therapy

Introduction

Erectile Dysfunction (ED) is defined as the persistent inability to obtain and maintain an erection sufficient enough to guarantee a satisfactory sexual intercourse. Erection is a multifactorial phenomenon that involves hormonal, neurological and vascular mechanisms and it has a great impact on patients' and couples' quality of life.

Many epidemiological studies have been carried out to estimate prevalence of erectile dysfunction worldwide. ED is a common disease with a prevalence rate ranging from 15 % up to more than 50 %, increasing with age [1, 2]. Nevertheless a recent study testifies that about 25 % of patients affected by ED are younger than 40 years old [3].

To date, although there has been an increase of public awareness on ED in last years, more than an half of men do not seek treatment for their problem and usually there is a delay between the onset of symptoms and the request of a medical consultation with a mean time of about 2 years [4].

The principal aim of ED treatment is to restore patients' erection and consequently improve their quality of life.

Treatment of ED is a stepwise process that involve lifestyle changes, pharmacological therapy, physical therapy until surgical interventions. Since the introduction of the first phosphodiesterase-5 inhibitor, sildenafil, in 1998, oral drugs represents the most widely used therapy for ED and they can be considered the first line treatment in almost all patients. The basic physiopathology of ED is a lack of smooth muscle relaxation in the corpus cavernosum, resulting in a reduced blood flow to the penis. Smooth muscle relaxation depends on releasing of nitric oxide (NO) from cavernous nerves that activate guanylate cyclase in the smooth muscle cell, leading to an increase of cyclic guanosine monophosphate (cGMP). The increased cGMP decreases cytosolic calcium, determining final relaxation of cavernous smooth muscle. The phosphodiesterase type 5 (PDE5), an intracellular enzyme, breaks cGMP down causing penile detumescence. This is the rationale for therapeutic use of PDE5 inhibitors for ED. In fact, the mechanism of the oral agents is based on their capacity to inhibit the PDE5 enzymes, thereby allowing for accumulation of cGMP and consequently prolonging smooth muscle relaxation and erection.

There are strong evidences that PDE5 inhibitors are effective and safe in treating ED and they represent today the first pharmacological line in ED management, irrespective of etiology. In most published trial, effectiveness of PDE5 inhibitors is about 70 %, although it is significantly lower in difficult-to-treat subpopulations [5]. Most patients affected by ED receive treatment in primary care settings on the basis of minimal diagnostic pathway. For this reason, urologist are facing more often first line treatment failures rather than treating naive patients, and they have to manage unsatisfied patients.

PDE5-Inhibitors Non-responders

Reasons for PDE5 Inhibitors Failure

Before labeling a patient as a PDE5-inhibitors non responder, a physician should check all the possible reasons for treatment failure. In fact, it has been demonstrated that more than 60 % of patients who are prescribed PDE5-inhibitors did not receive the correct information for drug use and the appropriate follow-up [6, 7]. Other possible causes of therapeutic inefficacy could be presence of comorbidities, unrealistic patient expectations, incorrect diagnosis, performance anxiety and problematic relationships (Table 17.1).

Inappropriate Use

Probably one of the main reasons why patients affected by erectile dysfunction complain no efficacy of oral drugs is an inadequate counseling from their physician. In fact, most common mistakes that can jeopardize PDE5-inhibitors effectiveness are:

1. use of PDE5-inhibitors without an adequate sexual stimulation. Sexual stimulation determine nitric oxide release in smooth muscle cells and it is mandatory for the PDE5-inhibitors action;

TABLE 17.1 Reasons for PDE5-inhibitors failure

Comorbidities:
Diabetes
Obesity
Hyperlipidemia
Cardiovascular disease
Metabolic syndrome
Inappropriate use:
Low number of attempts (<6)
Lack of sexual stimulation
Inappropriate dosage
Inadequate time between administration and sexual intercourse
Intake of drug with meals
Incorrect diagnosis:
Testosterone deficiency
Hyperprolactinemia
Peyronie's disease
Psychological and relationship problems

2. consumption of an incorrect dose of oral medication;
3. failure to wait an adequate time interval between taking the drug and attempting sexual intercourse. Each PDE5-inhibitor require a different time to reach maximal plasma concentrations and there is a period of time after oral intake during which the drug does not work properly and this lapse can widely vary between one patient and another [8–10]. For the same reason, waiting too long after drug ingestion could compromise its effectiveness;
4. incorrect use of PDE5-inhibitors related to food and alcohol consumption.

Comorbidities

Erectile dysfunction and cardiovascular and metabolic disease are closely related. Therefore the presence of metabolic syndrome components can impair clinical response to PDE5-inhibitors. So diabetic patients, obese men, patients affected by cardiovascular disease or hyperlipidemia could not properly respond to oral PDE5-inhibitors treatment [11].

Incorrect Diagnosis

Some patients can be initially considered as non-responders to PDE5 inhibitors, due to misdiagnosis. The most frequent eventuality is represented by patients affected by hypogonadism or hyperprolactinemia, who need specific hormonal treatment to improve erectile function. Although there is no complete agreement, testosterone deficiency seems to determine a poor response to PDE5-inhibitors and testosterone replacement therapy could be helpful to improve PDE5-inhibitors effectiveness. Another possible reason for PDE5-inhibitors failure could be a undiagnosed Peyronie's disease, who needs specific treatment for pain and penile curvature.

Patient's and Couple's Issues

Response to PDE5-inhibitors can be altered by patient's unrealistic expectations, such as considering drug a sexual enhancer, fear of side effects and anxiety about the recovery of their sexual life. In addition, all psychological issues that have been not recognized during the diagnostic process could compromise oral drugs' effectiveness.

In the same way, sexual dysfunction in female partners (anorgasmia, lack of lubrication, pain during intercourses, lack of sexual desire) can determine therapeutic failure.

How to Manage Non Responders to PDE5 Inhibitors

Before proposing to a patient a second line therapy, whose results are not always satisfactory, some possible strategies should be taken under consideration in order to try to convert "non-responders" in "responders" (Fig. 17.1). Pretreatment counseling is as important as the treatment itself.

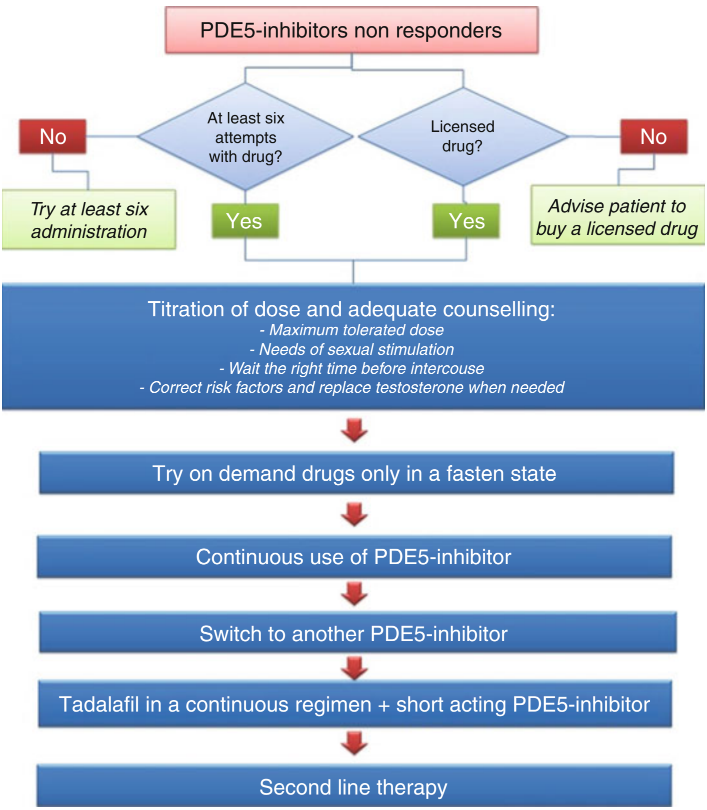

FIGURE 17.1 Flow-chart for preliminary management of PDE-inhibitors non-responders

First of all, it has been demonstrated that an adequate trial with PDE5-inhibitors should take into account at least six attempts before classifying a patients as non-responders [12]. This consideration is crucial as, in clinical practice, it is quite common that patients refer ineffectiveness of oral drugs after only one or two administrations and almost always after not more than four attempts. It is also mandatory to advise patients that the use of oral drugs for erectile dysfunction treatment requires an adequate sexual stimulation.

Patients should receive correct information about time of onset of therapeutic effect and interference of food and alcohol intake on clinical effectiveness for each prescribed drug. Sildenafil, Vardenafil and Avanafil have a similar rapid onset of action (30–60 min), with avanafil claimed to be the faster drug (15–30 min). Nevertheless the time between drug intake and onset of therapeutic effect is widely variable from one patient to another. So, in clinical practice, it is appropriate to advise patients that if a drug does not work after a short time, maybe the effects can be seen later with a longer latency time. Sildenafil works better when swallowed under fasting condition, while tadalafil absorption is independent by the food intake. Vardenafil and Avanafil effectiveness could be affected by a high fat meal. Just giving this information, more than 45 % of non-responders to PDE5-inhibitors become responders [7].

Another possible strategy to improve effectiveness of PDE5-inhibitors is to titrate oral drug dosage to the maximum tolerated. Patients who do not respond to low doses of PDE5-inhibitors often have a therapeutic effect with the maximum dosage [6].

In clinical practice, the acronym FAST (Follow-up, Adjustment of dosing, Sexual stimulation and Titration to the maximum tolerated dose), created by Hatzichristou in 2002, can be useful to remind the basic principles of patient information (Table 17.2) [6].

Another important issue is to ask patient where he bought the drugs in order to ensure that he has taken a licensed medication. In fact, more than 70 % of drugs purchased online result to be counterfeit, containing only a small amount of active drug (less than 50 %) and sometimes some harmful substances (lead paint, rat poison, printer ink, floor wax, drywall, chalk, boric acid, etc.) [13].

Table 17.2 Managing patients with erectile dysfunction: the FAST acronym [8]

F	Follow-up of patients
A	Adjustment of dosing
S	Sexual stimulation
T	Titration to the maximum tolerated dose

Regarding patients affected by testosterone deficiency, although evidences are contrasting about the role of testosterone replacement therapy in improving PDE5-inhibitors effectiveness, hypogonadal patients who are non-responders to PDE5 inhibitors might benefit from restoring testosterone levels, especially in men with low baseline testosterone levels (<3 ng/ml) [14].

Modification of other risk factors like hyperlipidemia, diabetes or hypertension improves the response to PDE5 inhibitors in non-responders, but predictive factors of this response are not known. A physichosexual counseling could be helpful when psychological or relationship issues were recognized.

Some data suggest that switching from one PDE5-inhibitors to another could improve the response to oral drug and it could be explained by the differences in term of pharmacokinetics between drugs [15]. Use of chronic administration (daily or two/three times per week) of a PDE5-inhibitors and the possible combination of a chronic regimen of tadalafil and a short-acting PDE5-inhibitor can be possible alternative strategies to manage non-responders before offering them a second line therapy [16].

Second Line Treatment Options

When patients do not respond to oral first line therapy despite all above described maneuvers or present contraindication to PDE5-inhibitors, they should be offered a second line treatment. Historically, intracavernosal injections (ICI) represented the most widely used treatment before development of PDE5-inhibitors and to date are the preferred second choice treatment. Nevertheless, some other options are available to manage non-responders men and it is not possible to define a gold standard and all the possibilities should be discussed and proposed to patients. Main indications and most frequent side effects for each second line treatment are summarized in Tables 17.3 and 17.4.

Intracavernosal Injection of Vasoactive Drugs

There is a wide and long clinical experience about ED therapy with intracavernosal self-injections (ICI). Overall success rate is high (>85 %) and ICI is relatively well tolerated with no significant side effects when patients acquire the correct injection technique [17]. Unlike oral drugs, use of ICI do not require sexual stimulation to work properly.

Table 17.3 Preferential indications of available second line treatment for erectile dysfunction

Treatment	**Indications**
Intracavernous injections	ED of all etiology in patients non-responder to PDE5-inhibitors
Intraurethral alprostadil (MUSE™)	Patients non-responder to PDE5-inhibitors with an injury (usually iatrogenic) of autonomic penile nerve supply or those who do not prefer ICI
Topical alprostadil	ED of all etiology in patients non-responder to PDE5-inhibitors
Vacuum Erection Devices (VCDs)	ED of all etiology in elderly man, non-responder to first line therapy, in a stable relationship with a low frequency of sexual intercourse.
Low Intensity Shockwave Therapy (LI-ESWT)	Vasculogenic ED without any neurogenic or psychogenic etiology

TABLE 17.4 Main side effects of available second line treatment for erectile dysfunction

Treatment	Side effect
Intracavernous injections	Priapism Penile fibrosis Penile pain Penile hematoma Bruise
Intraurethral alprostadil (MUSE™)/ topical alprostadil	Priapism Local erythema Penile/urethral pain
Vacuum Erection Devices (VCDs)	Pain Anejaculation Bruise Ischemia until necrosis
Low Intensity Shockwave Therapy (LI-ESWT)	Local irritation

The following vasoactive drugs are available for clinical use:

- Alprostadil (Prostaglandin E1 or PGE1)
- Papaverine
- Combination Papaverine/Phentolamine
- Combination Papaverine/Phentolamine/PGE1 (Trimix)
- Combination of Vasoactive Intestinal Polypeptide (VIP) and Phentolamine

Correct injection technique is showed in Figs. 17.2 and 17.3.

Alprostadil (PGE1)

Intracavernous alprostadil is most efficacious as monotherapy at a dose of 5–40 μg and its action arises after about 5–15 min from injection depending on the selected dose.

PGE1 acts on EP prostaglandin receptors on corpora cavernosa activating adenylate cyclase and determining an increase of intracellular concentration of cAMP. This mechanism causes

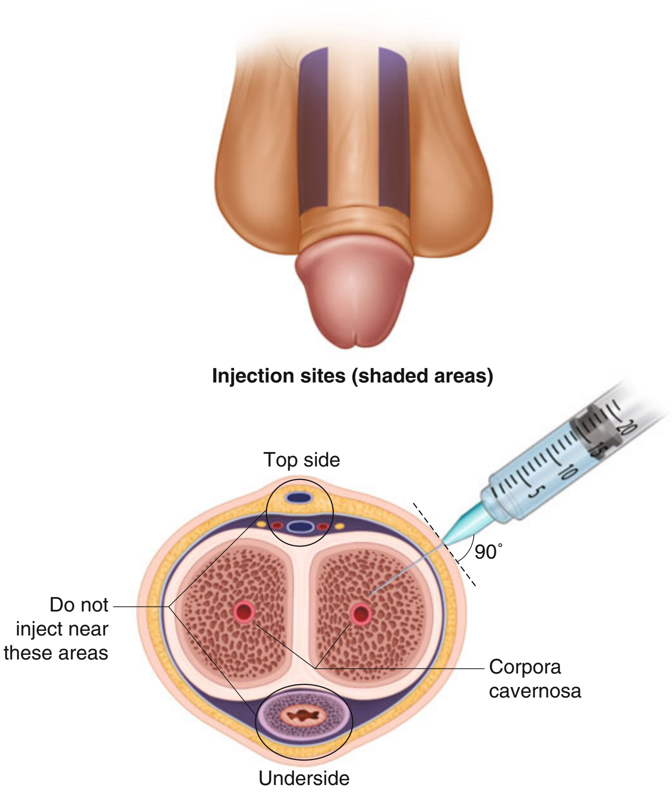

FIGURE 17.2 Sites of intracavernosal injection (Source: www.pfizer.com; Redrawn)

relaxation of corpus cavernosum smooth muscle [18]. Additional actions of PGE1 are inhibition of noradrenaline and angiotensin II secretion in the cavernosal tissues [19, 20].

Effectiveness of PGE1 injection in RCTs is high (>90 %) also in difficult-to-treat population (>70 %) (diabetes, CVD) [21] and patients are fairly satisfied of ICI therapy (78 %). Predictive factors of satisfaction include older age, younger partner, good therapeutic response and achievement of fully rigid erections (Erection Hardness score = 4) [21]. In a small

FIGURE 17.3 Technique of intracavernosal injection

percentage of patients (about 35 %) it has been showed a return of spontaneous erections after intracavernous injections treatment.

Despite the high satisfaction rate, more than 50 % of patients discontinue ICI therapy, especially in the first months of treatment [17, 22]. Among different causes of drop-out, the most frequent are poor effectiveness of drug, willing of a definitive and permanent therapy, discomfort in self-injection, lack of spontaneity in sexual relationship and stop of sexual activity.

Overall complication rate of alprostadil injection is quite low. Most frequent side effects include pain at injection site (frequent but usually mild), long lasting erection until priapism (<1 % of patients) and iatrogenic fibrosis [17, 22]. Diabetic patients are at a higher risk of penile pain and fibrosis.

In clinical practice, in order to avoid potential dangerous side effects and to teach patient the correct technique for self-injection, it is mandatory an office training with titration of dose, starting from the lowest available until the effective one. Usually, at least two or three training session are necessary for a good teaching. In cases of impaired manual ability, the partners may learn the technique. In addition, an adequate pre-treatment counseling could minimize drop-out rate. Patients should be warned of potential risk of priapism and of the possible early development of a Peyronie's disease. Pain at injection site could be reduced by use of local anesthetic or addition of sodium bicarbonate. Also the use of thin needles (27–30 gauge) could be useful. Based upon data from literature and clinical practice, patients on anticoagulants drug can perform safely self-injections.

Papaverine + Phentolamine

Combination of papaverine (30 mg) and phentolamine (1 mg) is available in some countries and its efficacy is comparable with 10 μg of Alprostadil in terms of effectiveness and side effects.

Papaverine + Phentolamine + PGE1 (Trimix)

Trimix combination represent a valuable alternative treatment in patients who do not respond to alprostadil or do not bear its side effects. Combination of these three drugs showed higher effectiveness (92 %) and less penile pain when compared to alprostadil alone [22]. In clinical trials, many combination have been tried up to 300 mg papaverine, 200 μg PG1 and 20 mg phentolamine. In clinical practice, higher dose of trimix can determine an elevated risk of priapism and penile fibrosis and a possible, although uncommon, decrease of systemic blood pressure. So it is mandatory to titrate the dose progressively until reaching the appropriate one. Expert clinicians suggest to not exceed the dose of 30 mg papaverine, 40 μg PGE1 and 1 mg phentolamine outside of clinical trials.

Combination of VIP (Vasoactive Intestinal Polypeptide) and Phentolamine

Although approved only in few counties, the combination of VIP and phentolamine at the fixed doses of 25 mg/1 mg and 25 mg/2 mg presented a more favorable injection system if compared to alprostadil and good results in term of effectiveness. In addition, unlike other ICIs, it is associated with a very low incidence of penile pain and risk of priapism [23].

Nevertheless, to date we have not enough data to suggest this combination as a reliable second line therapy in patients non-responder to PDE5-inhibitors.

Intraurethral/Topical Alprostadil

The MUSE™ (Medicated Urethral System for Erection) therapy is a patented formulation of alprostadil (125–1000 μg) available for transurethral delivery. Although promising, in clinical practice results of MUSE therapy are not satisfactory and less effective if compared to injective alprostadil [24]. Efficacy of transurethral alpostadil can be enhanced applying it immediately after micturition with the urethra still wet, dressing the penis with a compressive bandage or using a constriction penile ring. Treatment is usually well tolerated with no significant adverse events. MUSE therapy could be proposed to patients non-responder to PDE5-inhibitors with an injury (usually iatrogenic) of autonomic penile nerve supply or those who do not prefer ICI. Combination therapy with PDE5-inhibitors has been proposed to treat poor-responders patients [25]. Starting dose of 500 μg is highly recommended, as it has a higher efficacy than the 250 μg dose, with minimal differences in side effects.

Alprostadil can be delivered also by topical application. It is now available as cream (300 μg) in association with a permeation enhancer (Dodecyl 2-(N,N-dimethylamino) propionate Hcl), that facilitate absorption of drug through the urethral mucosa [26]. This formulation has a rapid onset of action (5–30 min in most patients) and the effect can last up to 1 h. Significant improvement of erectile function has been demonstrated in more than 80 % of naïve patients affected by ED irrespective of etiology when compared to placebo [27]. This formulation is effective also in patients non-responder to previous ED treatments. About 50 % of previous treated patients reported an improvement of erectile function [27]. Insertion of the cream dispenser directly into urethra rather than dropping the cream seems to improve success rate. Treatment is well tolerated with a minimum risk of systemic effects and a small percentage of patients complaining priapism, local erythema and penile pain. Studies on female showed that topical alprostadil does not alter pH, bacterial microflora or histology of vagina, supporting the safety of formulation transfer [28].

To date, it is not possible to give a specific recommendation for therapy with topical alprostadil cream. It could be useful as second line therapy, alone or in association with a PDE5-inhibitors, for non-responder patients who are not suitable for intracavernous therapy or as a first line therapy in patients in whom PDE5-inhibitors are contraindicated.

Vacuum Erection Devices

Although there are many vacuum devices (VCDs) available on market, all of them share the same mechanism of action: a plastic tube that fits around the penis is applied at the base of the penis with lubricant. Air is pumped out of the tube (manually or electrically), creating a vacuum. The vacuum facilitates the increase of blood flow into the penis, producing a passive erection in a few minutes. A constrictive ring is placed around the base of the penis to maintain the erection, and then the tube can be removed (Fig. 17.4).

The main advantage of VCDs is that they can be applied to every patients affected by ED regardless of etiology and the success rate is the highest among ED treatment (90 %) as first or second line therapy [29]. Unfortunately, the level of acceptance is quite low with a high discontinuation rate due to a perception of a mechanical and not natural erection by the patient and his partner. In fact, the crura of penis are not involved in the erection process and the penis can be perceived as cold by the patient and the partner too. So the best candidate for vacuum therapy is an elderly man, naïve or more often non-responder to first line therapy, engaged in a long-lasting stable relationship with a low frequency of sexual intercourse.

Side effects are uncommon (<30 % of patients) and include pain, ejaculatory dysfunction, bruises and hematoma [30]. Penile ring must be removed within 30 min in order to

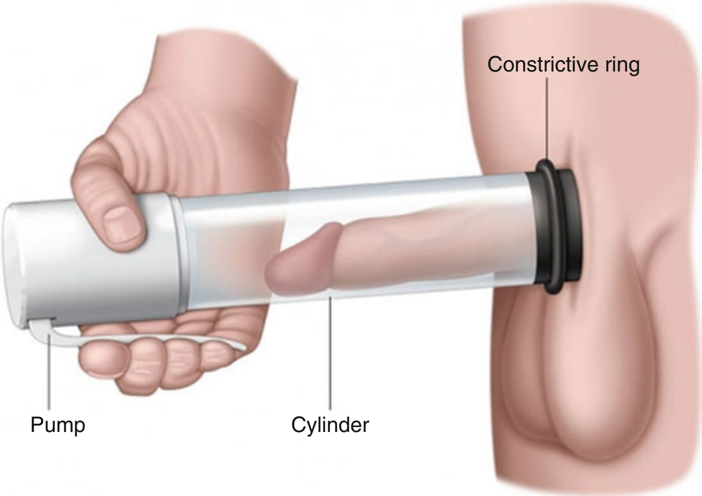

Figure 17.4 Vacuum device (Source: EAU website (Redrawn): http://patients.uroweb.org/erectiledysfunction/treatment/vacuum-erection-device)

reduce the risk of ischemic damage and consequent necrosis. Use of vacuum devices is contraindicated in patients on anticoagulant therapy and in patients with history or recurrent priapism. Patients with a severe penile curvature should be advised of the higher risk of penile fracture.

Low-Intensity Shockwave Therapy

When low-Intensity shockwaves (LI-ESWT) are applied to a tissue, the evocated shear stress activates a cascade of biological reactions that determine the release of angiogenic factors resulting in neo-angiogenesis and subsequent increase of blood supply.

The proposed protocol requires the application of 300 shockwaves at the intensity of 0.09 mJ/mm^2 to each of five different sites: three along the penile shaft (basal, medium, tip) and two down to the crura (Fig. 17.5). The whole thera-

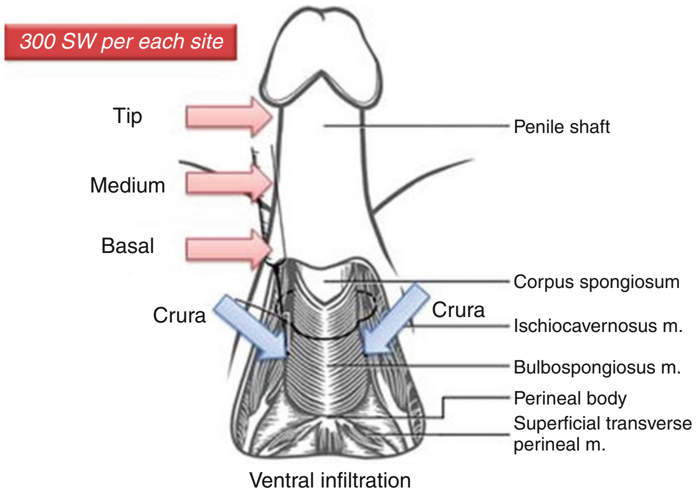

FIGURE 17.5 Site of low-intensity shockwave application

peutic session consist in two treatment per week for 3 weeks and this cycle must be repeated after a 3-week no-treatment interval. Data from clinical trials testify a good effectiveness of treatment in patients with mild, moderate or severe ED due to cardiovascular disease and without any neurogenic or psychogenic etiology. Erectile Function and cavernosal blood flow significatively increased after shockwave therapy [31]. A successive trial demonstrated that LI-ESWT therapy can convert more than 70 % of PDE5-inhibitors non-responders into responders [32]. These results have been confirmed in other studies with different SWT devices [33].

To date, published guidelines do not give a clear recommendation on LI-SWT, but in clinical practice many referral centers across Europe are performing successfully this therapy as second line therapy in non-responders patients before starting with intracavernosal injections.

Combination Therapy

Before proposing a penile prosthesis implant, some therapeutic combination could be tried in poor-responder patients. Data on literature about these treatment are lacking so it is not possible to give specific recommendation on their use.

– PDE5-Inhibitor short acting + Intracavernous injection of PGE1 or Trimix
– PDE5-Inhibitor short acting + Intraurethral/topical PGE1

Patients should be advised of the increased risk of side effects and a strict follow-up should be performed.

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Chapter 18
Management of Recurrent Urethral Strictures

Omar E. Soto-Aviles and Richard A. Santucci

Abstract Stricture recurrence, either after previous dilation/urethrotomy or urethroplasty, can be complex. After failed urethrotomy/dilation, we generally perform a urethroplasty. After urethroplasty, failures are treated with a single DVIU, because of a reported rate of lasting success which may be as high as 50 %. After failure of this initial salvage DVIU, we generally plan redo urethroplasty. For most urethral strictures, this will be a buccal urethroplasty. If the patient had a previous buccal urethroplasty, the redo surgery is done on the opposite side of the urethra (initial urethroplasty = ventral, then redo urethroplasty = dorsal). Patients with urethral obliteration may need a modified roof strip anastomotic technique. In rare cases of short bulbar stricture, redo EPA may be done. In patients with previous staged Johanson urethroplasty, especially in patients with hypospadias, failures may be treated with redo staged Johanson urethroplasty. In patients with failed PFUI repair, a redo PFUI can be performed with very high success rates.

Keywords Recurrent urethral stricture • Urethroplasty

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Introduction

Urethral stricture is a common urological condition that represents an economic burden to any healthcare system if not managed cost-effectively. There is sufficient data available to validate that recurrent urethral stricture should not be treated with multiple internal urethrotomy or dilations unless there are contraindications for surgical treatment with urethroplasty [2, 3]. We aim to describe our experience with recurrent urethral strictures, with emphasis on the management according to their initial treatment.

We think of "recurrent" stricture as recurrence after urethrotomy/dilation, and recurrent stricture after urethroplasty. Several risk factors can contribute to recurrent stricture including patient-related factors and those related to surgical technique. Patient factors such as stricture length, location, untreated perioperative urinary infection, extensive periurethral spongiofibrosis, diabetes, lichen sclerosus, and smoking may contribute to a unsuccessful initial intervention [1, 4]. Also surgical success will depend on whether the correct initial treatment was done. Endoscopic management for long bulbar urethral strictures is known to fail since these strictures will do better with urethroplasty rather than endoscopic management. Endoscopic management of even short penile strictures is also likely to fail (Table 18.1).

Initial Evaluation

Regardless of their previous treatment, all patients should undergo similar preoperative evaluation. Initial evaluation consists of a complete history and physical exam with emphasis on previous surgical history, GU instrumentation and any significant history that might represent a contraindication for buccal graft harvest for example head and neck radiation for malignancy. We generally diagnose recurrent stricture with a combination of obstructive symptoms, high post void residual, low peak urine flow rates, and a flattened uroflow pattern consistent with obstruction. Stricture is confirmed by cystoscopy, RUG or even by failure to pass an 18 F catheter to the bladder.

TABLE 18.1 Summary of recommended interventions according to the initial management prior to recurrence

Initial management	Recommended intervention
Endoscopic	Substitution urethroplasty with ventral BMG
Excision and primary anastomosis	
No obliteration	Substitution urethroplasty with BMG
Significant obliteration	Modified "roof strip" urethroplasty
Complete obliteration	Redo excision and primary anastomosis
Substitution urethroplasty	Direct vision internal urethrotomy for ≤1 cm Contralateral substitution urethroplasty >1 cm
Staged procedures (Johansen)	Redo staged repair
Repair of PFUI	Redo repair of PFUI

BMG buccal mucosal graft; *PFUI* pelvic fracture urethral injury

Once the suspected diagnosis of recurrent is established, we perform a retrograde urethrogram to establish the anatomy, determine if the recurrent stricture represents failure or a new stricture at a different location. Also all patients will provide a urine sample to evaluate the presence of asymptomatic bacteriuria to guide preoperative antibiotics and identify/treat an active urinary tract infection prior to intervention. In patients with a previous urethroplasty, our initial re-treatment is almost always a urethrotomy. We take advantage of this opportunity to thoroughly familiarize ourselves with the urethral anatomy during the urethrotomy procedure, in order to plan the subsequent redo urethroplasty.

Recurrence After Endoscopic Treatment

Recurrence after endoscopic treatment may be related to incorrect initial treatment of a long stricture or a location not amenable for endoscopic treatment such as penile strictures.

Recurrence may also be due to poor success rate of direct vision internal urethrotomy (DVIU) in general. Series confirmed over 92 % failure rate of initial DVIU and several series report 100 % failure for two or more DVIU [2, 3, 6]. One paper that famously reported 50 % overall success rate of initial DVIU, had no success in strictures longer than 1.5 cm [2]. In that series, also, dilation was shown to have a much higher failure rate than urethrotomy.

In patients who are fit for surgery, we plan urethroplasty in patients with even a single failure of previous urethrotomy. In patients that are not good surgical candidates for formal urethroplasty, then we may perform palliative DVIU with the expectations of recurrence.

Recurrence After Excision and Primary Anastomosis (EPA)

It is said that recurrence after EPA might be related to lack of a tension-free anastomosis at the time repair. It is important to mention there is always a subgroup of patients who will develop a new stricture distal/proximal to the initial repair, therefore recurrent stricture might not represent primary surgical failure but new disease at a different location within the urethra. Failure after excision and primary anastomosis represents a unique problem when compared to other surgical techniques since the recurrent stricture may obliterate the urethral lumen more often than other techniques. Also, patients who have failed a previous EPA are unlikely to be able to have a second EPA since the urethral length has already been compromised by the previous surgery. Assuming the initial surgery was for a 2 cm bulbar stricture, and the patient has a recurrent stricture of at least 2 cm, the total urethral excised at the time of redo excision and primary anastomosis will not be less than 4 cm. Primary anastomosis of a 4 cm gap is technically challenging and prone to failure and can create a significant chordee on patients with preserved erectile function.

Urethral obliteration, if present, may represent a challenge at the time of revision surgery. In our hands, we almost always perform a ventral buccal urethroplasty for bulbar recurrences after EPA (Fig. 18.1), and a dorsal buccal urethroplasty for penile recurrences after EPA (Fig. 18.2). If at the time of surgery the recurrent stricture after EPA does not completely obliterate the lumen, we tend to use a standard ventral onlay substitution buccal urethroplasty (Fig. 18.1). In patients where there is significant lumen obliteration, we will perform a "modified roof strip" urethroplasty with ventral placement of a buccal graft. This technique consists of performing a ventral

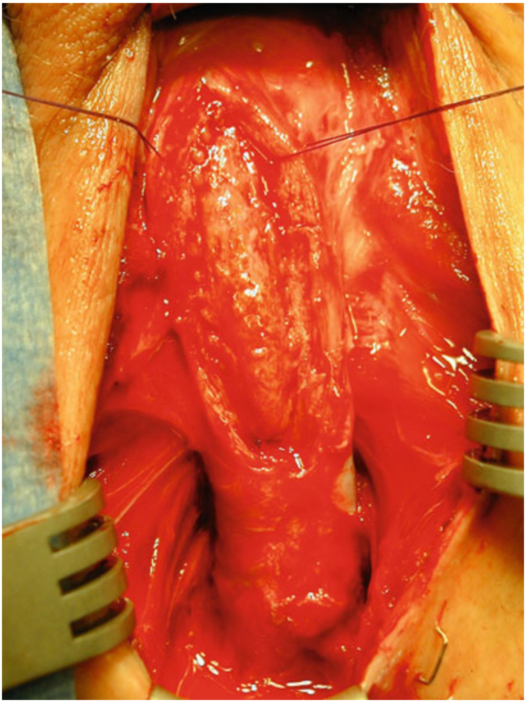

FIGURE 18.1 Standard ventral onlay buccal urethroplasty. Graft is in place, awaiting closure of the tunica spongiosum over the graft, to create a well vascularized graft bed and good graft backing

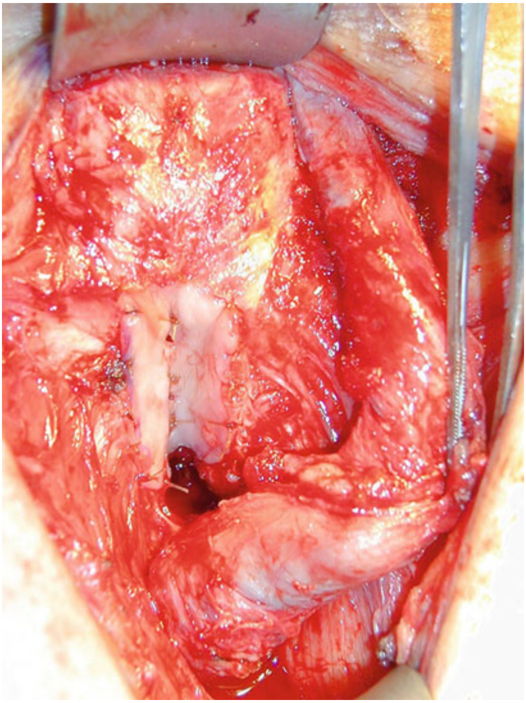

FIGURE 18.2 Dorsal buccal urethroplasty with urethra fully separated from the corpora. Alternatively, the urethra can be taken off one side only in the method of Kulkarni, leaving some of the urethral blood supply connections to the corpora intact

urethrotomy at the stricture and evaluating the residual urethral plate dorsally. If urethral plate dorsally is nearly not existent, we will excise just the urethra plate without transecting the corpora spongiosum. Once this is achieved, the ends of the dorsal urethral plate will be sutured together or a second buccal graft will be placed dorsally if the gap is more than about 1.5 cm. In only rare selected cases, where there is SHORT complete obliteration of the urethral lumen and the stricture location is within the proximal bulb we will perform a redo excision and primary anastomosis.

Recurrence After Substitution Urethroplasty

Recurrence after this technique is seen in about 10 % of patients and is said to occur at the anastomotic site of the graft or flap to the native urethra. However in our practice, we often see patients with new stricture distal or proximal to the previous repair site. To avoid recurrence at the anastomotic site, we aim to see healthy urethra at our proximal and distal margins and routinely place the buccal mucosal graft beyond the stricture length within normal appearing urethra, extending the graft at least 0.5 cm distally and 1.5 cm proximally.

Patient who have recurrent urethral stricture after substitution urethroplasty are initially treated with direct vision urethrotomy because of a reported lasting success rate as high as 50 % [5] (note that in our hands this figure is about 40 %). If there is recurrence after the endoscopic management then we will proceed with another substitution urethroplasty. It is important that at this moment patient's previous surgical history and operative reports are reviewed since this is taken in consideration at the time of redo surgery. Patients who had undergone a ventral onlay substitution urethroplasty will be treated with a dorsal onlay substitution urethroplasty, and vice versa.

Buccal Urethroplasty Practical Tips

1. Patient placed on an extended lithotomy position
2. Placed a 22 Fr soft catheter through the urethra to delineate stricture location and guide skin incision
3. Midline perineal incision
4. Adequate retraction (we use the Jordan-Knight retractor system developed for the Bookwalter retractor [J]. Hugh Knight Instrument Company; Slidell, Louisiana, USA)
5. Incise the urethra at the level of the stricture as indicated by the 22 Fr catheter

6. Placed a small caliber pediatric feeding tube or wire in the proximal end of the urethra to find the urethral lumen
7. Extend the urethrotomy as needed to be able to calibrate with a 30 Fr bougie both distally and proximally. The urethrotomy should extend at least 5 mm distal and 1.5 cm proximal to the urethral narrowing. The graft should generally extend over healthy-appearing, unstrictured urethra.
8. Place your graft without significant stretching.

Recurrence After Staged Urethroplasty (Johansen)

Recurrence after staged, Johanson type urethroplasty can be difficult. Often these patients have previous hypospadias and hypospadias repair, and they seldom have any "normal" urethral tissue to apply buccal grafts to. In the majority of cases, after failure of DVIU (where we also shoot a retrograde urethrogram, and carefully note the features of the recurrence during the DVIU) we will need to redo the first and second stage urethroplasty. We always place buccal grafts in the first stage, because it has been associated with higher success rates in our own series (Fig. 18.3). We will re-harvest previously harvested buccal graft beds, although we often find the mucosal defect is too tight to close and must be left open to close by secondary intention. We will also use lingual grafts, although we avoid labial grafts because of a high 20 % rate of lifelong lingual anesthesia even in expert hands. In the unlikely event that buccal mucosal tissue is not available, then meshed split thickness skin grafts can be placed in the first stage to augment the urethral plate. The use of skin grafts in the first stage may be associated with high long term failure rates in the 50 % range, though. Patients with hopeless urethral stricture who are out of options might consider a perineal urethrostomy (Fig. 18.4). This seems to be more commonly required in so called "hypospadias cripples" for whom still another urethroplasty is unlikely to be curative.

FIGURE 18.3 First stage Johanson urethroplasty with buccal grafts. Note the left-sided graft is yet to be sewn into the defect created between the urethral plate and the penile skin

This can be difficult unless there is some sparing of proximal bulbar urethra to bring out to the skin.

Recurrence After Pelvic Fracture Urethral Injury Repair (PFUI)

Recurrence after PFUI repair is said to be associated with inadequate resection of the scar tissue on the proximal side of the urethral disruption defect or failure to fully mobilized the distal side of the urethral disruption defect. However in

FIGURE 18.4 Perineal urethrostomy, which diverts urine from the bulbar urethra to the skin in the case of intractable obstruction of the distal urethra

our experience, failures are most likely relate to poor distal blood flow from loss of bulbar arteries and poor retrograde blood from cavernosal arteries. Most patients undergoing redo surgery for pelvic fracture urethral injury will need adequate urethral mobilization and complete resection of the scar tissue to have a successful operation (Fig. 18.5). Additional surgical maneuvers in order to achieve a tension-free anastomosis are always implemented when needed, but the majority of patients will get excellent results with simple re-excision of the scar and subsequent tension-free anastomosis. Selected cases where the proximal end cannot be reached

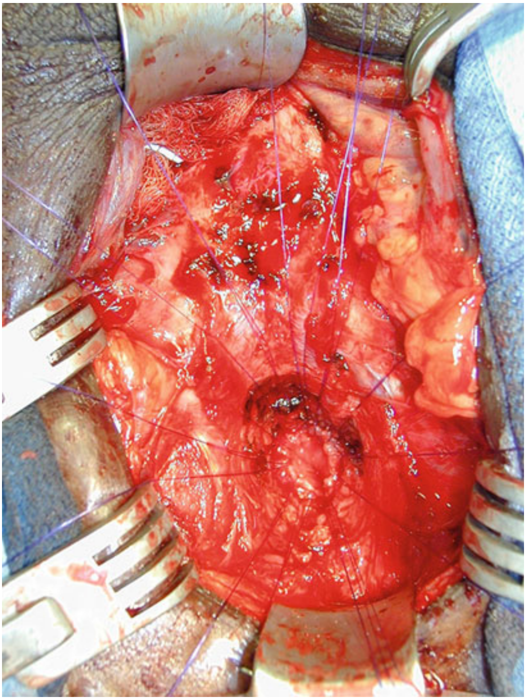

FIGURE 18.5 PFUI repair after removal of all the scar tissue between the proximal and distal urethral stumps. Note the defect in the "wall of scar" which then allows easy access to the proximal urethral stump and 12 sutures are placed through it. The distal urethra has been completely dissected free of the corpora and is not seen because it has been temporarily tucked proximally out of the way

need partial removal of the pubic symphysis after developing the intercrural space. The gap between the distal and proximal urethral stumps of patients after the posterior urethral injury trauma is highly unpredictable and the surgeon always need to be prepared to perform any surgical maneuver necessary to achieve a tension-free anastomosis after complete scar resection, but in our experience they are seldom needed if distal urethral mobilization is thorough enough.

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Chapter 19
Management of Severe Hemorrhagic Cystitis

Razvan Bardan

Abstract Hemorrhagic cystitis is a significant urological condition, consisting of inflammation and/or damage of the urinary bladder mucosa and superficial blood vessels, with subsequent diffuse bleeding. It can present with main clinical symptoms and a number of possible causes have been identified. Treatment options, from general supportive measures to surgical procedures, for this challenging disease are described in this chapter.

Keywords Hemorrhagic cystitis • Hematuria • Treatment

Introduction

Hemorrhagic cystitis is a significant urological condition, consisting of inflammation and/or damage of the urinary bladder mucosa and superficial blood vessels, with subsequent diffuse bleeding. Its main clinical symptoms are: persistent (and frequently severe) hematuria, urinary frequency, suprapubic

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pain, and even acute urinary retention (due to blood clots). A large number of possible causes of hemorrhagic cystitis have been identified, including radiation therapy (for prostate or cervical cancer), infectious pathogens (viral, as BK virus, adenovirus, herpes virus, or bacterial, as *Escherichia Coli*, *Proteus Mirabilis*, or *Klebsiella*), and chemical or drug exposure (to cyclophosphamide, ifosfamide, busulfan, thiotepa, or aniline dye, among many others).

General Supportive Measures

- If the risk factors or causes of the hemorrhagic cystitis are known, specific measures should be taken;
- If the etiology of the bleeding is not already established, a complete diagnostic workup is warranted, including urinalysis, urine cytology, ultrasonography, cystoscopy, CT/MRI examination of the urinary tract, associated with the lab evaluation of hemoglobin, complete blood count, and coagulation tests;
- Anticoagulant therapy should be stopped, if there is any suspicion that the bleeding is due to inadequate dosage of anticoagulant drugs;
- Patients undergoing chemotherapy may have also thrombocytopenia, which should be corrected;
- In patients with viral hemorrhagic cystitis (generally due to immunosuppression), the dose reduction of immunosuppressants, associated with the administration of antiviral agents, is sometimes useful;
- If we suspect a bacterial urinary tract infection, systemic antibiotherapy should be administered as fast as possible (don't forget to send a urine sample for urine culture before the initiation of the antibiotherapy!);
- Supportive care should include increased oral hydration (if possible), the immediate administration of intravenous fluids, and blood transfusions (if necessary);
- If these measures are not effective, we usually **insert a three-way Foley catheter** into the bladder, **remove the clots** by instillation/aspiration with a Guyon bladder

syringe, and start **continuous bladder irrigation** with sterile saline solution or water;
- For persistent, severe hematuria, not responding to continuous bladder irrigation, or for large clots, blocking the bladder, we recommend to do a **cystoscopy** under anesthesia, **evacuate the blood** clots, look for bleeding sources inside the bladder, and perform their **fulguration**.

Instillation Therapy

- Bladder irrigation with **alum** (aluminum ammonium sulfate or aluminum potassium sulfate) in a 1 % dilution, dissolved in sterile water, at a rate of 250–300 mL/h, up to 4 days, is effective in over 60 % of the cases of severe persistent hematuria, acting as an astringent, which leads to protein precipitation, vasoconstriction and decreased capillary permeability;
- Despite a reduced systemic absorption, alum instillations are not recommended for patients with renal failure, due to aluminum toxicity; in these patients, we may perform instillations with **silver nitrate** (in a concentration range of 0.5–1 % for 10–20 min), **aminocaproic acid**, or **prostaglandins** (PGF-2α);
- In severe cases, of intractable hematuria, refractory to all the before mentioned measures, we should try to do instillations with **formalin** (40 % formaldehyde), which induces cellular protein precipitation, being fixed on the bladder mucosa, and causing capillary occlusion; formalin instillation should be performed under anesthesia in relatively low concentrations (1–2 %), due to the potential severe side effects, including bladder fibrosis, and subsequent decreased bladder capacity.

Hyperbaric Oxygen Therapy

- Hemorrhagic cystitis due to radiation therapy is usually very difficult to treat, due to the ischemic nature of the bladder lesions;

- Hyperbaric oxygen therapy (HBO_2) has been proposed for patients with refractory hemorrhagic cystitis after radiation therapy or cyclophosphamide therapy, as a measure designed to increase local tissue oxygenation, stimulating angiogenesis, and diminishing edema;
- Therapy consists of at least 20–30 sessions of 90 min of exposure to 100 % oxygen, pressurized to 2–3 atmospheres in special hyperbaric chambers; the response rates are generally over 80 %, while the principal disadvantages are represented by the high cost of the repetitive procedure, and by the low availability of these chambers in most hospitals.

Selective Arterial Embolization

- In extreme situations of intractable, especially if the patients are not in a stable condition, bilateral superselective angioembolization of the vesical arteries may be considered; despite the recent technical advances, including the use of microcatheters and of new embolization agents, the success of the technique is relatively low, most probably due to the diffuse venous bleeding, which is refractory to arterial angioembolization;
- Moreover, the embolization of the posterior branch of the internal iliac artery should be avoided, because the obstruction of the superior gluteal artery will result in significant gluteal pain.

Surgical Management

- **Urinary diversion** is a logical solution in all cases of persistent hematuria, reducing the exposure of the new blood clots to urokinase, thus facilitating hemostasis; the most widely used and recommended method of urinary diversion in these patients is the **bilateral percutaneous nephrostomy** tube insertion, followed by occlusion of the ureters, using balloons; in some cases, permanent urinary diversion is necessary, by the creation of an **ileal conduit**, or of a bilateral **cutaneous ureterostomy**.

- Some of the patients with urinary diversion may still have significant bleeding, bladder infections, and pain, which will be resolved only by performing cystectomy; however, this procedure comes with a significant risk of perioperative complications, and even mortality, due to a poor general health status after chemotherapy, or radiation therapy;
- Despite these considerations, **cystectomy** with **ligation of hypogastric arteries** and **neobladder** creation is an important option, as a final step in the management of refractory severe hemorrhagic cystitis after radiation therapy.

Chapter 20
Penile Rehabilitation After Radical Pelvic Surgery

Mazhar Ortaç, Emre Salabaş, and Ateş Kadıoğlu

Abstract Erectile dysfunction (ED) due to radical pelvic surgery has been an interesting topic among clinicians. Surgical treatments have a negative impact on the quality of life in these patients and their partner due to incontinence and ED. However there is no standard treatment modality following radical pelvic surgeries such as radical prostatectomy or cystectomy. This article reviews the role for penile rehabilitation on ED after pelvic surgeries.

Keywords Pelvic surgery • Prostate cancer • Radical prostatectomy • Erectile dysfunction • Penile rehabilitation

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Erectile Dysfunction After Surgery

Erectile dysfunction (ED) and incontinence are the most important complications of radical prostatectomy (RP). Young patients with normal erectile function prior to surgery are the most negatively affected group. Approximately 60 % of prostate cancer patients younger than 65 are treated with RP and 70 % of these patients feel their quality of life negatively affected due to ED [1].

The rates of ED after treatment are still high despite the development of minimally invasive surgeries, improvement in surgical techniques and a greater understanding of prostate vascular and nerve supply. ED rate has a great variance of 30–87 % and factors such as patient age, nerve sparing surgery, preoperative erectile status and patient's comorbidities (diabetes, hypertension) are associated with postoperative ED rate [2, 3].

Physiopathology of ED after RP is clearly demonstrated by several animal studies. Injury of neurovascular bundle at the time of surgery is the primary cause and leads to spontaneous nocturnal erections failure and thus hypoxia, secretion of biochemical mediators (TGF b1, ET-1…), cavernous smooth muscle apoptosis and corporal fibrosis at the last stage [4] (Fig. 20.1).

Penile Rehabilitation for Erectile Dysfunction

Penile rehabilitation (PR) is defined as use of any drug or device for preservation of erectile function after radical pelvic surgery (e.g. RP or cystectomy). An accumulation of evidence indicates that penile rehabilitation program should be recommended for all patients who will undergo RP [5]. According to a well-designed study with a great number of patients, after nerve sparing surgery performed by high volume surgeons, erectile function recovery rates at 3. Year follow up were 73 and 37 % for PDE5Is user and non-user group respectively [6]. The aim of penile rehabili-

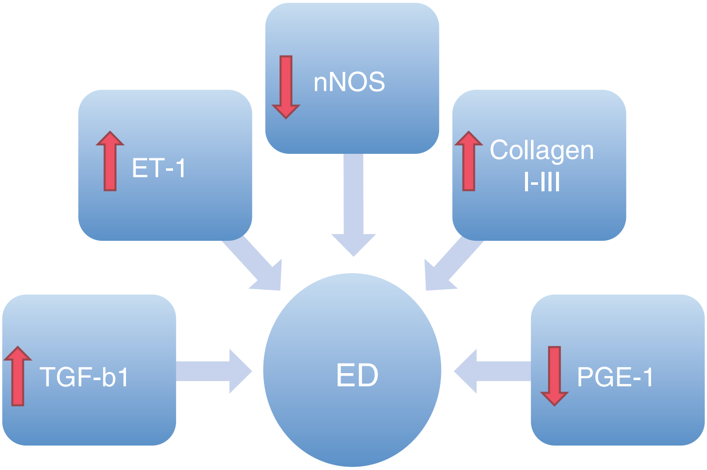

FIGURE 20.1 Biochemical alteration after neuro-vascular damage during radical prostatectomy. *PGE-1* prostaglandin E1, *TGF-B1* transforming growth factor b1, *ET-1* endothelin-1, *nNOS* neuronal nitric oxide synthase, *ED* erectile dysfunction

tation is preserve erectile function and minimize ED after surgery. Numerous studies show that penile rehabilitation is absolutely superior over controls for patients who undergo nerve sparing surgery in terms of erectile function preservation [7]. A review of the literature demonstrates a lack of evidence based data to determine the optimal treatment modality for EF recovery after RP. However recently a large number of studies focused on designated PR program have been published. According to current literature, phosphodiesterase type 5 inhibitors (PDE5Is) are the first line treatment while intra-cavernozal injection (ICI), vacuum erection device(VED) and intraurethral alprostadil (IUA) are optional second line treatments. Penile prosthesis is accepted as the final treatment modality [8].

Strategy and timing of PR are still not clear but starting PR as early as possible (removal of the urethral catheter or within 1 month after surgery) and even prior to penile structure injury is vital and may improve long time erectile function. Furthermore few studies even suggest "massive treatment", PR initiated 1–2 weeks prior to surgery decrease ED rate [9, 10].

The role of PDE5Is at post RP ED treatment has been investigated via both animal and human studies. The cause-effect relation between RP, nerve-vascular damage, and hypoxia, apoptosis, venous leak and fibrosis of cavernous tissue has been shown in the animal studies. The early usage of PDE5Is may prevent this process and preserve erectile function [11].

Nowadays, sildenafil, tadalafil and vardenafil are the most the commonly used PDE 5Is for ED after RP. Numerous penile rehabilitation programs using different PDE5Is are being conducted in current clinical practice (Table 20.1) [12, 13]. According to recent literature there is no consensus on the ideal PDEIs agent, dosage or timing for penile rehabilitation. While both on demand and chronic usage of PDE5Is are beneficial for patients with post RP ED when compared to control group, there is no evidence based data comparing the success rates between these two treatment regimens [14–16]. However a few studies derived from randomized placebo controlled trial (REACT data) showed that daily tadalafil 5 mg usage was superior to placebo and on demand treatment in terms of number of morning erections, EF recovery rate, quality of life improvement and penile length loss reduction were [17–19].

Intracavernosal injections (ICI), vacuum erections device(VED) and intra-urethral alprostadil (IUA) are second-line treatment options for PDE-5I non or partial responders or contraindications [20]. These agents may be used alone or in combination with another treatment modality such as PDE5Is. Patients under PR therapy should be assessed with 6–8 weeks intervals. In case of first line treatment modality failures, second line or combination therapy should be considered [21]. According to literature all treatment agents may be combined with PDE5Is and combination therapy provides better erectile function. In addition early

TABLE 20.1 Clinical studies with PDE5 inhibitors in penile rehabilitation after radical prostatectomy

Authors	Inclusion criteria/ number of patients(pts)	Design of study	Treatment period	Treatment	Outcomes
Kim et al. (2016) [15]	IIEF>22 No ED before surgery NSRP N:74 pts with ED	Prospective, randomized, double-blind, placebo-controlled, single institution	Starting midnight surgery At the end of double blind treatment (12 month) washout (13 month)	Nightly Sildenafil 50 mg+ on-demand sildenafil 100 mg vs On-demand sildenafil 100 mg and nightly placebo (1:1)	No significant differences were seen in return to normal EF between treatment group vs. placebo based on RigiScan TM and IIEF score at any time point. Return to normal EF based RigiScan: 40 % vs 40 % as measured by the IIEF-EF: 29.0 % vs. 32.4 % for treatment vs. placebo arms
Montorsi et al. (2014) [10]	IIEF>22 Age<68 No ED PCA:cT1c-T2c NSRP N:423 pts with ED	Randomized, double-blind, double-dummy, multicenter placebo-controlled trial	At the end of double blind treatment (9 month) Washout (10.5 month) Open label (13.5 month)	Tadalafil 5 mg daily, tadalafil 20 mg on demand vs. placebo (1:1:1)	Treatment effects versus placebo were significant for tadalafil once daily only. At month 9, penile length loss was significantly reduced versus placebo in the tadalafil once daily group only

(continued)

Table 20.1 (continued)

Authors	Inclusion criteria/ number of patients(pts)	Design of study	Treatment period	Treatment	Outcomes
Mulhall et al. (2013) [13]	Age: 18–70 Pts with ED least 6 months after RP NSRP N:298 pts with ED	A randomized double-blind, placebo controlled, parallel group phase 3 study	3 months	100 or 200 mg avanafil vs placebo	After 12 weeks there were significantly greater increases in SEP2 and SEP3 and change in mean IIEF-EF domain score with 100 and 200 mg avanafil vs placebo
Montorsi et al. (2008)	No ED history IIEF>25 Age: 18–64 NSRP N:628, pts with ED	A randomized, double-blind, double-dummy, multicenter, parallel group study	At the end of double blind treatment (9 month) Washout (11 month) Open label (13 month)	Vardenafil 10 mg daily, Vardenafil 10 or 20 mg on demand vs. placebo	On-demand vardenafil treatment resulted in significantly greater IIEF-EF scores and better SEP-3 response rates than placebo over the entire treatment period

Montorsi et al. (2004)	Pts with ED 12–48 months after NSRP N:303 pts with ED	A randomized, double-blind, placebo controlled multicenter study	3 months	Tadalafil 20 mg vs. placebo (2:1)	Tadalafil on demand produced significant improvement in both primary and secondary endpoints after 12 weeks of treatment compared with placebo Mean improvement in IIEF-5 Tadalafil 20 mg: 5.3 ± 0.5 placebo: 1.1 ± 0.6
Pavlovich et al. (2013)	IIEF>26 Age<65 NSRP N:100 pts with ED	A single-institution, double-blind, randomized controlled trial	12 months	Sildenafil and on-demand placebo (nightly sildenafil group), or on-demand sildenafil and nightly placebo	No significant differences in IIEF-EF scores between nightly and on-demand treatment
Padma-Nathan et al. (2008)	Normal EF before surgery 4 weeks after NSRP N:76 pts with ED	A randomized, double-blind, placebo-controlled study	36 weeks	Sildenafil 50 mg or sildenafil 100 mg vs. placebo	Nightly sildenafil administration for 36 weeks after surgery markedly increased the return of normal spontaneous erections. SEP 3: 27 % vs 4 %

NSRP nerve sparing radical prostatectomy, *ED* erectile dysfunction, *IIEF* international index of erectile function, *PCa* prostate cancer, *SEP* sexual encounter profile, *RP* radical prostatectomy, *EF* erectile function combination with VED may prevent penile length loss in comparison to monotherapy after RP. There is no evidence based data for the optimal combination therapy but the most favored combinations are daily PDE5 Is and ICI at least two times a week or PDE5Is and VED [22].

At every visit, PDE5Is despondence of patients should be questioned in order to cease ICI therapy. Second-line treatment modalities are more cost effective than daily PDE5Is but discontinuation rate of these patients is quite high due to serious side effects [23]. PR should be continued up to 24 months for the best erection capacity or to decide the failure of therapy because recovery of erectile function may extend up to 2 years, particularly for patients who were underwent nerve sparing surgery [24].

Penile prosthesis implantation is last treatment option for ED after RP. The various penile prosthesis exist for implantation such as non-inflatable, inflatable two or three piece configurations. Three piece prosthesis provide natural erections as well as high patient and partner satisfaction rates. Reservoir of prosthesis can be placed in posterior of transversalis fascia or between posterior and anterior to the transversalis fascia. Latter approach recently suggested for alternative reservoir placement and may decrease per-operative surgeons anxiety and major surgical complications [25] (Table 20.2).

Table 20.2 Penile rehabilitation program

Education of patients and decision treatment program
Education related to causes of ED post RP and rationale for rehabilitation program
Review of operative report and nerve sparing status
Assessment of recovery potential
Information for expectation post-operative ED
Information related to penile muscle preservation as the basis of rehabilitation

(continued)

Table 20.2 (continued)

First-line treatment
PR should be start with PDE-5Is
PDE5Is :Ease to use, effective -limited serious side effect
Use of on-demand or daily dose PDE-5 inhibitors
The benefits of early intervention and achieving an erection
Rates of response is wide depending on patient and surgical factors
Disadvantages of rehabilitation (cost, time and medication related side effects)
Second-line treatment
Intracavernosal injections, vacuum erection devices, intra-urethral alprostadil
Intracavernosal injections, vacuum erection devices typically started if useable erections are not restored with first-line therapy or a contraindication exists to PDE-5 inhibitors
Combination with PDE5Is is good treatment options for non-respond patients
Ideal combination does not exist but it seems to PDE5Is+ ICIS or PDE5Is + VED
VED is not medication, high rate side effect, difficulty to use, high dropout rates
ICI has high dropout rates, owing to invasive nature, lack of spontaneity
VED may preserve penile length
Third-line treatment
Penile prosthesis implantation
High patient and partner satisfaction
Significant cost and level of invasiveness

ED erectile dysfunction, *PDE-5* phosphodiesterase type 5, *RP* radical prostatectomy, *VED* vacuum erection device, *ICI* intracavernosal injection

In conclusion, ED is the most common complications in patients with radical prostatectomy and have been shown to vary frequency according to treatment modality and patient depended factors. Several effective treatment options do exist for the treatment ED after radical prostatectomy. The early interventions may provide recovery of ED and prevent penile length loss.

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Chapter 21
Tips for Intravesical Chemotherapy and Immunotherapy

Bülent Semerci and Volkan Ülker

Abstract Non-muscle invasive bladder cancer tends to recur after transurethral resection (TUR) and an intravesical adjuvant chemotherapy or immunotherapy is usually needed to decrease the recurrence rate, or sometimes progression. Instillations can be applied immediately after TUR and then in scheduled basis.

Keywords Bladder cancer • Intravesical chemotherapy • Bacillus Calmette-Guérin • Intravesical BCG • Intravesical immunotherapy • Mitomycin-C

Introduction

Intravesical chemotherapy for bladder cancer was first described by Herring in 1903 with using of silver nitrate [2]. Basically, chemotherapeutic agents can be used intravesically

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immediately after TUR to prevent tumor cell implantation and then to decrease local recurrence [6]. For intravesical chemotherapy, there is no clear evidence of impact on progression. Intravesical immunotherapy with BCG; however, can decrease the tumor progression rate in addition to their role in the primary treatment of CIS [7]. While intravesical chemotherapy is preferred adjuvant treatment in low and intermediate risk patients, intravesical immunotherapy with BCG is the treatment of choice in intermediate or high risk patients and in CIS.

Intravesical Agents in the Management of Non Muscle-Invasive Bladder Cancer

Several antitumor agents for the management of non-muscle invasive bladder cancer after TUR have been developed. Today, the most common used agents are doxorubicin (adriamycin), epirubicin, mitomycin-C, and BCG. Gemcitabine, Valrubicin or interferon are rarely used. Combination of these agents has no clear benefit.

Preparation of Patient and Application Procedure

It is considered that the interval after TUR should be 1–2 weeks in chemotherapy and 2–4 weeks in immunotherapy for tissue healing to avoid complications. A urinalysis should be performed before each intravesical treatment. The presence of infected urine may cause complications such as bacteremia and fever. The bladder should be emptied just before intravesical instillation, and patient should be advised to avoid excessive fluid intake on the day of instillation to prevent dilution of the agent in the bladder. After catheterization, if exists, residual urine should be emptied before the instillation. The diluted agent in 50 ml normal saline or distilled water is instilled to the bladder under low pressure with an injector through a low caliber catheter. We prefer 10 or 12 Ch feeding tube well lubricated with lidocaine jelly. Urethral trauma and bleeding during catheterization should be avoided and when it occurs, the instillation should be postponed for several days. Also, in patients with marked hematuria the instillation should not be done.

Preferably, the instilled agent should remain in the bladder for 1 h in chemotherapy and for 2 h in immunotherapy. The patient does not need to turn from side to side to bathe the entire urothelium. Coffee or tea consumption just before the instillation may interfere with retention tolerance of the agent for 1–2 h. For patients who cannot tolerate retention at least for 1 h, anticholinergics may be helpful. Then the patient is asked to empty his or her bladder. For patients with prostatic enlargement, there might be a marked residual urine, therefore voiding in sitting position or double voiding is recommended to empty the bladder completely. Patients should be informed not to contact the voided urine in the toilet and the contaminated surfaces should be well cleaned with bleach.

Early Postoperative Intravesical Chemotherapy

Early one immediate intravesical instillation of chemotherapeutic agent can prevent the spreading and implantation of tumor cells resulting from TUR and might ablate overlooked small tumors escaping from the resection [4]. For his manner, the instillation should be given as early as possible after TUR, when no bladder irrigation is needed and no marked hematuria. It is recommended to apply a single intravesical instillation of chemotherapy within the first 6 h after TUR. After the instillation, the Foley catheter is clamped for an hour. A care should be taken not to forget the catheter clamped. Intravenous fluid loading in preoperative and early postoperative periods may cause over dilution of the chemotherapeutic agent with urine. If there is suspicion of bladder perforation and extravasation, the instillation should not be done. Generally, epirubicin 50 mg or mitomycin-C 40 mg are preferred for the early postoperative instillation. After receiving the pathological report of TUR, the necessity of further intravesical chemotherapy or immunotherapy can be decided. This means, for low risk patients of recurrence, the intravesical treatment will be completed unless a new tumor is revealed in planned control cystoscopy.

Scheduled Intravesical Chemotherapy

It is still controversial for the schedule of intravesical chemotherapy. As generally accepted, when additional intravesical adjuvant treatment is considered, doxorubicin and epirubicin 30–100 mg or mitomycin-C 20–60 mg can be applied on a weekly basis for 6–8 weeks.

We prefer mitomycin-C or epirubicin in doses of 40 and 50 mg, respectively, for 6 weeks. One hour instillation is generally sufficient. Intravesical chemotherapy has less side effects compared to BCG and most of these side effects are self limiting. Enhancing of mitomycin-C with Microwave-induced hyperthermia (Synergo) or electromotive drug administration (EMDA) are still experimental and we don't use these in our practice. Chemical cystitis with the symptoms of disuria, frequency and hematuria is the most common side effect. Additionally, allergic dermatitis and skin eruptions, especially affecting the palms, soles and face may be observed in some patients after mitomycin-C installations. This problem can be treated easily with antihistamines and corticosteroids. If hematuria persists, cystoscopic examination should be done.

Failed Intravesical Chemotherapy

If non-muscle invasive bladder cancer under intravesical chemotherapy recurs, switching to BCG should be considered. Prior instillations have no advantage for the new BCG schedule.

Intravesical Immunotherapy

Intravesical immunotherapy produces an immune response as a result of the expression of cytokines in the bladder wall. Bacillus Calmette-Guérin (BCG) is the most common used agent. It has higher efficacy but more side effects than intravesical chemotherapy. Large studies showed that BCG is superior for preventing recurrences. Additionally, it may prevent or delay progression [1, 7]. Since it is an attenuated live mycobacterium, it should be stored and transported in a cold place. Connaught, Tice, RIVM, Armand-Frapier, Tokyo and Pasteur strains come from the same origin and no one is superior in terms of efficacy. The optimal treatment schedule and dose for BCG have not been established. Generally, it is used on a 6-week-schedule. Intravesical BCG is more beneficial when given in a maintenance schedule; however, there is no consensus about the maintenance schedule [3]. BCG is superior to intravesical chemotherapy in CIS if early radical cystectomy is not considered, since CIS cannot be completely treated with TUR only [7].

Intravesical BCG should not be administered on patients with macroscopic hematuria, symptomatic urinary infection and when the catheterization is traumatic. For immunosuppressed patients, BCG can be used with great caution if necessary. Asymptomatic pyuria is not a contraindication for BCG instillation. Since quinolones may interfere the viability of BCG, they should not be used to treat pyuria or any other infection during intravesical BCG instillations. A slight fever is usually observed in the day of instillation and can be treated with analgesics and antipyretics. Malaise and arthralgia are also common symptoms. Cystitis-like symptoms are usually treated with antispasmodics and non-steroidal anti-inflammatory drugs. When persists, quinolone antibiotics can be used empirically. A urine culture will be helpful to rule out simple bacterial urinary infection. If fever persists more than 48 h or exceeds 38.5° C, a full consultation for systemic mycobacterial infection, including chest x-ray and liver function tests, should be considered. For these patients, isoniazid 300 mg plus rifampicin 600 mg per day should be started until resolution of symptoms. Cystoscopy might be necessary in case of persistent hematuria. When symptoms are severe, the patient should be immediately hospitalized and consulted by a clinical microbiology specialist. Rarely epididymitis or epididymo-orchitis can be seen in patients receiving intravesical BCG. If treatment with antibiotics fails or in case of abscess formation, surgical excision of epididymis or testis should be considered. Granulomatous prostatitis due to intravesical BCG is usually asymptomatic or mild and can be treated with quinolones, but if persists, antituberculous treatment with isoniazid 300 mg plus rifampicin 600 mg per day for 3 months might be necessary. For patients who suffer from severe side effects after BCG instillations, dose reduction up to 1/3 of full dose is an option [5].

Failed Intravesical BCG

Patients who have persistent or recurrent CIS after the first course of intravesical BCG treatment may respond to the second course. Also, further course of BCG can be tried if tumor recurs in lesser grade or stage. However, in case of upgrading or persistence of non-muscle invasive cancer after BCG treatment, radical cystectomy should be preferred [8].

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Chapter 22
Stone Analysis

Abdülkadir Tepeler and Burak Turna

Abstract Stone analysis remains as an essential part of both initial evaluation and follow-up of patients with urolithiasis. For the most detailed analysis, the entire stone should be used. There is currently no standard method accepted for stone analysis. There are concerns about the accuracy of commercial laboratory results due to considerable variability in mixed calculi analysis reports. Besides the techniques described here, there are promising new technologies being developed.

Keywords Stone analysis

Introduction

The formation of a stone within the kidney occurs as a result of pathologies in various steps of ion metabolism. Despite advances in our understanding of the underlying pathophysiology

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Table 22.1 The chemical name and mineral name of the most common type of kidney stones are listed

Chemical name	**Mineral name**
Calcium oxalate monohydrate	Whewellite
Calcium oxalate dehydrate	Weddellite
Calcium hydrogen phosphate dehydrate	Brushite
Tricalcium phosphate	Whitlockite
Basic calcium phosphate	Apatite
Carbonate-apatite	Carbonate-apatite
Magnesium ammonium phosphate	Struvite
Cystine	
Uric acid	

of stone formation, the exact mechanism is still unclear. Therefore, determination of stone composition plays a key role in understanding abnormalities leading to the stone development process.

Stones are mainly composed of inorganic crystalline stone (95 %) and organic-matrix cellular components (5 %) [7]. Varying amounts of crystalline materials may be detected in multicomponent kidney stones. By contrast, the stone type known as a "matrix stone" consists entirely of an organic matrix. Determination of the types and amounts of each component helps to identify the condition and, consequently, the proper medical treatment. Despite advances in minimally invasive treatment methods, medical treatment is essential in preventing stone recurrence. Table 22.1 lists the most common components of human kidney stones.

Why Stone Analysis?

Stone analysis is used to evaluate and identify the specific conditions that led to formation of the stone. For example, stones containing calcium likely result from a condition related to calcium metabolism, while a stone containing cystine could suggest cystinuria. The presence of different types of components may be associated with multiple pathogenesis mechanisms. For this reason, stone analysis could be thought of as a "biochemical biopsy" of the urinary tract [3]. Stone analysis may also provide information about the urinary tract environment. A stone containing magnesium ammonium phosphate, for example, points to the presence of a urease-producing bacterial infection of the urinary tract. A new stone occurring in a treated patient can be analyzed to determine the treatment efficacy. A case in which a newly formed calcium phosphate stone is detected in a patient who formerly had a cystine/uric acid stone likely indicates an overdosage of alkali therapy.

Identification of stone composition may help in choosing future management options. A stone analysis that detected cystine and calcium oxalate monohydrate would contraindicate shockwave lithotripsy (SWL) for the treatment of residual fragments [4]. Detection of drug metabolites such as triamterene, indinavir, and some antacids that lead to stone formation can all lead to treatment modifications to prevent stone recurrence [4]. In addition to other benefits, stone analysis can be used to show epidemiological trends [9].

Techniques of Stone Analysis

There are two main types of analysis methods: (1) simple wet chemical analysis and (2) more complicated techniques, such as polarized microscopy, X-ray diffraction crystallography, infrared spectroscopy, scanning electron microscopy, and thermogravimetry.

Wet Chemical Analysis

This technique subjects the stone solution to quantitative analysis via the same standard biochemical methods used for analysis of blood and urine. Although it is the most widely used method in routine laboratories, it has several limitations, including the requirement for at least 15 mg of stone material and its tendency to miss rare or unidentified substances. It also has generally poor performance. The efficacy of this method can be improved by using a quantitative wet chemical approach [1, 3].

Optic Polarizing Microscopy

This method uses a polarizing microscope to assess crystals removed from different locations on the stone according to their characteristics (e.g., color and refraction of light) [10]. This method is cost-effective and allows for rapid analysis of small, simple particles. Limitations of the technique include the difficulty of identifying some special cases (e.g., stones containing uric acid, purine derivatives, or calcium phosphate), difficulty in identifying stones with mixed compositions, and the need for specialized training on the part of the analyst [1, 10].

X-ray Diffraction

In this procedure, the analyst determines the composition of the stone by observing diffraction patterns made when the crystalline material is exposed to X-ray bombardment. The main advantages include ease of preparation, automated measurement, quantitative analysis, and exact identification of all components. Limitations include high cost and the inability to detect non-crystalline or amorphous substances [1, 4, 9, 10].

Infrared Spectroscopy

In this technique, components are identified according to their interactions with infrared radiation. Benefits include moderate cost, fast sample turnaround, and the ability to identify the constituents of small pieces of sample and of organic samples. Limitations include difficulty in identifying uric acid, purine and calcium phosphate stones, as well as any components that are present in small quantities [1, 4, 9, 10].

Scanning Electron Microscopy

This non-destructive method is based on the evaluation of the specific morphology of calculi, but limitations include high cost and the need for a dedicated staff.

Thermogravimetry

In this technique, the stone material is determined from both weight and from the change in enthalpy while increasing the temperature up to 1000 °C. It is a fast and simple method, but is destructive and requires a large amount of material.

Conclusions

Stone analysis remains as an essential part of both initial evaluation and follow-up of patients with urolithiasis. For the most detailed analysis, the entire stone should be used. There is currently no standard method accepted for stone analysis [5]. There are concerns about the accuracy of commercial laboratory results due to considerable variability in mixed calculi analysis reports [5,6]. Besides the techniques described, there are promising new technologies being developed [2, 8].

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Chapter 23
Advice to the Families of the Pediatric Stone Former

Ali Tekin and Oktay Nazlı

Abstract Parents of the pediatric stone formers ask the physicians what they should give attention to or what the doctors recommend, in order to prevent the recurrence of stone disease. Answering these questions is always difficult in clinical practice. In this chapter we aim to clarify this relatively unexplored subject.

Keywords Pediatric • Prevention • Stone formers

Introduction

Pediatric urolithiasis differs from the adult disease with a higher risk of recurrence and its association with the metabolism. Lifestyle changes to be made for the treatment of

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pediatric urolithiasis are not much different than those required for a healthy life. However, one must balance the needs of the organism and the treatment requirements for the urinary system stone disease in children at the developmental age. Parents should undertake this task for children who cannot make their own decisions and meet their own needs. Especially the nutritional advices of the physician should be considered as a lifestyle standard rather than a short term treatment and followed by the entire family, thus motivating the child.

Liquid Intake

The main goal pursued in determining the daily amount of liquid intake is to prevent the super saturation of stone forming metabolites in the urine [3]. At least 2.5 L of daily liquid intake is advised to adults to produce at least 2 L of urine [2]. Same rates should be proportioned according to the body surface area for children and the daily liquid intake should be regulated to obtain daily urine production with a rate of 2 L/1.73 m^2. As the urine concentration increases at nights especially in cases with cystinuria, children should be encouraged to drink water right before going to bed and when they wake up at night to urinate [6]. In case of increased fluid loss as a result of temperature rise, excessive perspiration and diarrhea, the liquid intake should be increased accordingly. Although all kinds of liquids prevent the super saturation of the urine in theory; children should avoid fruit juices, tea, coffee and cocoa drinks for their oxalate contents; tomato juice for its salt content and instant drinks sweetened with fructose associated with hyperuricuria. One of the rare fruit juices that can be recommended for children with urolithiasis is lemonade, as it increases the amount of citrate in the urine. Since instant lemonades contain fructose and a low volume of lemon juice, homemade lemonades should be preferred. Nevertheless, grapefruit, orange and apple juices are not recommended as they might increase the concentration of oxalate in the urine [7].

Calcium

Patients with stone disease used to be advised to have calcium-poor diets in the past. Studies made with a large number of patients revealed an inverse proportion between the calcium oxalate stones and the amount of calcium in the diet [4]. As calcium in the bowels binds oxalate, increased amount of calcium in the diet reduces the absorption of oxalate in the bowels. In patients with fat malabsorption calcium in the diet combines with fatty acids requiring a higher amount of calcium intake than the daily recommended dose. When calcium intake in the diet is insufficient, it should be supported with calcium containing preparations. Calcium citrate is the ideal choice for this purpose, as it increases the amount of citrate in the urine at the same time.

Potassium

There are a number of studies that have shown that the higher the potassium concentration ratio in the urine gets the fewer stone formation occurs [5]. Potassium is abundant in fruits, vegetables and foods of animal origin. The intake of potassium from vegetative resources is more recommended, as it increases urine alkalinization and consequently citrate concentration in the urine.

Salt

There are a number of studies showing that the salt restrictive diets reduce the risk of stone formation [7]. This can be explained based on the fact that the increased sodium concentration in the urine reduces the reabsorption of calcium, thus increasing the amount of calcium in the urine. On the other hand, the increase of sodium concentration in the urine increases the stone formation in cases with cystinuria. Overconsumption of salt should be avoided in children just as the adults, and salt restrictive diets should be recommended.

Therefore, the children should be kept away from processed meat products, fast-food products, salty spices and sauces and instant soups.

Animal Protein

Animal proteins in the diet are known to increase the frequency and recurrence of stone formation. They provide a basis for stone formation by increasing the urine acidity, and also enhance the cysteine concentration in the urine in cases with cystinuria due to its methionine content. For this reason, the adult patients with urolithiasis are advised to have animal protein restrictive diets. However, the restriction of protein in children at the developmental age is inacceptable. Therefore, the daily protein need should be determined taking into consideration the age and the developmental stage of the cases with urolithiasis, and the protein intake exceeding this amount should be restricted if possible [3].

Oxalate

A small amount of oxalate in the urine is known to originate from the diet. Nevertheless, the intake of foods rich in oxalate such as dried nuts, soy, beet and chocolate can be restricted in patients with oxalate stones. Since oxalate is a by-product of the ascorbic acid metabolism, external intake of vitamin C should be prevented in these patients [8].

Vitamin

Prophylactic vitamin D supplementation is prevalently used for infants. The studies indicate that the vitamin D can play a role in the formation and development of the stone disease [1]. Abandoning the daily recommended amount of vitamin D supplementation in patients with stone disease is controversial. On the other hand, it should be born in mind that the intake of formula can result in exceeding the daily recommended dose of vitamin D the formula-fed infants due to their vitamin D content.

Formula

The studies on infants with urinary system stone disease have revealed that the sizes of stones are bigger in those fed with formula [1]. This situation can be associated with the contents of oxalate and vitamins D and C in formulas. Formula-fed patients should be evaluated based on pediatric metabolism needs and appropriate nutritional advices should be given.

Consultation

Pediatric urinary system stone disease requires a multidisciplinary follow-up due to its association with the metabolism. The patients should be definitely referred to a pediatric nephrologist and a pediatric metabolism specialist before or after the treatment, and the possible metabolic causes should be investigated. The parents should be informed that the stone disease can be a chronic disorder which may require examination of patients by several disciplines rather than a surgical disease which can be treated in a short period of time.

Possible side effects of operative and non-operative treatments should be elucidated in detail, and it should be asserted that the most effective method for the treatment of stone disease is to prevent the formation of stones.

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Chapter 24
General Advice on Recurrent Stone Former

Marin Ivnov Georgiev, Krassimir Prodanov Yanev, Plamen Dimitrov Dimitrov, Dimitar Grigorov Shishkov, and Peter Kolev Panchev

Abstract Stone recurrence has always been a complex matter with many controversies and lack of solid scientific evidences. One of the biggest problems evaluating the patient with stone recurrence disease is the complicated protocols. Easier and reproducible outpatient evaluation is outlined in this chapter trying to present in a schematic way: blood, urine investigations, conservative measures and medical treatment in a schematic way.

Keywords Stone recurrence • Metabolic evaluation • Fluid intake • Diet • Medical treatment

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Introduction

Despite major recent advances in surgical management of urolithiasis and progress in better understanding of pathogenesis and pathophysiology of stone formation medical treatment and dietary regimens have not change substantially. We have to admit that there is an extremely low number of randomized controlled trials assessing properly stone recurrence and more important the factors related to it.

Incidence and Risk of Stone Recurrence

There are a number of studies trying to estimate the risk of recurrence within subsequent period of time. According to Uribarri et al. first – time stone formers are generally estimated to have a 50 % risk of recurrence within 10 years. In another study by Ljunghall and colleagues the chance of recurrence was measured as nearly as 50 % at 5 years measured retrospectively and a prospective evaluation demonstrated a rate of 53 % within 8 years. Patients have higher risk of recurrence in the years immediately after the stone episode [1]. About 50 % of recurrent stone formers have just one lifetime recurrence. Highly recurrent disease is observed in slightly more than 10 % of patients [5, 6].

The risk evaluation of stone formers is the mainstay of a decision making process of medical treatment. Clinical determinants as stone type and disease severity stratify the patient into groups of low or high-risk of recurrence [8] (Table 24.1).

Selection of Patients for Metabolic Evaluation

Nowadays there is still a debate which patient requires metabolic evaluation. One helpful consideration could be the stratification of patient to low and high risk of recurrence. For routine every day practice abbreviated protocol for low-risk single stone formers may be applied in stone formers evaluated without increases risk of recurrence [2, 3] (Table 24.2).

TABLE 24.1 High-risk stone formers

General factors
Early onset of urolithiasis (especially children and teenagers)
Familial stone formation
Brushite-containing stones (CaHPO4.2H2O)
Uric acid and urate-containing stones
Infection stones
Solitary kidney (the kidney itself does not particularly increase the risk of stone formation, but prevention
Diseases associated with stone formation
Hyperparathyroidism
Metabolic syndrome
Nephrocalcinosis
Gastrointestinal diseases (i.e., jejuno-ileal bypass, intestinal resection, Crohn's disease, malabsorptive conditions, enteric hyperoxaluria after urinary diversion) and bariatric surgery
Sarcoidosis
Genetically determined stone formation
Cystinuria (type A, B and AB)
Primary hyperoxaluria
Xanthinuria
Renal tubular acidosis (RTA) type I
2,8-Dihydroxyadeninuria
Lesch-Nyhan syndrome
Cystic fibrosis
Anatomical abnormalities associated with stone formation
Medullary sponge kidney (tubular ectasia)
Ureteropelvic junction (UPJ) obstruction
Calyceal diverticulum, calyceal cyst

(continued)

Table 24.1 (continued)

Ureteral stricture
Vesico-uretero-renal reflux
Horseshoe kidney
Ureterocele
Drugs associated with stone formation
Active compounds crystallizing in urine
Allopurinol/oxypurinol, Amoxicillin/ampicillin, Ceftriaxone, Quinolones, Ephedrine Indinavir, Magnesium trisilicate, Sulphonamides, Triamterene, Zonisamide
Substances impairing urine composition
Acetazolamide, Allopurino, Aluminum magnesium hydroxide, Ascorbic acid, Calcium, Furosemide, Laxatives, Methoxyflurane, Vitamin D, Topiramate

A comprehensive evaluation is mandatory in patient who present with episodes of recurrence and are evaluated as stone formers at high risk. Historically extensive metabolic evaluation included fast and calcium loaded tests in order to discriminate between various forms of hyperoxaluria. In every day setting routine performance of calcium fast/load test is not required t complete metabolic evaluation (Table 24.3). Most urologists would perform specific metabolic evaluation of collection of two consecutive 24-h urine samples [4, 7]. For the initial specific metabolic work-up, the patient should stay on a self-determined diet under the conditions of everyday lifestyle. Follow-up should be performed at 6–12 weeks after the initiation of treatment regimen for stone recurrence.

Conservative Medical Management

All stone formers, regardless of their underlying etiology or risk of recurrence, should follow conservative measures including a number of recommendations including diet, fluids

Table 24.2 Abbreviated protocol for low-risk single stone formers

	Low-risk single stone formers
Medical history	Rule out bowel disease, chronic diarrhea, Crohn, (enteric hyperoxaluria), gout (hyperuricosuria), leading to calcium oxalate or uric acid stone formation
Information on dietary habits and social history	Fluid consumption, excessive intake of certain foods, list of all medications taken, prolonged outdoor exposure, manual labor, excessive exercise, patient on prolonged bed rest
Blood investigations	Primarily exclusion of hyperparathyroidism (serum calcium and serum phosphorus), hypophosphatemia, hyperuricemia, hipocalciemia
Urine investigations	Urine culture (Urea splitting bacteria – Klebsiella, Pseudomonas, Proteus Mirabilis) – formation of struvite calculi, pH – greater than 7 – infection, less than 5.5 – uric acid stone formation, crystaluria – different types of crystal may suggest the composition of stone
Imaging	Plain abdominal radiograph, ultrasound an CT – to rule out radiopacity of the stones and to screen for residual fragments
Stone analyses	Struvite, magnesium ammonium phosphate and carbonate apatite stones most likely infection is the reason for stone formation and recurrence Uric acid stones may be caused by gouty diathesis Calcium oxalate stones may suggest renal hypercalciuria, enteric hyperoxaluria, hipocitraturia

intake and life styles. For patient with high risk of recurrence pharmacological treatment and specific regimens are the mainstay [8]. Dietary, lifestyle recommendations and medical management are summarized in Table 24.4.

Table 24.3 Metabolic evaluation

Metabolic	Evaluation
Initial evaluation	Stone free at least 20 days, two consecutive 24-h urine samples. self-determined diet, under everyday conditions
Urinary constituents	Calcium, oxalate, citrate, potassium, magnesium, uric acid, cystine, sulfate, ammonium, pH, total volume, specific weight,
Follow up	6–12 weeks after the initiation of treatment regimen for stone recurrence
Evaluation	Every 12 months after adjustment of treatment
Blood investigations	Creatinine, sodium, potassium, calcium, uric acid, chloride, phosphate, blood gas analyses

Table 24.4 Dietary, fluid recommendations, and selective medical therapy

Fluid intake	Fluid amount: 2.5–3.0 L/day Neutral pH beverages Diuresis: 2.0–2.5 L/day Specific weight of urine: < 1010
Nutritional advice	Balanced diet Rich in vegetables and fiber Normal calcium content: 1–1.2 g/day Limited NaCl content: 4–5 g/day Limited animal protein content: 0.8–1.0 g/kg/day
Lifestyle advice	BMI: retain a normal BMI level Adequate physical activity Balancing of excessive fluid loss
Calcium oxalate stones	
Hypercaciuria	Thiazide + potassium citrate
Hyperoxaluria	Oxalate restriction
Hypocitraturia	Potassium citrate
High sodium excretion	Restricted intake of salt

TABLE 24.4 (continued)

Calcium phosphate stones	
Hypercalciuria	Thiazide
Inadequate urine pH	Acidification
UTI	Antibiotics
Uric acid stones	
Urine pH < 6	Alkaline citrate 9–12 g/d1 or Sodium bicarbonate 1.5 g tid Prevention urine – pH 6.2–6.8, chemolitholysis urine – pH 7.0–7.2
Hyperuricosuria, hyperuricemia	Allopurinol 100–300 mg/d
Infection stones	Surgical removal of the stone material as completely as possible, long-term antibiotic course, Urinary acidification: ammonium chloride, 1 g, 2 or 3 times daily, urease inhibition
Cystine stones	High fluid intake recommended so that 24-h urine volume exceeds 3 L, : potassium citrate 3–10 mmol 2 or 3 times daily to obtain alkalization of pH = 7.5, for cystine excretion >3 mmol/day – tiopronin, 250–2000 mg/day

Conclusions

- Stratifying stone formers into risk groups of recurrence has a certain impact on every day clinical practice.
- Low risk of recurrence stone formers are subject to abbreviated protocol as well as patient who are evaluated as having a high risk of recurrence should underwent t a metabolic evaluation.
- The schemes of work up in both groups nowadays is much more simple and reproducible.

- General advise on fluid intake is scientifically proven and should be offered to all stone formers.
- Imaging diagnostic and 24 h urine samples are the mainstay of long term follow of high risk stone formers.

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Chapter 25
Lifetime Advice to Patients After Urinary Diversion

Jan Klein, Ali S. Gözen, Marcel Fiedler, Jens J. Rassweiler, and R. De Petriconi

Abstract The use of bowel segments for urinary diversion is the reason of physiological changes, and therefore it has a lifelong impact on the patients metabolism and quality of life. Until now almost all bowel segments from stomach to the rectum have been used for urinary diversion techniques. The use of every different bowel segment causes its own pathopysiological changes in the patient. In the lifelong treatment of the patient it is inevitable to know about and monitor the changes caused by the urinary diversion to avoid serious health damage to the patient. In this chapter we focus on the nowadays mainly used urinary diversions and their spectrum of possible changes in the patients to give a lifetime advice to the patient after urinary diversion.

Keywords Complications • Urinary diversion • Prevention • Quality of life

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Introduction

There are numerous indications for a urinary diversion in a patient. The most frequent is the urinary diversion following radical cystectomy in the management of muscle-invasive bladder cancer, according to the EAU-guidelines.

The use of bowel segments for urinary diversion is the reason of physiological changes, and therefore it has a lifelong impact on the patients metabolism and quality of life. Until now almost all bowel segments from stomach to the rectum have been used for urinary diversion techniques. The use of every different bowel segment causes its own pathopysiological changes in the patient. In the lifelong treatment of the patient it is inevitable to know about and monitor the changes caused by the urinary diversion to avoid serious health damage to the patient. In this chapter we focus on the nowadays mainly used urinary diversions and their spectrum of possible changes in the patients to give a lifetime advice to the patient after urinary diversion.

Complications resulting from an urological surgical technique using a bowel segment have mainly three mechanisms:

- Technical: continence, renal reflux, infections, etc.
- Oncological: cancerogenesis in a bowel segment e.g. MAINZ Pouch II
- Metabolical: these are result of exclusion of a specific bowel segment or continuous contact of the bowel segment with urine

The type of diversion influences the clinical appearance of specific metabolic changes but there is a high variability to compensate the changes and in the velocity of the onset of the symptoms so the clinical diagnosis can be sometimes difficult.

To classify the different pathophysiological changes that happen to the patient after having radical cystectomy including the formation of a urinary diversion we first have to focus on the basic physiological aspects of bowel function.

Physiological Aspects of Bowel Function

The basic bowel function is the active reabsorption of water and electrolytes. Within the diversion this function is unwanted.

Because of the histological structure of the bowel wall the intestinal resorption of water and electrolytes is more important in the duodenum and jejunum than in the colon.

Energy sources for the reabsorption are the Na+/K+ Pump (basal) and the Na+/H+ pump (apical), and they are located in the cell membrane.

Reabsorption of Cl– happens by exchange with HCO3– in the ileal mucosa. Na+is reabsorbed by exchange of H+. The amount of reabsorbed Cl– exceeds the amount of reabsorbed Na+. As a result, the amount of secreted HCO3– exceeds the amount of secreted H+. This leads to a hyperchloremic metabolic acidosis. Additional reabsorption of NH+ is amplifying this process.

In general:

- Diversions using ileum segments have slight benefits compared to colon segments related to urine storage pressure and reabsorption of urine components.
- A usually mild form of metabolic acidosis can be seen when using the ileum (70 %).
- The utilization of jejunum for urinary diversion led to frequent development of severe metabolic acidosis (25–40 %). As a result the use of jejunum in urological surgery was clinically abandoned.
- Severe acidosis can be observed if the bowel segments were not discontinued e.g. ureterosigmoidostomy or Mainz pouch II.

Factors that make metabolic disorders more likely to appear:

- Length of the bowel segment
- Duration of urine contact with the bowel segment

The longer the specific bowel segment used, the larger the resorption surface gets and the more likely metabolic disorders will occur:

- Ileal conduit – 15 cm terminal ileum segment

- Ileum neobladder (e.g. Hautmann) – 60 cm ileum segment
- Ileal Pouch (Kock) – 80 cm ileum segment

If the contact duration of urine with the bowel segment is very shortly like in an ileal conduit of 15 cm length there are almost no clinical metabolic disorders observed. If the situation changes due to stenosis of the urostomy or a too long bowel segment used the patient develops the typical metabolic acidotic disorders.

In pouches and orthotopic neobladders the contact time depends on micturation or catheterization frequency what is patient related. In practical aspects: If the patient voids or catheterises infrequently the contact time is longer and metabolic changes are more likely to occur. Another factor that extends the contact time is residual urine >100 ml.

Contact of bowel segments with urine leads to histological changes in the wall of the diversion. Due to these changes the production of mucus in orthotopic neobladders (ileum & colon) is often decreasing over the time and many patients show a normalization of the blood pH even without medical treatment.

- Regular monitoring of venous blood pH, base excess, blood gases and adjustment of neutralizing drugs (e.g. sodium citrate, sodium bicarbonate) over the time

Changes in the urine composition, volume of urine, pH value and the osmolality can lead to a deterioration of the kidney function.

- Regular monitoring of retention values (creatinine, urea)
- Preoperatively influencing the choice of the diversion. A glomerular filtration rate of >60–80 ml/min is mandatory for a continent diversion
- Consequent antibiotic treatment of urinary infections

Multiple drugs and metabolites are renal eliminated (e.g. antibiotics, digoxin, theophyllin, chemotherapeutic substances). They are reabsorbed in the diversion and lead to overdosage and poisoning.

- Patients with a continent urinary diversion (pouch, orthotopic neobladder) undergoing chemotherapy need a drainage of the urine via a catheter during the duration of the therapy.
- Check the pharmacokinetics of the drugs the patient takes regularly and adjust the drugs in cooperation with the specialist in internal medicine. Adjust newly prescribed drugs (e.g. antibiotics) to the lower renal elimination rate.

Long term complications depending on the bowel segment used for the diversion:

Loss of the Terminal Ileum

Physiological Aspect

- Reabsorption of Vit B12 and bile salts (enterohepatic recirculation)
- Reabsorption of Vit A and Vit D

Long Term Complications

- resection of more than 100 cm ileum leads to bile salt loss
- bile salt loss leads to malabsorption diarrhea
- increased absorption of oxalate
- Kidney stone formation
- megaloblastic anemia due to lack of Vit B12
- Decreased uptake of Vit A & Vit D

Loss of the Ileocoecal Valve and Ceacum

Physiological Aspect

- prevents the fast passage of chylus into the colon ascendens
- prevents the reflux of chylus from the colon to the ileum

Long Term Complications

- fast passage of chylus into the colon leads to diarrhea (23 %)
- colonization of the terminal ileum with enterobacteria causing steatorrhea and malabsorption of Vit B12
- isotonic loss of water
- diarrhea
- hypokalemic hypomagnesemia
- decreased uptake of vitamin D & A

Loss of a Colon Segment

Physiological Aspect

- water absorption
- resection of one segment (< half of the colon) leads not to metabolic disorders

Long Term Complications

- in urologic surgery (relatively short bowel segments needed) there are no long term complications to expect.

Metabolic Disorders and Clinical Symptoms Due to Loss of a Bowel Segment

- diarrhea as a result of
  - short bowel syndrome
  - loss of bile salts
  - malabsorption of water (fast passage)
  - malabsorption of glucose and fat
- malabsorption of vitamin B12
  - loss of the ileocoecal valve or terminal ileum

  - megaloblastic anemia
  - axonal degeneration of nerves, spine, brain
  - paresthesia of the extremities
  - loss of proprioception and vibration perception
  - stupor
  - depression
  - visual scotoma

- malabsorption of vitamin D with osteoporosis
  - loss of the terminal ileum & ileocoecal valve
  - result of chronic acidotic metabolism
  - demineralization of the bones
  - hypophosphatemia
  - hypocalcemia
  - secondary hyperparathyroidism

- increased risk of cholelithiasis
  - loss of small bowel
  - loss of bile salts

- increased risk of nephrolithiasis

  - hyperchloremic acidose
  - bone demineralization
  - hypercalcuria
  - oxaluria
  - mucus retention
  - recurrent urinary tract infections

Long Term Complications and Lifetime Advice Depending on Different Kinds of Diversions

Ureterosigmoidostomy/Mainz Pouch II

- infectious
- oncological (de novo development of colonic cancer)
- metabolic (80 % acidosis)

Lifetime Advice

- consequent antibiotic treatment of urinary tract infections
- frequent colorectoscopy at least every 2 years
- monitoring of pH value and base excess in venous blood gas analysis
- oral treatment of the acidosis by sodium bicarbonate or sodium citrate
- in acute deterioration of the hypokalemic hyperchloremic acidosis intensive care treatment is necessary with the insertion of a rectal tube to minimize the reabsorption plus intravenous treatment of the hypokalemia under cardiac monitoring
- frequent control of the electrolytes including frequent cardiological controls to detect chronic hypokalemia and disorders
- frequent control of bone mineral density and Ca2+, PO43-, Vitamin D Level
- frequent sonographic kidney controls (implantation stenosis of the ureter)

Ileal Conduit

- rarely metabolic disorders (acidosis)
- stomastenosis
- dermatitis at stoma site
- ureteral stenosis at implantation site

Lifetime Advice

- frequent stoma controls – case of stoma stenosis significant acidosis will occur. In case of stoma stenosis surgical revision of the stoma is recommended. If not possible drainage via a transstomal catheter is necessary
- monitoring of pH value and base excess in venous blood gas analysis
- if necessary oral treatment of the acidosis by sodium bicarbonate or sodium citrate

- professional stoma care (specialized nurse)
- frequent sonographic kidney control
- normal water intake
- vitamin B12 control 3–5 years after the surgery and substitution
- substitution of the liposoluble vitamins E, D, K, A
- Substitution of Calcium

Cystoplasty/Bladder Augmentation

- kind of complication is linked to the kind and length of bowel segment used
- metabolic disorders are rare
- acidosis occurs mainly in patients with chronic renal failure

Lifetime Advice

- long term results show an atrophy of the intestinal mucosa of the augmented ileal bowel segment leading to an improvement of the metabolical situation
- if coecal bowel segments were used there is no improvement of the metabolic situation expected
- monitoring of pH value and base excess in venous blood gas analysis
- if necessary oral treatment of the acidosis by sodium bicarbonate or sodium citrate
- frequent sonographic kidney control
- sonographic check of postvoid residual urine can be detected
- urodynamic studies if new storing or voiding symptoms occur

Continent Diversions (Pouches and Neobladders)

Due to the function as a urine reservoir the long term complications and the long term advice is mainly influenced by the kind of bowel segment used.

Continent Pouches

- stoma related Complications (stomastenosis, stoma incontinence)
- bladder outlet obstruction (anastomotic stricture)
- metabolic disorders (metabolic acidosis)
- stone formation in the pouch/neobladder
- stenosis of the ureter implantation site
- pouch obstruction due to mucus formation
- recurrent urinary tract infections

Lifetime Advice

- frequent stoma controls – in case of stoma stenosis significant acidosis will occur. In case of stoma stenosis surgical revision of the stoma is recommended. If not possible drainage via a indwelling transstomal catheter is necessary
- monitoring of pH value and base excess in venous blood gas analysis
- if necessary oral treatment of the acidosis by sodium bicarbonate or sodium citrate
- frequent sonographic control of the kidneys, pouch or neobladder
    - normal water intake
    - vitamin B12 control 3–5 years after the surgery and substitution
    - substitution of the liposoluble vitamins E, D, K, A
    - Substitution of Calcium
    - alimentary treatment of steatorrhea
    - cholestyramin intake
    - loperamid intake

Neobladders

- development of bladder outlet obstruction (anastomotic stricture)
- metabolic disorders (metabolic acidosis)

- stone formation in the neobladder especially if nonresorbable material was used (staplers)
- stenosis of the ureter implantation site
- Severe mucus formation
- recurrent urinary tract infections
- night time incontinence (neobladders)

Lifetime Advice

- consequently emptying of the neobladder, scheduled voiding at least 4×/day
- frequent sonographic controls of the neobladder – in case of bladder outlet obstruction the residual urine will increase and significant acidosis will occur. Endoscopic treatment of the stenosis is recommended. In failure intermittent self catherization is necessary.
- monitoring of pH value and base excess in venous blood gas analysis
- if necessary oral treatment of the acidosis by sodium bicarbonate or sodium citrate
- pelvic floor exercises (before & after the surgery)
- frequent sonographic kidney control
- normal water intake
- vitamin B12 control 3–5 years after the surgery and substitution
- substitution of the liposoluble vitamins E, D, K, A
- Substitution of Calcium

The short term follow up of the patient (1st year after the surgery) is depending on the type of urinary diversion and the specific diversion-related risks including the intensive care treatment of a life-threatening metabolic acidosis. There are no time intervals for the scheduling of the patient defined in the literature. The patient benefits definitely from a rehabilitation therapy after the surgery (duration 3 weeks). After rehabilitation a control visit at the outpatient urologist to plan the risk-adapted follow up (metabolic, oncologic) is recommended.

The long term follow up of the patient (after the 1st year after surgery) has to be scheduled adapted to the risk. Acute metabolic problems are not likely to occur. However, slow metabolic changes have to be monitored. In this timeframe oncological and functional problems are most likely to occur e.g. postvoid residual, impaired renal function because of recurrent infections, oncological recurrence etc. The vitamin B12 should be checked routinely and substituted. Though metabolic changes after urinary diversion will occur if monitored consequently there is no harm for the patient to expect.

Chapter 26
Lifestyle Advice for Sub-fertile Men

Thomas J. Johnston, Rachel Hubbard, and Oliver J. Wiseman

Abstract This chapter summarizes the important lifestyle and environmental factors that can influence male sexual health. Sub-fertile men who reduce their exposure to harmful substances and lead an active and healthy lifestyle can significantly boost their chances of fathering a healthy child.

Keywords Infertility • Subfertility • Lifestyle • Environment • Occupational

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Introduction

Clinical infertility is defined in the United Kingdom (UK) as the inability to conceive after 1 year of unprotected vaginal sexual intercourse in the absence of any known cause of infertility [7]. It is estimated that infertility affects one out of seven heterosexual couples in the UK [7] and over 45 million worldwide [15]. Male factor infertility or subfertility accounts for up to 50 % of infertility cases [7]. There is now a considerable body of evidence that environmental and lifestyle factors can have a significant positive and negative impact on male reproductive potential. This chapter aims to provide a summary of the important modifiable factors men should consider when trying to improve their chances of fathering a healthy, live birth (Table 26.1).

Personal Health Factors

Nutrition and Exercise

Eating a healthy and balanced diet is a key part of maintaining good overall sexual health. Consuming a diet high in fish, fruits, vegetables and antioxidants has been shown to improve

Table 26.1 Positive and negative factors influencing male fertility

Positive factors	**Negative factors**
A healthy and balanced diet	Diet high in processed food and fat
Staying at a healthy weight	Being overweight or underweight
Regular exercise	Extreme exercising
Reducing stress levels	High caffeine intake
Prescription medication review with doctor	Smoking and excess alcohol
	Steroids, opioids and illegal drugs
	Excessive stress
	Increased temperature around the scrotum

semen quality. Whereas diets which have high amounts of caffeine, fat, protein and processed food appear to have a negative impact [16]. Being overweight or underweight has also been found to worsen sperm quality [5]. Obese men who improve their diet and take part in regular exercise can significantly improve their chances of fathering a child [8]. Men who exercise at least three times per week for over an hour at a time have improved sperm quality [18]. However, excessive exercise or lack of exercise has the opposite effect [22].

Harmful Substances

Several substances have been shown to adversely affect sperm production and function, including; cigarette smoking, alcohol, marijuana and anabolic steroids [2]. Men who smoke tend to have a reduction in their sperm count, semen volume, density and motility. These effects, however, can be reversed following smoking cessation for over 3 months or longer [14]. Alcohol is also a recognized testicular toxin with its effects being dose and duration dependent [4]. A number of studies have shown that stopping alcohol consumption can lead to rapid and dramatic improvement in semen characteristics [20]. Staying within the recommended alcohol intake for men does not appear to reduce sperm quality or function.

Anabolic steroids are increasingly being used by young men in their reproductive years who are unaware of the consequences associated with their misuse. Anabolic steroids suppress sperm production and reduce sexual drive by decreasing testicular testosterone levels [6]. These effects are usually reversible but it can take up to 3 years to regain function [2]. Some prescription medications such as opioids, anti-depressant and anti-epileptics can also reduce sperm quality [18].

The use of illegal drugs is common in peak reproductive age groups with marijuana being one of the most commonly used drugs worldwide. It misuse has been shown to reduce testosterone levels as well as sperm production and function [3]. Another large group of illicit drugs which impair testicular function are opiates, such as heroin and methadone [17]. Men taking these drugs reported sexual dysfunction with these effects persisting even after cessation [21]. Cocaine is also commonly used as a recreational drug with long term male users reporting it harder to maintain an erection and to ejaculate [9]. Men with sub-fertility who use illegal drugs will improve their chances of fathering a child if they quit and should seek medical advice for the appropriate support if required.

Stress

Stress due to psychological, physical or social reasons is unfortunately a common and prominent part of our society. Being stressed can affect a man's libido and semen quality [10]. Taking time to relax and unwind can boost libido, sperm quality and increase changes of a pregnancy [2].

Environmental and Occupational Factors

Raised Scrotal Temperature

The testicles are located within the scrotum to maintain their temperature a few degrees below core body temperature for optimum function. A number of studies have shown that increased testicular temperature decreases sperm quality with these effects being reversed by cooling [1, 19]. Having hot baths or regular sauna use; wearing tight under wear or restrictive clothing; prolonged sitting or driving; and using portable computers on their laps are possible contributory factors which sub-fertile men should try to avoid [19].

Electronic Mobile Devices

There has been a rapid rise over the past decade in the use of mobile telephones and other electronic devices with the long term effects on human health from exposure to radio-frequency electromagnetic radiation yet to be determined. Several studies have shown a decrease in sperm quality and function in men who use electronic devices on a regular basis [1, 11]. In addition, these effects appeared to be dependent on the duration of mobile phone possession and the frequency and length of telephone conversations [12]. Men who carry their mobile phone in their trouser pockets or on their belts have been shown to display poorer semen function compared to those who keep them elsewhere [13]. Sub-fertile men can help boost their reproductive potential by attempting to reduce their use and contact with these devices.

Occupational

Sub-fertile men should be aware of the potential hazards they are being exposed to in their working environments. Regular exposure to heavy metals, chemicals, pesticides and poor air quality can have a negative impact on reproductive health by interrupting the hormonal pathways involved in sperm production and reducing libido [4, 18]. Sub-fertile men should strive to minimize their exposure to these materials and take the appropriate precautions whilst at work (Table 26.2). It is also important to recognize that exposure to these materials can occur during hobbies, such as; gardening or craft work and therefore similar preventive measures should be taken at home.

Table 26.2 Summary of materials with potentially harmful effects on male reproduction

Heavy metals	**Chemicals and pesticides**	**Air pollutants**
Mercury	Bisphenol A (BPA)	Sulfur dioxides
Lead	Dioxins	Carbon monoxide
Arsenic	Pesticides e.g. DDT or DDE	Nitrogen dioxide
Cadmium	Phthalates	Particulate matter
Lithium	Solvents	
Aluminum		

Conclusions

This chapter has summarized the important lifestyle and environmental factors that can influence male sexual health. Sub-fertile men who reduce their exposure to harmful substances and lead an active and healthy lifestyle can significantly boost their chances of fathering a healthy child.

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Chapter 27
Optimal Use of PSA

Hasan Dani and Stacy Loeb

Abstract Prostate cancer screening reduces advanced cancer and disease-related death, but is controversial due to the limited specificity of the prostate-specific antigen (PSA) measurement and potential downstream harms. There are multiple ways to improve screening paradigms, including better patient selection, new commercially available tests with greater specificity, and a multivariable approach taking into consideration multiple risk factors when making biopsy decisions. This chapter summarizes the major randomized trials of PSA screening and subsequent research on different ways to optimize our screening approach.

Keywords Prostate cancer • PSA • Screening • Prostate health index • 4Kscore

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Few cancers offer the luxury of a simple serum tumor marker to aid in diagnosis. Prostate-specific antigen (PSA) is unique in its ability to screen entirely asymptomatic men for prostate cancer. However, the use of PSA as a screening tool remains controversial.

In the United States, widespread PSA screening was introduced in the 1990s. Population data from the Surveillance, Epidemiology, and End Results (SEER) program demonstrate a reduction in prostate cancer mortality by greater than 50 % since that time [1]. It has been suggested that PSA-based screening explains 45–70 % of the decline in mortality, with other factors such as improvements in treatment accounting for the remainder [2].

Two large, multicenter randomized controlled trials (RCTs) have been conducted to examine prostate cancer screening: the European Randomized Study of Prostate Cancer Screening (ERSPC) and the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening trial. After 13 years of follow-up, prostate cancer screening yielded a 21 % reduction in prostate cancer-specific mortality in the ERSPC [3]. By contrast, the PLCO trial reported no survival benefit to PSA screening after 13 years [4]. However, this trial suffered from significant contamination, in which more than 80 % of controls reported undergoing PSA testing [5, 6].

With any intervention, one must consider the balance of benefit and harms. Prostate cancer screening begins with a simple blood test, but the ensuing prostate biopsies and radical treatment can lead to significant associated morbidity [7]. Currently, there is an emphasis on reducing diagnosis of low-risk disease in the first place and dissociating diagnosis from treatment [8]. To achieve these goals, we must have screening tools that more specifically identify patients with clinically significant cancer.

Screening with Prostate-Specific Antigen

PSA is normally secreted into seminal fluid and leaks into serum at much lower concentrations. Processes such as prostate cancer, benign prostatic hyperplasia, prostatitis, and physical manipulation of the prostate can increase serum levels of PSA, likely due to disruption of the normal prostatic architecture [9, 10]. PSA levels are also dependent on age, race, and prostate volume [11, 12]. Thus, PSA is specific to the prostate but not to prostate cancer itself. Clinical interpretation of PSA values should always include consideration of the age of the patient, discernible prostatic disease, recent procedures involving the prostate, and relevant treatments (e.g. finasteride).

Target Age Groups

Various organizations propose different ages at which to initiate and terminate prostate cancer screening. The European Association of Urology (EAU) recommends earlier and more frequent PSA testing for men with risk factors including positive family history, African American race, or a baseline PSA level >1 ng/ml in the 40s [13]. The American Urological Association (AUA) recommends offering routine screening from ages 55 to 69 if normal-risk or younger than age 55 if higher-risk [14]. Similar to the EAU, the AUA does not recommend routine screening in any man with less than a 10–15 year life expectancy.

Evidence for these recommendations comes primarily from the ERSPC and Göteborg trials. The core age group in which the ERSPC demonstrated a survival benefit to PSA screening was ages 55–69 [3]. The Göteborg trial suggests that this benefit extends to men ages 50–54 [15, 16].

Baseline PSA Testing

Although men <50 years were not included in the major randomized trials, baseline PSA testing in younger men is strongly supported by several observational studies [17–20]. In men younger than 50 years, a baseline PSA above the age-specific median but still within normal range is a robust predictor of future prostate cancer risk; it is a stronger predictor than family history, race, or suspicious digital rectal examination (DRE) [18, 20]. Baseline PSA testing also predicts long-term risk of locally advanced disease, metastases, and disease-specific mortality [20–22]. Thus, it has been suggested that a baseline PSA can be used for risk stratification and to determine frequency of subsequent prostate cancer screening for an individual.

This evidence has been incorporated into select professional guidelines but is still lacking from the guidelines released by the AUA and others that are based more strictly on randomized trials. The EAU suggests baseline PSA testing in men as young as 40 years of age [13]. The National Comprehensive Cancer Network (NCCN) similarly recommends offering baseline PSA testing at age 45 [23].

Frequency of Screening

The optimal screening interval would minimize the overdiagnosis of low-risk disease while still allowing detection of life-threatening tumors at a curable stage. Data from Rotterdam (4 year interval) and Göteborg (2 year interval) ERSPC were used to compare the implications of different screening intervals. Compared to screening every 4 years, a 2-year interval reduced diagnosis of advanced prostate cancer by 43 % but increased diagnosis of low-risk disease by 46 %.

The AUA endorses screening no more often than every 2 years to reduce harms. [14] An alternate approach is to determine the screening frequency by a patient's individual risk. The Rotterdam section of the ERSPC showed that men with a PSA <1 ng/mL had a very low risk for prostate cancer after 4 and 8 years (0.23 % and 0.49 %, respectively) [24]. Considering both this data and the value of baseline PSA testing, the EAU and NCCN recommend risk-based screening intervals [13, 23]. The EAU suggests follow-up every 2 years if the PSA is >1 ng/mL at age 40 or >2 ng/mL at age 60. Follow-up for men with PSA values below these thresholds can be postponed up to 8 years.

Trigger for Biopsy

The indication for prostate biopsy in the ERSPC was primarily a PSA cutoff of 3 ng/mL. As this study demonstrated a survival benefit, a PSA threshold of 3 ng/mL can be considered evidence-based [3]. However, such a cutoff may diagnose many low-risk cancers and overlook some higher-risk cancers. PSA predicts risk of cancer in a continuous fashion, with no specific cutoff that can exclude clinically significant cancer [25]. Analysis of data from empiric biopsies in the Prostate Cancer Prevention Trial (PCPT) demonstrated that risk of Gleason ≥7 cancer in men with PSA levels between 2.1 and 3.0 ng/mL and 3.1–4.0 ng/mL was 4.6 % and 6.7 %, respectively.

Age-specific ranges have been suggested as a tool to increase the accuracy of PSA [11]. However, studies have shown mixed results regarding the value of these reference ranges [26]. As such, they are not included in recent guidelines from the EAU and NCCN. However, the AUA suggests considering a higher threshold of 10 ng/ml for biopsy in men over age 70 to reduce harms.

For men with mildly elevated PSA values, many guidelines now suggest further risk stratification with secondary tools such as free PSA, the prostate health index (phi), 4 kallikrein score (4Kscore), prostate cancer gene 3 (PCA3), MRI, and risk calculators. The EAU specifically recommends application of these tools in men with a PSA between 2 and 10 ng/mL to determine need for prostate biopsy [13]. The NCCN offers free PSA, phi and the 4 K score as secondary testing options for men with PSA >3 ng/ml considering initial prostate biopsy. The same three tests as well as PCA3, ConfirmMDx and multiparametric MRI are suggested as potential secondary testing options for men considering repeat biopsy.

PSA Derivatives

Free PSA

The majority of total PSA (tPSA) circulates bound to proteins, with the remainder existing as free PSA (fPSA). Men with prostate cancer have a lower fraction of fPSA, or %fPSA [27]. Many prospective studies have indicated improved specificity and accuracy for detection of prostate cancer and clinically significant cancer (i.e., Gleason ≥7, Epstein criteria) using %fPSA in men with tPSA between 4 and 10 ng/mL [28]. Evidence suggests that its utility even extends to men with tPSA <4 ng/mL [32].

Indications for %fPSA include men with mildly elevated PSA for whom initial biopsy or repeat biopsy is under consideration [33]. As with total PSA, the optimal %fPSA cutoff for clinical use is subject to debate. One study demonstrated that a %fPSA cutoff of 25 % in men with PSA between 4 and 10 ng/mL detected 95 % of cancers while avoiding 20 % of unnecessary biopsies [29].

Prostate Health Index

An isoform of fPSA, termed [−2]proPSA, is elevated in men with prostate cancer and appears more specific for cancer than tPSA [34]. The phi test incorporates tPSA, fPSA, and [-2]proPSA into a formula which predicts the probability of prostate cancer on biopsy. Compared to its individual components, phi has been shown to be more accurate for detection of prostate cancer and clinically significant cancer, defined by Gleason ≥7 or Epstein criteria [30, 31, 35–37]. Using a phi cutoff of 28.6, one study estimated that 30.1 % of unnecessary biopsies could have been avoided in men with PSA values between 4 and 10 ng/mL [30].

By reducing unnecessary biopsies, phi in conjunction with tPSA may be more cost-effective overall [38]. These studies support the application of phi to help patients make more informed decisions about initial or repeat biopsy.

4 Kallikrein Score

The 4Kscore is an algorithm containing tPSA, fPSA, intact PSA, and human kallikrein 2 along with age, DRE, and prior biopsy results to predict the risk of biopsy-detectable high-grade prostate cancer. Several studies have demonstrated that 4Kscore has high accuracy for detection of clinically significant cancer, comparable to that of phi [39–41]. It has also been shown to predict prostatectomy pathology and metastatic disease [42]. Both phi and 4Kscore are suggested by the EAU and NCCN as reflex testing options for prostate biopsy decisions [13, 23].

Multivariable Approach to Screening

Multivariable models and risk calculators attempt to translate various risk factors into a numerical probability of prostate cancer. The validated PCPT risk calculator 2.0 (PCPT-RC) incorporates race, age, family history, DRE, prior biopsy results, tPSA, and %fPSA to provide risk of high-grade, low-grade, and no cancer [43]. The ERSPC risk calculator (ERSPC-RC) is another validated tool, based on age, family history, DRE, prior biopsy results, tPSA, and prostate volume. Phi was added to ERSPC-RC to produce the ERSPC-PHI, which outperformed both ERSPC-RC and PCPT-RC in a multicenter European study [44]. Similar multivariable models incorporating phi have been internally and externally validated, demonstrating increased predictive accuracy compared to phi alone [45, 46].

The paradigm of prostate cancer screening is in transition. The days are past of routine, annual screening and hard triggers for prostate biopsy. To reduce overdiagnosis and overtreatment, PSA should be considered in the context of a patient's individual risk factors. If needed, secondary tests such as fPSA, phi, 4Kscore, PCA3, MRI, and multivariable risk calculators may provide a more accurate assessment of risk. Patient preferences should also be assessed to determine the optimal course of prostate cancer screening and detection in each individual.

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Chapter 28
Transrectal Ultrasound Guided Prostate Biopsy

Antonio Cicione, Francesco Cantiello, and Rocco Damiano

Abstract Prostate biopsy (PBx) is one of the most common urological procedures, with more than one million procedures performed per year in Europe and the United States. PBx is performed to diagnose prostate cancer (PCa) that may be considered as a singular malignancy despite other neoplastic diseases for which the biopsy can be direct to a single suspect area. At present, PBx is can be carried out in an office setting with low morbidity however the role of prostate biopsy (PBx) has changed and its findings play a crucial role in the choice of prostate cancer treatment. For instance, the recent introduction of active surveillance and focal therapy as ideally available treatment options have emphasized the role of PBx to assist patient clinical management requiring persuasive details on PCa quality. Likewise, in the effort to improve both the cancer detection and the cancer features assessment a notable improvement in PBx instrumentations and technologies has occurred over the last years moving from Vim-Silverman needle originally used in the 1980 to perform digital-guided PBx to many imaging technologies such as elastosonography or magnetic resonance aimed to

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improve the PCa detection. PBx can be carried out by both perineal and trans rectal approach. Herein, main technical aspects of the trans rectal prostate biopsy are summarized in order to provide the most current knowledge on this topic.

Keywords Prostate biopsy • Transrectaly ultrasound • Technique

Equipment and Patient Preparation

Ultrasound

Most of ultrasound system have a rectal biplane probe however many of available endocavitary end-fire probes are also suitable for both transvaginal and transrectal use. In such case, longitudinal and axial scans are obtained by rotating the probe through a 90° axis.

A sterile sheath is used to cover the probe while a needle guide is attached over. The last one can be disposable or sterizable according to own manufacture. It is advisable to maintain the work field as clean as possible although it is not a sterile area. Finally, the probe is covered by ultrasound gel in order to minimize air interference. The use of biopsy guide line generally available on US system-monitor is an homely tip to facilitate a precise sampling.

Biopsy Needle

A 16 or 18 gauge core biopsy needle are generally used. Core biopsy needle consists of one bayonet-shaped inner needle inside an outer cutting cannula. The needle is loaded in a spring-action device that advances about 23 mm the inner and outer cannula when the trigger button is pushed. In such way, 15–17 mm length of prostate tissue is captured inside the bayonet (Fig. 28.1). Larger needles are considered to be at higher risk of bleeding while smaller needles sample are related to poor tissue [6]. For instance, the 22 and 23 gauge

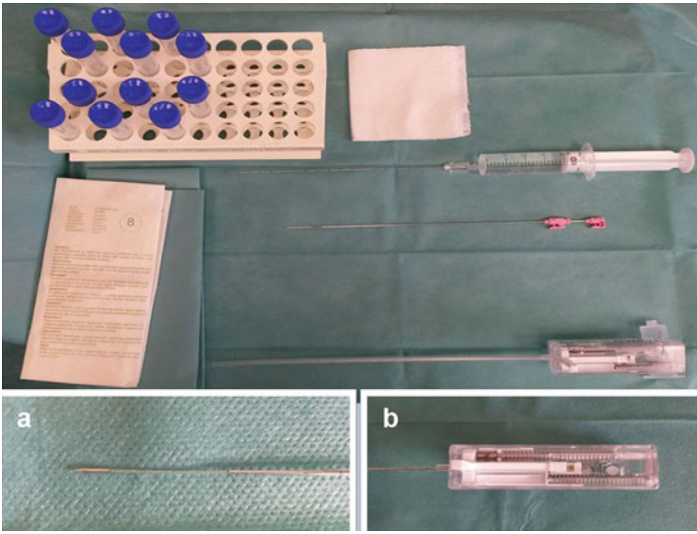

FIGURE 28.1 Operating table with biopsy tools including sterile sheet and gloves, numbered test tubes with Formalin, 22G with anesthetic solution, a biopsy needle, not reusable spring-action device. In the corner two details: (**a**) the bayonet-shaped needle tip and (**b**) the spring-mechanism

needles were traditionally used for aspiration cytology however this one did not permit histological grading and it is not more the state-of-the-art.

Enema and Antibiotic Prophylaxis

During the last decade a 4.3 % risk of hospital admission for PBx-related infection was computed [19]. Recently, a Cochrane review concluded that enema and antibiotics together reduce the risk of bacteremia compared to antibiotics alone [13]. On the other hand, self-administered enema on the same day of the examination can facilitate US visualization by evacuating gas and fecal matter that cause interference with ultrasound.

Uncomfortable mechanical bowel preparation such like those generally used for colonoscopy, does not reduce the risk of complications despite the rectal enema [7]. Then, disinfecting the needle tip by a safe amount of formalin (10 %) after each biopsy core has been suggested in a large study as simple technique to reduce the risk of urinary infection and sepsis [15].

Regarding antibiotic use, several classes of antibiotic are effective for prophylaxis however quinolone are the drugs of choice [21]. Although no wide consensus exists on the prophylaxis duration, a 3–7 days course is generally adopted among urologists [2]. Particular attention should be take regard the local rate of quinolone-resistant organism due to increasing rate of those infections. In this concern, some researchers have suggested to use rectal swab cultures to guide antibiotic choice. Finally, the prophylaxis for patients at increased risk of endocarditis should include coverage for both gram positive and gram-negative bacilli.

Stop Anticoagulation Therapy

Usually, any anticoagulation medications are stopped or replaced with low molecular weight heparin for an sufficient length before biopsy. However, some comparative studies showed no significative difference in term of bleeding rate when aspirin intake is not stopped at the time of the biopsy [14, 16] although it prolongs the duration of self-limiting hematuria [12] and the risk of bleeding looks to be correlated to the core number [5].

Patient Consent

Due to its invasive nature the risk of rectal bleeding, hematuria, urinary retention and hematospermia should be discussed in detail as well as a written consent should be obtained.

Procedure

Reducing Patient Pain

The administration of anesthetic medications to reduce patient discomfort related to PBx has been largely showed by an high number of published studies. Therefore, the absence of anesthesia may be considered malpractice since the most common guidelines also recommend to perform anesthesia [1, 9]. An intrarectal local anesthesia with lidocaine (2 %) gel has been proposed as simple way to achieve pain reduction. However, the periprostatic nerve block ensures an higher and durable pain relief as showed in randomized studies. About the technique, 10-ml lidocaine – showed to be the best amount of anesthetic – are injected through a 22 gauge needle while the site of injection may be different [18] for instance, around the prostate vascular pedicle – as originally reported by Nash et al. [17] – at three location (apex, mild, basis) and at pelvic plexus [4]. It is reasonable that combining the use intrarectal gel and periprostatic block may offer the maximum comfort. The first one may reduce the patient discomfort due to ultrasound probe in the anus while the periprostatic block may prevent the pain from puncture of prostate capsule and parenchyma.

Patient Position

Patient is collocated in left lateral decubitus with his buttocks places near the bed edge. In order to create a wide working area to easily move the ultrasound probe, the patient legs are bent like fetal position, and the pelvis lightly tilted front.

Sampling

The last few years have showed that a sextant biopsy scheme (six core) was inferior to an extended scheme (10–12 core) in term of prostate cancer detection rate. Certainly, the direction and core number determine the procedure's sensitivity. For these reasons, the sample sites should be bilateral from apex to base as far posterior and lateral as possible in the peripheral gland. Sampling the lateral prostatic horn increases about a 25 % the ability to detect prostate cancer as well as the apex and the base of the peripheral gland are the sites at which prostate cancer is most likely to be located while the para-sagittal biopsies have been demonstrated to have the lowest probability of PCa at initial biopsy. Likewise, the use of a extended scheme has been showed to increase the risk of Gleason Score concordance between prostate biopsy and radical prostatectomy specimen [18].

Keeping in mind that the 12 core is a concern in large prostate (more than 40 cc), such sampling can be considered adequate as well as a good compromise with compliance in case of initial biopsy. At the same time, the necessity of biopsying single hypoechoic lesions seems to be no longer necessary because the low accuracy of that finding as well as there is little benefit to adding transitional zone biopsy.

However, the initial prostate biopsy does not rule out the cancer diagnosis with certainty requiring often a repeat biopsy. Although there is not clear consensus on when to perform the rebiopsy, the saturation biopsy technique (>20 core) is considered as an correct choice with a cancer detection rate ranged from 17 to 41 %. To note, the probability of a positive biopsy generally decreases in according to the number of previous biopsies: men with total serum PSA level of 4–10 ng/ml undergone to one, two, three, and four previous biopsies have a risk of cancer diagnosis of 22 %, 10 %, 5 %, and 4 %, respectively [8]. Again, the new sampling should be accurately directed to the apices, to anterior prostate and very lateral edges including also transitional zone whereas this one has low detection rate (Fig. 28.2). Recently, multiparametric magnetic resonance image-targeted biopsy has been introduced as further way to detect tumor in case of persistent clinical suspicious of cancer.

Usually a preliminary trans rectal ultrasound is performed in order to compute prostate volume. Then, local

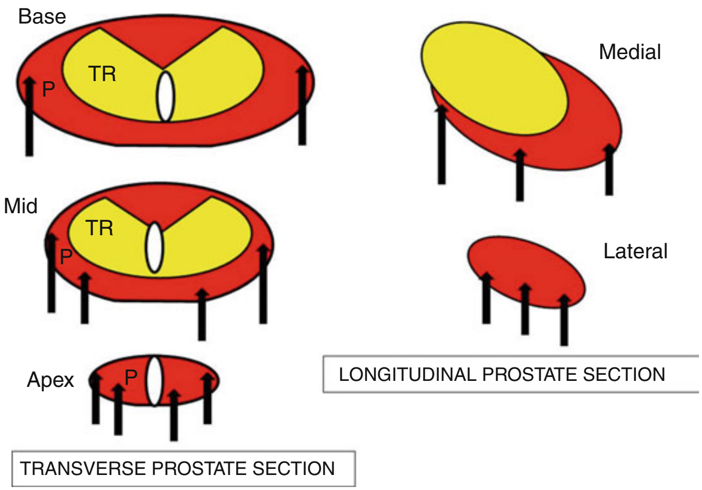

FIGURE 28.2 A scheme to elucidate the concern to guide the prostate sampling laterally and accurately to apex. Although a risk of missing prostate gland increases, it has been showed that lateral biopsies increase detection rate, likely due a greater glandular presence than paramedian area (*P* peripheral zone, *TR* transitional zone)

anesthesia is performed. Finally, the biopsy-needle is advanced through the biopsy guide and two resistances can be generally felt. The first one is the rectal wall while the second one is the prostatic capsule. Paying attention on ultrasound images, a slight distortion of capsular profile can be noted as well as the needle tip. A this point the sampling can be achieved. To note, the needle tip must to be at target point before biopsying as well as the probe should be not moved when the needle is at that point in order to avoid rectal bleeding. Furthermore, when biopsies are performed at base or anterior prostate, the risk of penetrating into bladder exists due to needle advancement. This may explain protract hematuria at the end of procedure. In such circumstance, inserting a urinary catheter should be considered.

Biopsy Core Assessment and Collection

Urologists must provide adequate clinical information and tissue sample to pathologist for an optimal histological examination. In this effort, some controllable factors can be recognized and correct at the time of biopsy:

- Check length of core and absence of fragmentation – a core length >10 mm is usually considered a quality indicator of prostate needle biopsies. Although sextant scheme was used, a direct correlation was observed between length of submitted prostatic tissue and PCa detention rate in the ERSPC (*European Randomized Study of Screening for Prostate Cancer*) [20]. Thus, core length shorter than 10-mm should be considered inadequate for a correct histological evaluation and not diagnostic. Of course, some factors including but not limited to who performs biopsy can affect core length: the needle (see above), core site (i.e. apex and lateral core may be shorter than base and paramedian core), prostate size, the methodology to collect biopsy cores and finally pathological analysis. Likewise, a fragmented core may interfere with the interpretation of the number of cores with cancer, the percentage of cancer involving a single core, the assessment of Gleason Score [10].
- Take care on tissue handling – abundant data show that the diagnostic value of prostate biopsy is influenced of how tissue is collected for pathological evaluation. In the effort to submit correctly the biopsy tissue some recommendations can be briefly summarized in the Table 28.1.

Table 28.1 Recommendations for prostate biopsy pathological processing, urologist's concerns

Recommendation ***How to do***	**Clinical implications** ***Why to do***
Separately submitting biopsy cores from different anatomic locations	• Treatment planning (i.e. nerve sparing technique, active surveillance, radiation therapy dose): presence and amount of cancer in different regions are correlated with risk of higher pathologic stage and margin positivity. • Facilitating processing and pathological assessment avoiding of diagnostic pitfalls (i.e. the prostatic central zone and seminal vesicles [base biopsy], that may mimic prostatic intraepithelial neoplasia [PIN] or cancer, respectively). • Lower risk of tissue fragmentation • Detailed correlation with clinical and imaging studies • Help to redirect part of repeat biopsy in case of suspicious lesions.
Flatten and align biopsy core	Needle biopsies tend to become curve after fixation reducing the amount of tissue to analyze. Flattening biopsy core can avoid this risk. In this effort, the use of cassette with nylon sponges or paper can be helpful. However, a maximum of three cores in the same cassette should be included in order to avoid the loss of assessable tissue and each sponge should be soaked in physiologic solution to facilitate fixation.
Immediate fixation of the cores by 10 % neutral buffered formalin solution	This avoids useless further tissue manipulations and reduces possibility of errors. Furthermore, delayed fixation may result morphological tissue changes. Although other fixative solutions have been proposed (i.e. alcohol-based, Bouin solution), formalin is the preferred one because largely used, does not alter any histological features needed for cancer diagnosis (i.e. nucleolar prominence). Finally, formalin fixation is compatible with immunohistochemical tests.

Adapted from Kwast et al. [20], Boccon-Gibod et al. [3], Fine et al. [11]

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Chapter 29
Transperineal Prostate Biopsy

Gabriele Gaziev, Stefano Germani, and Roberto Miano

Abstract The authors describe a transperineal prostate biopsy technique routinely performed under local anesthesia, including the management of the patient before and after the biopsy and trying to provide some tips and tricks for the readers.

Keywords Transperineal prostate biopsy • Prostate cancer

Introduction

Transperineal prostate biopsy (TPB) is an established technique of prostate biopsy carried out through the perineum. This approach, although less practiced than transrectal biopsy, presents several advantages. First and most important, the post-biopsy incidence of sepsis and urinary tract infection is almost nil compared to the significant incidence using transrectal route [6, 10, 12, 14]. Moreover TPB improves sampling of the anterior and apical regions and reduces the risk of

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urethral damage [3, 7]. Finally, the entrance axis of the needle during TPB allows for a potential better sampling of the posterior zone.

TPB can be performed in different ways: freehand [4] or grid/template guided [2], under ultrasound vision and/or under magnetic resonance imaging (MRI/TRUS fusion or in bore) [1, 5, 11], under general or local anesthesia [8, 9, 13].

Nevertheless the longer learning curve and procedure time, the use of general or local anesthesia and the higher equipment cost limited the use of TPB in urological practice. Most centers doing TPB use general anesthesia and a grid/template to guide the needle into the prostate, while the performance of freehand TPB under local anesthesia is limited to very few centers.

Nowadays the optimum methodology for prostate biopsy to detect prostate cancer lesions remains to be defined. In this chapter we describe our TPB technique, routinely performed under local anesthesia by the authors for almost 20 years, trying to provide some tips and tricks for the readers.

Preparation

All patients discuss about the procedure with the physician and sign the informed consent form. Patients are asked to stop anticoagulants or anti-platelet agents a week prior to the biopsy and replaced it with low molecular weight heparin when needed. Blood tests (full blood count, renal function, electrolytes, blood clotting), urinalysis and an ECG are required before the procedure. Patients routinely receive an enema the night before the biopsy.

Pre-biopsy Procedures

The day of the procedure, after the clinical history has been taking, patient's blood pressure is measured and the nurse places an endovenous cannula. Antibiotic prophylaxis is

Figure 29.1 Extended lithotomy position with buttocks taped above the scrotum to stretch the perineum

given through a single intravenous shot of Gentamicin 80 mg just before starting the procedure. Patients are placed in an extended lithotomy position (Fig. 29.1) and a digital rectal examination is carried out. The scrotum is elevated and the buttocks taped above it to stretch the perineum. The perineal skin is shaved and disinfected with aqueous betadine solution.

Ultrasound

After the introduction of lidocaine gel or lidocaine/prilocaine cream (EMLA®) into the rectum (to minimize the probe discomfort) a transrectal ultrasound (TRUS) of the prostate is performed with an endorectal biplanar linear array ultrasound probe: the prostate gland echographic feature is studied and the prostate diameters (anteroposterior height; transverse width; cephalocaudal length) are measured. A prostate gland projection is drawn on the perineal skin, based on the prostate ultrasound measures taken. Four different skin entry points (two posterior and two anterior on the prostate projection) are marked on the two sides of the mid vertical line, about 2 and 3 cm above the anus (taking also into account the estimated distance between the posterior prostate capsule and the anterior rectal wall) (Fig. 29.2). This is a useful tool especially during training.

FIGURE 29.2 Prostate shape projection with marked skin entry points

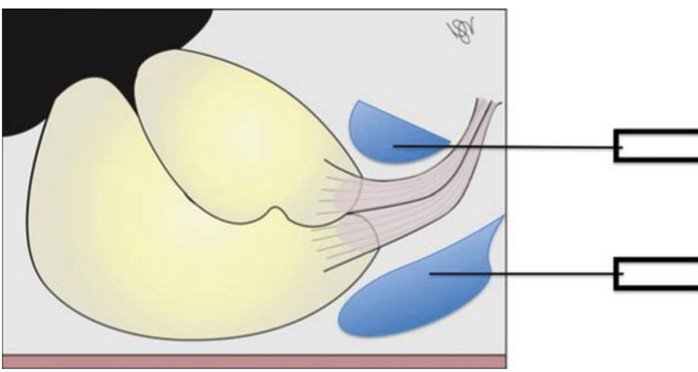

FIGURE 29.3 Anterior and posterior peri-prostatic local anesthesia

Local Anesthesia

Under the guidance of TRUS, local anesthesia of the skin, perineum and the periprostatic nerves is performed. Mepivacaine 2 % (5–7 ml per side) is injected using a 22-Gauge spinal needle inserted through the four skin entry points described above (Fig. 29.3). Local anesthesia is performed both anteriorly and posteriorly.

Biopsy Technique

A 18-Gauge biopsy needle is inserted through the perineal skin, under TRUS guidance. The standard setting for the first biopsy provides a minimum of 18 systematic cores taken from the peripheral posterior zone (PZ) and the anterior zone (AZ) (Fig. 29.4). The standard biopsy scheme includes: (1) six cores from each side of the PZ, from paramedian to lateral, accessing the gland via the posterior skin entry points, for a total of twelve cores; (2) three cores from each side of the AZ, paramedian to lateral, using the anterior skin entry points, for a total of six cores. Transitional zone (TZ) sampling (two cores from each side of the TZ) is performed only for patients with previous negative biopsies. Once in the perineum, the needle is navigated medially or laterally under strict TRUS guidance to reach the prostate. It is important to hold the needle always parallel to the probe (Fig. 29.5) in order to monitor its progression into the perineum. The needle should be directed to the prostate area to be sampled

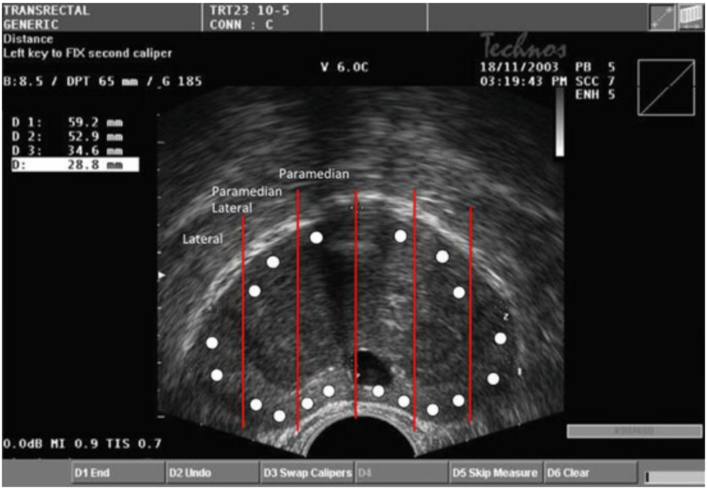

Figure 29.4 TPB scheme seen on TRUS performed according to our internal policies

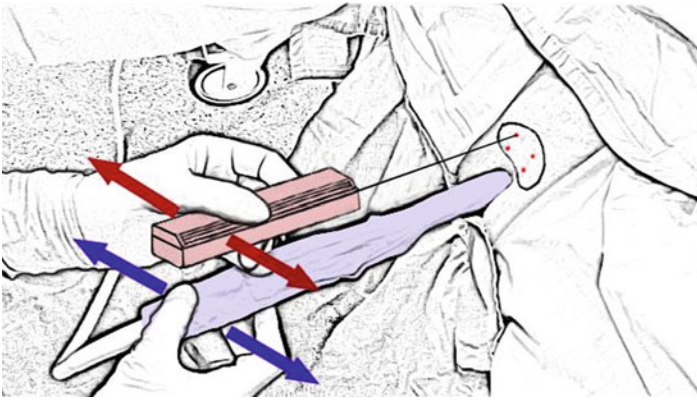

FIGURE 29.5 Proper movement of the needle and the probe: parallel and simultaneous

immediately after passing the skin. Moreover, the needle should not be bent during the sampling because it could affect the prostate cores length and quality.

Post-biopsy Procedures

After the biopsy the perineal skin is compressed for hemostatic purposes and a medicated plaster is applied. Any signs of urethrorragia are investigated. A digital rectal examination is performed to exclude a massive hematoma. Each specimen is sent in a separate histology pot fixed in 10 % formaldehyde. On completion of the procedure, the patients are asked to mobilize and are required to pass urine twice. If there are no severe signs or symptoms (severe pain, dizziness, severe hematuria, urinary retention) the patients are discharged some hours after the biopsy.

Results

In our clinical practice the global cancer detection rate with TPB is 49 % with an increase of about 9 % after the introduction of the AZ mapping through the anterior skin entry points.

Complications

In our experience (internal and not published data from more than 3000 procedures), major complications occurred in very few cases. In particular, acute urinary retention rate was 1.5 %, while perineal hematoma occurred in 0,8 %. Sepsis rate was 0 % with no case of hospital admission after TPB. The most frequent immediate minor complication was hematuria (14 %), that was considered mild in most of the cases. Vaso-vagal episodes occurred in 3.9 % of the cases, with no severe consequences. Pain during the procedure has been considered mild (30 mm on VAS score), while discomfort has been often probe-related. Anyhow intravenous sedation + local anesthesia seems to be the best anesthesia for the patients.

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Chapter 30
Tips for Open Renal Surgery

Tarık Esen and Ömer Acar

Abstract In this chapter, we will give some examples of surgical tricks which will be useful during open renal surgery. The informations provided below are derived from personal experiences of highly proficient open kidney surgeons and some of them are even non-existent in current surgical textbooks. Such invaluable feedbacks may not be possible to gain during standard residency training or during real-time O.R. mentoring. Some of the tricks are further supplemented with figures in order to augment the comprehensive nature of the information provided.

Keywords Open surgery • Kidney • Benign disease • Tumor • Surgical tricks

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Access to the Kidney

- For upper pole masses or adrenal lesions prefer 10–11 intercostal lumbotomy. For all other renal masses (middle zone, lower pole) 11–12 intercostal incision will be useful. Only for UPJ repair choose a subcostal incision. Use a Hemi-Chevron for big renal tumors with renal vein and/or caval thrombus or apparent T4 disease.
- During an intercostal lumbotomy rib resection is rarely needed. Abdominal or thoracal retractors (Balfour, Burford-Finochietto) are recommended. If rib resection is required, cut edge of the bony tissue should be cauterized, tapered with scissors and wrapped around with a wet gauze. Dissect intercostal muscles as close to the rib as possible to avoid pleural injury during intercostal lumbotomy. If injured, a primary repair under deep inspiration will be sufficient in most instances. Under-water drainage is seldom necessary.
- During a subcostal lumbotomy, intercostal vessels can be sacrificed in an effort to gain extra length and mobility for the intercostal nerve to prevent nerve injury and subsequent muscle weakness.

Stone Surgery

- If lipomatous peripelvic tissue hinders optimal dissection, avoid direct incisions on the renal pelvis. Find the ureter and follow its course, stay as close as possible to the adventitial surface with the help of right-angle dissectors. A "V" shaped incision to the renal pelvis will be helpful in most cases.
- Nephrotomies should always be oriented radially. "Brain-spoon" spatula may be useful for creating a regular nephrotomy cavity. Tissue strips that are hooked around the kidney poles may be used to elevate and rotate the parenchyma. These strips should not constrict the parenchyma but rather be kept loose by the aid of a hemostatic clamp (Fig. 30.1).
- Tips of the stone forceps should be closed while entering the calyceal system. It should be opened once you have stone contact. First clear the stone surface from the

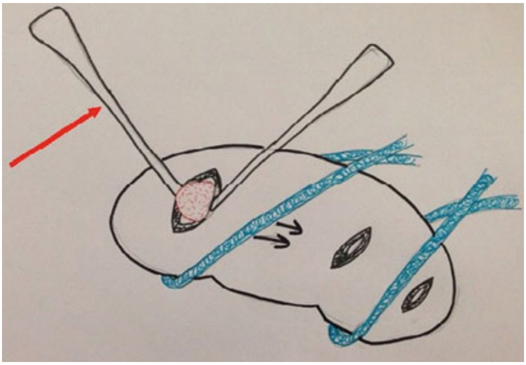

FIGURE 30.1 Gentle traction applied to the tissue strips (colored in *blue*) that are hooked around each kidney pole may be helpful while incising the renal parenchyma and working through the nephrotomy defect with "brain-spoon" spatula (*red arrow*). These hooks should be kept loose just like a hammock by the help of hemostatic clamps

mucosa entirely before manipulating it. Do not use force to pull it out of the pyelocalyceal system. Break the stone either manually or by a special saw if needed for a safe extraction. If a profuse bleeding follows the stone extraction, irrigate the system with ice-cold water through a feeding tube, exert manual compression and wait patiently.

- When searching for residual stones using intraoperative ultrasonography, keep in mind that air bubbles in the pyelocalyceal system may mimic stone echogenity.
- Under cold ischemic conditions make sure that you wait 10 min for the kidney to cool down to 14–16 °C before you incise the parenchyma

Tumor Surgery

Radical Nephrectomy

- If you are using a pedicle clamp, hold the pedicle stump with an Allis clamp before ligating to avoid any slip.
- Since kidney has an end-arterial system there is no need to control the distal arterial end once you have controlled the

proximal part of the renal artery. On the other hand, renal vein should be clamped both proximally and distally to avoid venous tumor spillage.

- If xanthogranulomatous pyelonephritis or tuberculosis is the reason for nephrectomy, the kidney should be mobilized as if you are performing a radical nephrectomy. However, you can switch to subcapsular nephrectomy to visualize the renal pedicle more easily when you get close to the renal hilum.
- Always start mobilizing the kidney first posteriorly and free the psoas muscle. Try to mobilize the adrenal gland en-bloc with the kidney not to violate the integrity of Gerota's fascia. If that is not possible, dissect the adrenal gland separately after removing the kidney. Use vessel clips to secure the central vein, staying as close to the caval surface as possible.
- One should always gain a readily available access to the inferior vena cava while removing the right kidney. In case of profuse venous bleeding from cava placement of a vascular clamp to the distal cava helps.
- While removing vena caval tumor thrombi, avoid excessive mobilization of the kidney, try to free the renal artery, do not dissect the renal vein free. Cavotomy should be commenced only after the cranial and caudal limits of the thrombus as well as the contralateral renal vein is secured with vessel loops or extracorporeal circulation is initiated.

Nephron-Sparing Surgery

- If you experience sticky, adherent perinephritic fatty tissue, do not try to free the renal fat digitally. This may lead to decapsulation and inevitable diffuse bleeding. Use sharp dissection and try to stay as close as possible to the renal capsule.
- While dealing with completely endophytic renal tumors, use ultrasonography to determine the boundaries and depth of the tumor and mark the limits of resection. A careful parechymal incision and "brain-spoon" spatula dissection is needed to visualize the tumor.
- Strategic gauze placement around the kidney may be utilized to elevate, rotate and stabilize the kidney during

nephron-sparing surgery. You may put gauzes underneath the contralateral parenchymal surface in order to excise or repair more comfortably on the other side.

- The kidney should be mobile enough to be brought above the incision line for complex and/or hilar tumors to facilitate better access. Abdominal or thoracal retractors (Balfour, Burford-Finochietto) and tissues strips that are hooked around the kidney poles will provide additional space and mobility (Fig. 30.2a, b).
- If you are able to isolate the tumor-feeding arterial branch then selective occlusion of that vessel might be attempted. In case of excessive bleeding you may need to control the rest of the renal pedicle.
- If there is a need for pedicle clamping, en-bloc occlusion of the artery and the vein will serve better to avoid venous oozing. Be sure not to entrap ureter.
- Keep in mind that most of the peripherally located, exophytic, small renal tumors would not necessitate any pedicle control, simple manual compression would be enough.
- Traction applied, figure of eight vessel loops offer a more controlled way of hilar clamping (Fig. 30.2b). For bulldogs or Satinsky clamps, there is the risk of sudden dislodgement.
- While trying to isolate the vascular supply of hilar tumors, use small, curved vein retractors for a less traumatic dissection of the renal hilum.
- First electro-incise the periphery of the tumor, then dissect the parenchyma with sharp brain spatula. Once you feel the pseudocapsule, proceed your blunt dissection with your fingertip. If you are unfamiliar with such a tactile feedback or the tissue planes are confusing then go sharp, adapt yourself to the contours of the tumor and make use of straight-tipped, short hemostatic clamps everytime you encounter a vascular structure or calyx. These structures are later to be suture-ligated or repaired as you adapt the medulla. Place a double-J stent only in case of excessive pyelocalyceal system violance or inadequate repair.
- During nephron-sparing surgery, preserve as much kidney parenchyma as possible. Principally prefer enucleating the tumor and leaving a minimal rim of normal parenchyma to wider wedge resections or polar amputations.

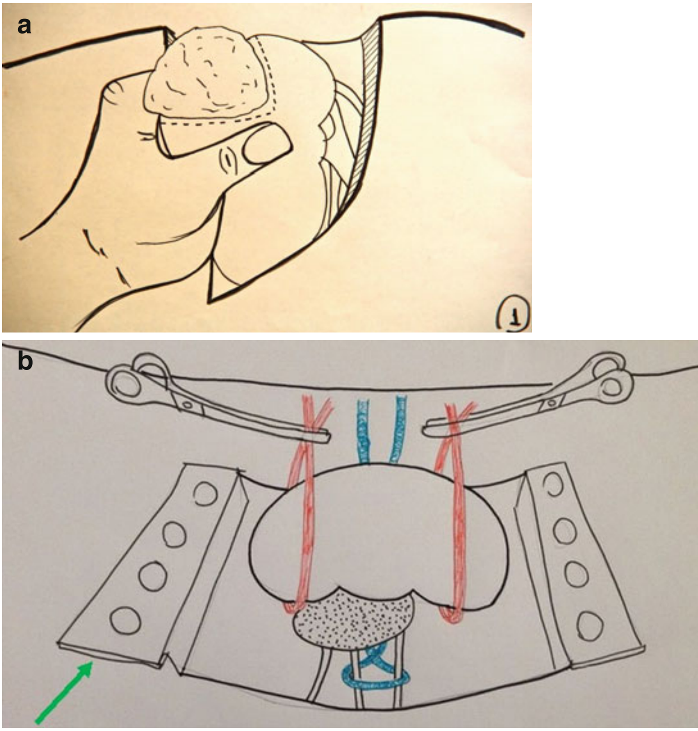

Figure 30.2 (**a**) Manipulating the kidney parenchyma above the incision plane such that rotation in various directions and hemostatic manual compression can be feasible. (**b**) Finochietto-Burford retractor (*green arrow*) and loose hooking tissue strips (colored in *red*) will be helpful while trying to create enough space and mobility during open kidney surgery. Renal pedicle should ideally be controlled with figure of eight vessel loops (colored in *blue*)

- Use peritumoral fatty tissue to retract the tumor gently for a better manipulation. Open Gerota's fascia strategically to free the kidney so that consecutive encasing of the kidney with the redundant perinephritic fatty tissue is possible.
- If the kidney is decapsulated at the tumor excision line surgical bolsters may be placed at each side to replace capsula fibrosa for proper parenchymal suturing (Fig. 30.3a, b).

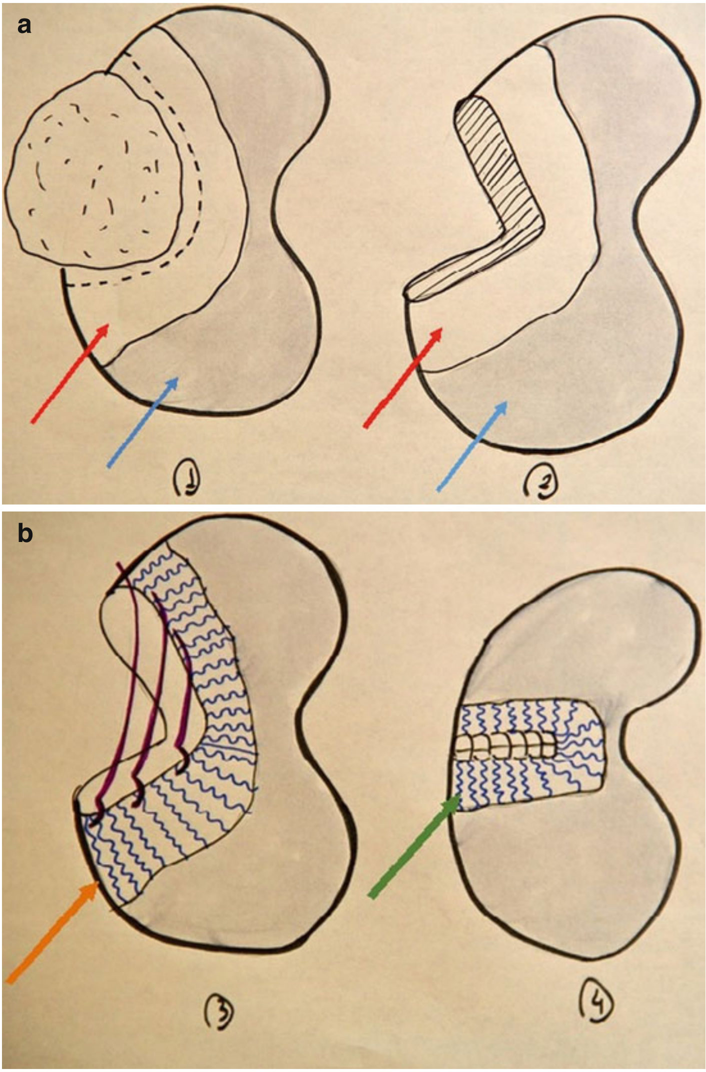

FIGURE 30.3 (**a**) Decapsulated surface (*red arrow*) lying in close proximity to the parenchymal cut-edges. Capsula fibrosa remains intact elsewhere (*blue arrow*). (**b**) Renorrhapy sutures placed and tied over the superficially applied topical bolsters (*green arrow*) which act as an adaptive interface

- Interrupted, figure of eight sutures with absorbable, monofilament 2/0 material will serve well for a proper renorrhapy after adapting the renal medulla with 3/0 polyglactin sutures.
- Topical bolsters should not be placed inside the tumor bed but rather they should be adapted over the kidney surface. They can be secured in place with the renorrhapy sutures. Interposed bolsters may hinder optimal coaptation of the cut renal parenchymal edges.
- The pathologist should be present in the O.R. while the tumor is being excised. This will help him/her to better understand the relationship between the excised surface and tumor bed. In most instances, the visual evaluation of an experienced urooncologist will ensure margin status. Keep in mind that only an inked surface examination will establish margin status. Tissue samples from the tumor bed are mostly not representative.

Chapter 31
Tips for Open Surgical Approach to Pelvis for Urologic Surgery

Yaser El-Hout, Rami Nasr, Nazih Khater, Samer Traboulsi, and Raja Bahjat Khauli

Abstract In this chapter we review the standard and most commonly performed surgical incisions and highlight some tips while performing these open surgical approaches to the pelvis in urological surgery.

Keywords Access • Incision • Pelvic surgery • Urologic surgery

Introduction

The goal of a surgical incision is to initiate the operation while anticipating the planned exposure, offering the best anatomical landmarks, while identifying vital structures and reducing any associated complications. Although a urological intervention may be performed by different incisions (Fig. 31.1), the optimal approach is the one that has the

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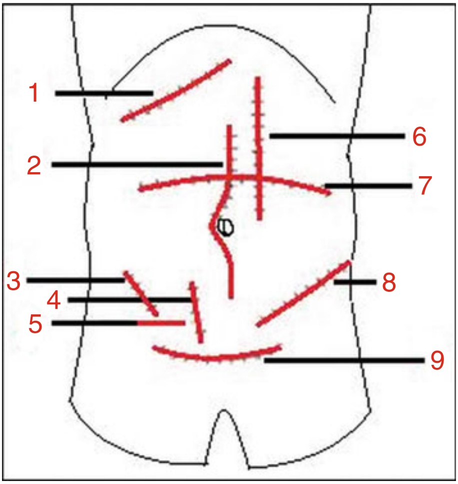

FIGURE 31.1 Described abdominal and pelvic incision: (*1*) Kocher incision, (*2*) midline incision, (*3*) Mc Burney incision, (*4*) Battle incision, (*5*) Lanz incision, (*6*) paramedian incision, (*7*) transverse incision, (*8*) Rutherford Morrison incision, (*9*) Pfannenstiel incision

fastest dissection planes, the least morbidity, and the best post-operative outcomes.

Kidneys, adrenals, prostate and bladder may be accessed by different approaches. A clear example is a kidney mass that may be resected partially while considering a flank incision (traditional way) or even a trans-abdominal sub-costal approach too. It depends also on surgeon's preference, and patient's anatomy.

The goal of this chapter is to review the standard and most commonly performed surgical incisions and highlight some tips while performing these open surgical approaches to the pelvis in urological surgery [1–4].

Midline Incision

A midline abdominal incision can be used to access the abdominal cavity above or below the umbilicus. The incision is quick to perform and it results in minimal blood loss, owing to the

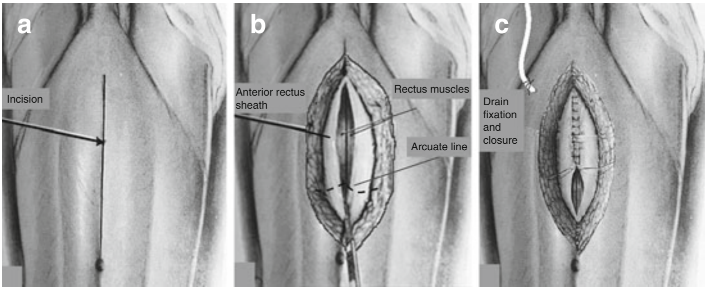

FIGURE 31.2 The midline incision: (**a**) Patient is in supine position, Trendelenburg position may be utilized to gain better exposure to the deep pelvis. (**b**) In urologic surgery, infra-umbilical incision is made. The linea alba is appreciated by the decussation of external oblique fibers. If entry of peritoneum is desired, incision of arcuate line and ligation of urachus are done. (**c**) Tight closure is ensured by approximating the anterior rectus sheath. If desired, a drain may be exited from a separate stab incision across abdominal wall

avascular nature of the linea alba. The exposure of the abdomen as a whole is excellent. Extensions, when required, can easily be made superiorly or inferiorly, providing access to the whole abdominal cavity, including the retro-peritoneum. All these properties render the midline approach suitable for emergency and exploratory laparotomy of the abdominal cavity.

As illustrated in Fig. 31.2, a vertical incision is made through skin, subcutaneous fat and Scarpa's fascia, linea alba, and peritoneum if needed. The exact location of the incision in the linea alba is based on the decussation of the fibers of the external oblique aponeurosis, thus serving as a surgical landmark. About one third of the distance from the umbilicus there is a demarcation line called the arcuate line. Above this line, the aponeurosis of the three flat muscles (external, internal and transversalis muscles) of the abdominal wall split into two lamina, one above and one below the rectus muscle (anterior and posterior sheaths, respectively). Below the arcuate line, the three aponeuroses pass above the rectus muscle, and only a thin transversalis fascia layer covers the rectus posteriorly. Consequently, when doing a extraperitoneal pelvic surgery, like retropubic prostatectomy or cystotomy, the transversalis fascia is incised below the arcuate line and swept up starting behind the symphysis pubis towards the umbilicus. Conversely, if a transperitoneal approach is utilized, like in a radical cystectomy, the posterior sheath is incised near the umbilicus giving early access to the peritoneal space. Exposure is obtained by separating the rectii using a self-retaining retractor.

The midline incision is generally preferred by all surgical specialties because of its ease, speed and excellent exposure. However, midline incisions can be associated with increased postoperative pain as compared to transverse or oblique incisions. Furthermore, it has a higher rate of incisional hernias as compared to lateral paramedian, oblique or transverse incisions.

Gibson Incision

Gibson incision is a crucial incision that gives an excellent exposure to the iliac fossa and the lower third of the ureter. It is mainly used in renal transplantation, in order to expose the iliac vessels, and is also ideal for any unilateral distal ureteral procedure when full exposure of the bladder is not needed.

Points of Technique

The patient is placed in supine position, with the lumbosacral junction flexed. The table is therefore gently flexed accordingly, to provide a better exposure. A curvilinear incision is initiated with a scalpel, 2 cm medial to the antero-superior iliac spine and aiming infero-medially one finger breadth above the inguinal ligament, to the lateral border of the rectus abdominis muscle. Some surgeons prefer to perform a "hockey stick" extension across the midline, around 2 cm above the pubic bone, in order to gain a better access to the bladder. The incision is then deepened down to the fascia using electrocautery. The external oblique aponeurosis is then reached and exposed with retractors. It is then carefully incised parallel to the course of its external oblique muscle fibers. The external oblique muscle fibers are then split apart, and gently retracted to expose the internal oblique aponeurosis, which is incised following the course of its fibers. The internal oblique muscle is split to expose the aponeurosis of the transversus abdominis muscle. The transversus abdominis is gently opened with blunt dissection and retracted. A self-retaining retractor or a fixed ring retractor may be used at this level. For a better exposure, the surgeon is advised to consider incising through the lateral border of the rectus muscle, or dissecting the tendinous attachment of the rectus muscle from the pubic symphysis. Peritoneal attachments are dissected off the pelvic wall, adjacent to the deep inguinal ring, Continuous gentle dissection is made to expose the peritoneum superiorly and medially, towards the umbilicus, allowing access to the retroperitoneal structures. The assistant's hand is important for reflecting then peritoneum, after incising the transversalis layer, and allowing a better medial exposure of the iliac vessels at the level of their bifurcation, and of the ureter. Wide exposure can be obtained by placing a Bookwalter retractor. The surgeon is advised to sometimes consider ligating the epigastric vessels in order to allow a better exposure. The surgeon is now able to identify the ureter and dissect it out of the retro-peritoneum. The ureter itself needs to be cautiously manipulated, by avoiding pinching it; instead, peri-ureteral tissues may be grabbed, and a vessel loop may be placed around the ureter. In some instances, it is useful to leave a drain in place, although many kidney transplant surgeons do not leave any drainage. Closure should be done layer by layer, starting by approximating the tendinous attachments of the rectus muscle, in case it was divided, with an absorbable suture (type Vicryl). A running suture is similarly applied on the respective muscles of the abdominal wall, and for Scarpa's fascia. Skin is closed with a running absorbable suture (Fig. 31.3).

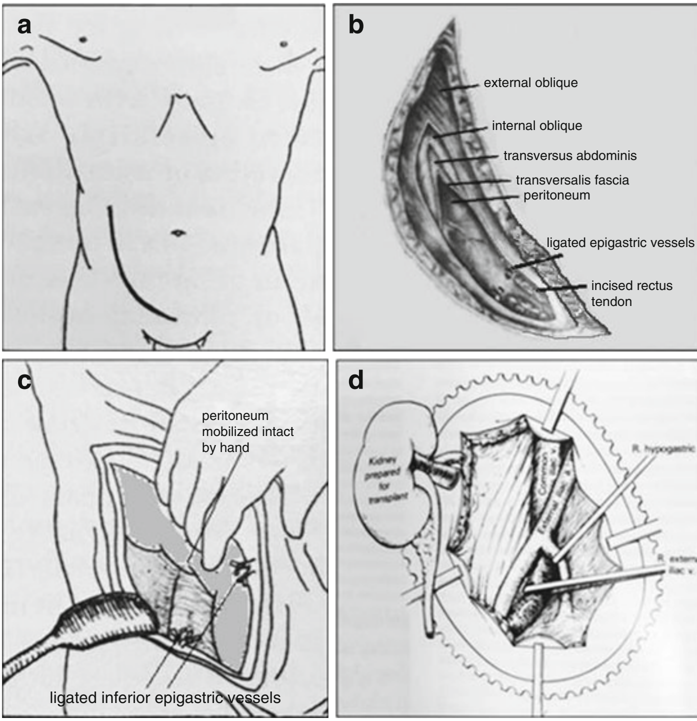

Figure 31.3 The Gibson incision: (**a**) A curvilinear "hockey stick" incision is planned just superior to symphysis medially and about three-finger breadth from anterior superior iliac spine. The incision can be extended superiorly if more exposure is needed (e.g. large graft in kidney transplantation or native nephrectomy concurrent with renal transplantation). In pediatric patients, a more medial and less curvilinear incision is made. (**b**) Abdominal wall layers encountered in a Gibson incision. (**c**) A very useful maneuver for exposure entails the assistant's hand medially reflecting the peritoneum intact with its contents while the inferior epigastric vessels are ligated to offer more freedom of mobility. (**d**) As shown, with the help of Bookwalter retractor, the exposure of the iliac vessels and the space made for the renal graft is excellent

Pfannenstiel Incision

Named after the German gynecologist, Hermann Johannes Pfannenstiel (1862–1909), the Pfannenstiel incision is popular for its widespread use in C-sections. It is a useful approach to enter the abdomen for bladder, uterine and distal ureteral procedures. It offers excellent exposure of central pelvis but has limited exposure to upper abdomen, limiting its utility in oncological procedures where exposure of aorta and common iliac arteries is required for adequate lymphadenectomy. However, it is preferred aesthetically, so called the "bikini line incision", for it does not alter or come close to the umbilicus and its scar blends with the pubic hair-line if it were made low enough.

Points of Technique

The patient is placed in supine or lithotomy position. The umbilicus and the symphysis pubis are noted and a line may be drawn between them to ascertain midline symmetry. The incision has to be made more caudal to 2–3 cm below the line joining the superior iliac spines to stay below the arcuate line of the recti as the incision is deepened. The skin incision is made along one of the Langer lines in a slight "smiling" curve. The incision can be made higher or lower, wider or narrower depending on surgeon's preference and experience. The span of the recti is the minimal width of the skin incision. An exaggerated low incision may be elected for superior cosmesis (Fig. 31.4). As skin is incised, selective hemostasis of mons vessels, branches of the superficial epigastric vessels are controlled. Scarpa's fascia is incised with cautery along the transverse incision. In pediatrics, it is expected to have a well-developed Scarpa's, not to be mistaken for the external oblique aponeurosis. Once the linea alba is reached, exposure

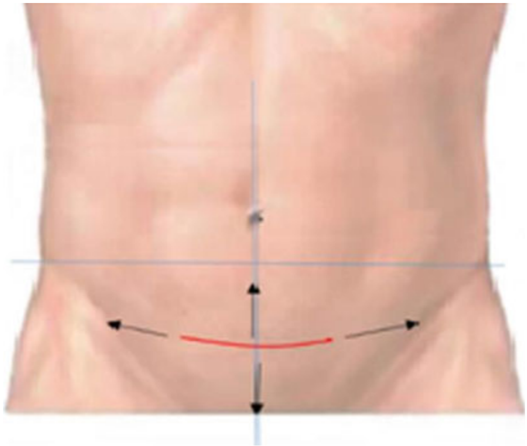

FIGURE 31.4 Planning of the Pfannenstiel incision: The location and width of the incision can be tailored to surgeon's preference

is maximized by creating either subfascial flaps (original description) or suprafascial flaps (modified technique) (Fig. 31.5).

In the original approach, the rectus sheath is incised transversely lateral to the linea alba in both directions and reaching the medial border of the external and internal oblique muscles and exposing the bellies of the rectus abdominis. Laterally, care must be made not to injure the inferior epigastric vessels or their branches, to gain a wide entry to the abdomen, subfascial flaps are created superiorly and inferiorly running tangentially to the rectus bellies. The inferior flap may include the Pyramidalis muscles. At this point, the abdomen can be entered by separating the recti laterally exactly in the midline. The bladder may be inflated, to allow identification of the extraperitoneal perivesical space against a full bladder. The peritoneal reflection can be noted at the dome of the bladder and peritoneum may be entered if desired.

The modified approach entails a suprafascial flap creation between the subcutaneous layer and the rectus sheath.

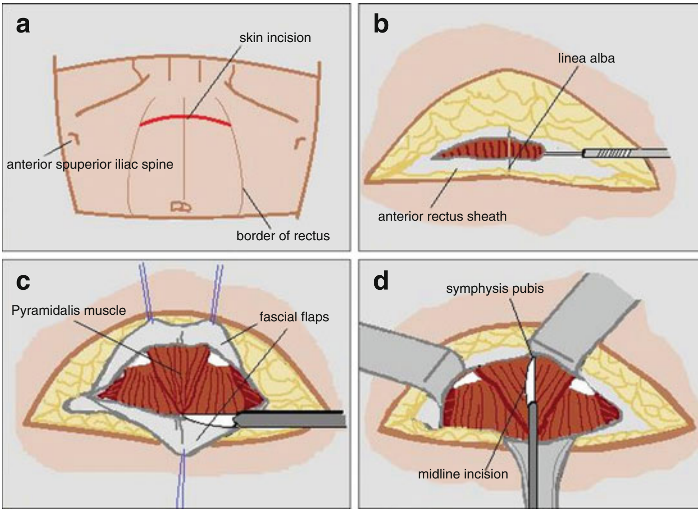

FIGURE 31.5 The Pfannenstiel incision: (**a**) Incision is made along a Langer line, usually to the outer borders of rectus abdominis muscles. (**b**) In the sub-fascial approach, the anterior rectus sheath is incised transversely below the level of the arcuate line. Care is made not to exaggerate incision laterally to avoid injury of inferior epigastric vessels. (**c**) Sub-fascial flaps are made tangential to the muscle fibers cephalad and caudad. (**d**) This allows a midline entry of the pelvis by incising through the avascular line in the midline between the rectus bellies, and incising of Pyramidalis muscle with electrocautery until the symphysis is reached

Grabbing the subcutaneous fat on one side with two to three Ellis clamps and with counter traction on the abdominal muscles will facilitate development of the flaps superiorly to the level of the umbilicus and inferiorly till the pubic bone. Care is taken to control perforator vessels as this step is progressing. Once completed the incision will proceed similar to a midline abdominal incision, as would be performed in an open retropubic prostatectomy, thus allowing for a hybrid benefit of the midline exposure while keeping the cosmetic skin closure of a Pfannenstiel.

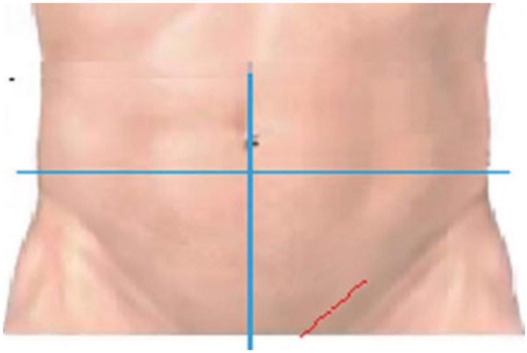

FIGURE 31.6 Inguinal incision in adults is made in the direction of anterior superior iliac spine over the palpated external ring and can be extended according to surgeon's preference

Inguinal Incisions

Inguinal incisions are required for common general procedures in adults and pediatrics including hernia repair, varicocele ligation, radical orchiectomy and standard inguinal orchidopexy.

Points of Technique

In adults (Fig. 31.6), patient is placed in the supine position. Shaving of pubic hair is done for exposure and infection control. The external inguinal ring can be palpated by inserting a finger in the high scrotum and a straight skin incision is done over the external ring in the direction of the ipsilateral anterior superior iliac spine. The length of the incision depends on surgeon's preference and experience, the body habitus of the patient and the requirement of exposure as per procedure, with longer incision in procedures like radical orchiectomy, and shorter for procedures like varicocele ligation. In general, incisions remain within the pubic hairline zone. Skin incision is made above and parallel to the inguinal ligament. Cutting is

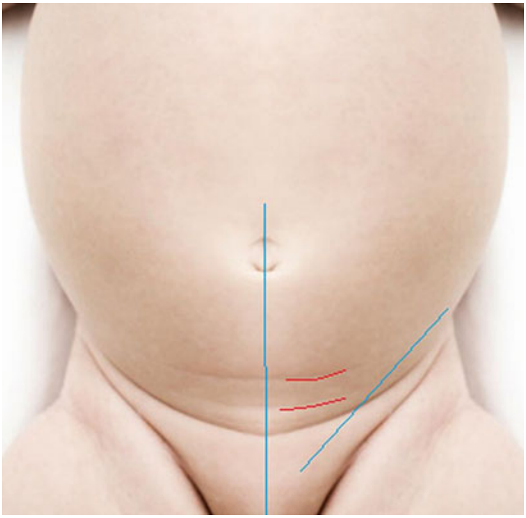

Figure 31.7 In Pediatrics, modification is made with the inguinal incision made along a Langer line medial to the line between the lateral edge of the symphysis and the anterior superior iliac spine

made through the subcutaneous fat tissue and Scarpa's fascia to expose the aponeurosis of the external oblique. In subinguinal approaches, the spermatic cord may be mobilized bluntly without incision of the canal. Care must be taken, however, of recognizing and preserving nerve branches of the ileoinguinal nerves. Extra-spermatic sizable cremaster vessels need to be controlled. When the inguinal canal is to be entered, the ileoinguinal nerve need to be identified and preserved. This can be facilitated by initially making a small sharp opening in the aponeurosis and sweeping underneath the fascia to displace the nerve laterally and inferiorly and proceed under direct vision. In pediatric patients, and due to small body habitus and the proximity of the external and internal rings, a bit higher approach is utilized (Fig. 31.7). The incision is made along a Langer line medial and superior to a line drawn between the lateral border of the symphysis and the superior iliac spine, thus coming at and acute angle with the inguinal ligament.

Gentle handling of tissues is expected in pediatrics. The Scarpa's fascia is well developed in pediatric and should be distinguished from the underlying aponeurosis. In this exposure, the external inguinal ring is approached "from top" and dissection between the reflection of the inguinal ligament and the fat lateral to it will facilitate anatomic exposure that will lead to the external ring.

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Chapter 32
How and When Do I Need to Perform an Exploratory Laparotomy After Major Urological Surgery?

Peter Alken and Tarık Esen

Abstract Bleeding, anastomotic insufficiencies, ileus and wound dehiscence are the rare complications that may require surgical revisions. Timing and type of re-intervention have to be balanced against the patient's individual conditions. Good cooperation with intensive care colleagues and experienced surgeons may be advisable.

Keywords Drainage • Hemorrhage • Anastomosis • Leak • Ileus • Fascial Dehiscence • Laparotomy • Relaparotomy

Introduction

In a nationwide USA sample of 229,743 prostatectomies, 111,683 nephrectomies and 31,213 cystectomies performed between 2009 and 2011 a rare complication was hemorrhage

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with 1.2, 3.2 and 3.4 %. More frequent were genitourinary complications with 0.8 %, 2.5 % and 15.4 % and gastrointestinal complications with 4.0 %, 10.7 % and 28 %, respectively [10]. No data were given on the frequency of re-intervention which fortunately are rare events.

Blood, urine or feces are what you would not like to have in the previous operative field after any kind of urological surgery. Prolonged postoperative ileus (PPOI) is a frequent problem after major urological surgery; fascial dehiscence and burst abdomen is a rare but dangerous complication of laparotomy. The proper diagnostic work up of the patient's condition, the "search part" should be "exploratory" but the surgical procedure based on the diagnostic finding, the "destroy part" should be targeted.

In these cases the need to, the timing and type and the risk of re-intervention are embedded in strategical thinking that considers the details and problems of the first surgical procedure, the patients conditions and the imagined details of the secondary intervention.

Drainage

Intraoperative drainage of the relevant anastomoses will not always but frequently help to reliably reveal such postoperative complications. The need to place drains near anastomotic sites is questioned in colorectal surgery [6], but it is still an unsettled question in major urological surgeries [1].

Blood

In case of bleeding after a laparotomy blood is diffusely dispersed in the peritoneal cavity; abdominal palpation or repetitive measurements of the abdominal circumference are usually not rewarding to establish the need for revision just as the rare cases in which we tried to find out about the site and extend of bleeding by CT or angiography in any form. Rapid or continuous blood accumulation in the drainage bag and/or equivalent circulatory signs may advise a revision at any postoperative time period even though an active bleeding is sometimes no more met during the reintervention.

Feces or Urine

If the primary surgical procedure was "uncomplicated", if the patient is in a well-balanced condition and if the complication is met within the first 3–4 days it is an early manifestation of either incorrect suture lines or necrotic tissue secondary to mistakes of coagulation or dissection. The operative site is still without major secondary changes. Consequently an early operative revision targeted to the site of the complication might then be useful to perform a definitive correction in the sense of a restoration of the primary surgical goal and prevention of a secondary peritonitis [4].

A prerequisite is that the preceding operative situation strategically allows a secondary reconstruction e.g., there will be enough ureteral length for a reimplantation or the previous operative situs will allow a secondary anastomosis at the same or a different site.

If the primary procedure was risky, if the patient's condition is unbalanced or if his advanced age or reduced general health argue against a second major operative intervention temporary measures like a percutaneous nephrostomy or a colostomy are more reasonable. Also in case of a late four or "more than how many?" days manifestation the secondary changes in the operative field may render orientation difficult and require complicated and time consuming maneuvers; temporary measures are to be preferred.

Postoperative Ileus (POI)/Prolonged Postoperative Ileus (PPOI)

The other more frequent postoperative problem arises on postoperative day 4–7. In case of insufficient bowel movements it is necessary to differentiate between a mechanical cause of small bowel obstruction and the paralytic form which may affect both large and small intestine or the colon only in form of the acute colonic pseudo-obstruction (ACPO), also known as Ogilvie syndrome.

In the 70s the diagnosis of POI was based on the clinical findings, and a.p. and lateral abdominal plain films; CT was not available. The treatment was more or less a trial and error procedure with repetitive stimulation of the bowel movements usually by intravenous metoclopramid and neostigmin which are still in use today [2, 11].

Much later on we had a patient with such a problem. He got an abdominal CT. We sat down with the radiologist. By clicking the sequential images down from the duodenum to the rectum he demonstrated that the intestinal lumen was patent at all sites and we were relieved to be on the save side going on with our conservative treatment. Of course the CT images can also guide the surgeon to the site of obstruction. CT offers more than just to see the intestinal transition point between the dilated small bowel proximal and the undilated part distal to the stenosis: for both, small and large intestine there is additional information to establish the need for surgical exploration like mural thickening, reduced or absent bowel wall enhancement, mesenteric fluid collection, venous congestion or arterial ischemia [3, 5, 7].

Ileus Prevention

Improved gastrointestinal recovery after radical cystectomy has been described with oral administration of an opioid receptor antagonist but it may be that chewing gum offers similar advantages with less cost [9, 13].

Fascial Dehiscence

Another rare complication is fascial dehiscence which is generally due to a wrong suture technique not grasping the fascia properly. Wet dressing of "unknown cause" in the early 1–7 days postoperative period is caused by peritoneal fluid draining through the wound. An immediate operative revision will prevent complete wound rupture with spontaneous eventeration, will guarantee a "sterile" abdomen and a good chance to an uncomplicated secondary wound closure. Late revisions may require open abdomen solutions and complicated late secondary reconstructions.

The final advice is to rely in complicated cases on a shared decision with radiologists, intensive care colleagues and surgeons. Especially the latter have more experience with limited damage control surgery versus primary definitive repair surgery [14], on-demand relook laparotomy strategies, vs. planned relaparotomy and open abdomen procedure [8]. These principles and techniques of treatment of the critically ill patients are in continuous transition and development [12].

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Chapter 33
How Do I Become a Surgeon Scientist?

Öner Şanlı

Abstract A surgeon scientist identifies a clinical problem, discusses the methods to address the problem with the "basic science" team, directs the research and according to his/her level of education, he/she participates in the laboratory actively. As a result, the surgeon scientist is a bridge between the laboratory and the clinic for the translation of research discoveries from basic science into practical applications that enhance human health and well-being. In this chapter, various aspects of surgical science and the surgeon scientist are discussed.

Keywords Surgeon scientist • Translational research

Who Is a Surgeon Scientist?

A surgeon scientist is a clinician performing translational clinical research for fundamental scientific discovery. As described by Nathan, "translational clinical research" focuses

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on the bench-to-bedside interface and requires a clinician-investigator schooled in the clinical aspects of a subspecialty, skilled in biomedical science and its methodologies, and endowed with enough intuition to recognize the patients who can, if carefully investigated in the laboratory, reveal the nature and/or appropriate treatment of diseases [7].

The aim of the concept of the surgeon scientist is to integrate both science and practice within a surgeon's experience. The proposed outcome is to create an environment where equal emphasis is given to research and to applied practice in order to develop a well-rounded surgeon. Meanwhile, essential components of the research experience such as presenting, writing and publishing, improve the background of a given trainee in the clinically based career [4].

Challenges of Surgical Science

It has been generally observed that the number of surgeons actively participating in research projects has been decreasing [2]. One of the reasons for this outcome is the lack of an established curriculum for research education and training, for residency as well as fellowship programs worldwide that range from a few months to 3 years. An intensive 1-year-research period may not be enough to internalize the complex methodology of basic research that has advanced dramatically in the last two decades and become more molecular in perspective. Meanwhile, despite residents who performed at least 2 years of research were more likely to become academicians in comparison with residents who did 1 year or less of research (53 % vs. 22 %); 38 % of the surgeons who continued to perform research after training stopped performing basic research before the age of 39. Moreover, 17 % and 23 % of the surgeons stopped performing basic research between 40 and 49 years of age and between 50 and 59 years of age, respectively [5, 10]. The common causes, in decreasing order, were increased clinical load (40 %), increased administrative duties (38 %), loss of funding, loss of interest, change of location and other miscellaneous reasons. Accordingly, it is becoming increasingly difficult to retain surgeons in basic research. Similar to the advances in the methodology of basic science, the techniques of surgery are also advancing and becoming more complicated to learn, practice and teach. The surgeon also has to adapt to the rapid changes in the life sciences, information technologies, changing population demographics and disease trends and the environment (social and physical) under which surgeons operate [9]. All these issues need a significant adaptation period, and in most of the instances, this period of adaptation is stolen from research activities [1]. As another factor, medical schools and teaching hospitals, the locomotive of research, face significant financial pressures from third party payers (such as Medicare in the US, and SGK in Turkey), which significantly affect their research funding. And finally, commercial companies are increasingly taking control of medicine with huge financial support and in their research laboratories, mostly MDs and especially surgeons do not take place.

How to Be a Surgeon Scientist?

One of the controversial issues is the depth of research training. There is almost a consensus of opinion that a well-trained clinical urologist must be proficient, if not an expert, in research methods and research consumerism. However, it is obvious that the current level of research training is not sufficient for urologist-based innovations. Yet, the extent to which residents or fellows are being trained to integrate science and practice, and the utilization of these skills have not been formally assessed. It is also unclear how to best train residents or fellows so that the skill sets for both research and practice remain strong and have an influence on each other.

In fact, there seem to be two different routes for an ongoing surgical career as a surgeon scientist. The first is the medical-scientist program that concludes with an MD-PhD degree. The PhD degree can be earned in the medical faculty, during a residency program or after the residency program. However, it is generally believed that the physician scientist pool should begin with medical students or in the early period of residency programs, so they may be trained at this young age with creative, inquisitive minds, and not constrained with social commitments such as marriage, children and mortgages. The second route is to incorporate surgical research into some aspects of the surgical training or later training (fellowship programs) under a structured laboratory research curriculum. Of note, a laboratory research curriculum should include, at the bare minimum, an introduction to the principles of basic laboratory research, including laboratory techniques, study design and hypothesis testing [8]. Despite the second route being appropriate for some authors, it is generally believed that a formal biomedical PhD program is important for learning the complex methodology of twenty-first century research. Otherwise, a promising surgeon scientist may face Paralyzed Academic Investigator's Disease Syndrome (PAIDS); meaning a scientifically paralyzed investigator who cannot capitalize on his/her observations because of the lack of appropriate basic science training [3]. Moreover, this type of methodology (research facilities intermingled with clinical training) allows learning and producing a single model, and repetition of this model with minor modifications will lead to PAIDS. A leadership role in a surgical research team may be a solution to this problem; however at this time, there is a risk of losing control of the team and having a limited role such as funding of the team; due to lack of positive contribution to the research because of the limited basic science education.

While conducting research activities in any period of the surgical life span, "the several Cs" of translational research defined by Nathan et al. should be kept in mind (Table 33.1). Apart from the 'Clinical' focus, which is the most important C, avoiding 'Chronophage', and having a 'Caring' mentor are the other important Cs for a surgeon who hopes to achieve success in the biomedical sciences. Chronophage[1] consists of the

[1] "time eater", from the Greek "chronos" (time) and "phago" (eat).

Table 33.1 Several "C's" of translational research

*C*linical problem of interest
*C*ollaborate with others
*C*ourage to learn new techniques
*C*linical awareness of literature
*C*ooperative family
*A*void conflicts of interest
*A*void chronophage
*C*aring mentor

Adapted from Nathan [7]

extraneous tasks, which waste precious time with little return for their investment, that are given by supervisors (not mentors). Avoiding chronophage will significantly increase the time available for translational research. Mentoring is critically important to assess the productive areas of research, provide constructive criticism, solve inevitable conflicts and introduce trainees to potential collaborators. Without a mentor, a novice scientist may lose his/her way in the dark forest.

Future Directions

The academic surgeon of tomorrow should also be a scientist because many of today's clinical conditions cannot be overcome using the current education of medical schools or surgical training. The solutions lie at the cellular and molecular level that is beyond the scope of surgical education. As an example, the genetic basis of many surgical conditions has revolutionized treatment modalities, such as the use of tyrosine kinase inhibitors in kidney cancer. Therefore, the appropriate basic scientific training is essential.

It is obvious that translational surgical research, unlike clinical training, is lacking in structure, organization and oversight, which is most likely the most important constraint for surgical science. Without education in the era of high technology, meaningful research cannot be performed. For this reason, a balanced approach should be the benchmark of this field, and research training should have a structured curriculum. Meanwhile, leaders of departments should promote translational research and young faculty to present novel work at meetings and be involved with grant writing. They should invest time and resources in young investigators to prevent them from decreasing their research activities. It should be known that it now takes up to 5–7 years for a surgeon scientist to become established and subsequently be a mentor for others [6]. In the era of modern technology, practicing urologists have a caveat of being an applier rather than an innovator, which is more prominent in the field of Endourology than in the other subspecialties of Urology.

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Chapter 34
How Do I Publish a Scientific Urological Paper?

Karl H. Pang and James W.F. Catto

Abstract Scientific publications are the foundation of evidence-based medicine and the primary route of sharing knowledge amongst scientists. Publishing a paper is usually a challenging process that starts long before the writing stage. Key components to manuscript writing (and eventual acceptance) are the study design, having a clear focus and hypothesis that you will test, adherence to reporting recommendations and honest interpretation of your findings. Writing a single case report can involve as much effort as for a well-conducted prospective study, so one should always aim as high as possible when starting a study. Publication of your work can be achieved by targeting of the correct journal, clear communication, and honest, detailed and transparent responses to reviewers comments. The key to getting published is to be organized and original. Try to identify the gaps in your field, design a study that can help answer the unknown and write concisely. This chapter describes our approach in writing and publishing a paper, and also what we're looking for as reviewers.

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Keywords Writing • Manuscript preparation • Publication • Getting published

Introduction

In this chapter we focus upon writing and communication of your scientific work. However, most of the hard work is done before this stage. Even the best author cannot make more of the work than the original design allows. So when starting a project it is vital to ask a relevant question, to address this question in the best possible and achievable manner, and to be realistic in your aspirations. Time spent designing the study, obtaining appropriate regulatory approvals, and asking for formal or informal peer review will be well spent when you come to write up your work. Likewise a thorough literature review will tell you what is known, what is not known, how has this question been addressed before and what you can add to the field. Your findings will be judged by their strength (which comes through study power and sample size), originality (identifying an area of your field that is unknown) and importance (to human health and disease, or to your field in general).

Step 1: Starting to Write the Paper

Each author will have their own particular style for writing. Whilst some prefer to write the paper in order of presentation (i.e. start with Introduction and finish with Conclusions), we advocate starting with the Methods and Results. The easiest chapter to write is usually the Material and Methods (or patient population etc.), and so this is the best to start with. Use sub-headings to make it easier to structure/write and easier to read. After Methods, we then focus upon the tables, images and results. These interlink and form the main body of the work. We then write the Introduction, before the Discussion and Conclusion(s). The final component to write is the Abstract and any additional short sections (e.g. take home messages, what this adds to the field, role of funding bodies etc.). When finishing the paper, remember that it is one piece of work. Make sure that each component leads into the next, and that there are no sudden surprises. The reader wants to know what they are reading and what it is likely to show them. If you have made a major discovery, then make this clear early on (or in the title).

Remember that reviewers and readers want concise and precise articles. Avoid superlatives ('very'), avoid redundant text and do not repeat yourself. Try to keep the paper in proportion. Most of the text should be in the Results and Discussions sections, and one should be able to understand the work using only the Tables and Figures. A common error is to have Introductions that cover the whole field and are too long/not focused. A good paper is not based on quantity of words, but on the quality of work and presentation.

Finally, when you have finished the paper, put it down for a few days before re-reading. Often small errors creep in, and too frequent viewing prevents one seeing these mistakes.

Step 2: Identifying a Target Journal for Submission

When selecting a journal, it is important to read their publishing criteria, manuscript layouts and to be familiar with the work they publish. Decide whether the quality and theme of your work fits into the scope of their journal. Some journals prefer prospective scientific work of strong design and others more topical or newsworthy reports. If you think your work is high-quality and cutting-edge, then aim for a high-impact journal. Decide, whether you want to publish in a specialty-specific journal (such as European Urology) or a generic medical journal (such as The BMJ, or The Lancet). Once you've identified a journal you wish to publish in, format your manuscript and edit your style of writing accordingly. **Remember to always read the 'instruction for authors' section and always download**

a paper from that journal and make yours appear similar in formatting. We suggest formatting your paper after you have written the first complete draft.

Step 3: Writing Each Section

Methods

We advocate starting with the Materials and Methods. This section describes what was undertaken in order to produce your results and is usually three or more sections; *(i). Patients or samples, (ii). Methods used, (iii). Statistical analyses.* If publishing clinical work or laboratory work involving patients, it is essential to mention about ethics approval, patient consent, trial registration numbers and how patients were recruited. Include reporting criteria; such as Inclusion and Exclusion criteria, and prospectively defined follow up protocols. With regards to scientific papers, be brief with your reagents and techniques, if you're replicating a common experiment such as polymerase chain reaction (PCR), a descent reference is enough to summarize your steps. However, include enough details for key equipment, reagents (company) and procedures that other researchers could follow and repeat, especially if you're describing a new technique. If they fail, your new technique may be flawed and your reputation may be affected. At the end of your methods, include short paragraphs on methods of analysis, including statistical analyses. If conducting large clinical studies, it is important to include a power calculation or conduct a pilot study first. **The aim of the Method section is to allow another worker to reproduce your study. Make sure this would be possible**.

Results

This section should include only your findings. Do not start discussing your data. Describe your findings in a logical order forming a story from start to finish. Use sub-headings to describe phases of your results, this makes it easier to follow. Typical subheadings are; *(i). Details of the Patient cohort (in total and stratified by your intervention), (ii). Univariable analysis of outcomes according to your study design/experimental treatment, (iii). Multivariable comparisons or more analyses of these outcomes.* Key to the results section are the tables, figures and their legends. Try to avoid repetition from tables to text. A well designed table/figure can save many words. Only include key results, the number of tables/figures allowed are different for each journal. Any important additional data can be included in the supplementary sections. Cite your tables/figures in order and make sure they are in the appropriate format (PDF, JPEG) and resolution requested by the journal you're planning to submit to. Always include a title and legend for each table/figure.

Introduction

This should be to the point. Identify what is known about your topic, what is unknown, and what issues need evaluation. Try to write it in a general way, avoiding too many abbreviations that a core-urologist or a non-urologist could follow, unless you're submitting to a specialized Urology Journal such as 'Endourology' or 'Andrology'. **List your hypotheses and describe how your aims and objectives could provide outcomes that would further understanding on your current topic**. State only 1–3 aims and your objectives should describe what steps need to be taken in order to achieve your aims. List 1–2 primary outcomes, secondary outcomes are optional, and it is important to understand how the results of your work make a difference to what is already known in the literature. Something that has no or little impact on the literature is usually difficult to get published in a reputational journal. Therefore, it is important to do some reading and identify the gaps in the literature before designing your research/audit/case report.

Discussion and Conclusion

We usually start by summarizing the key findings of our project. How our aims were accomplished in association with our initial hypotheses. Compare your findings with other papers published in the field, describe how your results fit into the literature and what advances you've contributed to the field. This section again, needs to be to the point and must not repeat points mentioned in the introduction. Reviewers are interested in new findings, or elaboration of pre-existing findings through large randomized-controlled trials (RCT) or systematic reviews. It is good practice to include limitations of your study, as reviewers will be identifying these anyway when they're reviewing your paper. It is not essential, but we tend to end by discussing how our observations open doors to further investigations and our future goals. Finish, by clearly stating your findings and what is now needed in your field.

Title and Abstract

The title is important in order to catch your reader's attention. Some include their findings in the title (i.e. 'x' mRNA is upregulated in prostate cancer), some include the study design in the title (i.e. a retrospective analysis of 'x'). There's no good or bad title, think of something short (one line) that would attract you to read the paper.

The abstract is the section we write last and include key points in each of the sections above. The introduction usually states the problem and includes your hypothesis and aims in solving the problem. The methods should only include your design (retrospective analysis, RCT, systematic review), participants, and regards to laboratory work, only the techniques used. The steps of each experiment can be described in the main methods section. The results should not be too descriptive but just a list of key findings. The conclusion should summarize what your findings add to the unknown. The title and abstract is what is read first, if this is concise, it will attract readers to read your paper. If it is difficult to interpret, then it is unlikely that a reader would read further.

Cover Letter

Most journals require a submission cover letter. This can be a vital step. Make sure you correctly address it to the current Editor in Chief, you correctly name the journal and you briefly, but clearly detail your findings and their relevance to your disease.

Step 4: Finishing

Finish your paper by checking the formatting (section order, references, images and legends). Make sure your references are styled correctly (Harvard or Vancouver) and once you've finished your paper, submit it to your co-authors for review. Take all comments into account and revise your paper before submitting it.

Remember, identify what the editors and reviewers are looking for, and try to think in their shoes. Don't be disappointed if your paper gets rejected, most papers get accepted after revision and in second or more submitted journals. Remember that rejection is not personal. Good luck with your paper.

Part II
Endourology

Chapter 35
How Do I Set Up a Stone Clinic?

Adam G. Kaplan, Charles D. Scales Jr, Michael E. Lipkin, and Glenn M. Preminger

Abstract A comprehensive stone center can effectively manage complex urinary stone disease with the right tools. A collaborative team that includes a Urologist, a Nephrologist, a Dietician and a mid-level practitioner is optimal. The center should coordinate with an efficient and convenient laboratory to provide point-of-care and at home services. Imaging capabilities must be convenient and suitable to detect metabolic stone activity. Initial and follow-up visits should be directed at determining metabolic derangements, understanding the level of stone activity, and assuring adequate response to medical management.

Keywords Nephrolithiasis • Set up • Stone center

Introduction

Kidney stone disease affects 1 in 11 people in the United States, and the disease is recurrent in many of these patients, ranging from 12 to 56 % at 10 years depending on individualized

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risk [6, 7]. A comprehensive kidney stone center can provide a wide variety of services to affected patients, ranging from acute care to chronic preventative services that can effectively reduce the risk of recurrence [4]. Surgical services aside, the center can provide targeted medical and dietary therapy for stone disease, which, when used appropriately, are effective and clearly supported by several observational studies, as well as guidelines from the European Association of Urology and the American Urological Association [1, 3, 5, 8].

Key Components of a Stone Center

A comprehensive stone center requires two important adjunct components:

1. An easy to utilize, efficient, and effective laboratory setup for performing simple and complex metabolic evaluation, parts of which must be done in the office and others at home (Fig. 35.1).
2. High quality imaging capabilities with available radiologic interpretation

Laboratory testing must be easy for patients to ensure proper follow-through. Initial metabolic evaluations and serum and point-of-care urinalysis can be performed in the clinic or in a neighboring laboratory. Complex metabolic evaluations, which include two 24 h urine studies on non-consecutive days, must be

Clinical laboratory testing	Studies performed at home
Serum electrolytes Serum ionized calcium Serum phosphate Serum uric acid 12-h fasting urinary pH Urinalysis	24 h urine studies (×2)

Figure 35.1 Laboratory testing is achieved by a combination of outpatient laboratory serum and urine studies. Comprehensive metabolic analysis requires at-home urine collections

completed at home. At home urine collections can be arranged through one of several companies (in the USA, LithoLink is preferred by the authors), and the studies must be completed by the patient at least 2 weeks ahead of their appointment to insure that the results are available to the practitioner. These reference laboratories may be able to export results into the practitioner's medical record system or provide an internet portal to view the results at the time of follow-up. For some practitioners, the 24 h urine studies can be evaluated by the hospital laboratory.

Initial kidney stone diagnosis will most often involve a low-dose CT of the Abdomen and Pelvis, however follow-up requires use of renal/bladder ultrasound, plain KUB or digital tomography of the abdomen. Follow-up imaging is used to determine whether a stone patient is metabolically active (enlarging known stones or forming new stones), and requires a change in treatment regimen [2]. Imaging systems within the clinic can provide additional ease for the patient, who can have follow-up imaging completed in the same setting, immediately prior to their routine visit.

Team-Based Approach

Management of complex stone disease is best accomplished with a collaborative team involving Urology and Nephrology and supported by dieticians and mid-level practitioners (Fig. 35.2). In the office setting, the Urologist is suited to manage basic metabolic issues derived from the metabolic evaluation

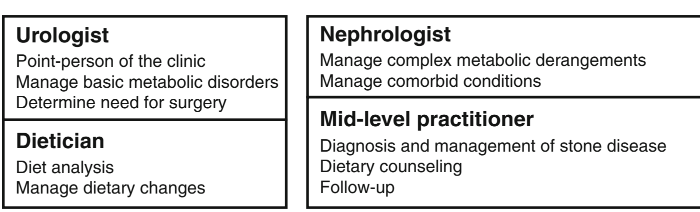

Figure 35.2 Members of the stone center

and determine the need for surgery. The Urologist is often the point person in the stone center. A Nephrologist can offer management strategies for more complex metabolic derangements and management of other comorbid conditions (chronic kidney disease, hypertension, etc.). Involving a dietician in the care team can be of great utility by providing strategies to maintain major dietary changes; dietary recommendations can be time consuming and challenging for the physician. Mid-level practitioners can play an important role in diagnosis and management of a wide range of patients depending on their experience.

How to Structure Initial and Follow-Up Visits

The initial visit to a Stone Center is used to take a complete history and physical exam and review imaging (Fig. 35.3). The history focuses first on the aggressiveness of the stone disease, querying how many stones total, stone formation rate per year, duration of the disease and stone-related symptoms. Comorbid conditions such as recurrent UTIs, bowel disease or disorders of calcium hemostasis must be identified. Asking about environmental factors such as heat exposure and work environment can be important. A thorough dietary history should be taken, including consumption of fluids overall, protein, coffee, tea, and foods high in citrate, calcium, and oxalate. Look for family history of stone formation or genetic disorders such as primary hyperoxaluria, cystinuria or distal RTA. Medication and supplementation use can provide clues to stone formation as well.

The patient often will come with imaging from an outside hospital or clinician, especially if they have or were recently treated for an acute stone episode. All imaging studies should be reviewed to get a sense of the burden of the disease and the type of stone formed. The patient will then have a limited or comprehensive metabolic evaluation based on the clinical and radiologic evaluation.

The limited evaluation includes serum electrolytes, serum ionized calcium and phosphate, serum uric acid, 12-h fasting urinary pH, and a urinalysis. The comprehensive evaluation includes the

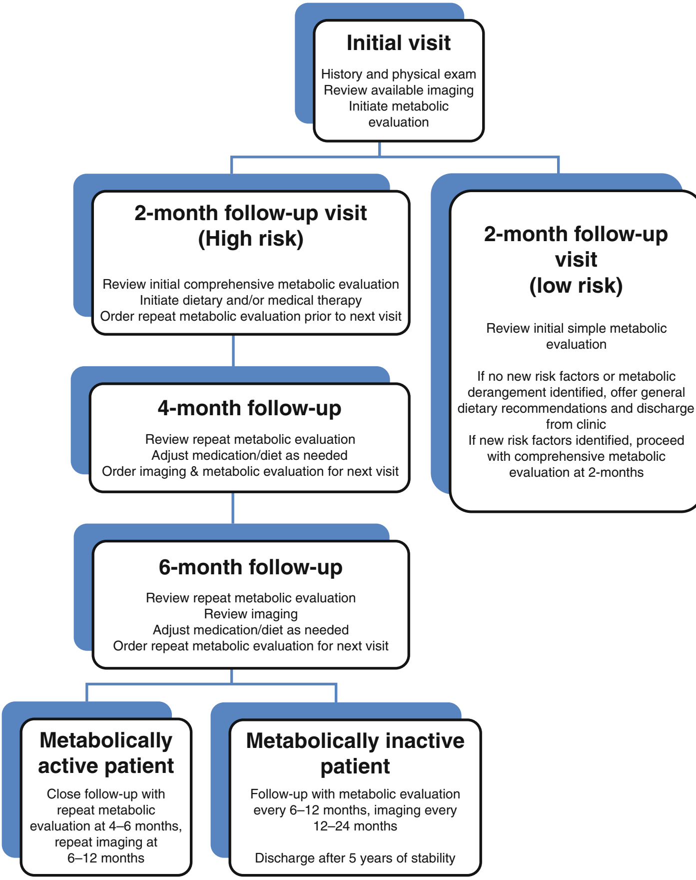

FIGURE 35.3 Components of initial and follow-up visits

above tests with the addition of two 24 h urine studies performed at home on non-consecutive days. The following urine chemistries are typically obtained: 24 h urine for: Total Volume Calcium, Oxalate, Citrate, uric acid, pH, creatinine, sodium, potassium, chloride, urea nitrogen, phosphate, magnesium, ammonia, sulfate and qualitative cystine. The supersaturation of calcium oxalate and calcium phosphate may also be calculated.

The low-risk, single stone former may not require additional follow-up after the labs are reviewed. Standard dietary recommendations are typically given prior to discharge. For patients undergoing a complex metabolic evaluation, the first follow-up visit occurs at 2 months when two baseline 24 h urine studies are complete. Depending on the findings, the patient may require medical treatment. A second follow-up evaluation should occur 4 months after initiating medical therapy with a repeat 24 h urine study. Follow-up thereafter can be tailored based on the response to medical therapy. We have found 6–12 month follow-up to be reasonable for most stable patients. Imaging should be repeated every 1–2 years based on the level of metabolic activity of the stone disease.

If the patient remains stable at 5 years without continued metabolic activity, they may be discharged from the Stone Center to their primary care physician with a recommendation to continue their medical therapy and have plain abdominal imaging performed every 2 years.

Conclusions

A comprehensive stone center can effectively manage complex urinary stone disease with the right tools. A collaborative team that includes a Urologist, a Nephrologist, a Dietician and a mid-level practitioner is optimal. The center should coordinate with an efficient and convenient laboratory to provide point-of-care and at home services. Imaging capabilities must be convenient and suitable to detect metabolic stone activity. Initial and follow-up visits should be directed at determining metabolic derangements, understanding the level of stone activity, and assuring adequate response to medical management.

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Chapter 36
How Does Shock Wave Break Stones

Jens J. Rassweiler, Philip Rieker, Marcel Fiedler, and Jan Klein

Abstract The introduction of new lithotripters increased problems of shock wave application. Recent studies concerning mechanisms of stone disintegration, shock wave focusing, coupling and application have appeared, that may address some of these problems.

The theory of dynamic squeezing offers new insight in stone fragmentation. With the water cushion, quality of coupling has become a critical factor depending on amount, viscosity and temperature of coupling gel. Fluoroscopy time can be reduced by automated localization or the use of optical and acoustic tracking systems. Efficacy of ESWL can be increased by lowering the pulse rate to 60–80 SW/min and by ramping the SW-energy.

Keywords ESWL • Stone fragmentation • Shock wave focus • Cavitation • Dynamic squeezing

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Introduction

Extracorporeal shock wave lithotripsy (ESWL) is a well-established treatment option for urolithiasis [1–3]. However, the introduction of new lithotripters has increased potential problems of shock wave application compared to first generation devices resulting to increased retreatment rates and reduced efficacy [4, 5] Additionally, young urologists favor endourology and are less interested in ESWL, particularly the underlying physical basics. Moreover, patients seem to be more attracted by the high chance of becoming rid of the stone in a single session rather than suffering from multiple ESWL-sessions plus the problems of passage of fragments [6]. All this resulted in a decrease of ESWL-procedures and a restriction of indications particularly concerning renal stones larger than 1 cm and all kinds of ureteral calculi. Recent studies concerning mechanisms of stone disintegration, shock wave focusing, coupling and application have appeared which may alleviate some of the problems associated with newer lithotripters [7]. If used appropriately such theories may be helpful to regain the attraction of ESWL.

Physics of Shock Waves

The shock wave represents a short duration (<10 μs) acoustic pressure wave consisting of a compressive phase (peak pressure 30–100 MPa) followed by a tensile phase (negative pressure). From the pressure form physical parameters can be calculated such as *acoustic energy* and *energy flux density* (Fig. 36.1). Effective energy (Eeff) contributes to fragmentation except for the portion not hitting the calculus. At present there is a debate on the fragmentation process and the tissue injury process and no clear metric indicates how well a stone will break respectively how much damage surrounding tissue will suffer.

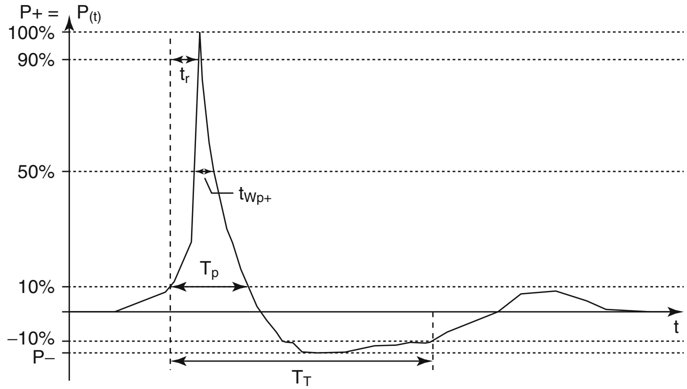


FIGURE 36.1 Pressure curve of a shock wave with a short duration (<10 μs) consisting of a compressive phase (peak pressure 30–100 MPa) followed by a tensile phase

Mechanism and Theories of Stone Fragmentation

Initial fragmentation represents a process whereby cracks form as a result of stresses generated by shock waves [1]. *Further disintegration* occurs due to growth and coalescence of these cracks under repetitive loading and unloading [8]. Beside established mechanisms describing initial fragmentation like tear and shear forces [1], spallation [9], cavitation [10], and quasi-static squeezing [11], further insight was gained by studies of Sapozhnikov [12] introducing the concept of *dynamic squeezing* (Table 36.1).

Tear and Shear Forces

If pulse length is smaller than the stone, then the *compressive phase* of the shock wave will generate pressure gradients, which can result in shear and tensile stresses in the stone.

Table 36.1 Summary of existing theories for stone fragmentation

Hypothesis	Mechanism	Prerequisites	Type of action	Comments
Tear and shear forces [1]	Pressure gradients due to impedance changes at stone front and distal surface with pressure inversion	Shock wave smaller in space extension than stone	Hammer-like action Resulting to a crater-like fragmentation at both ends of stone	Only relevant for small focus
Spallation [9]	Reflected tensile wave at distal surface of with maximum tension at distal part of stone	Shock wave smaller in space extension than stone	Breaking of stone from inside like freezing of water in brittle material	Only relevant for small focus No explanation for stone breakage at front side
Quasi-static squeezing [11]	Pressure gradient between circumferential and longitudinal waves result to squeezing of stone	Shock wave is broader than the stone SW-velocity is lower in water than in stone	Nutcracker-like action requiring large focal diameters	Only relevant for large focal zone

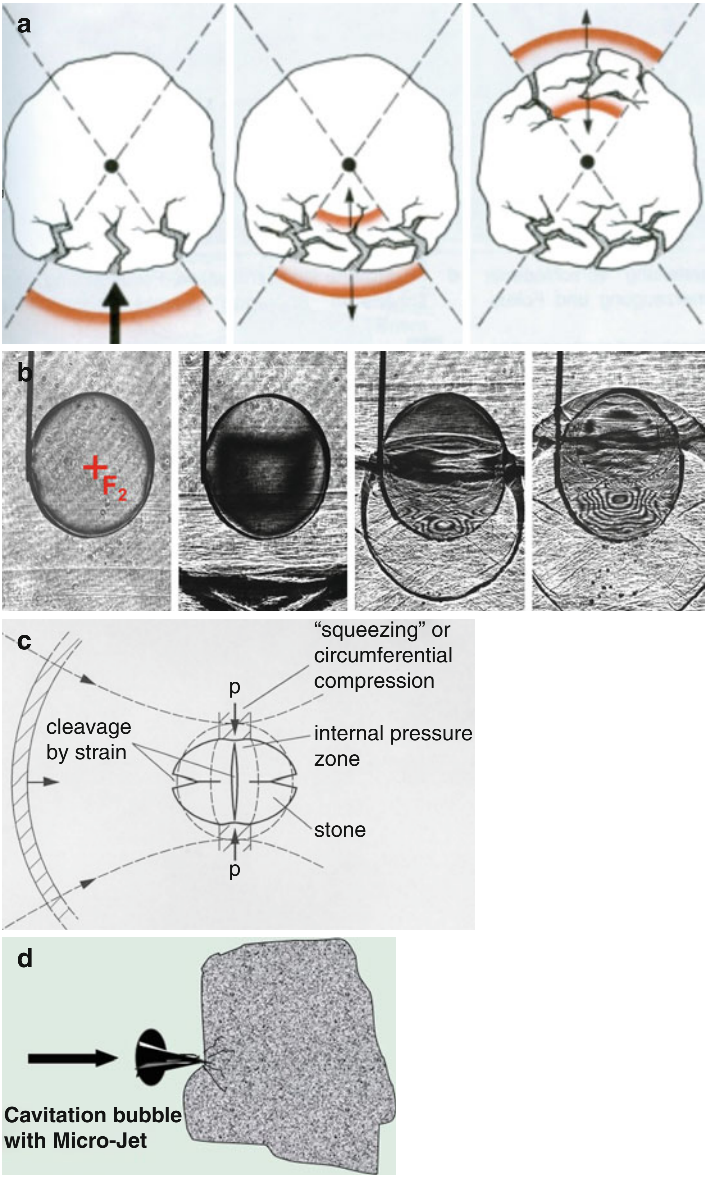
Cavitation [10]	Negative pressure waves induce collapsing cavitation bubble at stone surface	Low viscosity of surrounding medium	Microexplosive erosion at proximal and distal end of stone	More important during stone comminution Useful to improve efficiency of shock waves (i.e. EHL)
Dynamic squeezing [12]	Shear wave initiated at the corner of stone are reinforced by squeezing waves along the calculus	Parallel travelling of longitudinal waves SW-velocity is lower in water than in stone	Nutcracker-like action in combination with spalling	Best theory to explain results of numerical model

These stresses can produce tearing and shearing to fragment that stone [1]. In this theory, also the shock wave reflection at the *stone-water interface* with pressure inversion and splitting off stone material by *tensile stress of the reflected wave* is emphasized (Fig. 36.2a).

Spallation

The fluid at the posterior stone surface represents an acoustically soft interface, and the leading compressive phase will be reflected as a *tensile wave*. The amplitude of the tensile stress depends on the difference in acoustic impedance and the geometry of the stone surface. Using high-speed imaging to show stress waves in a translucent test stone (Fig. 36.2b), maximum pressure occurred within the distal part resulting

FIGURE 36.2 Different theories for initial stone fragmentation. (**a**) Tear and shear forces: Shock waves are transmitted and reflected at the low impedance stone-water interfaces with pressure inversion splitting off stone material by tensile stress. (**b**) Spalling: Distal stone surface as acoustically soft interface generates a reflected tensile wave of the initially compressive longitudinal SW-pulse propagating through calculus with maximum tension within the distal third of the stone (high-speed shadow-graphy by Zhong). (**c**) Quasi-static squeezing: Breakage of stone by tensile stress of the circumferential shock wave due to lower SW-velocity in surrounding fluid than within the stone (Modified from Eisenmenger). (**d**) Cavitation: Negative pressure waves of high-speed shocks cause cavitation in liquids surrounding stones and within microcracks or cleavage interfaces by inducing microjets. (**e**) Dynamic squeezing: Shear waves initiated at the corners of the stone and driven by squeezing waves along the calculus lead to greatest stress and tension (3D computer simulation according to numerical model by Cleveland). Note different pressure distributions and traveling time of waves inside and along stone surface. *Blue* = compressive phase, *Green* = maximum shear stress (55 MPa), *Red* = maximum tensile stress (80 MPa)


a
b
F2
c
"squeezing" or circumferential compression
p
cleavage by strain
internal pressure zone
stone
p
d
Cavitation bubble with Micro-Jet

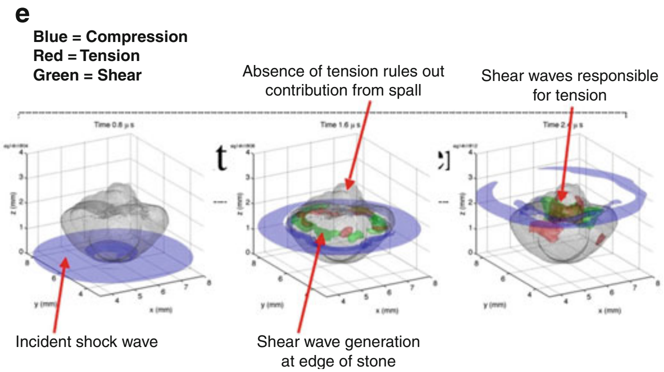


FIGURE 36.2 (continued)

in a fracture about 1/3 from distal end [9]. This fracture mechanism is considered similar to freezing of water inside brittle material.

Quasi-Static Squeezing

If the focal zone is broader than the stone pressure waves travel in the fluid along the surface. The leading compressive phase can create *circumferential stress*, which acts on the stone by quasi-static squeezing inducing a binary fragmentation similar to a nutcracker with first cleavage surfaces parallel or perpendicular to the axis of SW-propagation (Fig. 36.2c). This assumes that the SW-velocity in surrounding fluid is much lower than elastic velocities within the stone. The longitudinal SW moves through the stone leaving the thin waves in the fluid encircling and squeezing the stone [11]. For squeezing to be effective the focal width of the lithotripter must be wider than the stone, thus high fragmentation efficiency will be promoted by large focal diameters (i.e. up to 20 mm). Data suggest that P+ could be reduced to 10–30 MPa, sufficient to overcome fracture thresholds. This hypothesis has stimulated discussions about the importance of *larger focal size and lower pressure* compared to small focal size with high pressure in large-aperture sources.

Cavitation

Cavitation generated by the negative pressure phase of shock waves occurs in the fluid surrounding stones and within microcracks or cleavage interfaces (Fig. 36.2d). For initial fragmentation, cavitation is less relevant, but becomes important as stone fragments become smaller. Cavitation-induced erosion is especially observed at anterior surface of stones [10]. Suppression of cavitation using highly viscous media or hyperpressure or overpressure significantly reduces disintegrative SW-efficacy [13]. Recognition of the role of cavitation in stone comminution has led to efforts to enhance the action of cavitation bubbles such as tandem shock waves generated using a piezoelectric source fitted to an electrohydraulic system with an additional discharge circuit to produce the second pulse [14]. The same has been realized recently by the use of high intensity focused ultrasound with and without an electrohydraulic lithotripter [15]. However, cavitation can be also detrimental to fragmentation as it results in production of gas bubbles lasting for many seconds therefore attenuating subsequent impulses [16]. Higher PRF results in more cavitation bubbles, while higher acoustic energy leads to a longer lifespan of the cavitation bubbles.

Dynamic Squeezing

This theory mainly combines spallation and quasi-static squeezing. Following predictions from a numerical model Sapozhnikov presented experimental evidence of *dynamic squeezing* [12, 17] demonstrating that *shear waves* initiated at the corners of the stone and driven by squeezing waves along the calculus lead to greatest stress, whereas reflection of longitudinal waves at posterior surface was less important. Thus, in *dynamic squeezing* calculi are fragmented by shear waves created inside the stone reinforced by squeezing waves from the lateral stone borders (Fig. 36.2e).

Dynamic Fatigue

Fragmentation inflicted by SWL accumulates during course of treatment, leading to eventual destruction of stone integrity [8]. Therefore, stone comminution is characterized as a progressive process consisting of initiation (based on dynamic squeezing), propagation (associated by cavitation), and coalescence (due to increasing fragility). Finally, mechanical stresses produce micro-cracks resulting in a sudden break-off of calculus once its molecular structure is destroyed. This theory relates physical stone properties (fracture toughness, acoustic speed, density, void dimensions) to SW-parameters (peak pressure, pulse width, pulse profile).

Relevance of Different Theories of Stone Fragmentation

Sapozhnikov [12] carried out a set of experiments testing multiple mechanisms on a research lithotripter: spalling, quasi-static squeezing, and cavitation (Table 36.2). Whereas only one experiment supported spalling and quasi-static squeezing, *dynamic squeezing* sufficiently described initial fragmentation in all experiments (Fig. 36.3). Tear and shear forces and spallation remain only relevant in small focal sizes. The current consensus is that focal width may have a critical role in stone breakage at least for initial fragmentation.

Based on this, recent *broad-focus, low-pressure lithotripters* (LithoSpace, LithoGold, XX-ES) attracted attention as

Table 36.2 Models and results of experimental evaluation of stone fragmentation by shock waves

Mechanism	**Model**	**Hypothesis**	**Stone model/numerical calculation**
Spallation	Stone length 8–18 mm	Stone fractures at same distance from the distal end	Stone fractures at 1/3 from the distal end dependent from length
	Block of prox. surface by corprene disk	Stone fracture is significantly inhibited	Only little difference (50 vs 45 SW) Pressure field similar at last 1/3
Squeezing	Baffle ringing proximal end	Stone fracture is significantly inhibited	Significant inhibition (300 vs 45 SW) But reduced stress field still at last 1/3
	Conical shape of stone front	Stone fracture is not inhibited	Significant inhibition (200 vs 45 SW) Pressure field reduced due to diffraction
	Block of prox. End (complete)	Stone fracture is not inhibited	Significant inhibition (212 vs 45 SW) Pressure field reduced due to absorption

According to Sapozhnikov et al. [12]

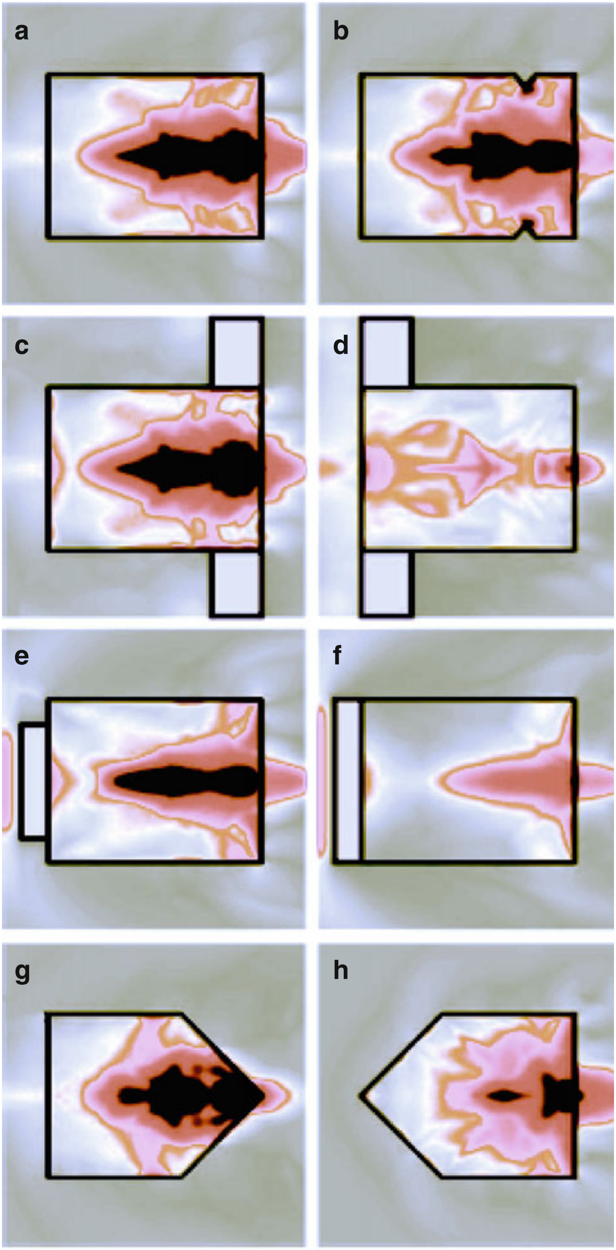

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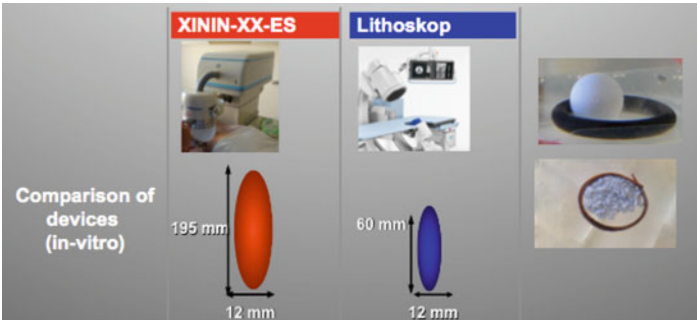
Table 36.3 Extracorporeal shockwave lithotripsy



Comparison of devices (in-vitro)	XININ-XX-ES	Lithoskop
Focal length	195 mm	60 mm
Focal width	12 mm	12 mm
Max. pressure	24 MPa	70 MPa
Localization	Ultrasound	Fluoroscopy
Early fragmentation	29	23
Complete disintegr.	850	651

research showed that focal width affects stone breakage in several ways [7, 18–21]. In vitro, the disintegrative efficiency of XX-ES was superior to HM3 (634 vs. 831 SW) and similar to that of the Siemens Lithoskop (Table 36.3). Since no data of applied energy at different shock wave sources were provided, differences in configuration and acoustic output of both devices must be considered when interpreting results. Moreover, recently modification of the lens of the electromagnetic System-C of Siemens resulted in a larger focal size and in-vitro-efficiency [22].

Fig. 36.3 Stress fields in the different stone experiments using a research lithotripter patterned after Dornier HM3 (Sapozhnikov et al. [12]). The maximal stress field (**a**) is little changed by blocking the longitudinal wave entering the stone (**e**) or altering the distal end of the stone (**b, c, g**). However, blocking the circumferential squeezing wave alone (**d**) or preventing the creation of shear waves at the corners (**f, h**) significantly reduces the intensity of stress

Further Factors Influencing the Efficacy of ESWL

Coupling Quality

Cost reduction, modular and multifunctional lithotripter design has changed the ideal coupling of the water bath of the HM3 to coupling cushions making coupling quality a key-factor of success. The main reason for this are air pockets within the coupling gel deteriorating significantly the transmission of the shock waves [23–27]. Factors for this effect are:

– viscosity/temperature of the ultrasound gel
– the amount of gel used
– whether the Gel is squeezed out of a bottle or it comes from a stock-container

In-line ultrasound probes enable intraoperative check of coupling quality [7]. Bohris et al. used a camera as tool to control coupling quality and found *imperfect coupling in 67 %* of the cases [27]!

Localization and Monitoring

Stones must be targeted effectively during delivery of SWs. This is difficult, because *respiratory movement* can carry the calculus out of target zone [28]. Immobilization by high-frequent ventilatory respiration anesthesia was clinically effective but too invasive. Systems with respiratory belts and SW-triggering (Siemens Lithostar) have been abandoned due to increased treatment time [21]. A compression belt may reduce respiratory movement of the kidney [21]. Larger focal zones reduce the number of impulses that miss the stone.

The debate continues, which imaging modality provides best localization. *Fluoroscopy* being first choice gets simpler with isocentric C-arm-systems compared to the HM3 in-bath-converters. Theoretically, in-line ultrasound is preferable, because sound and shock waves travel similarly through body. Because of acoustic deviation, lateral ultrasound may differ from coaxial ultrasound, e.g. Bohris found a 5 mm-deviation comparing co-axial and lateral ultrasound with fluoroscopy [29]. Duplex-Ultrasound or acoustic tracking of cavitation has been used to monitor if shock waves hit the stone and whether the fragmentation is progressing (Fig. 36.4) [30].

Automated fluoroscopic localization (Lithoskop, Sonolith-i-sys, Dornier Gemini) significantly reduces x-ray exposure [21]. The Lithotrack-system (Modulith) minimizes radiation exposure by *optical tracking* and the correct position of the SW-source can be controlled by virtual reality without the need of fluoroscopy (Fig. 36.5a). AST-LithoSpace uses an *acoustic tracking system* [31] adaptable to ultrasound as well as fluoroscopic devices (Fig. 36.5b).

Impact of Pulse Rates

Low PRF prolongs treatment time significantly and may lead to inconvenience for patients not maintaining a stable position.

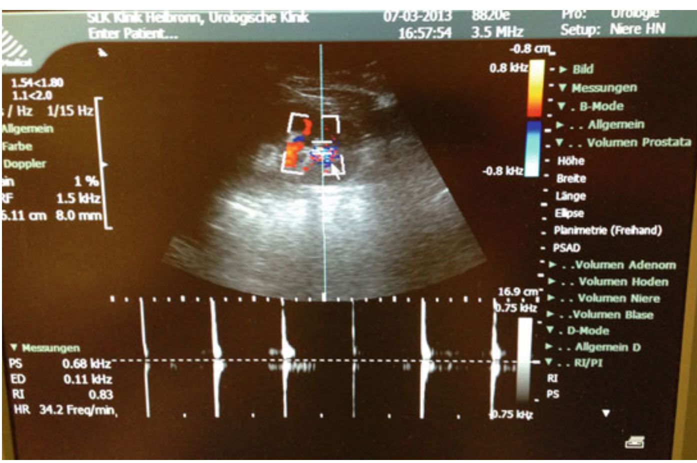


Fig. 36.4 Use of color-coded duplex ultrasonography for localization of stones during ESWL. CCD signal indicates by sound and graphics when the stone is hit by the shock wave. Moreover, the change of the signal may indicate breakage of the stone (From Rassweiler et al. [36])

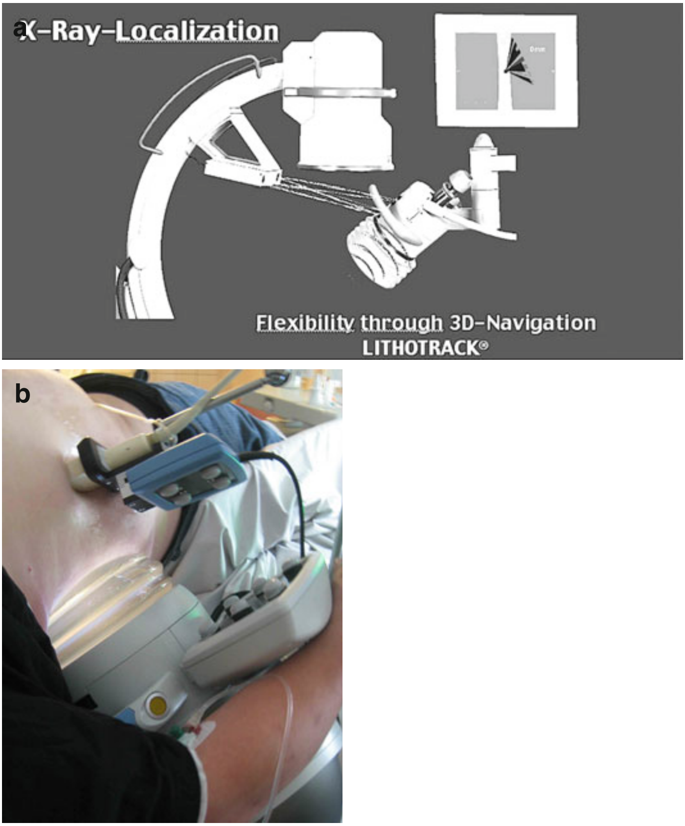


FIG. 36.5 Navigation for stone localization. (**a**) Optical tracking: A camera system checks the position of the shock wave source arranged with an isocentric fluoroscopic C-arm (LithotrackR, Storz-Medical, Switzerland). (**b**) Acoustic tracking: Sound waves of six piezo-electric sources attached to the shock wave source are tracked by six receivers attached to the localization system which has been calibrated before. The focal zone is displayed on the screen (SuperVision™, AST, Germany)

Experimental data [32] as well as the meta-analysis of seven RCTs (N=1235) suggests a better outcome at 60–80 SW/min compared to 120 SW/min being most obvious in stones >10 mm in diameter (Table 36.4). To detect significant differences for

TABLE 36.4 Clinical randomized controlled trials (evidence level Ib/A) comparing different pulse-rates for ESWL

Author Year	N of pat. (slow/fast)	Lithotriptor	Pulse rates (n/min)	No. of impulses (slow/ fast)	Overall SFR at 3 mos (%)	Stone free rate (3 mos) <10 mm	10–20 mm	Comments
[37]	220 (111/109)	Lithotron (Healthtronics)	60 vs 120	2423 vs 2906	60 vs 45	60 vs 49 % (n.s.)	60 vs 28 %	Double-blind RCT Only SSA >100 mm^2 significant
[38]	170 (56/57/57)	StoneLitho3pter (PCK)	60 vs 90 vs 120	3037 vs 2989 vs 3019	n.a.	n.a.	n.a.	Success rate (< 3 mm fragments) 73 vs 88 vs 89 %
[39]	156 (76/80)	Lithostar Multiline (Siemens)	60 vs 120	5755 vs 7414	85 % overall	n.a.	n.a.	Success rate (<2 mm fragments) 99 vs 90 % Stone size most important for success

(continued)

Table 36.4 (continued)

Author Year	N of pat. (slow/fast)	Lithotriptor	Pulse rates (n/min)	No. of impulses (slow/fast)	Overall SFR at 3 mos (%)	Stone free rate (3 mos) <10 mm	Stone free rate (3 mos) 10–20 mm	Comments
[40]	349 (171/178)	DoLi 50 (Dornier)	70–80 vs 120	2428 vs 2785	n.a.	65 vs 57 % (n.s.)	67 vs 46 %	Difficult to determine treatment endpoint in small stones
[41]	104 (50/54)	DoLi S (Dornier)	60 vs 120	3000 vs 3000	49 vs 47 (n.s.)	59 vs 61 % (n.s.)	n.a.	Related to stone area of 60 mm^2 no difference
[42]	134 (66/68)	Modulith SLX (Storz.Medical)	60 vs 120	6348 vs 6348	77 vs 76 (n.s.)	83 vs 75 % (n.s.)	65 vs 79 % (n.s.)	Disintegration rate 65 vs 47 %
[43]	102 (51/51)	DoLi S (Dornier)	70 vs 100	3045 vs 4414	67 vs 26	n.a.	n.a.	Cost reduction by slow rate
Total	1235							

From Rassweiler et al. (2013)
SFR stone free rate, *n.s.* not significant, *SSA* stone surface area (length × width)

smaller stones is problematic, because treatment endpoint is difficult to determine with current imaging techniques [37–43].

Application Mode

Both in-vitro and in-vivo studies, show advantages in slow increase of generator voltage ("ramping") during SWL [23, 33–36]. Lower generator voltage results in less pain, thus patients can better accommodate to treatment under iv-analgesia. Pre-treatment on lower voltage (100 SW at 12 kV) reduces renal trauma by vasoconstriction and reduction of oxidative stress. Lower SW-pressure is also sufficient to initiate fragmentation. Higher energy is only required to overcome attenuation and scattering effect by fragment collection. Moreover, on lower energy scattering occurs less.

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Chapter 37
Which Lithotriptor Should I Buy?

Cahit Şahin and Kemal Sarıca

Abstract Following its clinical introduction in early 1980s, extracorporeal shock wave lithotripsy (ESWL) has proven itself as a successful, reliable and safe treatment option for urolithiasis. Despite all attempts to improve the efficacy and safety of the lithotripsy systems; the efforts did not produce evident improvements due to our limited knowledge concerning the exact mechanism stone fragmentation which makes it is still unclear what parameters should be modified. In this present chapter by focusing on the developments of lithotripsy systems; we aimed to outline the characteristics of the systems that will make them preferred in clinical conditions.

Keywords Urolithiasis • Extracorporeal shock wave lithotripsy • Lithotripsy systems • Human lithotriptor type

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Introduction

Following its clinical introduction in early 1980s, extracorporeal shock wave lithotripsy (ESWL) has proven itself as a successful, reliable and safe treatment option for urolithiasis [3, 4]. Since its first introduction as a dedicated "urinary stone crusher", the lithotriptor not only revolutionized urinary stone management but also obtained a significant role in concept of "integrated endourology" [5].

From the first human lithotriptor type (HM3) till today, as a result of the increasing technical as well as clinical experience manufacturers have introduced new devices with significant modifications in an attempt to improve the effectiveness and safety of SWL [5, 12]. Among the well known developments, the introduction of lithotripters with dual shock wave sources and a broad focal width. Development of new devices which may allow us to track and target the stones during management is currently in the experimental phase [7, 8, 14]. However, despite all attempts to improve the efficacy and safety of the lithotripsy systems, the efforts did not produce evident improvements, due to our limited knowledge of exact mechanisms underlying stone fragmentation.

In this present chapter we focus on the developments of lithotripsy systems and we outline the characteristics of the systems that will make them preferred for clinical use.

Advancing Technology and Changing Characteristics in Lithotripsy Systems: What Has Changed So Far?

Over the years, as the technological advancements introduced new lithotrptor systems into clinical use, the following changes have made the application of SWL in a more practical and safer manner:

1. Improved imaging modalities have expanded the indications for SWL in the management of urinary stones

2. Shock wave sources have improved to deliver more power without increasing the complication rates
3. Lithotripsy systems became "dry" using a water cushion instead of a water bath for coupling greatly simplifying handling of the machines.
4. Patient's comfort was considerably improved when general or spinal anesthesia could be abandoned in favor of sedoanalgesia, making ambulatory treatments possible
5. Additionally most manufacturers begin to try constructing new machines for multifunctional (Endourology) and multidisciplinary use (ESWT). The extracorporeal shock wave treatment (ESWT) of non-urologic problems, such as pseudarthrosis, tendinosis calcarea of the shoulder, tennis elbow, heelspur, indeed seems to gain momentum

Evolution of Machine Design: A Closer Look

First Generation

As the first lithotriptor produced and used worldwide; the Dornier HM3 can be considered the pioneer of a first-generation lithotriptor. Still as the "gold standard" of this techniques [6]. The HM3 machine featured a large water bath for optimal shock wave coupling, fluoroscopic imaging, an ellipsoid reflector with a small aperture and an 80 nF-generator, necessitating general or spinal anesthesia. With these unique features multifunctional or multidisciplinary use of this system has never been possible.

Second Generation

These lithotriptors had three different sources namely the electrohydraulic, electromagnetic or piezoelectric ones [9]. Coupling has been provided by a water cushion or partial water bath. These machines were further equipped with either ultrasonic or fluoroscopic imaging. Although anesthesia free application is a major advantage of these systems; multifunctional and/or multidisciplinary use remained to be limited. Dornier HM4, Dornier MFL 5000 and Dornier MPL 9000 could constitute good example for second-generation lithotriptors [13].

Third Generation

As the last generation, such lithotriptors have a combined targeting system which usually enables the use of both fluoroscopy and ultrasound in an alternately manner or in some ideal systems simultaneously [5]. Patients could be treated without anesthesia and the integrated of localization system in an endourologic treatment table gives the physicians the chance of multifunctional and multidisciplinary use The Dornier MFL 5000U, the Dornier Compact-series and the Dornier Lithotripter (U/15/50 and S) and the Dornier Gemini can be considered third-generation devices.

Evaluation of Lithotriptor Performance

The performance of a lithotriptor generally is measured with EQ parameter [2]:

$$\frac{\%\ \text{Stone free patients}}{100\% + \%\text{Re-treatment} + \%\text{Aux. Proc.}} \times 100$$

Considering the EQ's of most systems currently available, the newer electromagnetic machines (Compact, Dornier Lithotripter S) score equally good and even better than the Dornier HM3. The EQ's of piezoelectric machines are generally low and not at all in the range of electrohydraulic or electromagnetic machines. However one should keep in mind that some certain machine related (smaller focus, improved imaging with better targeting), patient related (decrease in average stone size) as well operator related (better treatment strategies, greater experience) factors could affect the efficacy of a lithotriptor system in a considerable manner.

Imaging Systems: Advantages and Disadvantages

The success rates obtained by ESWL technique are largely influenced by the imaging system integrated with the lithotriptor. While the first and to some extent the second generation lithotriptors were equipped either with ultrasound or fluoroscopy; modern lithotriptors have both imaging modalities in an integrated fashion by offering simultaneous use of both localization systems [11].

Fluoroscopy

Although the in situ treatment of all ureteral stones and shorter learning curve are the main advantages of this system; disadvantages include the ineffectivity for the localization of radiolucent and sometimes small stones, lack of real-time image and most importantly the radiation exposure [10].

Ultrasound

In contrast to fluoroscopy, sonographic imaging has more advantages among which the easy targeting of radiolucent and smaller stones, real-time imaging during therapy, fast and practical use and lack of radiation exposure could be counted. However, in situ treatment of ureteral stones is possible only for very proximal and very distal ureteral calculi with this system and the learning curve is evidently longer than fluoroscopy [1].

What Do We Expect from a Lithotriptor?

In the light of the basic information given above, the endourologists prefer to work with a modern lithotriptor which will exhibit following characteristics;

1. Resulting in higher stone free rates with limited or no tissue damage and/or pain,
2. Being suitable for all kinds of stones, multifunctional and multidisciplinary use
3. Offering simplified handling and lower costs.
4. Integrated with a shock wave source with large aperture which allows simultaneous use of both fluoroscopy and ultrasound
5. Enabling the endourologist for an anesthesia free ambulatory treatments both in ESWL and ESWT.

Last but not least; this ideal lithotripsy system should be installed in a large EndoUrology suite equipped with a full range of endoscopic equipment and disposables for endourologic procedures. Well trained and knowledgeable nursing staff is another "must" to improve the efficiency and safety further. In addition to all qualifications above, published data so far did show that the use of slower pulse rates, ramping strategies, and adequate coupling of the shock wave head can significantly increase the efficacy and safety of ESWL.

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Chapter 38
How Should I Operate on a Lithotriptor for Optimum Results?

Geert G. Tailly

Abstract Although ESWL remains the primary treatment of choice for the majority of urinary stones smaller than 2 cm many centers report disappointing results. The reason for this is often multifactorial. Excellent results can be obtained however provided proper attention is paid to all aspects of the procedure. These aspects are discussed in detail together with some simple tips to optimize results and at the same time minimize complications.

Keywords ESWL • Urolithiasis • Shockwave lithotripsy • Lithotripter • Stone management

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Introduction

Least invasive of all treatment options, ESWL remains the primary treatment of choice for the majority of urinary stones smaller than 2 cm. In successful ESWL an important role is played by three actors: the lithotripter, the patient and the urologist.

Although too often underestimated, the importance of a skilled and experienced urologist cannot be over-emphasized. With proper equipment a urologist with an interest in stone management, an understanding of the basic physics of shock waves and an adequate training in the safe application of shock wave energy can obtain excellent treatment results with minimal complications.

The Lithotriptor

The device should of course be in proper working condition [7]. The shockwave source should be maintained and serviced according to the specifications of the manufacturer. The proper alignment of the imaging systems (fluoroscopy and ultrasound) is especially critical and should be checked daily prior to start of treatments. This only takes a couple of minutes but guarantees proper targeting.

While the system is started up, the coupling cushion needs to be checked for air bubble inclusions. Any air bubbles within the cushion will pool in the shockwave path and reduce energy transfer and hence disintegration capability. If air bubbles are present, they should be removed as described in the user manual.

After each and every treatment the coupling cushion needs to be thoroughly cleaned. This is important not only for hygienic reasons. Any ultrasound gel residues on the surface of the cushion will impede the energy transfer of the shockwaves.

The Patient

It is not uncommon that a stone changes position in between initial diagnosis and the actual treatment. This may require an updated treatment strategy. Therefore we always ascertain the actual position of the stone to be treated with a KUB immediately prior to treatment.

Prior to attaching patient monitoring tools (ECG, O_2-saturation, blood pressure) we explain the course of the procedure as detailed as possible and also make sure that the patient position on the treatment table is stable and comfortable. Good cooperation of a comfortably installed patient is essential for an efficient treatment.

Even in obese patients excellent results are obtained with lithotriptors with high resolution imaging systems and above all a shockwave source with a high penetration depth largely exceeding SSD (skin-to-stone distance). (Slightly) tilting the side to be treated towards the therapy head can facilitate proper focusing in obese patients.

Even very small children can be safely treated with extracorporeal shockwaves. In children a stable position on the lithotriptor is even more important. A pediatric positioning aid provided by the lithotripter manufacturer or an Op-Site® sheath can be used to adapt the gap in the treatment table to the child's size. As in children the lung area is in closer proximity to the kidney the lung area needs to be protected from the impact of SW. A sheath of styrofoam will effectively block SW from entering the lung area.

The Urologist

An ESWL-treatment is comparable to a surgical procedure and therefore the urologist performing this procedure should pay maximal attention to every single detail.

Pain Management

Shockwaves stimulate both cutaneous and visceral nociceptors causing both superficial pain at skin level and deep visceral pain. Optimal treatment results can only be obtained with effective pain management. Although some centers may still prefer general anesthesia, a regimen of IV analgosedation is most commonly used. As this proved most comfortable for both patient and operator we prefer an on-demand regimen with the administration of a Propofol-Alfentanil cocktail via a patient controlled analgesia-device (PCA) (Table 38.1) [8]. Main parameters in analgesia consumption are characteristics of the SW-source, number and energy level of SW, stone size, location and patient related factors. While older children may tolerate ESWL under IV analgosedation, general anesthesia is preferred in younger children.

Table 38.1 On demand IV analgosedation during ESWL: PCA-device with Propofol/Alfentanil

	Dose			
Drug	**Induction bolus**	**Maintenance PCA device**	**Advantages**	**Disadvantages**
Propofol Alfentanil	0.8–1 mg/kg 8–10 μg/kg	0.25 mg/kg 5 μg/kg	Very good analgesia Very flexible system Excellent tolerance Fast recovery Antiemetic effect (Propofol)	Transient O_2-desaturation after induction (as compared to “blind” coupling) (obstruction > apnea): rare

Stone Targeting

In order to avoid time consuming moves later in the procedure it is advisable to pre-position the patient in as close proximity to the focus as possible.

We advocate to use ultrasound imaging whenever possible, especially in children:

- smaller stones are easier to detect
- it is possible to detect radiolucent stones
- real time imaging allows far better monitoring of the entire treatment
- there is no radiation exposure.

Following the administration of IV analgosedation once targeting is completed, the patient will relax and "sag" a little. This may move the stone slightly out of focus in the Z-axis necessitating a small adjustment in the Z-axis.

With real time ultrasonic imaging it is usually possible to fine tune positioning in such a way that the stone nicely "swings" in the focal area with respiratory movements, thus increasing the hit rate to a maximum.

This is slightly more difficult with fluoroscopy and may increase radiation exposure times. When using fluoroscopic imaging the stone needs to be targeted in both imaging projection planes (AP and CC) prior to treatment start. During treatment it is very important to re-check targeting in both image projection planes at regular intervals: small movements of the patient may pass unnoticed save for a discreet change in sound of the shockwaves. The sound of the shockwaves is muffled by the patient on top of the water cushion. A change in the quality of this muffled sound is an important indication that the patient may have slightly moved. Of course radiation dose should be reduced according to the ALARA-principle (as low as reasonably achievable). This is mainly done by reducing the image size once initial targeting is completed and by keeping the exposure times with pulsed fluoroscopy as short as possible.

Coupling

The quality of coupling of the SW-source to the patient is one of the most important factors in the energy transfer and thus in the quality of stone fragmentation. Air bubbles in the coupling area considerably reduce the disintegration capability [1, 4].

Bubble free coupling is therefore essential. It is advised to use a sufficient amount of a low viscosity ultrasound gel from a large mouthed container. A thick layer of gel is applied in the center of the water cushion. While inflating the water cushion the patient is gently lowered onto the inflating cushion. This will spread the gel radially and minimize air entrapment.

Following coupling air bubbles are removed from the coupling area by gently swiping a hand between patient and water cushion; when available optical coupling control with a camera mounted in the water cushion is preferable as optically controlled swiping significantly improves the adequate removal of all air bubbles. With the use of optical coupling control (OCC) we established a significant reduction in number of SW, energy level of SW and total energy administered as compared to "blind coupling" (Table 38.2). Theoretically this reduction in total energy applied (number of SW × energy level) should also reduce the incidence and severity of SW-induced adverse effects.

SW Delivery

Four different mechanisms (Hopkinson effect, shear forces, quasistatic squeezing and cavitation) are considered to act together in stone fragmentation [2, 9]. Of these mechanisms, cavitation probably is the single most important factor in the occurrence of acute adverse effects. These cavitation induced adverse effects can be minimized by adhering to some simple measures in SW-delivery.

TABLE 38.2 Optical coupling control: effects on treatments results (as compared to "blind" coupling)

	RENAL stones	**URETERAL stones**
Number of SW	–25.4 %	–25.5 %
Energy level	–23.1 %	–22.5 %
Accumulated energy	–42.9 %	N/A
Effectiveness quotient		
"Blind" coupling	73	75
OCC	74	78
Treatment time	–25.4 %	–25.5 %

A lower pulse repetition frequency (PRF) improves outcome: better stone free rate, lower retreatment rate, better effectiveness quotient (EQ) and improved cost-effectiveness. In general PRF should be decreased with increasing energy level. A PRF of 60 SW/min is ideal, but a PRF of 80 SW/min is an acceptable compromise. Apart from reducing the PRF, the power output of the lithotriptor should be gradually (and slowly) increased to improve stone fragmentation and reduce injury to the renal parenchyma. The introduction of a short treatment pause of 1–2 min after an initial dose of ±200 SW may further reduce the risk of adverse effects.

In general, the maximum energy level ultimately used is lower for renal than for ureteral stones. As ureters have no parenchyma the risk of adverse effects there is lower.

Be aware that good bubble free coupling, ideally with optical control, will further reduce total energy needed. Careful monitoring of the entire treatment is also paramount. Total energy applied should be as low as possible: just enough to do the job. This is especially important in children. Avoid "casual" overtreatment.

Patient risk factors that require a lower SW-dose (energy level × number of SW) are: untreated hypertension, diabetes mellitus, impaired renal function, hydronephrosis, age >65 years, pediatric patients.

Treatment Strategies

"Emergency" ESWL (eESWL) within a short interval after a first episode of renal colic offers improved fragmentation, a shorter time to achieve complete stone clearance, an increase in SFR, a reduced need for repeat ESWL-sessions and treatment of the renal colic in itself [3, 5, 6, 10].

Immediate Follow-Up

Prior to discharge, patients who underwent ESWL for renal stones need to be observed for signs of subcapsular or perirenal hematoma. Although rare (±0.3 %) post-ESWL renal hematomas are a severe and possibly life threatening complication.

Excessive pain following SW-treatment could be indicative of a developing subcapsular or perirenal hematoma and should trigger urgent attention with adequate imaging (CT or US) and the prompt initiation of management of these conditions.

We always have a KUB performed in the radiology department immediately after ESWL-treatment. A good quality KUB is superior to fluoroscopy in the final appraisal of fragmentation. Apart from this it makes it easier to identify a larger fragment that may descend into the ureter and cause problems. In these cases we may still decide to introduce a stent.

Finally it allows to eventually plan additional treatment sessions. A second ESWL-session should not be planned less than 1 week following the initial session.

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Chapter 39
Tips and Tricks of Rigid Ureteroscopy

Athanasios Papatsoris

Abstract Herein the most useful tips and tricks to perform a rigid ureteroscopy and lithotripsy for the treatment of ureteral stones are provided. Following established principles and standardized steps, this procedure can be safely performed with a successful outcome.

Keywords Rigid ureteroscopy • Tips • Technique

Introduction

The first ureteroscopy (URS) was performed by happenstance as Hugh Hampton Young introduced a 12 Fr cystoscope into the dilated ureter of a child with posterior urethral valve in 1912. Since then, rigid URS has become a routine diagnostic and therapeutic procedure, especially for the middle and lower ureter [1–6].

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Tips

- Fluoroscopy guidance is mandatory for safety reasons and fluoroscopy time should be as minimal as possible (e.g. by reducing continuous screening).
- General anesthesia is preferred in comparison with regional anesthesia in order to perform rigid URS as the patient is relaxed and not in pain due to the black flow.
- Insertion of a hydrophilic safety guidewire into the ureteral orifice and up the kidney under fluoroscopic control is the first step for a successful URS.
- Retrograde contrast studies although advisable in all case, could be avoided in experienced surgeons that recognize normal advancement and curling of the safety wire.
- Usually, the first (safety) guidewire is advanced through an open access ureteral catheter, which is introduced with the cystoscope. This step could be avoided in experienced hands in case the first wire is placed through the ureteroscope from the very beginning (provided that the bladder is emptied).
- The placement of a second (working) wire can ease the insertion of the rigid ureteroscope in the intramural part of the ureter. The insertion of the wire(s) could straiten a ureter with kinking. The ureteroscope can be advanced between the two wires (railway technique) without pushing in case of resistance (i.e. narrow ureter).
- The use of a double lumen ureteral catheter can enable retrograde contrast studies and the placement of the second wire.
- In case of a narrow ureter and/or a stricture the use of the balloon can dilate the ureter and facilitate the advancement of the rigid ureteroscope. Caution is needed in order to avoid excessive inflation of the ureteral balloon, which may cause ureteral rupture. The intramural part of the ureter can be dilated with the balloon or with consecutive plastic dilators. Also, rotation of the ureteroscope may facilitate the insertion of the scope into the ureteral orifice.

- Intracorporeal lithotripsy is performed better with the Holmium-YAG laser at various levels of energy, frequency and pulse. Several lasering techniques have been practiced such as the "painting", the "drilling" and the "popcorning". Each technique is accomplished by adjusting the laser frequency, energy and pulse in different settings. Single use laser fibers are more expensive in comparison with fibers that are for multiple uses. When cutting the fiber tip it is more important to obtain a completely vertical surface than to strip the cladding. In order to protect the ureteroscope from accidental laser firing, the tip of the laser should be always visible. Especially for junior surgeons, is advisable to fix the laser fiber in a way that the cladding is visible. Also, caution is needed in order not to break the fiber at its entry into the ureteroscope.
- Visualization during URS could be impaired when using larger instruments through the working channel and in case of bleeding. In such cases, increase of the irrigation pressure could clear the view, especially when high-definition camera is not available However, proximal stone migration may be caused by the irrigation system, with gravity-based systems exerting less force than hand-held and foot-pump devices.
- Prevention of stone fragments migration can be achieved with the use of anti-retropulsion disposable devices. Stone extraction devices include stone-graspers, tipless baskets and forceps. While performing laser dusting at the end of the procedure a stone fragment can be extracted and sent for stone analyses and culture. To minimize complications it is important to carefully select the extraction device according to the size and location of the stone. Maintaining a good view at all times and avoiding forceful or blind manipulation is mandatory. Ureteral avulsion is the most serious complication and it may result from forceful manipulations (upwards and downwards).
- Impacted stones may be difficult to treat especially if they are at the proximal ureter and cause complete obstruction. In such cases it might be impossible to insert a safety wire

into the kidney as it may curl just below the site of impaction. It is advisable to leave the safety wire there and advance the ureteroscopy with the aid of a second hydrophilic wire. Under direct vision it might be possible to advance the safety wire and bypass the impacted stone. Irrigation under pressure could facilitate this maneuver as well as rotation of the ureteroscope. The usage of baskets in the middle ureter should be used with caution because of the risk of blocking the basket with a large stone fragment. Before using a basket the surgeon should be able to understand how to dismember it. It is preferable to dust the stone with the laser than to fragment it to big particles that could be difficult and dangerous to extract.

- Special categories of patients undergoing rigid URS include pregnant women, children and patients on anti-coagulation medication. In pregnant women care should be taken to minimize fluoroscopy exposure; thus in such cases ultrasound could be used to check the position of the wire and the double J (JJ) stent in the kidney at the end of the procedure. Miniaturization of the ureteroscopes has increased the performance of URS in children, where complete stone clearance is essential. URS can be effectively performed without stopping the anticoagulation medication.
- A solitary renal pelvic stone could be approached with the rigid ureteroscope, especially in women and if a JJ stent have been in place prior to the URS. The advantage of treating a solitary renal pelvic stone with rigid URS is the possibility to use the large (365 μm) laser fiber. Nevertheless, it is advisable to perform rigid URS for a renal stone only provided a flexible ureteroscope is available on site in case the stone is not approached with the rigid ureteroscope. In such cases the rigid ureteroscope could be used to dilate the ureter prior to the usage of the flexible scope.
- At the end of the rigid URS, a JJ stent can be placed or even an open-ended ureteral catheter for 1 day in quick and straightforward cases. Stenting is advised in cases of bilateral URS, ureteral injury or bleeding, urinary tract infection as well as in pregnant women and in solitary kidney.

- When stenting the appropriate size and length should be chosen in order to prevent JJ-related lower urinary tract symptoms. Medications that could be given in order to alleviate the JJ-related symptoms include alpha-blockers, anticholinergics and anti-inflammatories. One to two weeks is a reasonable period of time after which the JJ stent could be removed with the flexible cystoscope or the rigid ureteroscope under local anesthesia.

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Chapter 40
Tips for Flexible Ureteroscopy

Jonathan Cloutier and Olivier Traxer

Abstract The first flexible ureteroscope was introduced in 1983 and since then, the use of flexible ureterorenoscopy (F-URS) has never ceased to grow, and its indications have continued to expand. This chapter presents some particularities, tips and tricks of F-URS that could accommodate urologists throughout general and particular circumstances. Urologists who have an interest in flexible ureteroscopy should be armed of patience, and be always on the lookout for the next step and the technical possibilities to assist him in troublesome situations. There are plenty of equipments and tricks in flexible ureteroscopy, and the surgeon needs to know the existence of them and accomplish his own experience and familiarity.

Keywords Flexible ureteroscopy • Kidney stones • Laser lithotripsy

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Introduction

The first flexible ureteroscope was introduced in 1983 by Bagley and colleagues. Since then, the use of flexible ureterorenoscopy (F-URS) has never ceased to grow, and the indications have continued to expand. This chapter presents some particularities, tips and tricks of F-URS that could accommodate urologists throughout general and particular circumstances.

The Equipment

Urologist's knowledge regarding his own equipment application and limitation should be well understood. The new digital flexible ureteroscopes are highly attractive with their higher visual quality and lightness. However, the user should know that, during a lower pole calyx surgery with a high angulation degree, the digital ureteroscope have more limitation and principally when a fiber laser or basket is into the working channel. Don't forget: the fiberoptic can remain useful and efficient particularly in particular situations.

When you have to fragment or fulgurate a stone or tumor in a kidney lower pole, always operate with an unused 150–200 um fiber laser with low energy setting. Try to avoid reusable laser fiber in this case due to the highly fragility of re-sterilization. Throughout a stone surgery, the stone should be repositioned as soon as possible in the pelvis or upper pole calyx.

Knowing the different baskets and their use in appropriate circumstances could assist you in the achievement of a stone free surgery. NGage® or NCompass® baskets (Cook Medical) may be usable ensuring a fragmentation of a sizable stone, and there are countless small fragments. A different situation is following a monohydrate calcium oxalate stone fragmentation, which is usually not easily broken and requires additional energy, the fragments are frequently more significant. The Zero tip® basket (Boston Scientific®) would be an interesting option for this fragment type. Advantage of the Zero tip® basket is also the gradual opening that let you just opened as necessary to engage the stone into the basket and remarkably facilitate the removal stone maneuver. The small detail of not continually necessitated a full basket opening reduce the probability of pushing the tip of ureteroscope back of the working calyx.

The protection of the equipment is an important part of F-URS since the repairing cost is relatively high. Basic principals are avoiding to work with high deflection for a long period, try vaporizing first and then remove stone fragments to reduce the number of in and out instrument passage into the working channel, and insert an instrument every time into a straight scope.

While trying to introduce an ureteral access sheath and meet resistance at the ureterovesical junction (UVJ), the first consideration is to avoid pushing too arduously, no mistake is made if you do not push exceedingly firmly. We recommend to place the access sheath below the UVJ. First, empty the bladder to decrease the closure pressure from a full bladder on the UVJ. Try to use smaller ureteral access sheath if needed. While a ureteral access sheath does not warrant, and the flexible ureteroscope tip has difficulty to pass at the junction, turn the scope of 180°, and it can make smoother the tip passage of the ureteroscope. Another rule to keep in mind, stenting and coming some days later is secure and effective to obtain an ureterorenal access easily.

The Exact Orientation

A good sense of direction during F-URS is important to provide anticipation and accuracy of movement. The two tips to give a better understanding of your position into the cavities are the air bubbles and the dusty deposits. Air bubbles allow knowing where anterior (12 h) localization is, this is particularly important when a surgeon desires to perform an endopyelotomy and should exactly laser postero-laterally to lessen the risk of vessel injuries. Moreover, the dusty deposits orientate you to recognize where the posterior part of the calyx is.

Stone Fragmentation

Usually, stone vaporization begins from the external part of the stone to the central. There is a subtlety mainly for partial staghorn, fitted calyceal or large proximal ureteral stone. In these cases, started from the center and progressively moved to the peripheral part of the stone, and try to move as frequently as possible on the stone surface to avoid the creation of a hole. Continuously with fragmentation progression, access to the encrusted peripheral part is created. This tip has the advantage to protect the mucosal injury and minimize the risk of bleeding and loss of visibility.

Suitable laser setting is necessary, obtaining the desired effect for the appropriate situation. When dusty fragments are desired, energy of 0.3–0.8 J and frequency of 10–20 Hz are preferable. Begin with less power and modify to find the efficient adjustment, which reduce retropulsion and the creation of significant fragments. In front of a monohydrate (calcium oxalate) hardness stone, higher power is needed. Laser setting with 0.8–1.5 J and 5–10 Hz should be efficient. For tissue incision or tumor fulguration, energy of 1–1.5 J and frequency of 10–15 Hz is adequate.

Stone Removal

Removal of every significant fragment can be difficult and laborious, principally in the lower calyx. Techniques to prevent this problem is to pump with irrigation as fragments as possible outside the lower pole.

Another method for small difficult fragments to catch is to inject 5–10 ml of autologous venous blood into the appropriate calyx with calculi and wait 5–10 min. After, you can remove the blood clot with several little fragments into it.

Calyceal Diverticula Stones

This situation may be a challenging one. When suspecting a calyceal diverticulum, the neck of the diverticulum should be searched during a F-URS. The trick to find the neck of the diverticulum is a mixture injection of methylene blue or indigo carmine with contrast through the working channel of the ureteroscope into the cavities. Renal collecting system is irrigated, and localization under fluoroscopic guidance can be possible if the neck of diverticulum is patent. Moreover, methylene blue could be seen from the neck of the diverticulum and give its localization. Once identified, the neck can be incised, and stones fragmented. At the end of the procedure, when feasible, the proximal loop of the ureteral stent should be inserted into the calyceal diverticula cavity.

Take Home Message

The urologists who have an interest in endourology, especially F-URS, should be armed of patience, and be always on the lookout for the next step and the technical possibilities to assist him in troublesome situations. There is plenty of equipments and tricks in F-URS; the surgeon needs to know the existence of them and accomplish his own experience and familiarity.

Chapter 41
Technical Tips for Laser Lithotripsy

Andreas Hoznek

Abstract Laser fibers are characterized by their ability to fragment even the harder stones and also by their flexibility which allows them to reach each part of the urinary tract. Accordingly, they are presently routinely applied in different endourologic procedures: retrograde intrarenal surgery, percutaneous nephrolithotomy, ureteroscopy and bladder stones.

Keywords Laser lithotripsy • Kidney stones • Bladder stones • Percutaneous surgery • Retrograde intrarenal surgery

Introduction

Lasers have revolutionized the treatment of urinary stone disease. Laser fibers are characterized by their ability to fragment even the harder stones and also by their flexibility which allows them to reach each part of the urinary tract.

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Accordingly, they are presently routinely applied in different endourologic procedures: retrograde intrarenal surgery, percutaneous nephrolithotomy, ureteroscopy and bladder stones. But the various endoscopes employed for these different approaches have specific technical characteristics especially regarding their flexibility and the diameter of their working channel and also the amount of irrigation fluid they are able to provide. Therefore, the size of the laser fiber and laser settings differ significantly according to the surgical procedure.

Retrograde Intrarenal Surgery

Flexible ureteroscopes are miniaturized instruments with a tiny working channel of 3.6 Fr. It is quite consensual to use small 200–270 μm fibers for many reasons. First, these fibers are the most flexible and are able to reach all parts of the collecting system including lower pole of the kidney. Furthermore, they allow ensuring adequate irrigation during the whole procedure. However, their small diameter permits transmitting only low power levels up to 15 W to the stone.

Before determining optimal laser settings, a clear understanding of the interaction between laser fiber and stone is required. There are three distinct effects that happen when firing on a stone: fragmentation, stone retropulsion, and fiber tip degradation [4, 5, 9]. It has been shown, that higher energy levels produce more ablation but also more retropulsion [3]. Retropulsion occurs mainly on smaller stones that have low kinetic inertia. Retropulsion significantly reduces the efficacy of the fragmentation process, because it increases the distance of the tip of the laser fiber and the stone at the time of subsequent shots. It has also been shown, that with the same energy settings (Joule) small fibers produce the same ablation volume as bigger ones, but the crater is deeper and narrower [3]. However, bigger fibers provoke more retropulsion. On the other hand, there is more fiber tip degradation on smaller fibers [4, 5, 7].

Considering these observations, four fragmentation strategies have been proposed during a flexible ureteroscopy [2]:

- Dusting – it uses small energy associated to high frequency. Low energy permits limited fragmentation and virtually no retropulsion, increasing the frequency allows accelerating the fragmentation procedure. Depending on the laser device, the laser settings could be 0.3 J and 50 Hz, 0.5 J and 30 Hz and 0.8 J and 20 Hz. The technique of dusting consists of "painting" the stone by moving the laser fiber on its surface.
- Chipping – it is very similar, but with somewhat higher energy settings up to 1 J. The fiber is directed on the periphery of the stone and tiny fragments are detached.
- Fragmentation – it is proposed to treat harder stones which can be cut into bigger pieces allowing their removal with the help of a stone basket. This requires energy levels of 1–1.5 J associated to 15 and 10 Hz respectively.
- "Popcorn" – it helps to transform tiny fragments unsuitable for basketing into sand. The principle is to put the laser fiber into the center of the calix containing stone debris and produce a series of shockwaves with a high energy setting i.e. 1–1.5 J combined with 15 and 10 Hz respectively. The shockwaves that result provoke collisions between stone debris and lead to their transformation to sand.

Percutaneous Surgery

Percutaneous surgery underwent major innovations especially in the field of miniaturization. Miniaturized instruments have smaller working channel and require innovative fragmentation tools.

The first dedicated mini-perc kits commercially available were elaborated by Sven Lahme et al. [6], and shortly after by Udo Nagele et al. [8]. Are the principles described for flexible ureteroscopy appropriate for a usage during a mini-perc? Certainly not. First of all, small fibers of 200–270 μm would tremble in the larger working channel making the precision of lasering less precise. Furthermore, flexibility of the laser fiber is not required in a rigid nephroscope. Therefore, larger fibers of 500–1000 μm can be used for this technique.

A larger laser fiber means a bigger diameter and surface. Therefore, an additional parameter should be considered: energy density which means the amount of energy in Joules passing through a given surface. It has been shown, that an intensity of 10 J/cm^2 is required to boil water at the tip of the fiber. The difference of surface between a 200 μm fiber and a 500 μm fiber is 5.33 fold. This means, that to obtain the same effect on a 500 μm fiber compared to a 200 μm fiber the energy in Joules should be multiplied by approximately 5.

There are only a few studies concerning laser settings during a PCNL. Two randomized studies have shown, that high power laser settings with 3–3.5 J and 20 Hz are more efficient than lower energy settings in terms of operative time [1, 10]. Obviously, for such energy levels, 500–1.000 μm fibers are required. The large working channel of nephroscopes allows maintaining sufficient irrigation while preserving low intrarenal pressure.

Ureteroscopy

During a ureteroscopy, the principles are very similar to retrograde intra-renal surgery. However, semi-rigid ureteroscopes have larger working channels allowing the use of larger laser fibers such as 365 μm. When using these fibers both energy levels and frequency can be slightly increased, for example 1 J and 25 Hz at the beginning of the procedure and adaptation depending on the shock wave resistance of the stone. Retropulsion of the stone can be avoided by turning the rigid ureteroscope up-side down, thus having the laser fiber on the 12 o'clock position instead of the 6 o'clock position.

Bladder Stones

Bladder stones are treated with the largest available fiber i.e. 1000 μm. The use of a standard nephroscope mounted with its outer shaft and in and outflow valve is optimal because it offers continuous irrigation. The highest laser power levels can be used, such as 3 J and 25–30 Hz.

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Chapter 42
Tips and Tricks for Difficult Ureteral Stent Insertion

Asif Raza

Abstract Stents are widely used in urology to relieve obstruction or bypass strictures. In order to simplify stent insertion in difficult situations it is essential to have a wide range of endourological equipment available including guidewires, ureteric catheters, rigid and flexible ureteroscopes, ureteral dilatation equipment including serial and balloon dilators, baskets, ureteric access sheaths, various stent types and sizes and an image intensifier. An excellent assistant, scrub nurse and theater staff who are familiar with endourological equipment and techniques is also vital. In cases were a retrograde approach fails an antegrade approach should be attempted.

Keywords Endourology • JJ stents • Guidewires • Baskets • Image intensifier • Dilators • Ureteroscopy • Hydronephrosis

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Introduction

Stents are used to relieve collecting system obstruction secondary to benign or malignant causes. Stents can also be used for prostatic obstruction or urethral stricture disease.

Stents are usually placed intracorporeally although can be used extra anatomically when the obstruction is impassable by a standard stent. Routine stent insertion is usually performed retrogradely under general or spinal anesthesia. When a patient is not fit for this a stent may be inserted under local anesthesia with a flexible cystoscope.

Stents are inserted under fluoroscopy however when radiation exposure is contraindicated e.g. pregnant female, a stent may be inserted retrogradely or antegradely with ultrasound guidance.

Routine stent insertion is performed in standard lithotomy position. A rigid cystoscope is inserted into the bladder and ureteric orifice identified. A standard guidewire (0.035 or 0.038 inches) is inserted through the ureteric orifice under direct vision and fluoroscopy used to confirm its correct placement.

A 5/6 Fr ureteric catheter is passed over the guidewire just beyond the vesicoureteral junction. The guidewire then is removed and a retrograde performed with a 50/50 mix of contrast and saline.

Stent insertion without a retrograde should be avoided, as occasionally a guidewire may appear to be in the collecting system but be in a tortuous dilated ureter rather than in the kidney (Fig. 42.1).

After the retrograde a guidewire should be inserted through the ureteric catheter into the collecting system and the ureteric catheter exchanged with a stent. A stent inserted with a string (tether) that is left outside the patient can be removed without a further cystoscopy [1].

Difficult Stent Insertion

Vesicoureteric Junction (VUJ)

A tight VUJ may be due to a stenosis or impacted stone. If a standard guidewire will not pass beyond this a sensor wire (Boston Scientific) with a nitinol hydrophilic end or a hydrophilic guidewire (Terumo) can be used. Occasionally the stenosis needs to be dilated to allow access. This can be performed with a 6/7 Fr semi-rigid ureteroscope over a guidewire, a balloon dilator (Uromax, Boston Scientific) or with serial ureteric dilators.

Balloon dilators come in varying lengths. A 4 cm balloon should be used for the VUJ. The maximal balloon inflation

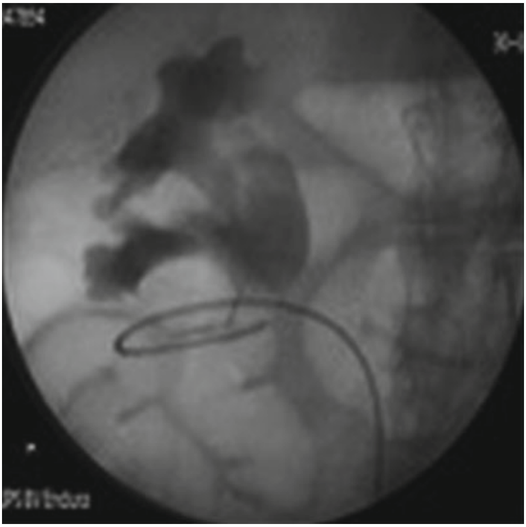

FIGURE 42.1 Insertion of ureteric catheter and retrograde in tortuous ureter – guidewire removed to allow retrograde study

pressure should not be exceeded. Dilatation is best performed over a super stiff guidewire. After wire insertion a JJ stent is passed. The VUJ may also be incised with a laser, Collins knife, bugbee electrode or occasionally resected if necessary to gain access. Dilatation is contraindicated in the septic patient with an obstructed system. An urgent nephrostomy with an interval antegrade/retrograde stent should be considered.

If the VUJ is still impassable the procedure should be abandoned and an antegrade approach used (Fig. 42.2). If the guidewire passes through the VUJ but not past the obstruction in the distal ureter I pass a short 6/7 Fr semi-rigid ureteroscope over the wire to the stone and fragment this with a holmium laser. This creates space for the wire to be placed beyond the stone and aid subsequent JJ stent insertion. The size and length of JJ stent to be inserted is dependent on the diameter of the stricture/stenosis that has been dilated and the length of the ureter [3, 6].

The Tortuous Ureter

A tortuous ureter, demonstrated on retrograde, can make guidewire and subsequent stent insertion difficult. A standard 6 Fr ureteric catheter with/without a curved/floppy tip can be used to try and straighten the ureter and navigate the wire around the bend. A hydrophilic tipped wire (Sensor) or hydrophilic wire (Terumo) straight/curved is best in this situation. If this does not pass, an 8/10 Fr coaxial dilator (over a wire) can be used. The stiffness of this often allows the ureter to be straightened. This can be advanced to the renal pelvis and the inner sheath removed and the JJ stent inserted through the outer 10 Fr sheath. If this fails a flexible or rigid ureteroscope can be passed over a wire to the point of curvature (Fig. 42.3). The guide wire is always advanced ahead of the scope under direct vision.

Another described technique involves inserting a small (7 Fr) occlusion balloon tip catheter under direct vision to the point of curvature and inflating this and pulling the balloon distally to straighten the ureter [2].

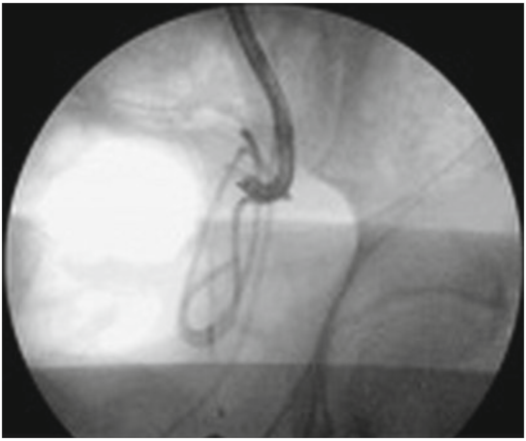

FIGURE 42.2 Antegrade removal of a stent, stenotic VUJ secondary to previous ureterolithotomy

FIGURE 42.3 Insertion of a rigid ureteroscope up tortuous ureter to help guidewire and stent insertion

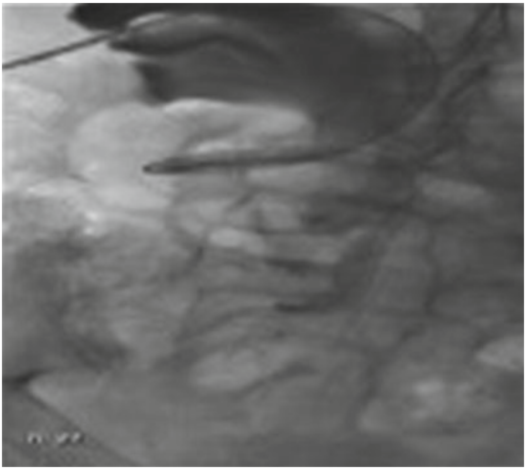

FIGURE 42.4 Antegrade guidewire insertion in tortuous ureter after failed attempt at retrograde

Once a ureteric catheter is advanced into the kidney over a hydrophilic wire, the wire should be replaced with a stiffer teflon-coated wire before the ureteric catheter is removed. If these methods fail an antegrade approach will be necessary (Fig. 42.4).

The Duplex Ureter/TUU

On occasion it may be difficult to insert a guidewire and subsequent stent into the affected moiety of 2 ureters that join before entering the bladder. An ureteroscope can be passed to the junction of the 2 ureters and the guidewire inserted under direct vision into the affected moiety. The position of the wire can be confirmed with a retrograde through the ureteroscope. If it is difficult to enter the affected moiety because the guidewire preferentially enters the other moiety or the angle to the affected moiety is too acute a ureteric catheter inserted into the unaffected moiety can prevent the entry of the second guidewire into this space again. A similar technique

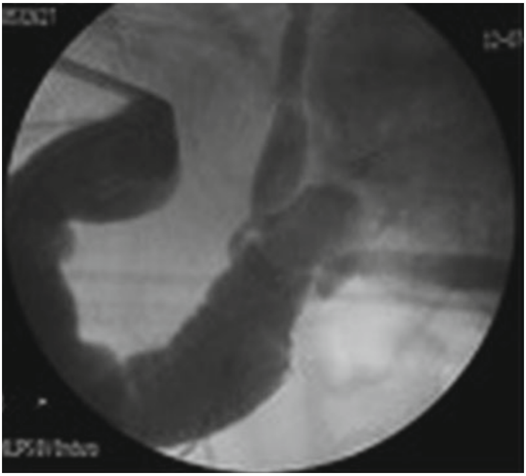

FIGURE 42.5 Ileal conduit with Bricker anastomosis

can be tried with a trans uretero–ureterostomy. If it is not possible to stent the obstructed moiety an antegrade approach may be necessary.

Reimplanted Ureter or Ileal Conduit (Bricker)/Wallace Anastomosis/Congenital Anomaly/Transplant Kidney

An ileal conduit may be formed using a Bricker technique (Fig. 42.5) (2 ureters joined separately) or Wallace (2 ureters joined together to the ileal loop) with a refluxing or non–refluxing anastomosis.

Retrograde stenting will require the use of a flexible cystoscope inserted into the conduit (Fig. 42.6). Methylene blue/indigo carmine can be given intravenously to identify the ureteric orifices prior to guidewire insertion. A ureteric catheter (straight or curved tip) can be inserted through the flexible cystoscope to help direct the guidewire into the reimplanted ureter. A stent is inserted over the wire. The length

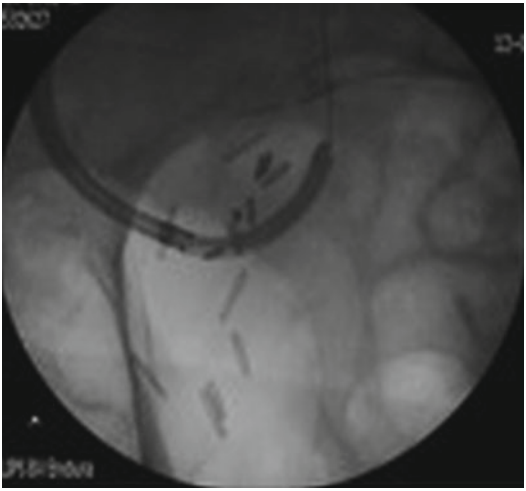

FIGURE 42.6 Ileal conduit with flexible cystoscope with retrograde guidewire insertion into collecting system

of the stent may need to be longer in the left ureter due to its longer length in a right-sided conduit. Occasionally a flexible ureteroscope may be used to identify the ureteric orifices.

If the re-implanted ureters cannot be entered retrogradely an antegrade approach will be required. Similar principles apply to the re-implanted ureter or transplant kidney.

Dealing with a Stent Where Distal End Positioned in Ureter

Occasionally the distal end of a stent may be pushed completely into the ureter. If the VUJ is accessible an ureteroscope is inserted into the ureter and a 3 pronged or steel wire basket is used to grasp the end of the stent and reposition this in the bladder. Others have used a partially deflated ureteric balloon placed alongside the stent to bring the distal end back into the ureter [4].

Stenting in Children

Stenting in children may be more difficult due to the size of the ureter and ureteric orifice however VUJ dilatation or stenting is not always necessary post ureteroscopy. A small diameter, short adult ureteroscope (6 Fr) can be used in most children [8]. Pediatric stents are available and the appropriate length can be selected according to the child's age [7]. In cases of proximal placement of a stent in the ureter the stent may be removed with an Amplatz goose neck snare [5].

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Chapter 43
Tips to Puncture the Kidney Using the Triangular Technique

Andreas Skolarikos and Athanasios Dellis

Abstract We describe our triangular technique of kidney puncture, in percutaneous nephrolithotomy (PCNL). In particular, we emphasize a step-by-step description of the procedure, based mainly on personal experience, so it can be used in difficult pelvicalyceal anatomic variations and stones.

Keywords Percutaneous nephrolithotomy • Stone disease • Triangular technique

Introduction

Ideally, the best approach to the kidney is achieved by a transpapillary puncture with direct access to the renal pelvis. It is of utmost importance to identify the ideal target calyx

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preoperatively as well as to obtain a three-dimensional knowledge of the kidney anatomy and stone extension.

The principle steps of percutaneous nephrolithotomy (PCNL) are primarily the puncture of the calyx, followed by the tract dilation, the stone fragmentation and the proper pelvicalyceal system drainage.

Herein, we present our step-by-step triangular technique of kidney puncture during PCNL in prone position [1–5].

Technique

Along with anesthesia induction, a single dose of a second generation cephalosporin is administered intravenously. After careful rigid cystoscope introduction, with the patient in a lithotomy position, the ipsilateral ureter is catheterized with a 0.035 inch PTFE guide wire over which an angiographic (open-ended) catheter is advanced into the renal pelvis or at about one cm above the obstructing stone and contrast medium is injected under fluoroscopic guidance. Once imaging of pelvicalyceal system is performed, opacification of the collecting system renders the collecting system visible and helps to identify its accurate distribution, while it slightly distends it. The non-ionic contrast medium used is diluted at 1:2–1:3 ratio in normal saline. After cystoscope removal a 16 F bladder catheter is placed. The angiographic catheter is fixed with the catheter for contrast administration to the next step.

Alternatively, in case of use of flexible cystoscopy, the patient can be placed from the beginning of procedure in prone position and a prone flexible cystoscopy be performed. The benefits of prone flexible cystoscopy include avoiding a second patient transfer, reducing the likelihood of accidental ureteric catheter dislodgement, and less risk to the airway, while care should be taken in order to avoid introducing air into the bladder during cystoscopy, as identifying the ureteric orifices might become difficult.

After the aforementioned procedure, the patient is placed in prone position carefully in order to avoid face or extremities pressure. Legs are bended at the hip-level in order to achieve a sufficient interval between the 12th rib and iliac crest (if a lower calyx is to be punctured). Pronounced bends must be avoided and attention must be paid to secure and properly cover the patient and his extremities. Patient's flank is properly cleaned with antiseptics and a disposable drape with fluid collection pouch is applied.

Although in many institutions the kidney access is performed by interventional radiologist, requiring transferring the patient to the operating room at a second stage, in our institution kidney puncture is performed solely by urologists, thus PCNL is carried out as a single stage procedure. Along with that, access-related complications were fewer and stone-free rates improved when the urologist made the percutaneous access.

Tips

- The target calyx choice is made using the preoperative imaging and intraoperative retrograde urography.
- The puncture is performed always through the fornix of a posterior calyx, posterolaterally, along the imaginary line of Brodel.
- Never puncture through a calyceal infundibulum – risk of renal bleeding.

Remember

- In order to avoid injury of adjacent organs puncture should remain medially to the posterior axillary line. More laterally than this line increases colonic injury rates. If colon interposition is respected, an ultrasound exam should be performed.

- Avoid puncture through paraspinal muscles (too medially), in order to avoid posterior segmental artery damage.
- The choice of puncture level in relation with ribs depends on the anatomy of the patient, the location of the stone and the experience of the surgeon.
- The aim of surgery is to remove the whole stone load; therefore the urologist should know and be able to perform infra-costal, supra-costal and trans-costal access.

Landmarks

To access the upper calyx puncture should be performed between 11th and 12th rib adjacent to paraspinal muscles and far from the lower rim of 11th rib, in order to avoid subcostal vessels injury or traversing the pleural space. The medial half of the 12th rib and medial three-quarters of the 11th rib provide attachment to the pleura. The puncture is preferably performed in end-expiration to avoid pleural and lung damage although kidneys are in a higher position. To access the lower calyx the puncture site is usually 1 centimeter (cm) lower and 1 cm inwards from the 12th rib tip (Fig. 43.1).

Under fluoroscopy guidance the puncture needle is placed on the skin along and in alignment with the target calyx axis. Immediately *we set the first level of kidney access (coronal)*. Furthermore, aligning the access line with the infundibulum also allows the most efficient use of a rigid nephroscope and decreases the need for excessive torque on the rigid instruments, which may cause renal trauma and bleeding. The puncture line orientation towards the target calyx is easily performed simply by moving the fluoroscopy unit. The (continuous or in only two positions with increasing experience of the surgeon) change of the fluoroscopy unit position from the vertical to the lateral level gives in a two-dimensional image the correct position of the puncture needle towards the target calyx (Fig. 43.2).

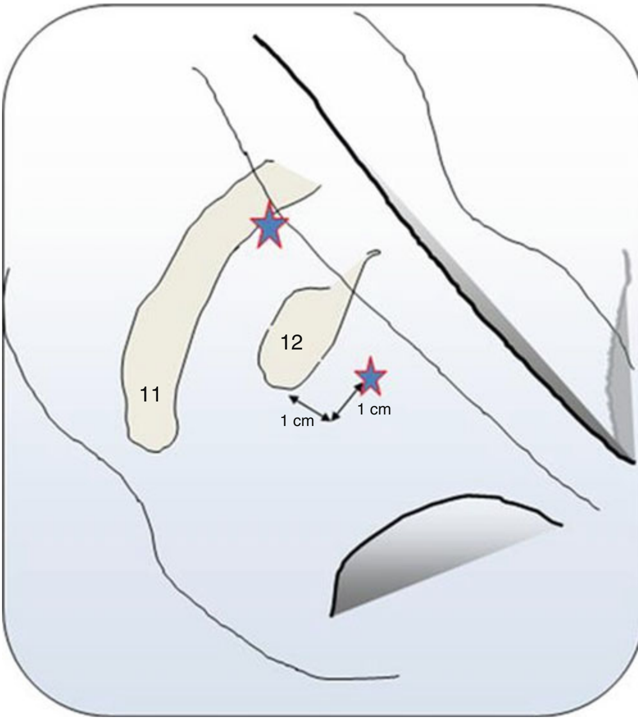

FIGURE 43.1 Lower calyx puncture site is approximately 1 cm lower and 1 cm inwards from the 12th rib tip

- **Tip**: The ideal puncture plane is determined between the long calyceal axis and its perpendicular projection, while it is a direct, straight path to the renal pelvis as well the least traumatic.

With fluoroscopy unit placed vertical (sagittal plane or parallel to the puncture line) the movement of the needle is adapting our inward-outward direction, i.e. moving left–right. *We define in this way the second level of puncture (transverse)* (Fig. 43.3).

Needle axis and calyceal axis should carefully maintain a constant relationship. With fluoroscopy unit in a lateral position (30° towards the surgeon–side to the line of puncture)

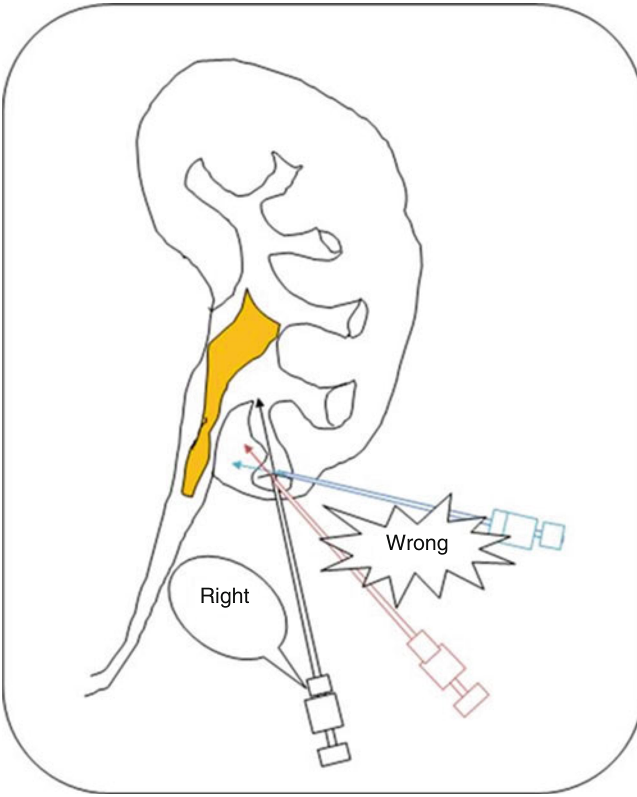

FIGURE 43.2 Alignment of puncture needle with the long calyceal axis and its perpendicular projection

the movement of the needle fits in our cranial–caudal axis that moves up and down. *We define in this way the third level of puncture (sagittal)* (Fig. 43.4).

If the needle-tip is below the target stone, then axis of the puncture should become more acute (deeper) while if the needle tip is above the target stone, then the axis of the puncture must become more obtuse (more superficial). This position of the fluoroscopy unit determines the depth of the calyx and the puncture should be performed.

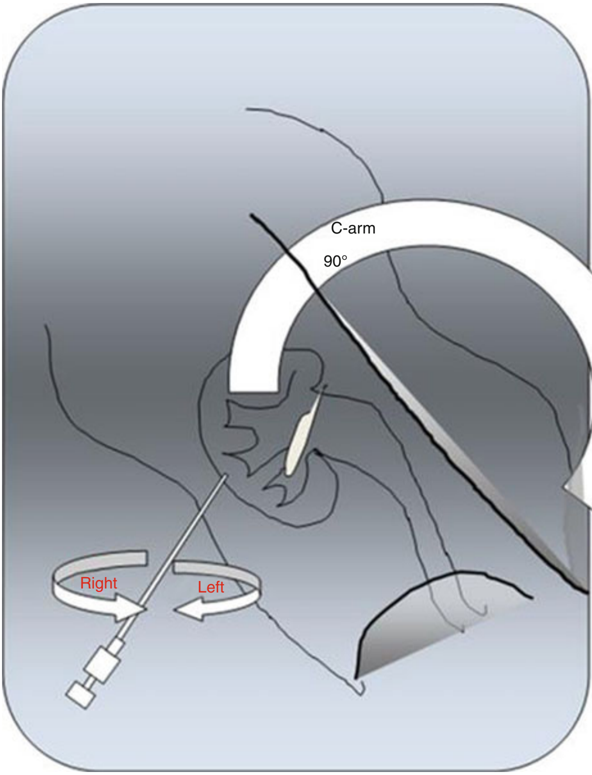

FIGURE 43.3 Fluoroscopy unit placed vertical. Needle movement is adapting our inward -outward direction, i.e. moving left–right

- **Tip**: Rotating the fluoroscopy unit away from the surgeon the posterior calyx seems to lengthen, while an anterior calyx seems to shorten and vice versa. Air injecting in the collecting system, results in occupying the posterior calyx with the patient in a prone position.

The needle is advanced with a step of 1–2 cm and the puncture depth is determined by turning the fluoroscopy unit in sagittal axis (vertical) or by turning 10° from the middle line away from the surgeon (Fig. 43.5).

FIGURE 43.4 Fluoroscopy unit placed lateral (30° towards the surgeon – side to the line of puncture). Needle movement fits in our cranial – caudal axis, i.e. moving up – down

With the aforementioned technique access is achieved at the junction of all three levels (triangular technique) and given it involves an oblique puncture "Bull's eye" cannot be seen. The right access is confirmed by urine or irrigation fluid flow through the needle. A hydrophilic guide wire is passed through the needle and slips into the ureter and urinary bladder. If the guide wire cannot be advanced

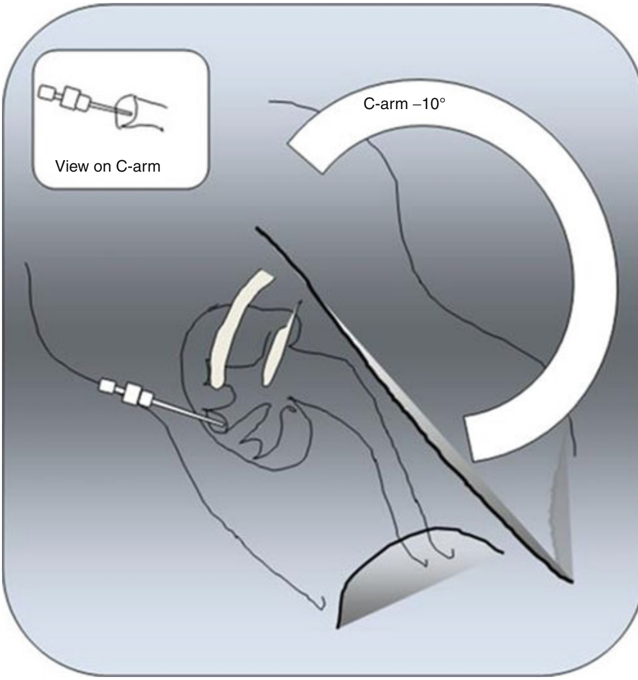

FIGURE 43.5 The puncture depth is determined by turning the fluoroscopy unit in sagittal axis (*vertical*) or by turning 10° from the middle line away from the surgeon

properly, an angiographic Cobra-catheter is used. Its rotation within the renal pelvis and the simultaneous guide wire advancement enables the correct position of the latter within the bladder in most cases. If, however, guide wire advancement is impossible, it could be left in the pelvicalyceal system. A 10Fr dual lumen catheter is placed over the guide wire in the pelvicalyceal system or the proximal ureter. A second guide wire (a PTFE or even better a combined PTFE with hydrophilic end) is advanced. In accordance to the aforementioned, the second guide wire is better placed within the bladder. The objective of nephrostomy-tract dilation is to place a plastic 24–30 Fr sheath (smaller diameter in children) in the pelvicalyceal system of the adult, through which the 22–26 Fr nephroscope can be introduced.

Conclusions

The “triangular technique” for kidney puncture in PCNL is safe and efficient in experienced hands with minimal risks when performed properly. Urologist directed access ensures a single stage approach, with less complication and improved stone-free rates.

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Chapter 44
Tips for Puncturing the Kidney Using the "Bull's Eye" Technique

Stilianos Giannakopoulos

Abstract Percutaneous nephrolithotomy (PCNL) is a widely used surgical procedure for the treatment of renal stones. Generally, PCNL is a demanding procedure with a steep learning curve. The most crucial and difficult step of the operation is usually the initial access to the collecting system. In this chapter, the so-called "Bull's eye" technique is described in detail. This is a fluoroscopy-guided technique, and once mastered, it provides consistently accurate access to the collecting system.

The C-arm is rotated 20–30° towards the surgeon. Using a needle holder, the tip of the instrument is projected over the desired calyx, and the entry site at the skin level is marked. The needle is held with the needle holder and should be positioned perpendicular over the selected calyx. Ideally, at this point, the needle should be observed on the screen as a dot in the center of a "circle". The "circle" is the calyx observed end-on. The needle is advanced for several

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centimeters until it is stabilized at its trajectory. The C-arm is now rotated 10–15° away from the surgeon. This provides an oblique view that helps the surgeon to appreciate the depth. The needle is then advanced a few more centimeters until its tip lies within the calyx.

Keywords Percutaneous nephrolithotomy • Renal access • Fluoroscopy • Bull's eye technique • Percutaneous surgery

Introduction

Percutaneous nephrolithotomy (PCNL) is a widely used surgical procedure for the treatment of renal stones. The most recent edition of the European Association of Urology (EAU) guidelines on urolithiasis recommends PCNL as the first-line treatment for kidney stones measuring more than 2 cm [7]. Generally, PCNL is a demanding procedure with a steep learning curve. The most crucial and difficult step of the operation is usually the initial access to the collecting system. Access can be achieved under fluoroscopic or ultrasonic guidance depending on the surgeon's preference, experience and training or/and on specific clinical circumstances.

However, one should bear in mind that independent of the access technique, a successful PCNL procedure depends on accurately selecting the most suitable calyx for treatment of the particular stone. Therefore, careful preoperative assessment of the available imaging studies is crucial for the best possible outcome. An initial plan for access that includes selecting the most appropriate calyx, is advisable, but a back-up access plan should also be devised if the clinical situation changes intraoperatively.

In this chapter, the so-called "Bull's eye" technique will be described in detail. This is a fluoroscopy-guided technique, and once mastered, it provides consistently accurate access to the collecting system.

Radiological and Surgical Anatomy

Before attempting percutaneous access to the kidney, the surgeon should be familiar with some basic anatomical information. Figure 44.1 demonstrates a cross-sectional view of the kidney at the interpolar region. Typically, at this level of the kidney, the posterior calyces form a 30° angle with the vertical axis of the body. Of course, there is great variation, but this general rule applies in the vast majority of the collecting systems. For insertion of a needle in a posterior calyx through the renal papilla, the needle and the calyx must be aligned. This can only be achieved if the needle is placed at a 30° angle with the vertical axis with its tip exactly over the desired calyx. The same rule applies for upper and lower pole calyces, although in these regions, there are no true anterior and posterior calyces. Rather, the calyces at the upper and

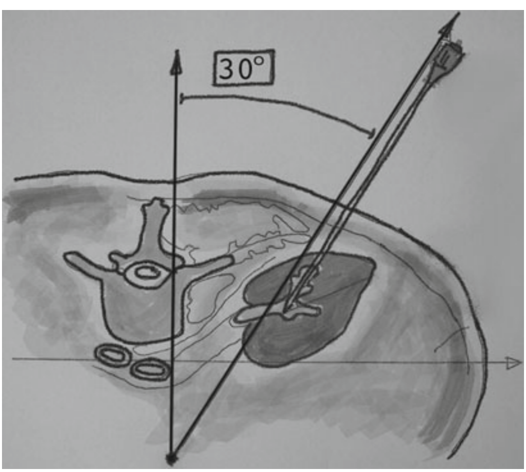

FIGURE 44.1 Cross sectional view of the kidney at the interpolar region. Typically, a posterior calyx forms a 30° angle with the vertical axis. This angle should be considered when the needle is inserted. By doing so, the needle is inserted through the respective papilla, and its trajectory is aligned with the infundibulum

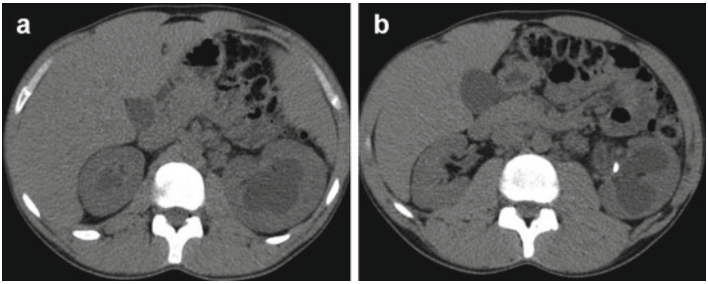

Figure 44.2 Computerized tomographic images of the kidney in a patient with hydronephrosis. (**a**) At the level of the upper pole, the calyx is situated medially. There is no true anterior or posterior major calyx, although some minor calyces may face anteriorly or posteriorly. (**b**) At the level of the interpolar region, posterior and anterior calyces are clearly distinguishable

lower pole of the kidney are more or less medially situated, although some minor calyces may face anteriorly or posteriorly (Fig. 44.2).

Intraoperatively, when a C-arm is used, the best way to identify the posterior calyces of the kidney is by noting their movements on the screen while performing rotational movements of the C-arm. With the patient in the prone position, when the C-arm is rotated towards the surgeon, posterior calyces move medially on the screen while anterior calyces move laterally. On the contrary, when the C-arm is rotated away from the surgeon, the posterior calyces move laterally and the anterior calyces move medially. Again, one should bear in mind that very rarely this rule does not apply, depending on the position of the kidney and the presence of malrotation. The anatomy may be even more confusing in cases of ectopic and anomalous kidneys.

Finally, extreme caution is necessary regarding the neighboring organs especially when only fluoroscopy is used to guide access. At the level of the upper pole, the liver and spleen might cover part of the posterior renal surface on the right and left sides, respectively. As we descend, the liver and spleen move laterally, leaving more space for safe access. The pleura typically descends medially at the level of the origin of the 12th rib and then runs horizontally occupying the medial half of the 11th intercostal space. The lateral half of the 11th intercostal space is usually a safe place to puncture in most, but not all, patients. How can we put these guidelines to good use? When a supra 12th intercostal space access is attempted, the needle should be placed at the lateral half of the 11th intercostal space to minimize the risk of pleural injury but should be kept medially to the posterior axillary line to minimize the risk of liver or splenic injury. Occasionally, a retrorenal colon might be encountered. In one study, a retrorenal position of the colon was observed in 4.7 % in the prone position on abdominal computerized tomography (CT) [5], but is more frequent in patients with advanced age, ectopic and anomalous kidneys and chronic bowel distension (e.g., paraplegic patients) [2]. However, if the surgeon stays medial to the posterior axillary line, a colonic injury is unlikely under normal clinical conditions.

The author strongly recommends the availability of preoperative CT imaging of the abdomen. This exam is valuable not only for evaluating the stone configuration and the stone burden, but also for appreciating the anatomic relation of the kidney to the surrounding organs. Therefore, a better access plan can be devised, which minimizes the risk of liver, splenic and colonic injury.

Placement of a Ureteral Catheter

Placement of a ureteral catheter, cystoscopically, at the outset of the procedure is most helpful. The ureteral catheter is used for contrast medium injection and opacification of the collecting system. Additionally, by injecting contrast, an artificial hydronephrosis is created, which makes subsequent puncture much easier [6]. The author typically uses a 6Fr open end ureteral catheter. A ureteral catheter with an occlusion balloon can also be used, but it is not necessary. Although this is an easy step of the procedure, the ureteral catheter should be inserted carefully. The tip of the catheter is placed at the ureteral orifice.

A retrograde study can be performed at this point. Then, a 0.035 in. guidewire is inserted in the ureter, and its tip is coiled at the renal collecting system. The ureteral catheter is then placed over the wire in a railroad fashion under cystoscopic and fluoroscopic guidance. This is the safest way to place the ureteral catheter and avoid injury to or, even worse, perforation of the ureter. The tip of the catheter is placed at the upper calyx to provide extra length. Then, its position can be adjusted after the patient is placed in the final position for percutaneous access.

Injection of Contrast Medium

Injection of contrast allows for opacification of the collecting system. Although this can also be achieved by intravenous injection, direct injection through the ureteral catheter is more versatile and as mentioned before, distends the collecting system. Contrast diluted 50:50 with normal saline should be used. If the contrast is not diluted, the guidewire and the other instruments during access cannot be observed easily on the fluoroscopy images. Contrast should be injected very carefully to avoid excessive pressure, which might cause contrast extravasation outside the collecting system. Should this occur, serious difficulties might be encountered during percutaneous access. For example, the fluoroscopic view will be obscured, and the procedure may need to be abandoned and rescheduled several days later. Rather than using gravity-based systems, the author prefers careful manual injection through a syringe with careful monitoring of the process using the C-arm. Although some surgeons use methylene blue mixed with contrast, the author does not see any significant advantage of this.

Percutaneous Access

The author typically performs PCNL with the patient in the prone position. Therefore, the description of the surgical steps refers to the prone position. Nevertheless, the basic principles of this access technique are also applicable for supine PCNL. The only difference is the movements of the C-arm, which are exactly the opposite of those described for prone PCNL.

1. Identify the posterior calyces. This is most effectively achieved using rotational movements of the C-arm. Typically, when the C-arm image intensifier is rotated towards the surgeon, the posterior calyces move medially on the screen and are observed end-on, while the anterior calyces move laterally. When the C-arm is rotated away from the surgeon, the posterior calyces move laterally and the anterior calyces move medially. If the posterior calyces cannot be identified, injection of a few cc of air is helpful. The air accumulates in the posterior calyces aiding in their identification (Fig. 44.3). Although theoretically there is a small risk of air embolism, this should be considered an extremely rare event, which the author has never witnessed.
2. Select the appropriate calyx for puncture. This must have been already performed during the preoperative review of the imaging studies, but quite often, the initial plan needs to be changed for several reasons. For example, the initially selected calyx might project above the ribs, necessitating a supracostal puncture. If the surgeon wishes to stay subcostally, obviously another calyx must be selected. Many surgeons prefer to access the kidney through the lower pole only, but this strategy is not ideal for every case.
3. Rotate the C-arm 20–30° towards the surgeon. Using a needle holder, project the tip of the instrument over the desired calyx. Mark the entry site at the skin level by firmly pressing the tip of the needle holder against the skin. Then, make a small skin incision using a No. 11 blade.
4. Hold the needle with the needle holder to avoid irradiating your hand. The needle must form a 30° angle with the vertical axis and should be placed perpendicularly over the selected calyx. The C-arm image intensifier, the needle and the concave part of the calyx should be aligned. Ideally, at this point, the needle is observed on the screen as a dot at

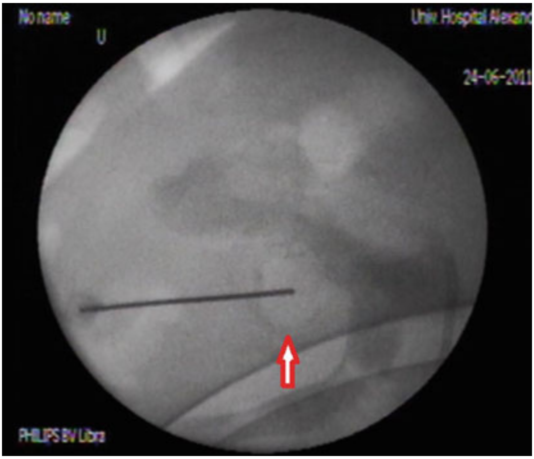

FIGURE 44.3 Distortion of the collecting system anatomy due to a parapelvic cyst. Air has been injected through the ureteral catheter. The air accumulates in the posterior calyces aiding in their identification. The needle has been inserted in a posterior calyx (*arrow*)

the center of a "circle". The "circle" is the calyx observed end-on (Fig. 44.4a, b). This perfect alignment cannot be achieved at all times and is not absolutely necessary, but the surgeon should at least try to keep the tip of the needle within the borders of the "circle".

5. Advance the needle several centimeters, depending on the body habitus, until the needle is stabilized at its trajectory and the tip remains in the center of the "circle" even if the needle holder is removed.
6. The C-arm is now rotated 10–15° away from the surgeon. This provides an oblique view that helps the surgeon appreciate the depth. At this point, an oblique view of the posterior calyx with almost the entire length of the needle is observed on the screen (Fig. 44.4c, d). Advance the needle a few more centimeters until its tip lies within the calyx. Occasionally, the needle might need to be withdrawn for a few centimeters if it is advanced too far during the previous step.

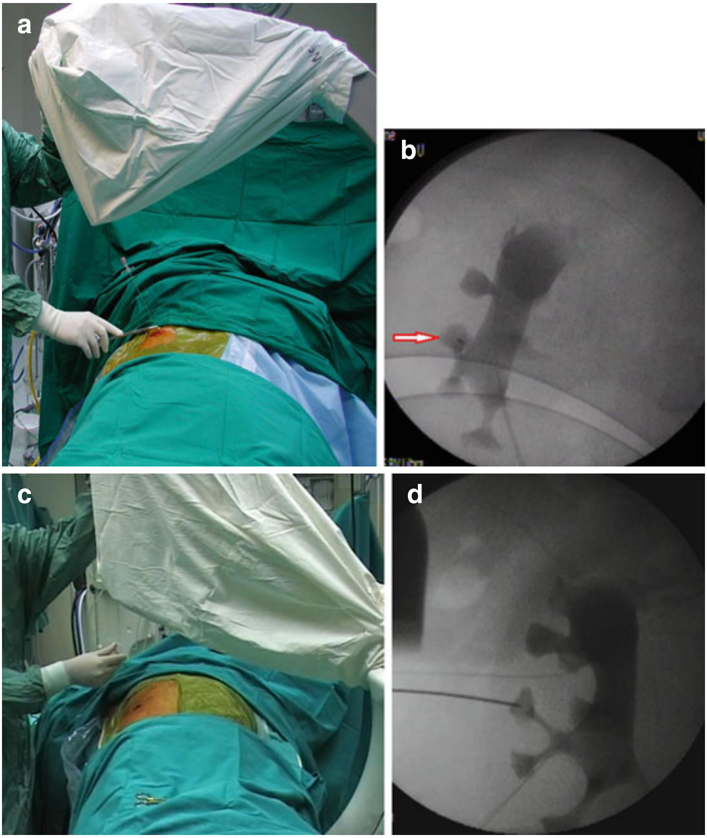

FIGURE 44.4 The "Bull's eye" technique. (**a**, **b**) The C-arm is rotated 20–30° towards the surgeon. The C-arm image intensifier, the needle and the fornix of the intended calyx are now aligned. Ideally, at this point, the needle is observed on the screen as a dot at the center of a "circle" (*arrow*). The "circle" is the calyx observed end-on. The needle is advanced with a needle holder for several centimeters. (**c**, **d**) The C-arm is now rotated 10–15° away from the surgeon. This provides an oblique view that helps the appreciation of the depth. At this point, an oblique view of the posterior calyx with almost the entire length of the needle is observed on the screen. The needle is advanced for a few more centimeters until its tip lies within the calyx

7. Remove the inner part of the needle, leaving the outer sheath in place. Normally, one should observe extrusion of urine. Sometimes, the surgeon may have to aspirate with a syringe because a small clot or debris obstructs the needle.
8. Place the guidewire. The author prefers a 0.038 in. stiff type Terumo Glidewire (Terumo Corporation, Tokyo, Japan). This guidewire can be very easily advanced down the ureter in the majority of cases. Placing the guidewire down the ureter with its distal tip coiled in the bladder is very advantageous for several reasons. The subsequent dilatation is much safer by reducing the risk of perforation of the collecting system. The kidney moves slightly downwards and is stabilized, which facilitates the dilatation. Finally, one can easily place a pig-tail stent at the end of the procedure if needed. If the guidewire cannot be advanced all the way to the bladder, one can use an angiographic catheter to manipulate it towards the ureteropelvic junction. The author has found the JB1 5 Fr, Imager™ II, angiographic catheter (Boston Scientific Corporation, Natick, MA, USA) to be most helpful for this purpose. A second guidewire can be inserted at this stage using an 8/10 Fr coaxial dilator system. However, many experienced surgeons do not routinely place a second guidewire.
9. The final dilatation can be performed using Alken metal dilators, Amplatz plastic dilators or a balloon dilator [1]. The author favors Amplatz plastic dilators using the two or three shot technique. An Amplatz sheath is placed and nephroscopy can be started.

Avoiding Supracostal Access

One of the problems encountered with the “Bull’s eye” technique is the frequent need for supracostal access. This occurs because the upper and middle calyces quite often project above the 12th rib. Occasionally, even the lower calyces project above the 12th rib in patients in the prone position.

Therefore, if one tries to stay perpendicular over the desired calyx, the access becomes supracostal. This can be avoided in many cases using the following steps.

1. Rotate the C-arm 20–30° towards the surgeon. Using a needle holder, project the tip of the instrument over the desired calyx. If the entry site at the skin level is above the 12th rib, move the tip of the instrument caudally (towards patient's feet) in a vertical line until the tip lies under the 12th rib.
2. Rotate the C-arm 10–20° along the cephalocaudal axis (the 20–30° tilt towards the surgeon is kept as is) until the tip of the needle holder projects over the center of the selected calyx. The anesthesiologist can help by keeping the lungs fully inflated. This will cause the kidney to descend a few more centimeters. The remaining steps are identical to those previously described, but there is now a 10–20° cephalocaudal angle of the needle in addition to the 20–30° lateral angle. This maneuver will result in an angular access to the kidney. However, this should not be a problem in non-operated kidneys that are sufficiently mobile to descend during dilatation and nephroscopy. In previously operated kidneys, which are usually fixed in position, supracostal access might be preferable.

Avoiding Contrast Injection

In certain cases, the stone is conveniently located in a posterior calyx. If this becomes clearly evident, for example, in a non-contrast CT, then the surgeon can use the stone as a target for puncture. The technique is exactly the same except that the needle will be directed towards the stone itself. Usually, when the tip of the needle reaches the stone, there is tactile feedback. If this technique is used, a ureteral catheter is not necessary, and the total operating time can be reduced. However, the surgeon should carefully review the imaging films preoperatively. If the target stone is the only stone, this access will work without problems. However, if

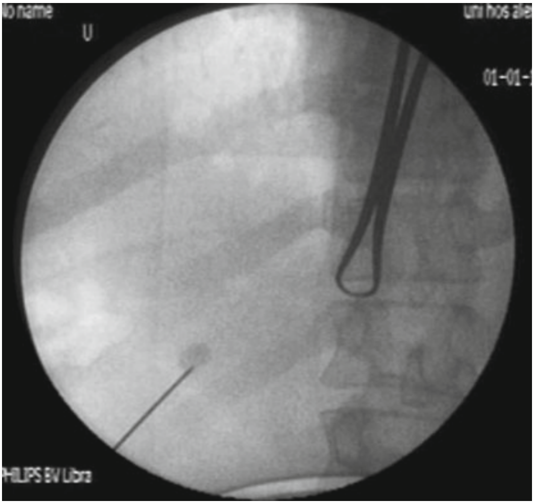

FIGURE 44.5 The "Bull's eye" technique, using the stone within a posterior calyceal diverticulum as the target for access. Fluoroscopic image providing an oblique view of the puncture. The tip of the needle is in contact with the stone

there are more stones in the kidney, the surgeon should ensure that the access through the stone-bearing calyx is suitable for treating the rest of the stone burden. Otherwise, a different strategy should be employed. An excellent application of this technique, is percutaneous access for the treatment of stone(s) within a posteriorly located calyceal diverticulum (Fig. 44.5).

Salvage Technique in the Case of Contrast Extravasation

Very rarely, contrast extravasation may occur, obscuring the fluoroscopic view and making fluoroscopic access impossible. This is usually caused by excessive pressure during contrast injection or after several failed puncture attempts. Should this occur, even ultrasound guidance will not help because there is

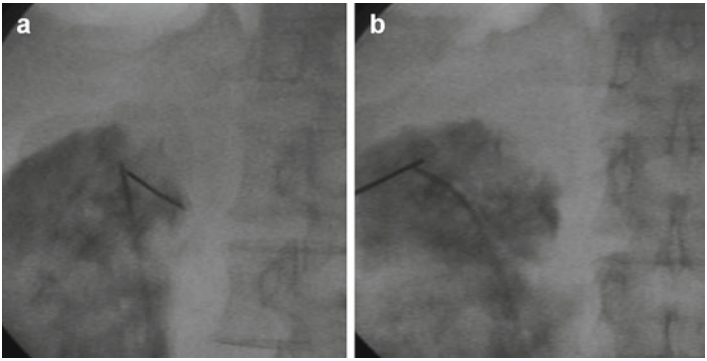

FIGURE 44.6 Salvage technique in the case of contrast extravasation. (**a**) The C-arm is rotated 20–30° towards the surgeon. The needle is directed perpendicularly into the tip of the catheter. (**b**) The C-arm is rotated away from the surgeon, and the depth of puncture is monitored. The needle is advanced until its tip is in contact with the catheter

no dilatation of the collecting system due to the contrast extravasation. In these cases, either the procedure should be terminated or a salvage technique should be used [3].

1. Using a guidewire, the open-end ureteral catheter is exchanged for an angled tip angiographic catheter. A JB1 5Fr, Imager™ II, angiographic catheter (Boston Scientific Corporation, Natick, MA, USA) is suitable. Its radiopaque tip can be observed fluoroscopically despite contrast extravasation.
2. With the aid of a guidewire, the tip of the catheter is placed in a posterior calyx, usually of the middle or upper calyceal group. If the catheter is correctly placed -in a posterior calyx or in the upper calyx-, when the image intensifier is rotated towards the surgeon, the angled tip of the catheter moves medially on the screen and is observed end-on.
3. The "Bull's eye" technique is employed using the tip of the catheter as the target for puncture (Fig. 44.6). The tip of the catheter also serves as a guiding point for the final dilatation because it indicates the calyx.

4. Alternatively, a flexible ureteroscope can be inserted and used as a guide for puncture using the same principles [4].

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Chapter 45
Tips to Puncture the Kidney Using Ultrasound

Thomas Knoll, Jan Peter Jessen, Patrick Honeck, Gunnar Wendt-Nordahl, and Peter Alken

Abstract The crucial step of percutaneous nephrolithotmy is proper establishment of the percutaneous tract. If appropriately done, optimal efficacy with low complication rate can be achieved. The ideal approach to the kidney is achieved by a transpapillary puncture with direct access to the renal pelvis. To achieve an ideal access with low complication rate, the combination of fluoroscopy and ultrasound is optimal.

Keywords Urolithiasis • Renal access • Percutaneous nephrolithotomy

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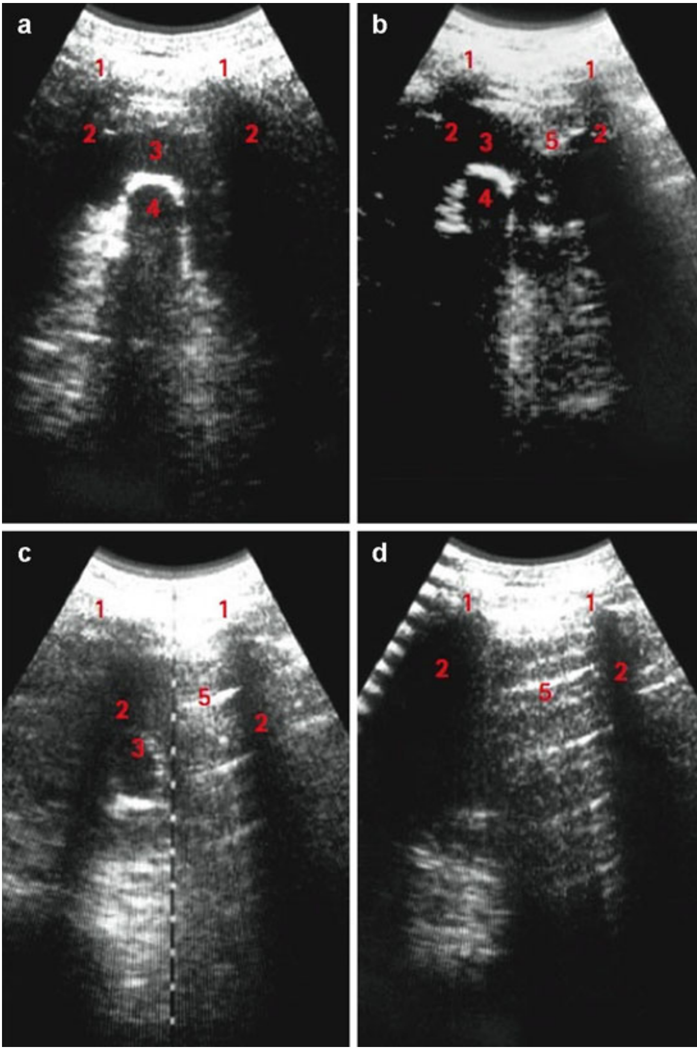
Introduction

The crucial step of percutaneous nephrolithotmy is proper establishment of the percutaneous tract. If appropriately done, optimal efficacy with low complication rate can be achieved. The ideal approach to the kidney is achieved by a transpapillary puncture with direct access to the renal pelvis. To achieve an ideal access with low complication rate, the combination of fluoroscopy and ultrasound is optimal.

Visualization

To establish the proper access to the collecting system, as much information as possible should be obtained about the stone and the patient's anatomy, best achieved by the combination of fluoroscopy and ultrasound. Opacification of the renal collecting system (CS) by intravenous dye injection or by a retrograde ureter catheter renders the CS visible and helps to identify its distribution accurately. Ultrasound will visualize all other structures like the renal parenchyma, stones of all compositions and all surrounding organs like spleen, intestine, liver, pleura or ribs, and, most importantly, simultaneously the needle during the puncture (Fig. 45.1).

FIGURE 45.1 How ultrasound helps to easy identification of surrounding organs (lung, liver, spleen, intestine or liver) that are not visible in fluoroscopy. (**a**) Ultrasound image of a stone bearing kidney viewed from the 10th intercostals space; (*1*) surface 10th or 11th rib, (*2*) backshadow of ribs, (*3*) kidney parenchyma, (*4*) bright echo of stone backshadow. (**b**) During inspiration diffuse reflections caused by air in the lung obscures the view on the kidney, which moves caudally. (**c**, **d**) During deep inspiration the intercostals space is completely filled by the lung, indicating that this access should be avoided, as it will lead into the lung or thoracic cavity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The advantage of this combined visualization principle is to obtain real-time pseudo three-dimensional information during establishing the percutaneous access [1, 2]. Prior puncture of the kidney we routinely place an ureteral balloon catheter in the proximal ureter that allows retrograde filling and slight dilation of the renal collecting system with contrast dye and prevents loss of fragments into the ureter while later stone disintegration.

Ideal Access

The ideal approach to the kidney is achieved by a transpapillary puncture with direct access to the renal pelvis. The first step in preoperative planning of the procedure is to identify the ideal target calyx and to obtain a three-dimensional knowledge of the kidney and the stone. It is essential to understand the anatomical location of the kidney. It is located anterior to the psoas muscle, between 12th thoracic vertebral body and 2nd/3rd lumbal vertebral body. Both kidneys are located within the retroperitoneum at approximately 30° posterior to the frontal plane of the body. Access to the kidney is always established individually according to the particular anatomy. Frequently, the ribs or the iliac crest limit the space for access. In these cases, the area has to be shifted a few degrees (caudally or cranially 10–20°) (Fig. 45.2).

For the determination of the target calyx and puncture plane the long axis of the target calyx is first identified by fluoroscopy. The plane between the caliceal axis and its perpendicular projection of the axis on the patients back is the ideal puncture plane. This is the least traumatic access because a direct straight way through the calyx to the renal pelvis is possible.

Puncture

To determine puncture site and direction, the ultrasound scanner is moved laterally on the predefined puncture plane while keeping the scanning plane within the predefined

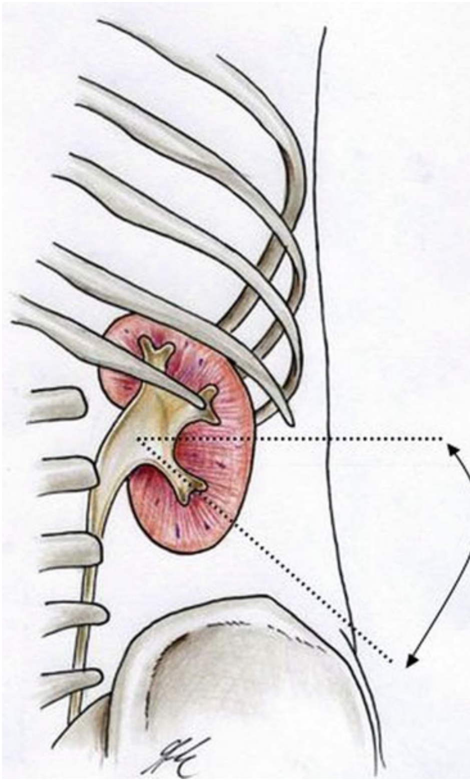

FIGURE 45.2 Anatomic location of the kidney within the body. Frequently, the ribs or the ileal crest limit the space of access

puncture plane, the image will then change until the access calyx will point directly towards the scanner head. An electronically generated line marks the puncture path from the needle guidance adapter to the stone. Puncture from this site will guarantee optimal access to the stone. At this moment, the direction and depth to reach the collecting system can be determined (Fig. 45.3a, b).

Two fashions of puncture are possible, either using needle guidance or a freehand puncture. Using the needle guide adapter may be advantageous for the beginner, but frequently the needle will be deflected from the predefined

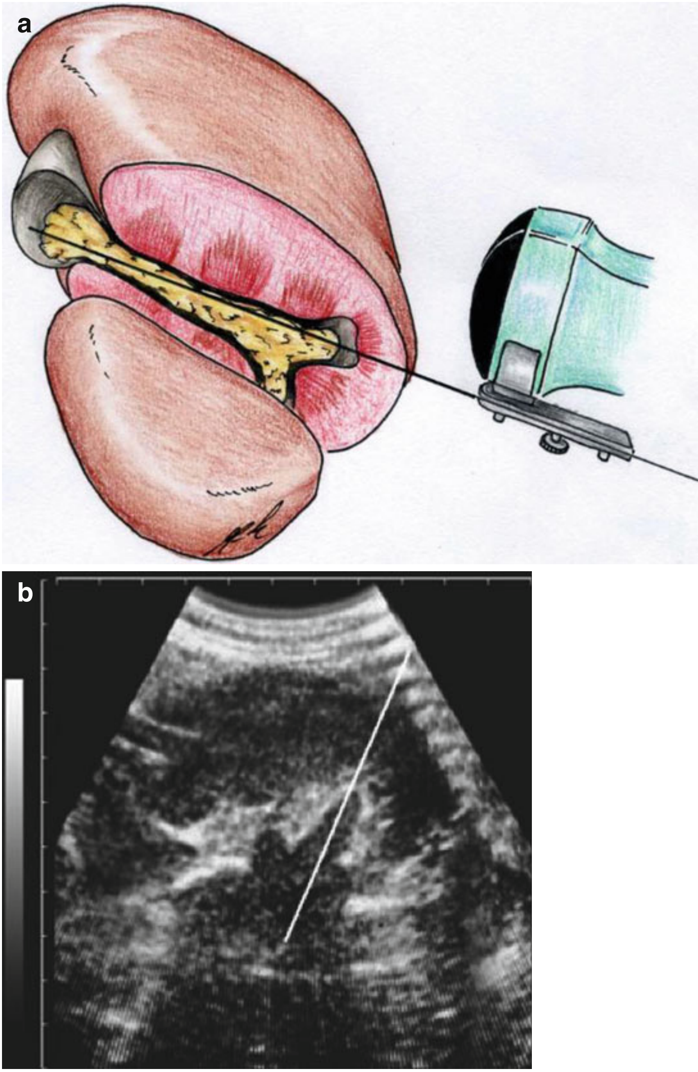

FIGURE 45.3 (**a**) Schematic drawing of the ideal access to the kidney with a transpapillary puncture, allowing straight access from the calyx to the renal pelvis. (**b**) Ultrasound image of the kidney showing dilated collecting system and the needle running straight through a lower caliceal papilla into the renal pelvis

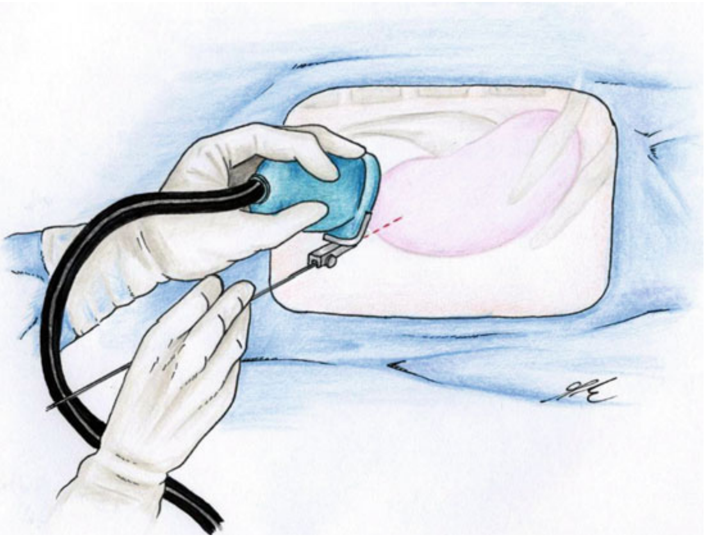

FIGURE 45.4 Ultrasound-guided puncture of the lower renal pole using a probe with needle guide adapter

path due to different tissue consistencies. Freehand puncture allows easier detection and correction of the needle's direction. To correct of the needle's direction it has to be moved outside the kidney, sometimes even out of the skin.

Immediately before and during the puncture, short intermittent fluoroscopy pulses should monitor the needle advancement and possible deflection. The needle can be followed until it reaches the calyx by ultrasound. In those cases where the stone completely fills the target calyx, no urine will flow through the needle. Minimal amounts of dye have to be injected to assure the optimal position of the needle tip. All further steps are then done under fluoroscopic control (Fig. 45.4).

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Chapter 46
Tips to Enter the Pelvicalyceal System in the Supine Position

Cesare Marco Scoffone and Cecilia Maria Cracco

Abstract A suitable, accurate and atraumatic percutaneous access is the key point for the success of any percutaneous nephrolithotomy, maximizing its effectiveness in terms of stone-free rates and its safety by reducing the risk of complications. The percutaneous renal access can be divided into five main steps, regardless of the patient's positioning: personalized preoperative planning, puncture of the collecting system; insertion of the guidewire; dilation of the percutaneous tract; insertion of the working Amplatz sheath. There are several tips to optimize the aforementioned steps of the percutaneous renal access. Some of them are very general ones, a sort of *forma mentis* applicable in any position, others are exclusively related to the supine and supine-modified positions, mainly the Galdakao-modified supine Valdivia position in our experience.

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Introduction

A suitable, accurate and atraumatic percutaneous access is the key point for the success of any percutaneous nephrolithotomy (PNL), maximizing its effectiveness in terms of stone-free rates and its safety by reducing the risk of complications.

The percutaneous renal access can be divided into five main steps, regardless of the patient's positioning:

1. personalized preoperative planning;
2. puncture of the collecting system;
3. insertion of the guidewire;
4. dilation of the percutaneous tract;
5. insertion of the working Amplatz sheath.

There are several tips to optimize the aforementioned steps of the percutaneous renal access. Some of them are very general ones, a sort of *forma mentis* applicable in any position, others are exclusively related to the supine and supine-modified positions, mainly the Galdakao-modified supine Valdivia (GMSV) position in our experience [17].

Tip 1

Prepare a thorough and personalized preoperative planning: Table 46.1 [5].

Tip 2

Set up an adequate armamentarium before the procedure

In general, a variety of scopes (semirigid and flexible ureteroscopes, rigid and flexible nephroscopes of different sizes), accessories (ureteral access sheaths, double J stents,

TABLE 46.1 Scheme of the personalized preoperative planning

DEFINITION OF THE PATIENT: - age - sex - body habitus - skeletal malformations - previous surgeries (urologic and others) - comorbidities	DEFINITION OF THE UROLITHIASIS: - number - shape - volume - location - composition - infectious vs non-infectious	DEFINITION OF THE ANATOMY OF THE COLLECTING SYSTEM: - features of the meatus/ureter - width/length of the infundibula - infundibulopelvic angles - number, size, morphology, spatial orientation of the calyces - congenital renal malformations - outcomes of previous renal surgeries, renal transplant, urinary diversion, neobladder - kidney and surrounding viscera
HOW: - anamnesis - multidisciplinary medical approach (anesthetist, cardiologist, lung specialist, internist, endocrinologist,...)	HOW: mainly NCCT (Non Contrast Computerized Tomography), after preliminary plain KUB radiogram and ultrasound examination	HOW: - mainly multidetector CT pyelography with multiplanar reconstruction and three-dimensional (3D) reformatting [2]

TABLE 46.2 Preparation of the armamentarium before the percutaneous procedure

In terms of diversity	In terms of quantity	In terms of functioning
18 Gauge Chiba needle Hydrophilic guidewires Scalpel Fascial dilators Semirigid serial Amplatz dilators Metallic telescopic Alken dilators Balloon dilators of different diameters Amplatz sheaths of different sizes and lengths	At least two of each element needed, if fundamental (in case of damage or accidental loss of sterility)	Foolproof preliminary control that all the armamentarium is not only present in the operating room, but that it works correctly (C-arm, fluoroscopic screen, ultrasound machine, the complete series of serial/progressive dilators, …) before receiving the patient in the operating room

nephrostomies,…), lithotripsy devices (pneumatic/ultrasonic combined lithotripter, holmium laser lithotripter) and other materials (guidewires, contrast medium, …) should be prepared and preliminary checked. In particular, for the renal access an adequate armamentarium should be at disposal (Table 46.2).

Tip 3

Bear in mind few basic rules to avoid the well-known complications (Table 46.3)

Tip 4

Correctly position the patient, and adapt the position to the current requirements

– *Place the patient in the Galdakao-modified supine Valdivia (GMSV) position:*
  - put the patient supine,
  - elevate the flank to operate with jelly pillows (or rolled towels, or a 5-l saline bag, or an inflatable pillow),

Table 46.3 How to avoid complications

Bleeding:	**Infections:**
Remember renal vascularization (the Brodel's avascular line/arterial distribution within the parenchyma/less vascularized areas)	Negative preoperative urine culture
Reach the tip of the chosen papilla following the axis of the calyceal infundibulum	Stop procedure if purulent urine comes out from the needle
Avoid inadvertent overadvancement of the dilators or of the Amplatz sheath	Keep low intrarenal pressures during the procedure
Avoid insufficient insertion of the dilators or of the Amplatz sheath	Avoid retrograde and/or pressurized irrigation in absence of adequate drainage
Avoid excessive torqueing/ inclination of the instruments during the procedure	Be sure that the Amplatz sheath is in place
	Use operating instruments 4F smaller than the Amplatz sheath
	Use heated irrigation (excluding shivers due to hypothermia, in case of fever)

Table 46.3 (continued)

Damage of the collecting system:	**Lesion of neighbouring organs:**
Remember the spatial orientation of the kidney in all planes Superior poles are more medial and posterior Lateral margins are more posterior Avoid transpyelic or transinfundibular punctures Avoid inadvertent overadvancement of the dilators or of the Amplatz sheath Avoid excessive torqueing/inclination of the instruments during the procedure	Remember the topographic anatomy in the supine and supine-modified positions Draw the anatomical landmarks to respect (see Tip 4) Check on preoperative CT for retrorenal colon, hepato/splenomegaly, variations in the anatomic relationships due to congenital renal malformations, skeletal deformities, previous surgeries, very high or very low BMI Check with ultrasound for interposed viscera

- arrange the ipsilateral leg on a padded stirrup extended, with the ankle in axis with the body, and fix it,
- arrange the contralateral leg on a padded stirrup well abducted and flexed and fix it,
- bend the ipsilateral arm on the thorax on an adequate support (we use towels) and fix it,
- moderately abduct the contralateral arm for venous access and pressure control (Fig. 46.1a,b).

– *Mark the reference lines to be respected during the puncture:*

- the anterior limit is the posterior axillary line (which should be drawn in advance, with the patient standing),
- the cranial limit is the 12th rib,
- the caudal limit is the iliac crest,
- the posterior natural limit is the lateral margin of the paravertebral muscles (Fig. 46.1a).

FIGURE 46.1 (**a**) Patient in the classical GMSV position; (**b**) Obese patient in the GMSV position; (**c**) 20-month-old boy in the GMSV position with a modified arrangement of the lower limbs

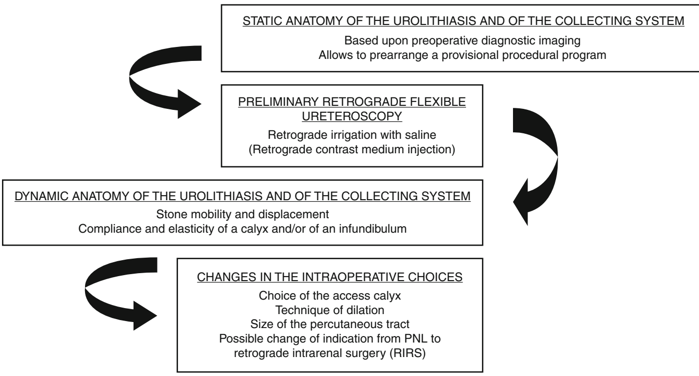
- *Adapt the described position to the patient's requirements:*
  - in very thin patients, or in those with mild forms of retrorenal colon, or in case an upper calyceal access is needed, the elevation of the flank should be increased, obtaining a more oblique position of the patient, so that the puncture can be performed closer to the paravertebral muscles;
  - in obese patients the fat falls on the side opposite to the treated one (Fig. 46.1b), and might be fixed and flattened applying adhesive strips of Tensoplast, thus reducing skin-to-stone distance [3, 10]
  - children may avoid the classical lithotomic position with padded stirrups for the lower limbs; a simple and stable retrograde access may be sufficient (Fig. 46.1c);
  - particular care should be taken when positioning a patient with skeletal deformities, adapting it in different ways from time to time, and paying particular attention to avoid pressure damages during the procedure.

Tip 5

Be able to adapt technical choices to intraoperative conditions

The issue of the intraoperative versatility is an essential feature of any modern PNL, in agreement with the principles of personalized medicine and tailored therapies which are currently the standard of modern healthcare. Preliminary retrograde ureteroscopy is the main tool we have in order to contextualize each step of PNL, and to adapt the procedure to the patient and not vice versa (see Tip 5) (Table 46.4).

Table 46.4 Algorythm useful in order to adapt technical choices to intraoperative conditions



The Puncture of the Collecting System

Tip 1

Choice of the calyx for the access

- preliminarily choose the best access calyx in view of PNL, based upon the features of the urolithiasis to treat, the relationships between tract and neighboring organs, the pelvicalyceal anatomy. This is the reason why urologists should always establish renal access by themselves, instead of relying on radiologists [19]. Usually our preference goes to an inferior one in most cases, to be reached subcostally, and a posterior one, easily allowing access to the anterior ones;
- there are particular cases that would require a middle or upper calyceal access, but that might also be adequately managed with flexible scopes and the contribution of the retrograde access in the supine position, using a single inferior calyceal access;
- if a superior calyceal access is absolutely needed, the anesthetist may contribute reducing the respiratory movements, and even inducing apnea in maximal inspiration, in order to facilitate it. The renal displacement technique [15] may also be of help: initially a

lower or middle calyx is punctured with an 18-Gauge needle; then the proximal end of the needle is progressively pushed in the cephalic direction, consequently pushing the kidney caudally by a lever maneuver. In this way the kidney is many millimeters lower and the upper pole calyx is more accessible for the puncture.

Tip 2

Ultrasound guidance (Fig. 46.2)

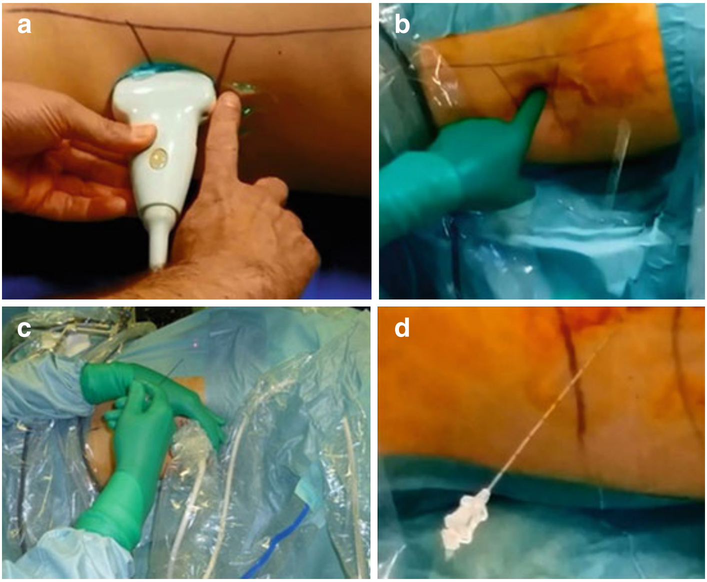


FIGURE 46.2 (**a**) Before starting the procedure preliminary ultrasound (US) is useful, in order to check the absence of visceral interposition along the needle path, assess the target of the puncture, and identify with the inclination of the US probe the inclination of the puncturing needle. (**b**) Remember the inclination of the needle by heart, maintaining the same point of entry of the needle, and perform the puncture under biplanar fluoroscopic control only. (**c**) Alternatively, integrate fluoroscopic puncture with freehand US. (**d**) The inclination of the needle after an inferior calyceal puncture successfully performed at the first attempt is the same as in b

Tip 3

Fluoroscopic guidance

- when the access needle is put under the C-arm over the body of the patient for the preliminary biplanar identification of the exact target of the puncture (Fig. 46.2c), remember that in the supine position the X-ray incidence is nearly perpendicular to the orientation of the access needle, and not oblique forming an acute angle as in the prone position. This circumstance simplifies the renal puncture, and allows the surgeon to avoid to work during the whole procedure with the hands under the fluoroscopic beam;
- when retrograde pyelography is performed in the supine position the posterior calyces turn out to be darker than the anterior ones, because due to gravity the contrast medium fills them more and earlier; on the contrary and for the same reason, in the prone position the posterior calyces are filled later and appear paler than the anterior ones;
- insert the needle under fluoroscopic control, maintaining the same point of entry of the needle and the same inclination previously identified by US; if urine doesn't come out check with US and delicately move up and down the needle under fluoroscopic control: the consensual movement of the papilla of the calyx filled by the contrast medium will help to understand the missing distance between tip of the needle and target calyx. In any case, the needle should enter into the calyx only for a short tract, without overpassing it;
- if fluoroscopic-only guidance is used in the supine position, the identification of the third dimension without the aid of US is also possible, exploiting the cephalad 30° tilting of the C-arm [12]. A reference clamp is placed on the abdominal wall in the vertical projection

of the target calyx and the needle is advanced towards the calyx. If no urine comes out from the needle, the C-arm is tilted 30° cranially. If the distance between needle and reference clamp increases this means that the needle is under the calyx, on the contrary, if needle and clamp become nearer this means that the needle is above it. In any case the needle should be repositioned accordingly. The three-finger technique [18] can also be applied with the patient in the supine positions.

Tip 4

Ultrasound/CT fusion imaging guidance

- generally, the introperative guidance of the renal puncture relies on fluoroscopy and/or US, which are very basic tools if compared to the more sophisticated preoperative diagnostic imaging, including CT and magnetic resonance imaging (MRI) [16]. The use of fusion imaging systems, able to transpose the more accurate preoperative planning into the intraoperative context, is nowadays an issue [9], not only in terms of feasibility and reliability (already demonstrated), but also in terms of cost-effectiveness and ergonomics;
- we experienced the US/CT-guided percutaneous access using the MyLab Twice system (Esaote spa, Genova, Italy), equipped with the virtual navigation option and an electromagnetic tracking system, correlating and synchronizing preoperative CT images obtained in the supine-modified position with real-time intraoperative US guidance. The exact target of the puncture could be easily defined in the three dimensions, and all the punctures were performed at the first attempt, with a minimal use of fluoroscopy and in absence of any kind of complications, thus in a safe and effective way (Fig. 46.3).

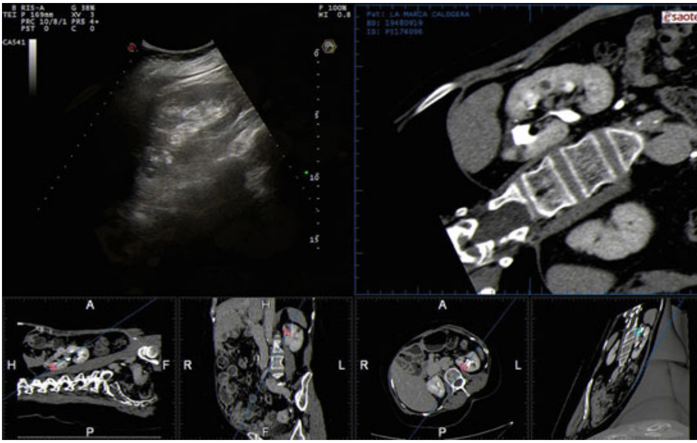


FIGURE 46.3 US/CT-guided fusion imaging system for renal percutaneous access guidance

Tip 5

Endovision control

– retrograde flexible ureteroscopy is in our experience an essential adjunct to the PNL procedure. ECIRS (Endoscopic Combined IntraRenal Surgery) is in fact the combined retrograde and antegrade approach to treat large and/or complex urolithiasis. Retrograde flexible ureteroscopy is a inalienable prerequisite for the Endovision technique, which is not always possible, especially in case of staghorn stones, and particularly advantageous for non-dilated systems [11, 17]. When feasible, the entrance of the access needle through the tip of the chosen papilla can be checked, and possibly corrected and improved, thus reducing the bleeding risk due to an inappropriate puncture (Fig. 46.4a);
– a limited retrograde ureteroscopic irrigation should be used before the working Amplatz sheath is in place and able to ensure an adequate fluid drainage, thus avoiding high intrarenal pressures or forniceal ruptures;

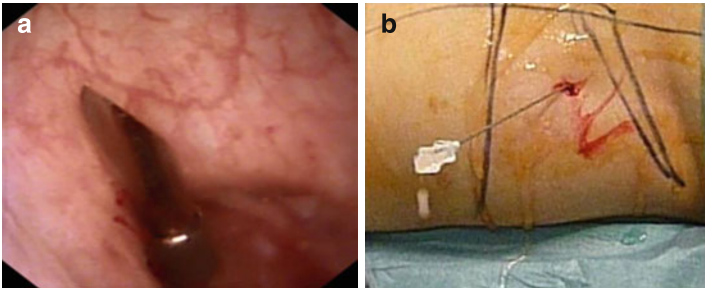


FIGURE 46.4 (**a**) Endovision control of the entry of the needle through the tip of the renal papilla; (**b**) purulent urine coming out from the access needle

– high intrarenal pressures also cause intrarenal reflux and infectious complications [13]. Since the renal cavities in supine position may be more collapsed than in prone position [14], due to the easier drainage of the irrigation fluids, vision may sometimes be compromised; delicate and transient injection of saline through a syringe may improve the situation.

Tip 6

The issue of kidney hypermobility in the supine position

One of the reported difficulties in percutaneously accessing the kidney in the supine positions consists in an enhanced renal displacement during the access phase [14]. Of course this does not happen in all patients [8], but might be true especially in case of females or obese patients [1]. A solution might be to exert a counterpressure on the abdomen, with the hand or with any other device.

Tip 7

Pus from the needle = stop and postpone the procedure

If the urine coming out from the needle after the puncture is purulent (Fig. 46.4b) (in spite of a negative preoperative urine culture and of good clinical conditions of the patient), place a guidewire and a nephrostomy tube on it, after sending a sample for urine culture. In this case the uroseptic risk of a PNL is particularly high, and it is cautious to defer it after an adequate period of specific antibiotic therapy, obtaining negative urine cultures [4, 7, 13].

The Insertion of the Guidewire

Tip 1

Managing difficulties in guidewire introduction

- in case of staghorn stones, retrograde flexible ureteroscopy plays an important role in the creation of the so-called water path around the stone, allowing the hydrophilic guidewire introduced through the access needle to overpass the stone and to slip down the ureter. Retrograde irrigation of the pelvicalyceal system with saline, also injected through the needle (sometimes also gently pushing against a stone attached to the mucosa) (Fig. 46.5a), can contribute to create a sliding space between calyx and stone for sufficient guidewire insertion into the collecting system (and possibly down the ureter) (Fig. 46.5b);
- the Endovision technique (Fig. 46.6a) may assist the guidewire insertion and the resolution of possible loops within the collecting system (Fig. 46.5c);
- if the guidewire coils into a calyx refusing to access the ureter, it may be retrieved by means of graspers or a nitinol basket and retrograde ureteroscopy, and externalized through the urethral meatus (Fig. 46.5c);
- alternatively, later on a retrogradely inserted guidewire may be retrieved with forceps through the nephroscope and externalized through the Amplatz sheath; in this case, and especially if the wire is inserted only for a short tract into the pelvicalyceal system, it should be quickly stabilized after fascial dilation using the stylet of the Alken dilators (and then the Alken dilators) (Fig. 46.5d);

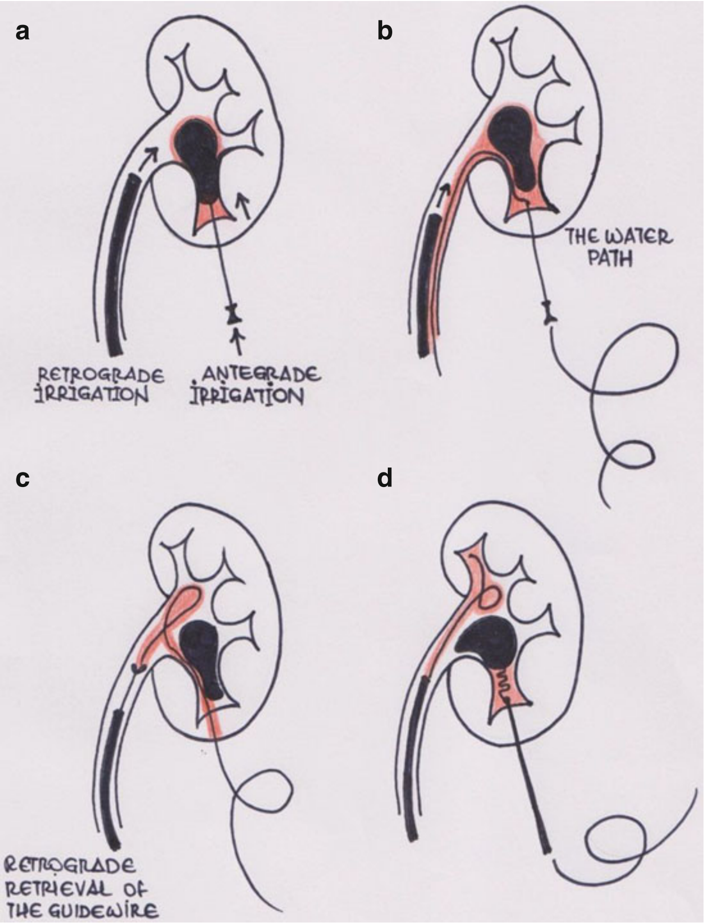


FIGURE 46.5 (**a**) Retrograde and antegrade irrigation; (**b**) water path creation around the stone; (**c**) retrograde retrieval of the guidewire to obtain the so-called kebab patient; (**d**) retrograde wire in an upper calyx and antegrade wire inserted for a short tract in absence of water path, stabilized by the Alken stylet for tract dilation

– if no guidewire can be inserted within the collecting system through the access needle, the surgeon should consider to perform another access, or even to stop the procedure.

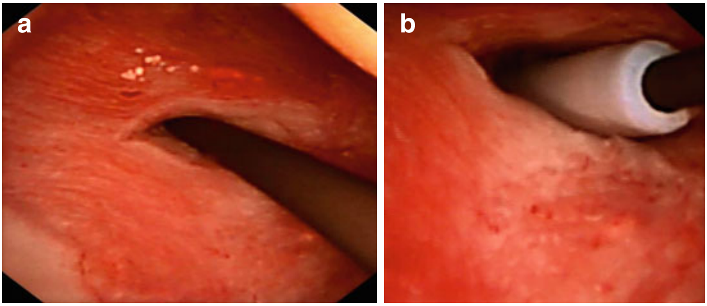


FIGURE 46.6 (**a**) Endovision control of the inserted hydrophilic guidewire; (**b**) of the fascial dilator

Tip 2

The "kebab" patient

- the hydrophilic guidewire is inserted through the access needle into the pelvicalyceal system, down the ureter into the bladder, and possibly externalized through the external urethral meatus (through-and-through guidewire). In this way it becomes at the same time safety and working guidewire;
- hydrophilic wires find easily their way, but attention should be paid not to peel away the hydrophilic coating from the guidewire, repeatedly moving it in and out the access needle.

The Dilation of the Percutaneous Tract

Tip 1

The choice of the technique of dilation and the issue of previous renal surgeries

- balloon dilation is very effective, and may also be less traumatic and cause less bleeding than other dilation techniques, thanks to the progressive enlargement of the tract. Since this device is more expensive than the

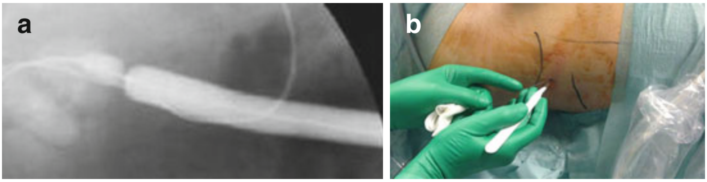


FIGURE 46.7 (**a**) Fluoroscopic image of the hourglass shape of an incompletely inflated balloon due to fascial/perirenal scarring; (**b**) skin incision using a scalpel

other reusable progressive dilators, surgeons should try and avoid to waste it, when possible causes of failure of this technique of dilation can be foreseen;

- mainly, rigid fascial and perirenal scarring due to previous lumbotomic/renal surgeries may prevent the correct and complete pressurized inflation of the balloon, assuming a hourglass shape in correspondence of the scarred fascia (Fig. 46.7a);
- there are some new balloons that can be inflated at higher pressures without bursting, from the previous 16 to 20 mmHg, but even those may not be sufficient. It is also important to precede balloon dilation with an adequate skin incision using a scalpel (Fig. 46.7b), followed by preliminary progressive fascial dilation from 8 to 10 F. The Korth knife might also be useful in this circumstance;
- however, all these measures may not be adequate to nullify the scarring outcomes. For this reason, in such a case the Alken or silicon progressive dilators should be the first choice.

Tip 2

The choice of the technique of dilation when the guidewire is inserted only for a short tract into the collecting system

- the risk that a guidewire (especially a hydrophilic one) might slip out inadvertently during the tract dilation is concrete, and if this happens tract dilation must be suspended, and the renal access started again from the beginning;

- if the guidewire is inserted only for a short tract within the collecting system, apply the Alken stylet on the wire in order to stabilize the tract, then employ Alken metallic dilators (see Tip 1 and Fig. 46.5d).

Tip 3

The choice of the technique of dilation when there is no space between a staghorn stone and the calyx

- a space of at least one centimeter must be present between stone and calyceal wall, in order to allow insertion and admission of the tapered end of a balloon or of a silicon dilator (which in fact is about one centimeter in length), even though there are now balloons with shorter tapered ends (Fig. 46.8a);
- in case the guidewire overpasses the stone, during the dilation care should be taken that any dilator (and especially a deflated balloon dilator) is not advanced along the wire between stone and infundibulum, with the risk of breaking the latter. Careful fluoroscopic control of the position of the tip of the dilator is essential during this step;
- if there is not enough space between stone and calyx, the risk is to insert the Amplatz sheath over the dilator insufficiently without reaching the collecting system, its distal end remaining within the renal parenchyma, damaging it and causing bleeding (Fig. 46.8b). If irrigation does not enlarge the space between stone and calyx, Alken progressive dilators are the better choice, because the stylet can be inserted immediately against the stone, and the subsequent elements are coaxial and all with a flat end, in contact with the buttoned tip of the stylet itself.

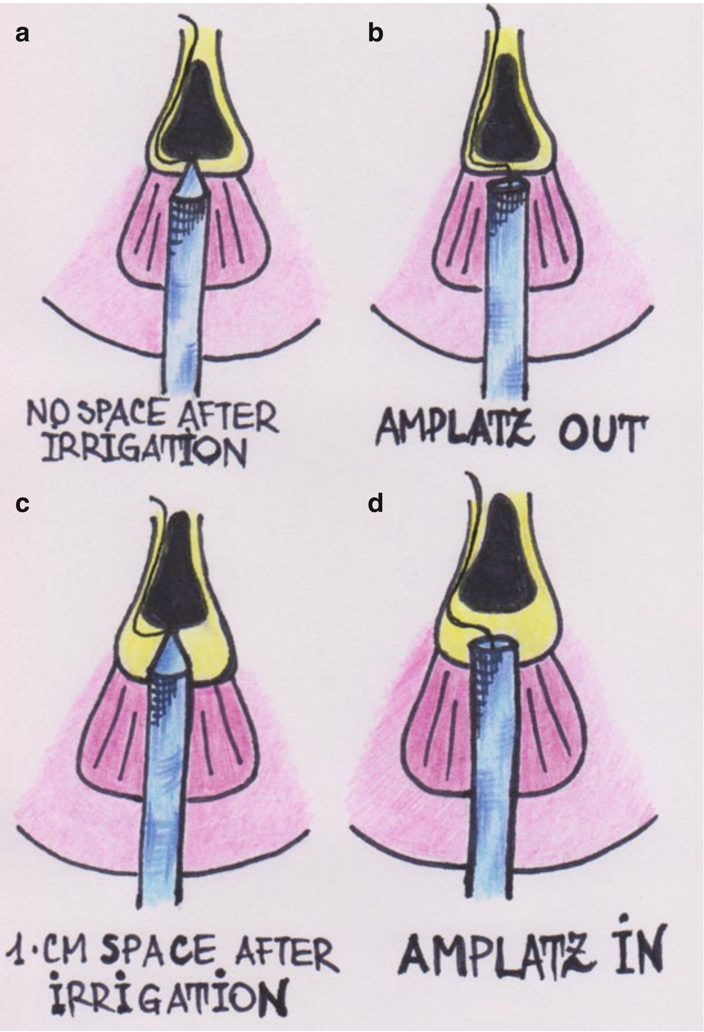


FIGURE 46.8 If there is no space between stone and calyx (**a**) there is no space for the introduction of dilators with a tapered end and Alken dilators are preferred, otherwise there is the risk to apply the Amplatz sheath within the renal parenchyma causing bleeding (**b**). On the contrary, in case at least a 1-cm space can be created between stone and calyx (**c**) any dilator can be used and the Amplatz sheath correctly inserted (**d**)

Tip 4

The choice of the size of dilation with the contribution of the Endovision technique

- retrograde flexible ureteroscopy directly assesses the dynamic anatomy of the collecting system in response to irrigation. The morphological modifications of calyces and infundibula (Fig. 46.9) may therefore guide the choice of the size of dilation of the percutaneous tract (standard 30 F PNL versus 24 F midi or 15–16.5 F mini-PNL, UltraMiniPerc (UMP), 4.85 F micro-Perc or micro-ECIRS), also taking into account the stone burden to treat. In particular, the evidence of a thin and anelastic infundibulum of the calyx chosen for the access should suggest to select a smaller diameter for tract dilation, avoiding to break it and thus reducing the bleeding risk, according to the principle that we should adapt the instruments to the patient, and not vice versa;

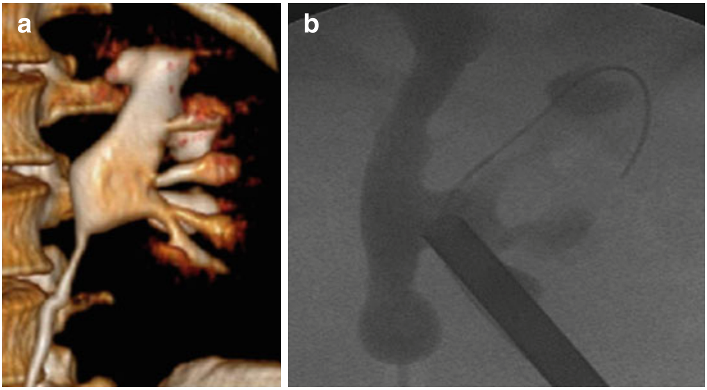


Figure 46.9 (**a**) Preoperative 3D-CT pyelography, demonstrating inferior calyces with rather thin infundibula; (**b**) intraoperative pyelography with a 30 F Amplatz sheath in place, after retrograde irrigation and dynamic dilation of the infundibulum of the accessed inferior calyx, which turned out to be rather elastic and compliant

– the Endovision control of the progressing dilation reduces the risk of damaging the collecting system and radioscopic exposure.

The Insertion of the Working Amplatz Sheath

Tip 1

Never forget to pre-load the Amplatz sheath on the balloon dilator (Fig. 46.10a)

It may happen that the nurse connects all the components of the balloon and forgets to pre-load the Amplatz sheath. If the nurse or the urologist do not realize this mistake in time, balloon dilation will be carried out and they will acknowledge this problem too late. In this case the balloon will be deflated, and the dilation started again, loosing precious time and increasing the risk of complications, especially bleeding.

Tip 2

Insertion under fluoroscopic control

It is essential to be very careful when inserting the working Amplatz sheath over the balloon dilator, first of all pouring abundant saline on the balloon and inside the sheath, in order to promote an easy reciprocal sliding (Fig. 46.10b), and then inserting the sheath with a gentle, continuous and clockwise rotational movement, always under fluoroscopic control to avoid overadvancement or insufficient insertion (Fig. 46.10c). In this phase it is fundamental that the urologist maintains with the other hand the dilator over which the Amplatz sheath is inserted very steady, without overadvancing it. This holds true for progressive metallic or silicon dilators as well, remembering not to use any gel thinking to facilitate sliding of the sheath over the last dilator; on the contrary, everything becomes sticky and difficult to manage.

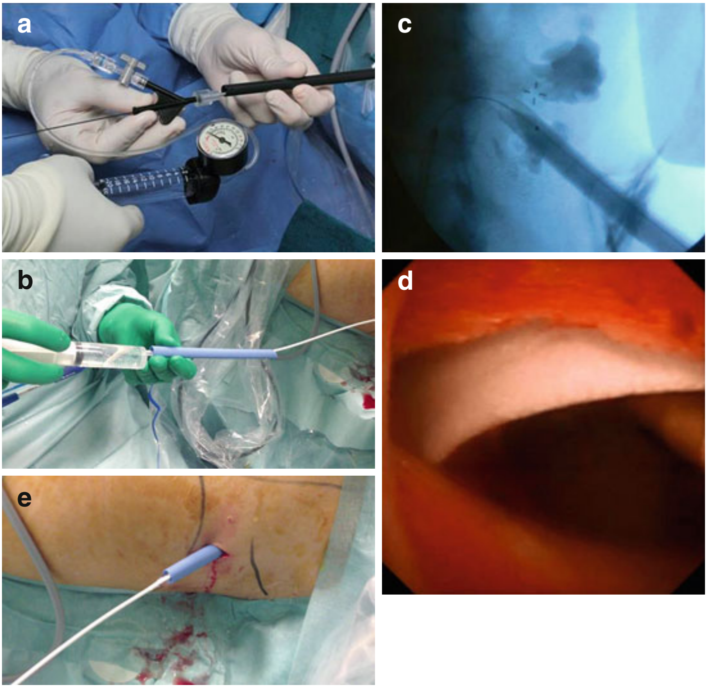


FIGURE 46.10 (**a**) Don't forget to preload the Amplatz sheath before connecting all the elements of the balloon; (**b**) abundant saline is poured between the pre-loaded Amplatz sheath and the balloon before insertion; (**c**) insert Amplatz sheath always under fluoroscopic control; (**d**) Endovision control of the Amplatz sheath insertion; (**e**) in supine position the Amplatz sheath is horizontal or slightly inclined downwards

Tip 3

Insertion under Endovision control

The integrated Endovision control allowed by retrograde flexible ureteroscopy integrated with PNL, as during ECIRS, allows to check visually the correct insertion of the Amplatz sheath (Fig. 46.10d), additionally reducing overall radiation exposure. In this manner we can avoid overadvancement of the sheath (possibly injurying the collecting system and causing bleeding), as well as the opposite situation, i.e., the insufficient insertion of the sheath (producing parenchymal damage, bleeding, possible fluid absorption and extravasation with fluid overload).

Tip 4

Favorable orientation of the Amplatz sheath in the supine position

In the supine position the Amplatz sheath is horizontal or slightly inclined downwards (Fig. 46.10e), reproducing the same inclination of the access needle. This declivity favours the spontaneous evacuation of stone fragments during lithotripsy much more than in the prone position, entailing a more oblique or even vertical orientation of the sheath.

Conclusions

The decision of the position for PNL should be made on patient's characteristics and surgeon's preference and experience [3]. The supine positions have several advantages, including cardiovascular and airway benefits for anaesthesia and ergonomics [6, 17], and by the way seem to have a rather modest learning curve [2]. But the very important thing is to optimize the percutaneous renal access, standardizing every step and paying attention to every detail in order to guarantee to the patient a safe, effective and personalized procedure.

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Chapter 47
Tips for Mini and Micro PCNL

G. Bianchi and R. Galli

Abstract Mini and Micro percutaneous nephrolithotomy (PCNL) techniques were born with the aim of reducing the trauma associated with the procedure. The main advantages of instrument miniaturization are less bleeding, and more likelihood of a tubeless intervention, with reduced post-operative pain, without interfering with the stone-free rates. The purpose of this chapter is to give practical tips that may be useful to make the procedure safer and prevent complications.

Keywords Kidney stones • Mini • Micro • Percutaneous nephrolithotomy • PCNL

Introduction

Mini and Micro percutaneous nephrolithotomy (PCNL) techniques were born with the aim of reducing the trauma associated with the procedure. The main advantages of

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instrument miniaturization are less bleeding, and more likelihood of a tubeless intervention, with reduced post-operative pain, without interfering with the stone-free rates.

Mini PCNL technique can be performed with a tract size of 16–20Fr [2]. Micro PCNL in addition to reducing the diameter of the tract using Microperc system of 4.85–10Fr, decreases the number of steps required to set up standard PNL so that the entire procedure could be done as a single step because the needle acts as a sheet [1]. The purpose of this chapter is not to describe in details the techniques, but rather to give some tips that may be useful to make the procedure safer and prevent complications, optimizing surgical gestures.

Preparation Before PCNL

Accurate patient selection and CT imaging with delayed phases of contrast excretion are very important in the evaluation before PCNL [4].

For stones that are less than 2.5 cm, in solitary kidney or patients with thin collecting systems it is better to use a mini or micro-PCNL procedure. Spinal deformity, uncorrected medical co-morbidities as diabetes, hypertension, renal insufficiency and anemia must be considered. CT allows to assess the spatial relationship of the kidney relative to the stone, and the kidney in relation to adjacent viscera, for tract planning. Special attention should be given to patients with urinary tract infections and perform a target antibiotic prophylaxis because with these techniques we have a lower drainage of urine and increased liquid pressure with risk of sepsis.

Check your surgical team, and be sure that everyone understands what you are planning to do. Take precautions to avoid hypothermia with hugger bear and warm irrigation fluids. In prone position, when you turn the patient be careful of the face and extremity pressure points. Put bolsters under lower chest and pelvis to let the abdominal contents fall forward. Supine position is recommended in patients with cardio-respiratory issues. You need to have an appropriate laser that allows the use of low-energy and high frequency to pulverize.

Access

Ureteral catheter is critical to see in a retrograde pyelography the urinary tract and have a way of proper drainage to decrease the pressure in the urinary tract. The puncture in both techniques takes advantage of the mixed control ultrasound and radiology. Micro-PCNL also allows puncture under vision, but it can often be hampered by the layers of the abdominal wall. Mini-PCNL provides the position of a guidewire followed by dilation with Amplatz dilators or with nephrostomy balloon to be able to introduce the sheath that normally has a diameter of 14Fr. It's recommended to use the safety guidewire, possibly placed in the ureter. Micro-PCNL does not provide dilation but thanks to the "All Seeing Needle" the needle itself acts as a sheath and allows the introduction of optic, laser fiber and irrigant fluid (Fig. 47.1).

Percutaneous access into the collecting system is safe when using a direct puncture through the overlying renal parenchyma into the fornix of the intended calyx, to avoid major blood vessels. Direct entry into an infundibulum has a risk to injury one of the interlobar vessels or segmental branches of the renal artery, resulting in significant hemorrhage [3].

During PCNL

The mini-PCNL is a technique similar to the traditional PCNL, and it has only a smaller sheath. Therefore, the fragmentation must be conducted in a manner that you can easily extract stone fragments from the sheath but no effective rigid instruments are available that can give good results. The best method to remove the fragments is to use a basket.

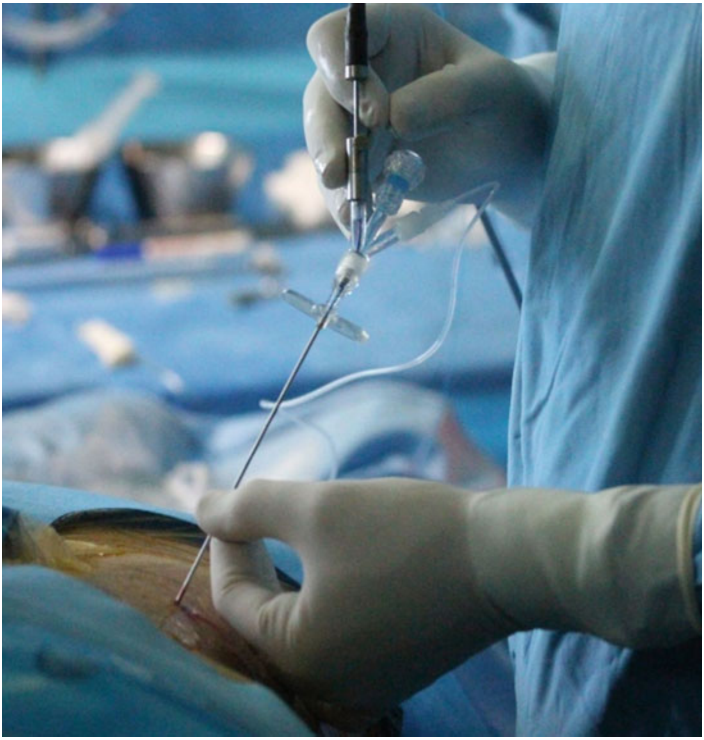

Figure 47.1 "All seeing needle" for micro PCNL

You can use both the ballistic lithotripter that the laser getting good results with the two methods.

The micro-PCNL is completely different from traditional PCNL because it does not allow you to extract fragments. Therefore the stone must be reduced to tiny fragments as close as possible to the pulverization. It is mandatory to use a laser that allows to achieve these result. Depending on the chemical composition of stones the laser must be set with low energy and high frequency to pulverize the stone (the setting depends on the brand of the laser). During surgery is important to remember that high power has a negative impact that can cause moving of the stone and creating large fragments.

We suggest to enter the optic fiber in the center channel of the needle to avoid bending it; in the lateral canal we insert the laser fiber. In micro-PCNL you use an irrigation system connected to a pump to improve the vision; it is important that irrigation is reduced to a minimum and that the ureteral drainage is free to allow the outflow of the washing fluid.

During the navigation in the kidney, it is mandatory not get out the kidney to avoid losing of the access. At the end of the procedure with the mini-PCNL you must be sure to be stone-free while in the micro-PCNL, it is important to be sure to have minimum size of fragmentations to be easily expelled. In both cases it is necessary to perform a fluorescence control. The mini-PCNL involves placing a nephrostomy or a open end catheter for 24 h; the micro-PCNL is always completed by placing a ureteral catheter for 24 h.

Postoperative Care

Patient is discharged on postoperative day 1. If nephrostomy tube is left in place, ante grade pyelogram can be performed in the second post-operative day.

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Chapter 48
Use of Laser in Urology

Andreas Johannes Gross and Christopher Netsch

Abstract A good understanding of laser principles is required to choose the appropriate laser for any medical application. In respect of urological interventions the most important parameters are emission-mode, wavelength of the laser and power emitted (Watt). Whereas pulsed lasers are used for both prostates and stones, continuous wave (cw) lasers are mainly used for soft tissue such as prostates, ureters, urethrae, bladder tumors, and partial nephrectomy.

Keywords Laser • Holmium • Thulium • Greenlight • Pulsed • Continuous-wave

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Introduction

Before using a laser, fundamental understanding of this technical device is mandatory. Lasers interact with tissue, no matter whether it is soft tissue or stones. The absorption process acts like a sponge for light. Laser wavelength determines the penetration depths, and the power used the degree of tissue damage. Once the incidence beam hits the targeted tissue parts of it is reflected from the surface and parts are transmitted through the tissue. In addition to that, some energy is lost when scattering internally. These effects determine the biological effect: high absorption leads to better performance, with a cw laser results in a clear cut, and with a pulsed laser in good lithotripsy. At the same time they bear the risk of collateral damage in themselves. At some steps of a procedure, "bad" absorption is desired. The beneficial side effect would be better coagulation. One can reach this goal by either defocusing of the laser beam or shorter wavelength.

Lasers are mainly applied in two fields of endourology: stones and prostates.

Stones

For disintegration of stones pulsed lasers are used. The question arises, how much power such a laser should have. The total power (measured in Watt) is not as important as the question how this power is achieved. Power is the product of Energy (Joule) and Frequency (Hertz).

There are two ways to break stones: fragmentation or dusting. To fragment a stone high energy and low frequency are used. In opposite, for dusting low energy and high frequency are used. It is advisable to start with 8 W. In consequence of the abovementioned, those 8 W could have a setting of 4 J and 2 Hz for fragmenting or 2 J and 4 Hz for dusting.

In addition to that, pulse duration and breaks between pulses play a role in the efficiency of disintegration. Wezel et al. found that reduction of the pulse length from 700 to 350 μs resulted in a higher stone disintegration (Fig. 48.1) [1, 5].

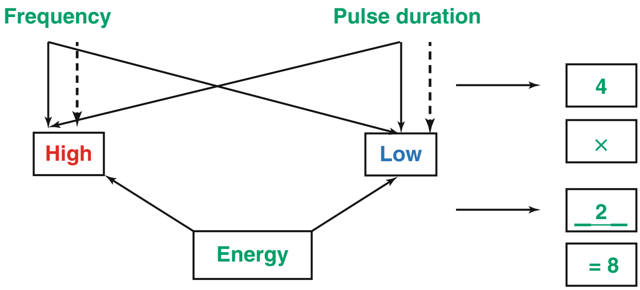

FIGURE 48.1 Manifold settings for pulsed lasers at the same power

	Ho:YAG	Tm:YAG	KTP
Immediate effect	+	+	+
Clean cut	–	+	–
Hemostasis	+	+	+
Large glands	+	+	(+)

FIGURE 48.2 Various parameters of laser effects

Prostates

Various lasers are used for the treatment of benign prostate enlargement (BPE). This is an interesting development, because lasers in this field have been discredited for many years after its uncritical use without knowledge of laser physics during the 1980s. Emission mode (cw or pulsed), wavelength and power used distinguish lasers from each other. To judge the quality of a laser for the treatment of BPE one has to check for the parameters immediate effect, clean cut, hemostasis, suitable for large glands (Fig. 48.2).

Lasers can either be used for vaporization or as a tool to remove pieces of the prostate. This can be done either by resecting or by enucleating the gland.

From a physical standpoint vaporization in BPE treatment is a so-called "vaporization". During vaporization the tissue is converted into steam, but only as deep as the penetration depth of the laser is. The underlying tissue remains untouched. Pure vaporization can be used for small prostates. The advantage is that this procedure is easy to learn, but the anatomical structures cannot be recognized, so that vaporization is often incomplete. In addition, pure vaporization is very time consuming with far less than 1 g/min of tissue removed and no histology available (Table 48.1).

To overcome this problem high Watt lasers have been introduced – with a higher risk of side effects such as capsular perforation or even scattered energy outside the prostate. Vaporization can be done with any laser, but is most typical for greenlight lasers.

The best long-term results are available for Holmium-YAG-lasers [4]. Since the 1990s, many studies published. Holmium lasers have been used for ablation, for a short time for resection, and since many years for transurethral enucleation. Its outcome demonstrated good urodynamical and symptom score results. It has been proven to be durable over many years. The drawback of holmium laser enucleation is a long learning curve due to difficult visibility as a consequence of the pulsed mode.

Thulium lasers followed Holmium lasers with a delay of 10 years [2]. The surgical procedure is identical, even so performed in a continuous wave mode, which helps to overcome the difficult visibility during Holmium procedures and consequently leads to a shorter learning curve. Large series with good outcome of all measured parameters are published.

Greenlight lasers have been promoted very aggressively [3]. A 2 year follow up of a multicenter randomized noninferiority trial comparing GreenLight-XPS laser vaporization of the

Table 48.1 Optical penetration depth varies from laser to laser

	Penetration	
Laser type	**Water**	**Tissue**
Greenlight	30 m	0.8 mm
Holmium	0.4 mm	0.4 mm
Thulium	0.2 mm	0.2 mm

prostate and transurethral resection of the prostate for the treatment of BPE has been published recently, and it showed an intermediate effectiveness and safety of GLP-XLS being similar to conventional TURP.

Conclusions

- For stones there is no doubt that Holmium lasers have stood the test of time. Most stones will be fragmented with a 10 W laser. In referral centers with many and hard stones a 20 W laser might be an interesting option.
- For prostates all three lasers have their role: Holmium in institutions where only one laser is affordable and few residents are trained; Thulium in an opposite situation, and Greenlight in high-risk patients with smaller glands.

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Chapter 49
TUR-P

Jan Klein, Ali S. Gözen, Marcel Fiedler, Philip Rieker, and Jens J. Rassweiler

Abstract Monopolar-TUR-P is the current surgical standard procedure for men with prostate sizes of 30–80 ml and bothersome moderate to severe LUTS secondary of BPO. Bipolar TURP represents a good alternative. In this chapter we reviewed the techniques and technologies for this procedure.

Keywords Benign prostatic obstruction • Bladder outlet obstruction • Transurethral resection of the prostate • TURP

Introduction

Prostate surgery is usually required when patients have experienced recurrent or refractory urinary retention, overflow incontinence, recurrent urinary tract infections bladder stones or diverticula, treatment-resistant macroscopic hematuria due to

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BPH/BPE, or dilatation of the upper urinary tract due to BPO, with or without renal insufficiency (absolute operation indications, need for surgery). Surgery is usually needed when patients have had insufficient relief on LUTS or PVR after conservative or medical treatments (relative operation indications) [1].

Monopolar-TUR-P is the current surgical standard procedure for men with prostate sizes of 30–80 ml and bothersome moderate to severe LUTS secondary of BPO. Though there are numerous variations in surgical techniques there are mainly two different surgical strategies described:

1. Resection from proximal to distal [4].
2. Resection in lobes [3].

Nesbit Standard Technique

Resection Strategy: From Proximal to Distal

The starting point of the resection is located at the bladder neck → 2nd phase of the resection is the resection of the midportion of the prostate → last stage of the procedure is the resection of the apical tissue.

Steps of the procedure:

1. Resection of the bladder neck in quadrants beginning at 12 o'clock until the circular fibers of the bladder neck appear.
2. Quadrantlike resection of the midportion of the prostate (superior to inferior) until the fibers of the prostatic capsule can be seen. (a) right upper quadrant 12–9 o'clock; (b) left upper quadrant 12–3 o'clock; (c) right lower quadrant 9–6 o'clock; (d) left lower quadrant 3–6 o'clock).
3. Resection of apical tissue – beginning next to the anatomical landmark verumontanum and directed towards the 12 o'clock position in a circular manner. Avoid unintentional slippage of the resectoscope to avoid damage to the sphincter.
4. The resection of tissue should not exceed the distal end of the verumontanum to preserve the external sphincter function.

Mauermayer Standard Technique

Resection Strategy: Resection in Lobes

The resection starts with the removal of the middle lobe including the tissue lateral to the verumontanum → 2nd phase: resection of the left lobe → 3rd phase: resection of the right lobe → last phase: resection of apical tissue.

Steps of the procedure:

1. The resection starts at the proximal part of the middle lobe at 6 o'clock. The resectoscope is placed directly proximal the verumontanum with the shaft exactly covering and protecting the verumontanum. The tissue is removed in long cuts while the endpoint of the cut can be precisely controlled. The midlobe is continuously resected from 5 to 7 o'clock.
2. The resection of the distal part of the midlobe includes the area next to the verumontanum. During the resection of this part increased attention has to be paid not to damage the external sphincter. Exceeding resection of the distal end of the verumontanum should be avoided on all costs. To check if there is still some remnant obstructive tissue the resectoscope should be pulled into the urethra just distal to the verumontanum.
3. The next step is the resection of the lateral lobes. It is up to the surgeons preference on which side to start.
4. Tip: if there is a big prostate to resect it is very heplful to resect the lateral lobes in quadrants – the surgical technique is to bisect the lateral lobes down to the surgical capsule. As a result you get four lobes: lateral left superior and inferior lobe; lateral right superior and inferior lobe.
5. Resection of the proximal part of the left lateral lobe in long precisely parallel cuts to achieve a smooth surface of the resected cavity. Remember the spherelike shape of the prostate that requires a spooning movement of the tip of the resectoscope to resect the adenoma down to the surgical capsule.

6. Resection of the proximal part of the right lateral lobe in long precisely parallel cuts to achieve a smooth surface of the resected cavity. Remember the spherelike shape of the prostate that requires a spooning movement of the tip of the resectoscope to resect the adenoma down to the surgical capsule.
7. Tip: after the resection of both lateral lobes – the resection chips should be evacuated from the bladder whether using a bladder syringe or an Ellik Evacuator. Thereafter a digital rectal examination shows the amount of remaining apical tissue and with a milking movement of the index finger remaining tissue of the side lobes can be pushed inside the prostatic fossa and resected – this maneuver helps to have a proper resection cavity.
8. Resection of apical tissue – beginning next to the anatomical landmark verumontanum and directed towards the 12 o'clock position in a circular manner. Avoid unintentional slippage of the resectoscope to avoid damage to the sphincter.
9. The resection of tissue should not exceed the distal end of the verumontanum to preserve the external sphincter function.

Monopolar TURP

Monopolar TUR-P is still the surgical standard procedure. But there are some advantages favoring bipolar TUR-P with comparable short- and mid-term results compared to monopolar TUR-P [1]. Especially due to the possibility to use saline as a resection fluid prevents the incidence of the potentially life-threatening TUR-P syndrome. Bipolar TUR-P has a more favorable perioperative safety profile compared to monopolar TUR-P.

Standard TURP uses monopolar current. The generator provides different programs for cutting and coagulation. To get an electrosurgical effect the electric circuit has to be closed.

Monopolar current flow: Generator → cable → Resection loop → prostatic tissue → shortest distance through the body to the return electrode pad (the distance depends on the area where the return electrode has been placed) → generator.

The irrigation solution used in monopolar transurethral resection has to be non-conductive to prevent uncontrolled current flow.

The disadvantage of using a salt-free irrigation fluid is the increased risk for causing a TUR Syndrome. This happens if large amounts of hypotonic fluids enter the circulation. If a big venous vessel is opened during the procedure it is necessary to limit the resection time to an absolute minimum [2].

The application of the pad electrode has to be monitored closely because too less contact with the patient leads to an error on the generator and more dangerous the pad electrode has to be kept dry to prevent burning of the patients skin [2].

Bipolar TURP

Bipolar resection is a good and save alternative compared to monopolar TUR-P [1]. The irrigation fluid used in bipolar TUR-P is saline 0.9 %. The advantage is that there is no risk of a TUR-Syndrome. But the risk of a fluid overload-syndrome is still there. The generator provides different programs for bipolar resectoscopes for cutting and coagulation. The standard settings of the generator are shown in Fig. 49.1.

Bipolar current flow: Generator → cable → Resection loop → Prostatic tissue → resection loop (alternatively shaft depending on the technical setup of the instrument) counter-electrode → cable → generator.

General tips when working with HF current:

1. It is important to avoid unnecessarily high current power. High current can cause collateral damage to the urethral sphincter and the Nn. erigentes.
2. Monopolar current application leads to a spray coagulation that means a wide area is affected by the coagulation effect.
3. Bipolar current application leads to a very precise effect. As a result an injured vessel can just be sealed by touching the vessel lumen with the loop and directly applying coagulating HF-current to the structure.

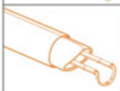
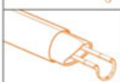
APPLICATION				ARC 400/ARC 350		ARC 303	
				EFFECT	POWER (W)	EFFECT	POWER (W)
TUR-P PROSTATE	MONOPOLAR		CUT	1	---	3–6	50–100
			COAG	---	40–70	---	40–70
			CUT	4	---	5–8	150–200
			COAG	---	70–100	---	70–100
TUR-VAP PROSTATE VAPORISATION			CUT	4	---	6–9	150–260
			COAG	---	90–120	---	90–120
TUR-P PROSTATE	BIPOLAR		CUT	1	---	NOT AVAILABLE	
			COAG	---	200		
			CUT	2	---		
			COAG	---	250		
TUR-VAP PROSTATE VAPORISATION			CUT	3	---		
			COAG	---	300		

FIGURE 49.1 Generator settings (BOWA) for TUR-P mono and bipolar

4. The use of bipolar energy in transurethral resection techniques requires specific technical modifications of the generators – an effective bipolar generator device is working with a so-called high cut modification allowing the device to start and ignite the plasma around the bipolar resection loop.
5. If the tissue especially the prostate capsule is cut or teared by applying bipolar coagulation to seal vessels, the effect has to be decreased.
6. After intense spray coagulation with the monopolar resectoscope the cutting of the tissue gets worse (reason: high energy applied to the tissue causes desiccation → the electrical conductivity decreases) [5].
7. If an obturator reflex is occurring during the procedure (TUR-B and TUR-P) even if working with the bipolar device the effect has to be decreased.

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Chapter 50
How to Perform a Good TURP

Nitin C. Shrotri

Abstract Practical tips on how to obtain good outcomes when performing a transurethral resection of the prostate for benign prostatic enlargement are provided in this chapter. From patient selection, to standardization of the intraoperative technique to a careful postoperative management of the patient are all important issues to address.

Keywords Technique • Transurethral resection of prostate

Pre Operative Selection

Performing a good TURP starts right at the beginning from patient selection, the importance of which cannot be understated. Ensure that the patient has bladder outflow obstruction using the IPSS/AUA or similar scoring systems with a

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high Symptom and Bother score. Poor selection with poor outcomes may lead to cause for complaints.

When the patient is admitted for surgery, ensure you are aware of hemoglobin, platelet count, clotting screen, creatinine levels. When consenting the patient ensure that side effects like retrograde ejaculation and erectile dysfunction have been discussed with the patient using patient-friendly language. This may also be the best time to establish rapport with the patient and reassure them.

In theaters, go through your WHO Checklist. During team brief, discuss hypotensive general anesthesia or spinal anesthesia with your anesthetic colleague. Intravenous gentamicin is the antibiotic of choice in the dose of 3–5 mg per kg, adding augmentin for patients with indwelling catheters. In cases of penicillin allergy, use ciprofloxacin or another appropriate antibiotic in accordance with your hospital policy. Urinary tract infections must be treated. For patients with catheters ensure that your microbiologist is aware of this fact so he can test appropriately.

Before Starting

After placing the patient in the lithotomy position, check that all pressure points are well padded with absence of patient contact with any metallic table parts. Calibrate the external urinary meatus and carry out a meatal dilatation or Otis urethrotomy, if necessary. If this is not done, it may result in meatal stenosis and scarring affecting the patients urinary stream within days or weeks of the operation. A complete cystoscopy is a must: missed tumors are embarrassing, to say the least! Use a visual obturator for a cystourethroscopy. Blind dilatation routinely with Clutton's dilators is not desirable without a prior urethroscopy.

The Procedure Step by Step (Fig. 50.1)

After noting the landmarks, especially the verumontanum, resect the middle lobe forming a central channel first between 5 and 7 o'clock position. Then resect at 2 and 10

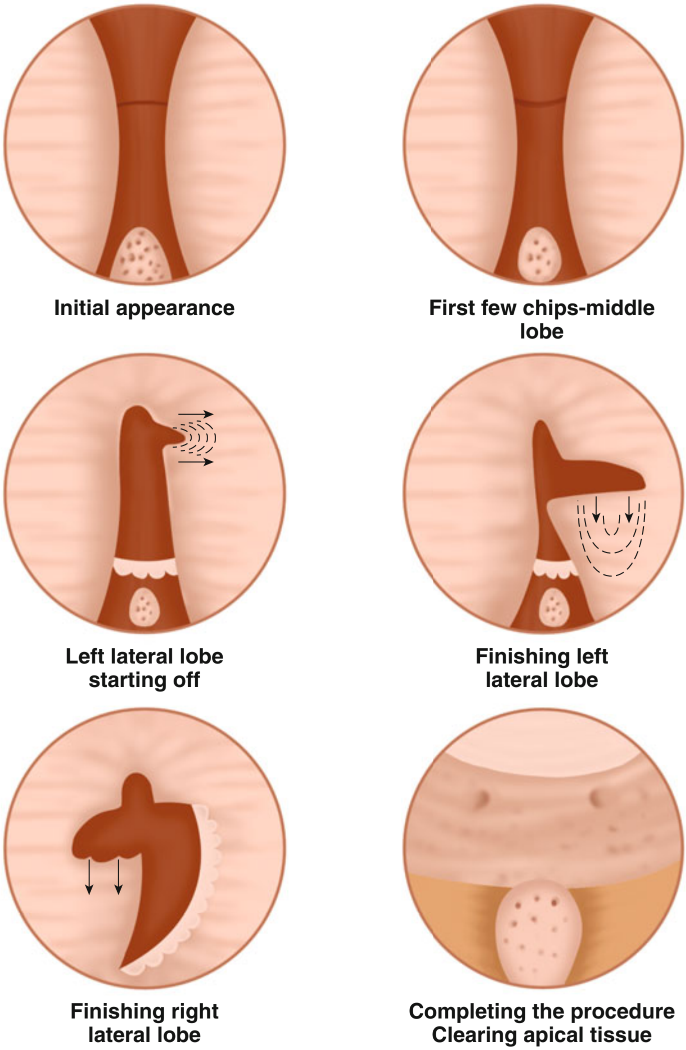

FIGURE 50.1 Step-by-step TURP: schematic illustration

o'clock down posteriorly to join the central channel. As for a new resectionist, it is safer to diathermy bleeding points as you go along. There can be very large vessels at 4 and 8 o'clock, so ensure that your irrigant flow (glycine or saline) is appropriate, with a theater assistant on hand to change bags at the correct time. The anterior lobe should then be resected, with the resection limit at all times being proximal to the verumontanum. The depth of resection should be limited by the transverse fibers of the prostatic "surgical" capsule. Its thickness varies in different glands so beware of small prostates where capsular perforation is often seen.

In patients with prostate cancer, a good channel may be enough. Be careful in resecting the apex in prostate cancer patients with sphincter infiltration since this may lead to incontinence, making the patient's life miserable, and possibly the surgeon's too!

It is good practice to empty bladder intermittently and specially at the end to look for bleeders at the bladder neck. As the bladder distends, these point inwards and may not be visible easily, leading to "post-operative" bleed. Empty the bladder also to prevent over distension. If using hypotensive general anesthesia, ensure blood pressure returned to normal before you finish so that all bleeders are caught.

Completing the Operation

When inserting a three-way catheter, which is usual practice, always use a catheter introducer, "sounding" the urethra. Follow the "roof" of the urethra to prevent pushing the catheter behind the bladder. Inject 30 ml of water into balloon with mild traction on the bladder neck for 30 min.

It is good practice to resect for 60 min when using glycine. This is to avoid the well described TUR Syndrome. Though well known, it may often be difficult to recognize due to its insidious onset and vague symptoms. Still, if a patient's behavior seems abnormal after surgery, think of "TUR

Syndrome" as one of your top differential diagnoses. One can of course, resect for longer when carrying out a transurethral resection in Saline.

Post Operative Management

Always visit the patient in the recovery area to ensure that the patient is comfortable and the irrigation is not turned. Make sure that the patient not in clot retention. Often, an indwelling catheter can set off a severe bladder spasm, so ask your anesthetic colleague to prescribe appropriate analgesics and anti-cholinergics.

Chapter 51
Management of Postoperative Complications Following TURP

Thomas Frede and Jens J. Rassweiler

Abstract Despite continual improvements in the technique and instrumentation, transurethral resection of the prostate is still accompanied by a significant and specific number of complications. The goal of this chapter is to give a short and compact overview of the most important early and late complications (e.g. hemorrhage, extravasation, TUR-Syndrome, infection, micturition disorder), their diagnosis and to provide some practical day-to-day working tips on how to manage these problems. One should also keep in mind that good cooperation between the surgeon, the attending physician and the nursing staff and the use of standards and clinical pathways is advisable to increase the likelihood of an uneventful postoperative course. That includes also to provide a patient guideline for the discharged patient and an outpatients appointment to control and evaluate the success of the operation.

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Keywords Complication • Management • TUR-Prostate

Introduction

Despite continual improvements in the technique and instrumentation transurethral resection of the prostate is still accompanied by a significant and specific number of early and late complications [1–3, 5]. The goal of this chapter is to give a short and compact overview of the most important complications and to provide some practical day-to-day working tips on how to manage these problems.

Early Complications

Bleeding

The management of a postoperative bleeding complication following TUR-Prostate varies in terms of the underlying cause. Therefore it is of great importance to be able to recognize a significant bleeding and distinguish between a venous and an arterial bleeding complication.

Venous Bleeding

Diagnostic Signs of significant venous bleeding are a *continual dark red discoloration* of the irrigation fluid which does not clear up despite good irrigation.

Therapy Initially a clot retention should be treated and special attention should be paid to recognizing a blocked catheter to ensure early management with a bladder syringe (*suctioning and irrigating*). In case of a clot retention a *complete removal of the clots* is urgently required and can be controlled by ultrasound examination. A maximal irrigation will prevent further clot retention.

Arterial Bleeding

Diagnostic Signs of significant arterial bleeding are a *light red, cloudy pulsating discoloration* of the irrigation fluid which does not clear up despite good irrigation.

Therapy Initially, any clot retention should be treated by a *complete removal of the clots* and can be controlled by ultrasound examination. Relatively weak arterial bleeding can sometimes be managed conservatively by maintaining a *maximal irrigation* and *increasing the blockade* of the catheter. A *strain on the catheter* and placement at the bladder neck is advisable if the origin of the bleeding is suspected behind the bladder neck (Fig. 51.1). However, a strong arterial bleeding

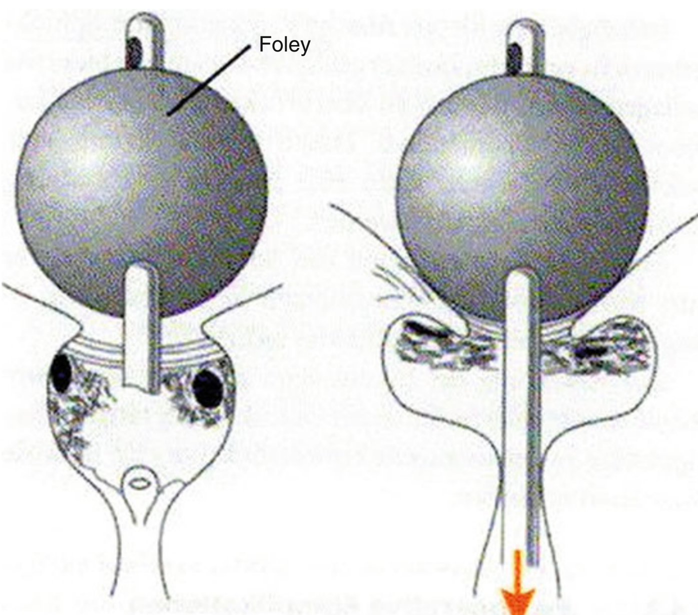

FIGURE 51.1 Management of bladder neck bleeding. Balloon is blocked with 20 cc more than the resection weight in the bladder and put under traction to occlude venous bleeders (From Rassweiler et al. [5])

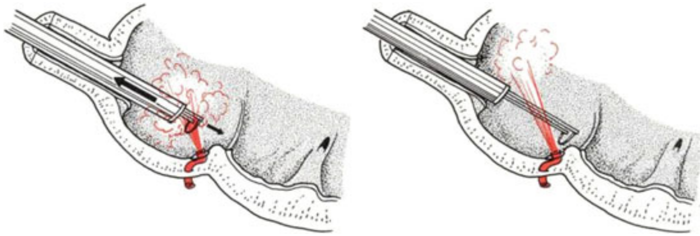

FIGURE 51.2 Retraction of resectoscope with advancement of the loop to achieve a better angle for visualization of a bleeding artery (From Rassweiler et al. [5])

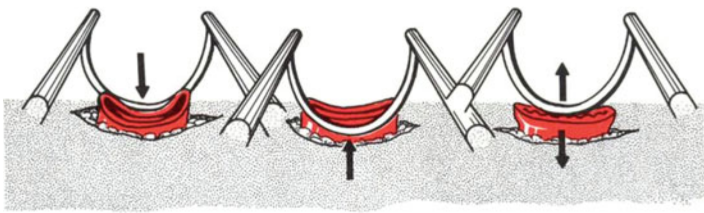

FIGURE 51.3 Effective coagulation of a large vessel by sealing of the lumen using slow circumferential movements of the loop (From Rassweiler et al. [5])

will require an early revision and haemostasis (Figs. 51.2 and 51.3). Particular attention should be paid to *complete removal of the blood clots* as the origin of the bleeding is often located below a layer of blood clots. Special attention should be paid to the bladder neck as *bleeders directly behind the bladder neck* are often not directly visible.

Extravasation

Early recognition of an extravasation is of great importance as a delayed diagnosis will cause more severe complications such as extra- or intra-abdominal fluid retention or a TUR-Syndrome.

Diagnostic In case of an unnoticed perforation of the prostate capsule the *palpation* of a tense (lower) abdomen will be crucial. Furthermore, *symptoms of a TUR-Syndrome* should draw the attention to the possibly underlying causes.

Therapy Controlled, but *early termination of the operation* is vital to avoid unnecessary aggravation of the situation. The *flow* of the irrigation should be *as limited as possible* and *normal saline* should be used. Special care should be taken with the *fluid balance* of the patient including balancing the fluid bags. A severe and symptomatic fluid retention requires *puncture and drainage*.

TUR-Syndrome

Fortunately, the frequency of a TUR-Syndrome is rare compared to the early years due to improvements in the technique and instrumentation. However, the rareness of the occurrence also increases the risk of missing an early diagnosis. The symptoms of a TUR-Syndrome will occur mostly intra-operatively but can be also seen in the early post-operative period. Also during bipolar TUR-Prostate fluid overload of the patient can occur.

Diagnostic *Symptoms of a TUR-Syndrome* are: Nausea and Vomiting, Hypertension, Bradycardia, Tachypnea, Pulmonary Oedema, Vision Disorders, Confusion and Agitation.

Therapy Intensive *Monitoring* and *fluid balance* is required. The flow of the irrigation (normal saline) should be as low as possible. Electrolyte imbalances need to be treated carefully.

Infection

Urine analysis prior to surgery and appropriate antibiotic treatment in case of an urinary tract infection is recommended. However, peri-operative urinary tract infection will still occur in this inhomogeneous patient collective with predisposing factors such as residual urine, retention and indwelling catheters.

Diagnostic *Symptoms of a urinary tract infection / septicaemia* are: Tachycardia, Fever, Shivering, Circulatory failure. Blood and urine should be analyzed for signs of infection; blood and urine cultures should be collected prior to an antibiotic treatment.

Therapy Early antibiotic treatment: in case of septicaemia immediate antibiotic treatment is required, as every hour counts in these patients.

Late Complications

Bleeding

In case of ongoing and not declining bleeding a urological examination is required to diagnose the underlying cause. It is not unusual to find clot retention in these patients causing and maintaining the hemorrhage.

Diagnostic *Ultrasound examination* is recommended to diagnose clot retention (Fig. 51.4). Urine analysis will exclude or confirm a possible urinary tract infection.

Therapy In case of clot retention a complete removal of the clots should be attempted by use of a catheter and a bladder syringe. If complete removal is not feasible operative revision is required.

Micturition Disorders

Ongoing obstructive micturition problems several weeks after TUR-Prostate require careful examination of the underlying problem as the patient will increasingly become embittered by the absence of the promised success.

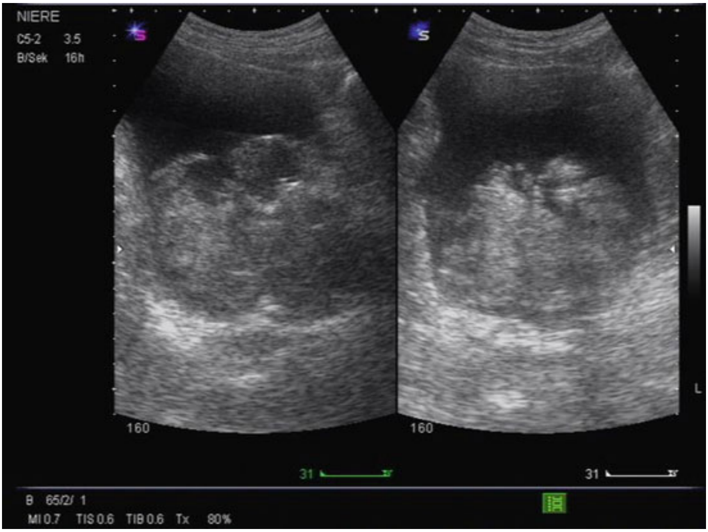

FIGURE 51.4 Clot retention – diagnosis by ultrasound examination

Diagnostic Standard urological examination includes the measurement of *IPSS, Uroflow and residual urine (5). Early cystoscopy* is recommended to exclude or diagnose blood clots or residual tissue which is not rarely located in the apical area of the prostate.

Therapy In case of blood clots *complete removal of the clots* is required and should be controlled by ultrasound. In case of residual tissue an *early resection* will possibly better ensure patient satisfaction than waiting with delayed reintervention.

Infection

Ongoing irritative micturition problems several weeks after TUR-Prostate can be caused by a urinary tract infection together with the patient's tendency to reduce fluid intake to keep the symptoms bearable.

Diagnostic Urine analysis prior to antibiotic treatment is mandatory.

Therapy Appropriate antibiotic treatment, anticholinergic drugs where appropriate and increased oral fluid intake, even if this initially increases symptoms, are indicated.

Conclusions

The best management of postoperative complications following TUR-Prostate is to avoid complications as far as possible. This goal is most likely achievable with good cooperation between the surgeon, the attending physician on the ward and the nursing staff. The goal of the surgeon should be to perform a standardized and uneventful operative procedure and to transfer the patient to the ward with a more or less clear irrigation fluid. The patient's treatment on the ward should be based on standards and clinical pathways and the physicians and nurses should be taught about possible complications and their management. One should keep in mind, that the treatment is not completed with the discharge of the patient. It is mandatory to inform the patient about possible problems and their management to avoid late complications. It is also recommended to provide patient guideline for the discharged patient. Of course an outpatients appointment should be arranged to control the success of the operation [4].

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Chapter 52
How to Perform a Good TURBT

Giovanni Grimaldi, Carlos Oliveira, Vincenzo Mirone, and Estevao Lima

Introduction

Transurethral bladder resection of Bladder Tumor (TURBT) is a crucial procedure in the management of Bladder Cancer. It has the double purpose of establishing the pathologic diagnosis, local staging and starting the treatment in the setting of non-muscle invasive tumors. A complete removal of all macroscopic visible lesions and biopsies of suspicious areas is essential for the correct management of the patient [1–9].

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Surgical Technique

TURBT should be performed systematically in the following steps:

1. Patient is positionated in lithotomy position and a bimanual palpation of the bladder is performed under anesthesia.
2. Introduction of the resectoscope under vision control and inspection of the whole urethra.
3. Careful inspection of all bladder mucosa taking advantage of the 30° lens optical characteristics. The number, size and position of all visible lesions should be registered as it is the key issue in the choice of the strategy of resection.
4. After identification (when possible) of both ureteral meatus, check urine characteristics. In case of hematuria identified from the meatus, collect a separate urine sample for cytology.
5. Resection of the tumor.

   (i) *Small papillar lesions* (up to 1 cm) can be resected "*en bloc*" in one piece antegrade fashion including the underlying bladder wall. This kind of approach allows an improved pathologic study because it preserves the spatial orientation of the lesion, with fewer cautery artifacts (Fig. 52.1).

   (ii) *Large papillary tumors* are resected anterogradely in fractions from the superficial area up to the pedicle of the tumor. A better control of the resection area is achieved by starting at the periphery and proceeding centrally.

   (iii) In case of *large papillary tumors with a small pedicle*, retrograde resection can be considered. It has a higher risk of bladder wall perforation, but it may allow an "*en bloc*" resection of bigger pedunculed tumors. A better control of the resection depth is achieved with small and fast resection impulses. Then an anterograde resection of the base is performed. When choosing this approach always remember to take care that the resected fragments allow extraction through the

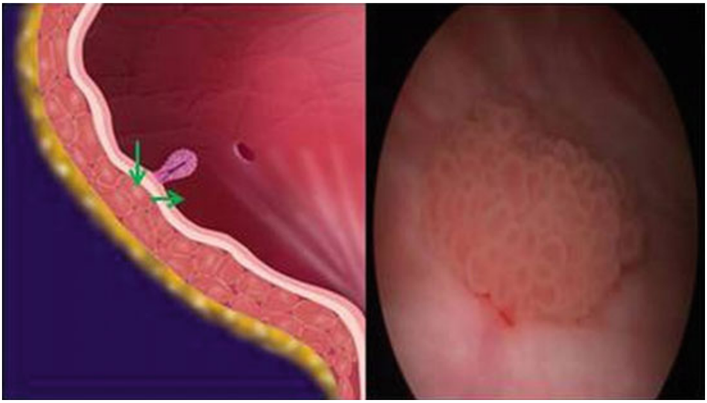

Figure 52.1

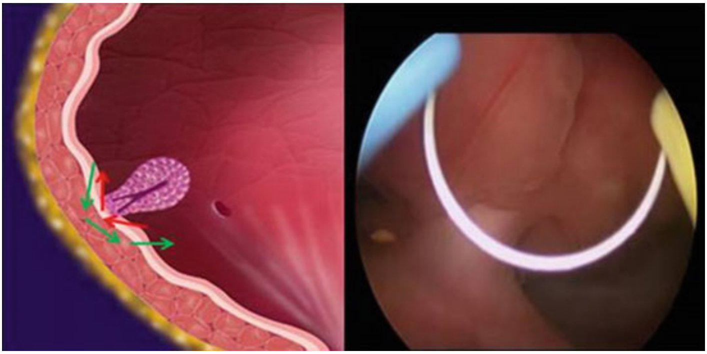

Figure 52.2

resector sheath. If the tumor is too big it will be impossible to remove without previous fragmentation. It is very difficult to resect in smaller parts a free floating tumor (Fig. 52.2).

6. Extraction of the specimen after the resection of the tumor. According to the sample size, removal of the specimen can be done manually with resectoscope or with Ellik evacuator. In case of Ellik use, after removal of specimen it is

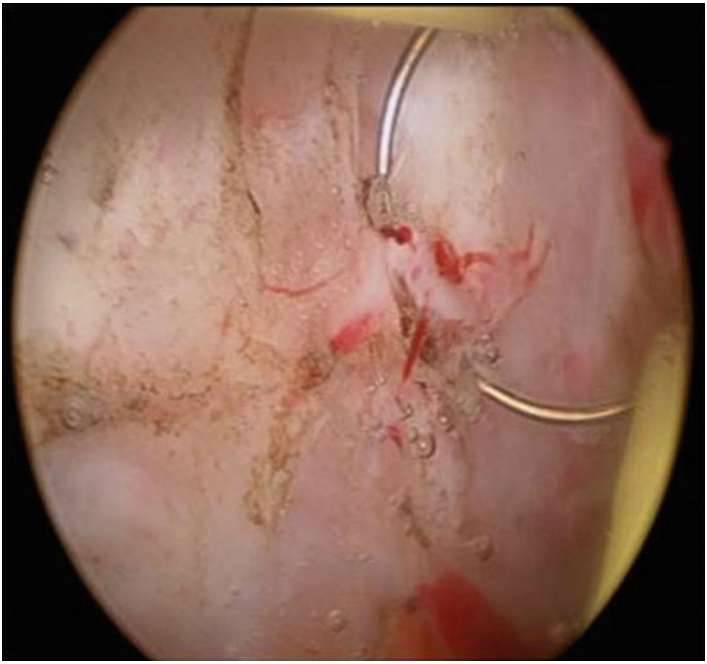

Figure 52.3

necessary to re-inspect the bladder to check for bleeding and to confirm the complete removal of all fragments.

7. Then it is important to sample the underlying bladder wall with muscular tissue and the edges of the resection area and label them separately to allow a complete pathological evaluation of existence and depth of tumor invasion into the lamina propria and detrusor muscle. The ideal depth should permit good detrusorial sampling without causing a perforation (Fig. 52.3).
8. Hemostatic control is performed by selective coagulation of bleeding vessels, resection bed and edges of resection area. Residual bleeding is checked under minimal bladder filling.
9. At the end of the procedure an indwelling three-way bladder catheter is placed with continuous bladder irrigation. The flow is determined by the degree of residual hematuria.

Postoperative Care/Complications

The most frequent complication of the TURBT is the postoperative hemorrhage and blood clots formation. Thus, a continuous irrigation through a transurethral three-way catheter (18–22 Fr) is usually performed for 24 h to avoid this complication. Normally the catheter is removed 24–72 h after surgery.

Special Circumstances

Tumor in Bladder Diverticulum

The TURBT is performed in a similar way as for other tumors. However, keep in mind that the diverticulum wall has no detrusor muscle, so the risk of perforation is higher.

Tumor Located at the Dome of the Bladder

It can be helpful using the non-dominant hand to press down on the lower abdomen above the pubic bone, elevate the operating table and minimally reduce the degree of bladder distension.

Tumor Near Ureteral Orifice

In the approach to tumors located near the ureteral orifice it is important to remember that cutting current is unlikely to cause ureteral stenosis. Coagulation has to be used sparingly due to high probability of occluding the ureteral orifice. Complete ablation of the ureteral meatus is performed if the tumor extends to this area. Normally, routine stenting is not necessary.

Multiple Tumors

It is difficult to perform a staged resection in separate containers of all tumors in patients presenting with multiple lesions. There is no standard way to approach these patients.

Our proposal is that the larger lesion is resected and sent in separate containers (tumor, base, borders) and the remainder tumors sent altogether.

Tips and Tricks

No procedure is easy, as every patient, every surgery is unique and needs full surgeon concentration. Remember that there are some insidious conditions such as obesity, BPH, increased bladder capacity, a thin-walled bladder (especially in women and older patients) and diverticular tumor that can hide surgical difficulties. In case of tumors located on the lateral bladder walls, there is the risk of eliciting an obturatory reflex causing the ipsilateral leg to adduct. This can cause a bladder perforation. In order to prevent this reflex it is useful to adopt the following indications:

(i) Minimize the filling of the bladder;
(ii) Use bipolar resector whether possible;
(iii) If the patient is under general anesthesia give myorelaxant drugs;
(iv) Local (transvesical or ultrasound guided) obturatory nerve block can be done if the patient is under spinal anesthesia.

Before proceeding with the cut mentally program its course; stabilize the resectoscope; get a firm contact with the tissue before starting the resection and move the loop slowly to get a continuous section. This technique promotes hemostatic effect and reduces the risk of perforation.

Cleaning the loop allows a more efficient resection. Best ways to brush off the resected tissue between two consecutive cuts are to brush the loop in the opposite direction of the last resection to dislodge the chip or make repeated quick movements of loop extraction and return or just a fast free tissue fulguration (both not too close to bladder wall) (Fig. 52.4).

Use cauterization only as long as necessary to get a good hemostasis and save the integrity of the pathologic specimen.

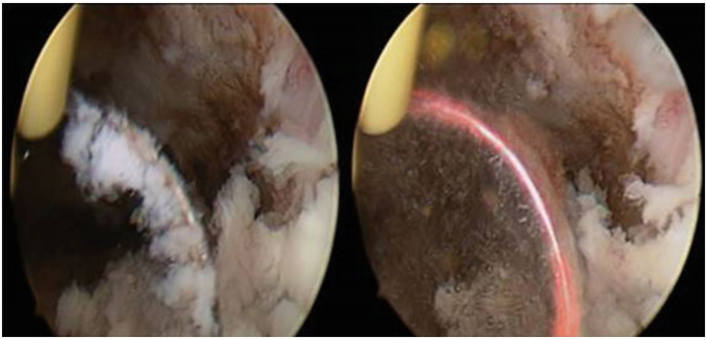

FIGURE 52.4

Use different sampling boxes to separate tissue specimens from the tumor body and base and collect it immediately so that detrusor muscle sample evaluation can be ensured and the depth of tumor invasion exactly assessed.

In case of positive cytology but negative findings at normal cystoscopy, initially diagnosed CIS or in the follow-up of patients with recurrences, new imaging techniques for NMIBC such as Photodynamic Diagnosis (PDD), Narrow Band Imaging (NBI), Storz Professional Image Enhancement System (SPIES), Optical Coherence Tomography (OCT) and Raman Spectroscopy can be extremely useful.

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Part III
Laparoscopic and Robotic Surgery

Chapter 53
Starting a Robotic Surgery Program

Ryan W. Dobbs, Laurel Sofer, and Simone Crivellaro

Abstract Starting a robotic surgery practice can be a daunting task for the novice urology attending. Over the past two decades, a significant shift has occurred in the field of minimally invasive urologic surgery with widespread adoption of robotic techniques for many major surgeries. The utilization of robotic surgery can be a key differentiator for hospitals and providers. In this chapter, we will briefly review the history of robotic urologic surgery and provide a practical guide addressing economic concerns, marketing, support staff and training needs, resident and fellow education, data collection metrics and general tips for creating a robust and sustainable robotic surgery practice.

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Robotic Surgery: History and Utilization

Over the past 25 years, a fundamental change has occurred in the role of laparoscopic and minimally invasive surgical techniques in the field of urology. The development of minimally invasive techniques were appealing to both patients and providers for the goals of decreased postoperative pain, more cosmetic surgical results, decreased rates of blood transfusions and decreased postoperative recovery time. While complex urological surgeries were described including laparoscopic nephrectomy by Clayman et al. in 1991 [6] and laparoscopic radical prostatectomy by Schuessler et al. in 1997 [29], these initial techniques were not widely utilized in part due to the lengthy learning curves and need for advanced laparoscopic surgical techniques required for proficiency.

The approval of the Intuitive Da Vinci robotic surgical platform (Mountain View, CA) by the Food and Drug Administration in 2000 and the description of the feasibility of robotic assisted laparoscopic prostatectomy (RALP) by Binder et al. in 2001 [4] proved to be critical advances towards the wide dissemination and utilization of robotic surgery.

Between these initial feasibility studies and today, robotic surgical techniques have become increasingly widely adopted. Between 2003 and 2010, the proportion of RALP adopters (as defined as performing >50 % of prostatectomies with robotic assistance) rose from 0.7 to 42 % in the United States [5]. Similarly, while robotic partial nephrectomies comprised only 23.9 % of all partial nephrectomies performed in the Nationwide Inpatient Sample between 2008 and 2010, there was a marked relative annual increase of 45.4 % for robotic partial nephrectomies observed during that time period [15]. These trends in the utilization of robotic urological surgeries would suggest that robotic surgery will be an increasingly critical element of the contemporary urologic practice.

In this chapter, we will describe an evidence based approach towards creating a comprehensive robotic surgery program. While the introduction of new minimally invasive surgical technology provides opportunities for significant benefits for patients, the implementation of this technology may also have significant pitfalls. In the United States, the period of the introduction of robotic technology was associated with higher risks for voiding and erectile dysfunction [1], and thus a structured and organized approach to the creation of a robotic surgery is critically important to obtain the excellent oncologic and functional results observed in several large high volume center studies [12, 13, 23].

Economics of a Robotic Surgery Program

Prior to acquiring a robotic surgical system, an economic analysis and plan should be developed for the purchase and maintenance of the robot. An accurate assessment is critically important for determining the economic limitations of an institution and if the current surgical volume is sufficient to support both the fixed (cost of purchasing the robotic platform, maintenance contracts) and variable (cost of training, disposal instruments, operative time) costs associated with the initiation of a robotics program. While urologic surgery comprises a significant portion of robotic procedures, acquiring a robotic surgical platform represents a hospital wide resource and consultation with colleagues in across several surgical specialties including gynecology [14], general [32], transplant [16], and colorectal surgery [9] can be helpful in determining if there is appropriate demand for a robotic platform as well as devising a plan for dividing costs and surgical block time for this resource. Administrative support is also vitally important to help assist with marketing, updating websites and educational resources for patients, supply management and to track costs and reimbursements associated with a robotic surgery program.

The initial cost of a robotic system can be significant ranging from $1 million to $2.5 million for each unit [2], and additional per procedure costs have been estimated as $1,600 per case as an additional variable cost and $3,200 per case, if the amortized cost of the robotic system is included [11]. These costs can be related to several factors including disposable surgical instruments and maintenance contracts and the additional cost is typically not covered as an additional fee by Medicare or most private insurance companies, so hospitals should account for the additional per procedural costs associated with this technology. Many other factors may also contribute to hospital related costs including blood transfusion [11], length of hospital stay [24], and operative time [3], and the overall cost effectiveness of robotic surgery remains a contentious area of debate and discussion [33].

Nevertheless, hospitals acquiring a robotic platform should perform a market analysis to determine potential for growth, regional and local competition and reimbursement and payers to thoroughly evaluate the potential of introducing this technology. While fixed costs regarding the purchase and upkeep of the machine are stable regardless of use, a high volume surgical center with an experienced robotics team should allow for a standard and efficient operative experience that can reduce variable costs and complications and provide the most cost effective approach to providing robotic urologic surgery.

Marketing and Creating a Robotic Referral Base

Marketing and website design are an essential part of the success of any new program, including robotic surgery. Prior to the purchase of a robot and establishing your robotic program, a well-balanced marketing team with financial resources specifically dedicated to your department should be implemented. A formal marketing plan should be developed, including assigning staff to develop a referral base to recruit new patients for your practice. It is important to implement the marketing strategies once proficiency of the surgical procedure has been accomplished. While the robotic platform is an excellent tool for providing minimally invasive surgery, it is no substitute for meticulous surgical technique and surgeon skill.

A website should be established which provides education and background information on the disease process at hand, and the potential advantages of using the robot vs other surgical modalities. It is important to reference published peer-reviewed data and to provide contact information for your practice for patients to contact you.

Educational brochures may be provided to patients and referring physicians to provide more information about the surgery being performed. These brochures can be used both for physician reference and for patients to educate themselves on the benefits of robotic surgery. While it may be tempting to delegate the creation and oversight of marketing materials, the attending surgeon should play an active role to produce materials which are educational for patients and are also well balanced. Unfortunately, many of the available materials presently on robotic surgery do not provide a balanced message. It has been previously reported that 42 % of websites regarding robotic prostatectomy failed to mention potential risks and many that many websites claimed benefits which have not been supported in evidence based medicine [22]. Prior studies have shown that the language used in these marketing materials may have a significant impact on patient decision making and that words such as “innovative” or “state of art” may strongly influence patient’s choice towards surgical treatment [10]. Given these findings, it is critical to provide a balanced message that weighs both risks and benefits associated with robotic surgery.

The media of the twenty-first century has created new marketing strategies for robotic surgeons. Television, newspaper and hospital website advertisements have been created by the manufacturers of the robotic system, and hospitals and surgeons around the country have helped in getting the word out. Many patients will present to your office requesting robotic surgery as an alternative due to an advertisement they have seen on television or on social media and so it is advisable to have a comprehensive approach towards marketing and patient education.

Support Staff and Training

Once the decision has been made to acquire a robotic surgical platform, a dedicated robotic operating room should be designated. A large OR with appropriate high definition video screens should be requested due to specific space requirements for the surgical console, surgical cart and the robotic platform and need for additional support staff, particularly during the learning curve of robotic surgery.

This beginning can be a particularly challenging time for a new attending as multiple team members are learning a new technology and their role during robotic operations. In many operating rooms, the support staff including the circulating nurse, surgical technician and surgical assistant may freely rotate between specialties and rooms depending on staffing needs. Given the unique aspects of robotic surgery, including docking and undocking the robot, the use of specialized disposable instrumentation and challenges associated with bedside assisting and draping, we strongly recommend identifying a specialized team of support staff who would benefit from additional training and experience to help smoothly facilitate robotic surgery from start to finish. In community settings, this dedicated team approach was used for comparable outcomes to academic settings with an estimated learning curve of 20–25 cases for robotic prostatectomy [25].

The attending surgeon should act as a leader for the implementation of a robotic surgical program. The lead attending is responsible for the performing the clinical aspects of care including preoperative counseling, performing the operation and postoperative follow up as well as responsible for coordinating the logistics and necessary training for support staff. In addition to good operative technique, strong communication and effective leadership are critically important for a fledgling robotics program. Depending on the experience of the surgeon, robotics proctoring and credentialing may be required prior to independent practice.

One of the most critical roles for the success of a robotic surgery program is the training and involvement of the bedside assistant. While some surgeons operate in tandem with another experienced attending surgeon at the bedside, this role may also be fulfilled by a Physician's Assistant (PA) or a resident physician. This assistant should have a strong understanding of the surgical anatomy to assist in retracting tissue, port placement and applying vascular clips as well as a thorough understanding of the robotic platform to assist in exchanging surgical instruments and troubleshooting the robotic platform at the bedside. Having a dedicated staff member for the robotics program like a PA can be helpful for training resident physicians to learn the fundamentals of robotic surgery prior to being involved with operations at the surgical console [27].

Resident and Fellow Involvement and Training

In many institutions, a key element of their mission is the education and training of residents and fellows. The involvement and education of residents and fellows within a robotic surgery program can be very beneficial for both faculty and trainees. Depending on their level of training and operative comfort, their role of trainees can vary from prepping and positioning the patient, assisting in the bedside role or operating on the surgical console. One of the great advantages of the robotic surgical platform is the ability to record video of resident operating experience and use for reviewing surgical technique in feedback sessions.

Prior to participating in the operating room, a high functioning robotics program should include a structured didactic curriculum for trainees prior to their involvement in direct patient care. Unfortunately, in a recent nationwide survey of urology residents in the United States, only 34.8 % of respondents reported a formal laparoscopic & robotic curriculum, a decrease from 41 % from a similar survey 5 years prior [7]. We believe that incorporating a formal robotics curriculum for resident education represents an opportunity for building a more robust and more successful robotics program. One important adjunct to the didactics portion of this education is the involvement and use of simulation training, either in the form of a dry lab with the robotic console or with a virtual reality simulator. Multiple studies have demonstrated that these tools can provide an excellent simulation experience and improve performance on specific robotic surgical skills prior to operating on patients [18–20].

While the availability of these trainers in residency programs has substantially improved from 14 % in 2009 to 60 % in 2013, this technology should be considered an essential part of the resident robotics educational experience and again represents an area for improvement [7]. These tools are primarily targeted for use with novice surgeons, however they also may be helpful for experienced robotic surgeons to maintain and refine their robotic technique as well.

Once trainees are comfortable with the robotic platform and ready to operate on patients, multiple studies have demonstrated that their involvement in these complex surgeries does not lead to adverse patient outcomes. Schroeck et al. evaluated a series of robotic prostatectomies which residents and fellows assisted in following a structured teaching curriculum which demonstrated a similar learning curve to those operations performed by an attending surgeon and with no significant differences in operative time, estimated blood loss or positive surgical margins [30]. Similarly, a recent analysis of the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) demonstrated that resident involvement in minimally invasive cases was not associated with an increased odds of overall complications, reoperation or readmission rates for minimally invasive prostatectomy, radical or partial nephrectomy, although they did note that operative times were longer with resident participation [28].

These studies should be reassuring that with a structured and well supervised approach to education, these trainees can be a valuable asset to a robotics program.

Data Collection, Benchmarks and Progress

The start of a robotics program can be challenging time for a lead surgeon, even if they have had a strong background and experience with robotics in residency and fellowship. One of the most important tools for improving surgical performance and patient outcomes is a structured approach towards data collection and reporting. Standardized approaches to data collection and evaluation of early complications have been reported in a number of different robotic surgeries including robotic assisted radical cystectomy (RARC) [17] and RALP [8] and these standardized systems can be a very helpful method for data collection. Standard datasets allow for comparing like to like outcomes between different institutions and surgeons and facilitates multi-institution research projects. In addition to tracking surgeon and operative data such as operative time, estimated blood loss and positive surgical margins, it may also be helpful to acquire patient centered data to evaluate for functional outcomes after robotic surgery. This patient driven data has proven to be a productive area of recent research, particularly for major oncologic surgeries associated with potentially significant morbidity such as RARC [26] and RALP [31] and a number of different metrics are available for use which can help to track sexual, urinary and quality of life aspects following surgery [21, 34]. Most importantly, this data should be used to critically analyze strengths and weaknesses and to provide the best outcomes for patients in the future.

Conclusions

While the initiation of a robotic surgery program may require a great deal of hard work, the rewards can be substantial. Building a robust infrastructure that allows for the education and training of support staff, residents and fellows allows for the creation of a highly efficient minimally invasive surgical program that will benefit patients for years. The robotic surgical platform is a reliable and effective tool for performing minimally invasive operations with a less steep learning curve than the often technically demanding pure laparoscopic approach. Building a program requires an approach that takes into account many factors including economic needs, education and continual review of patient outcomes and results. Addressing these concerns, devising a long term strategy and working to maintain and develop this robotics program will benefit patients and providers alike for years to come.

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Chapter 54
Tips for Education in Laparoscopy

Yaşar Özgök and Serdar Yalçın

Abstract This chapter includes a critical analysis of the issues related to contemporary surgical training. In addition, it provides useful tips to build an effective structured training program for laparoscopic urologic surgery.

Keywords Training • Laparoscopy

Introduction

To achieve an appropriate and efficient surgical experience, currently there are several difficulties. An operation performed by a laparoscopy trainee takes more time and it is more expensive [2, 3]. In today's conditions, it is not easy to ensure appropriate environment for a trainee to give the necessary training in the operation room and the modern operating room is not recognized as an ideal learning environment [15]. The laws for malpractice and the ethical considerations, the demand to get higher quality health services, stress, current economical constrictions, and government cost

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reduction pressure limits the health care professionals to give the best training on the real patients for the laparoscopy trainee [15, 41].

Besides all these issues, extensive and high-quality training is needed for the best laparoscopic performance. Hence, different authors offer different urologic laparoscopic training programs [8, 16, 17, 34, 35, 37, 39]. These programs aim to train urologists for the best laparoscopy practice.

While laparoscopic surgery is clearly advantageous in terms of patient outcomes, the procedure is more difficult from the surgeon's perspective when compared to the open surgery. The surgeon has limited range of motion and view at the surgical site resulting in a loss of dexterity and poor depth perception. These disadvantages disturb the surgeon's observation, manipulation and the eye-hand coordination. Images of the laparoscopic surgery on the monitor are presented by the camera assistant and no longer follow the head and eye movements of the surgeon. Surgeons must use laparoscopic instruments to touch, feel and interact with tissue rather than manipulate it directly with their own hands. This results in an inability to apply the appropriate force for the tissue not to damage it. This limitation also reduces tactile sensation. The vision is three-dimensional, the tactile sensation is fully present and hand freedom is 6° in open surgery while the vision is mostly two (three dimensional systems are present today), the tactile sensation is reduced and the hand freedom is 4° in laparoscopic surgery [16, 17, 38, 42]. Additionally, the instrument endpoints move in the opposite direction to the surgeon's hands due to the fixed entry point of the instruments in the abdominal wall (pivot point). This is called the "fulcrum effect", and it results in a disparity in the directions. These non-intuitive motor skills make laparoscopic surgery difficult to learn and a surgery to be trained on it [6, 10, 16, 17].

Training, time and experience are required until proficiency is reached for the laparoscopic surgery. Learning by trial and error is not possible today. Laparoscopy training is a need in surgeon's education while the number of minimally invasive procedures rises in the urological field.

Surgical Education

Surgical education shows the fastest growth of all time. Residents and surgeons are being expected to have core competencies. New methods are being tried and new evaluation criteria are being determined [7].

For centuries trainees has learned the ability to conduct surgery while performing in the more experienced or mentor one's mastery. Knowledge, skills and attitudes are the three domains of competence. Knowledge is needed to have information, which is reachable, by books, articles, multimedia and web. Skill needs psychomotor competencies. A competent training program including regular practice and proper motivation can develop competency. Clinical judgment, decision-making and behavioral qualities should be given to the trainee [13, 16, 17, 21]. During laparoscopic surgery training, a trainee should practice procedures repeatedly till she/he judged to be proficient. Basic and complex laparoscopic tasks should be taught to the trainees in parts and repetitive practice should be performed [29]. Cognitive phase, psychomotor phase and automatic phase are the three phases of acquisition of a new psychomotor skill. It is clear by now that only after a didactic session, individuals significantly improve performance [9, 14, 16, 17]. Motor skill learning has "fast learning" and "slow learning" phases. Fast learning phase, which is a GABA-related neural process, selects optimal routine for the performance of the task. Second learning phase provides long-term structural modification of basic motor modules and time dependent strengthening of links between motor neurons in different areas of the brain [11, 43].

A standardization of surgical education is needed; but there is still lack of the procedures and standardization tools. Surgical competence and learning curve of the procedures are the main subjects of the surgical training. It is very hard to standard this subjects in an objective way. Making the description of defining competence and learning curve is very hard. ADEPT (Advanced Dundee Psychomotor Test), OSATS (Objective Structured Assessment of Technique

Skills) and MISTELS (McGill Inanimate System for Training and Evaluation of Laparoscopic Skills) are the three tests in skill assessment [16, 17].

Tips

- Three domains of the competence are knowledge, skills and attitudes.
- Regular practice and proper motivation can develop competency during the training program including.
- During the training, a trainee should practice procedures repeatedly till she/he judged to be proficient.
- A trainee should learn clinical judgment, decision-making and behavioral qualities during the treatment.
- Cognitive phase, psychomotor phase and automatic phase are the three phases of acquisition of a new psychomotor skill.
- Motor skill learning has "fast learning" and "slow learning" phases.
- Fast learning GABA-related neural phase selects optimal routine for the performance of the task.
- Second learning phase provides long-term structural modification of basic motor modules and time dependent strengthening of links between motor neurons in different areas of the brain.
- ADEPT, OSATS and MISTELS are the three tests in skill assessment.

Simulation in Laparoscopic Training

Different urological laparoscopic training models and simulators are available. Simulation-based training is playing an increasingly important role in surgery. The rapid advancement of technology, increased effort on best adaptation to the new technologies in clinical practice, limited working time, patient safety and ethical concerns, increasing health care costs, and new device training regulations makes the simulators and ideal tool for the laparoscopy training [7].

The interest and implementation of simulation in laparoscopy education in urology continues to expand. They vary physical to virtual reality, outcome based to movement based and demonstrated validation level [5]. It was determined that the peg transfer, marked cutting, needle driving, knot tying and clip application psychomotor skills exercises could be translated directly to laparoscopic urology training [7].

Training with pelvic trainers (training boxes) and real laparoscopic instruments called as physical simulators. Real tissues or tissue like materials are used in these simulators [12, 26, 28, 30]. New training curricula have been developed around virtual reality simulation as well. Virtual reality (VR) simulators are controlled by computer systems. These kinds of simulators are mostly very expensive and do not have tactile feedback [7, 19, 32]. But an objective metrics or assessment of the performance can be expected in computer-based systems. Thinking three dimensional in the two dimensional environment, minimizing the fulcrum effect, automatism, eye-hand coordination, shorten the learning curve and maintaining the competence should be the goals of the simulators in laparoscopy [16, 17].

Animal models and cadaveric models are being used in the wet lab stages in the laparoscopy training programs. Animal models are the other kind of training models [24]. Most of the authors say step by step transition, dry lab to wet lab, is better for the training process of a laparoscopic surgeon; but Tunç et al. showed no statistically significant changes at the end of their course despite the fact that the trainees had started their training at dry lab or wet lab stages [39]. Pigs are the most common used animals as a training model. Pig models are useful living models and their anatomy is comparable to that of humans. The trainees can have a real practice in a living model and correct their errors in vivo and cope with the problems. Trainers should observe the trainees on the wet lab and they should let the trainees perform the real laparoscopic operations on the human when they do the procedure in the pig living models without any difficulty. Ozgok has described the planning and designing of an ideal animal laboratory set up for surgical training in his article [24]. Cadaveric models are being used for the laparoscopy training [16, 17, 23, 39, 40].

Basic laparoscopic skills such as eye hand coordination, depth perception and knot tying can be improved with in vitro and in vivo training models. But advanced laparoscopic skills such as dissection, cutting, coagulation, and stitching need more sophisticated animal or human cadaver models [40]. Several studies have been published to investigate the improvement of laparoscopic skills in animal models [24, 35, 40]. Most training devices such as pelvitrainers or VR simulators provide training capabilities with a focus on eye-hand coordination, targeting the proficiency of suturing and knotting techniques. Especially the low cost pelvitrainers are used for these purposes widespread. Several pelvitrainers are described in the literature. Also there are commercially available models in the market such as video Pelvitrainer (Karl Storz Endoscopy, Culver City, CA) and the dual mirror Simuview (Simulab Corporation, Seattle, WA), pulsatile organ-perfused (POP) trainers (Optimist, Austria). The development of laparoscopy in urology has been slower than that witnessed in general surgery.

Urological procedures are more complex and needed advanced training, especially complex reconstructive urologic procedures, such as pyeloplasty and urethrovesical anastomosis [35].

Tips

- Simulation-based training is playing an increasingly important role in surgery.
- Physical simulators, virtual reality simulators, animal models and cadaveric models are the current simulator models.
- Basic laparoscopic skills such as eye hand coordination, depth perception and knot tying can be improved with in vitro and in vivo training models.

- Advanced laparoscopic skills such as dissection, cutting, coagulation, and stitching need more sophisticated animal or human cadaver models.
- Reconstructive urological procedures needed advanced training.

Warm-Up Exercises

Many disciplines accepts that age-old idiom; "Practice makes perfect". Some of the disciplines engage in routine "warm-up" exercise before the performance such as sportsmen, musicians, paint artists and military men. Pre-performance warm-up improves both mental and physical exercises. Some of the studies showed warm-up exercises improve the performance in surgery. Surgeon's high stakes skills-based performance benefits the warm-up exercises in both surgical performance and patient's outcomes [1]. Lee et al. concluded in their study that performing preoperative warm-up exercises approximately 1 h before the laparoscopic renal surgery improve in cognitive, psychomotor, and technical performance [18].

Tips

- Pre-performance warm-up improves both mental and physical exercises.
- It has been shown that warm-up exercises improve the performance in surgery.
- Performing preoperative warm-up exercises approximately 1 h before the laparoscopic renal surgery improves in cognitive, psychomotor, and technical performance.

Laparoscopic Training Programs

Laguna et al. agreed the statement of The American College of Surgeons: "the surgeon must be qualified, experienced, and knowledgeable in management of the disease for which the technology is applied" [16, 17, 27]. Learning curve of laparoscopic interventions is higher than open surgery and there are many reasons for a laparoscopic training program for the surgeons [36]. Morrison et al. showed in their study that 88 % of the urologists consider training useful and necessary during residency.

Colegrove et al showed that only 54.3 % of the attending trainees performed laparoscopic surgery 5 year after the workshop [4]. In addition, Laguna et al. stated that 45 % of the professionals in Europe consider training in laparoscopy insufficient [16, 17]. It is unclear how to transfer the acquired laparoscopic skills in the laboratory to real operating room. The importance of the participation of the mentors to the laparoscopic training is certain [35].

Edward et al. made evidence-based recommendations for optimal training design for procedural motor skills and laparoscopic surgery. These recommendations are deserve to be cited here. These recommendations facilitate efficiency in laparoscopic motor skill training such as session spacing, adaptive training, task variability, part-task training, mental imagery and deliberate practice [33].

Tips

- Training models need to be validated in terms of build up and predictive validity. Objective criteria for the different training models should be determined. The goals of the training should be established. The focus of the training design should be on learning.
- A suitable and adaptable schedule for trainees should be engaged. In this way trainees will progress their motor skills, cognition and awareness in a time depended manner.
- To facilitate the learning and reduce the cognitive load, complex tasks should be practiced dividing into parts. It needs to be researched more to determine the validity of the learning strategy.

- To make a realistic transfer setting of the operating room dual and multiple task training conditions should be observed and measured for automation of the motor skills.
- Long-term retention of the skills should be considered in the training period.
- Cumulative spaced training should be performed for the trainees to reduce mental fatigue and get the maximum benefit.
- Mental imagery should teach the trainees to increase surgical skills and reduce the time and materials required for the training.
- The training should lead the further development of the trainee

Hands-on Training Courses

Competence-based and time-based training schemas are available. Most of the training programs are time-based. Every training program should explain the way of acquiring skills, certification form and safe clinical transmission [16, 17]. Basically two types of training are available: the hands-on training courses proposed by different urological societies and centers and the fellowship program of variable duration. An additional advantage of most of the fellowships is the possibility to extend the program with a mentor. Hands-on training courses are popular and easy to attend. These 2–5 days are available in specialized centers. This kind of courses improves some skills such as knot tying [22, 27, 39]. In these courses didactic lectures, video explanations of the exercises, live video cases, bench and animal simulation are available.

The Applied Laparoscopic Urology Courses and Symposiums have been organized nationally and internationally in collaboration with the EAU Section of Uro-technology since 2005. Overall, each course has an intensive graduate training program comprising real dry-laboratory application of laparoscopic instruments, hands-on training, development of stereotactic

Figure 54.1 Video-based theoretical session

abilities, a video-based theoretical session, and real wet-laboratory training on live porcine tissue [39]. We have modified "Ozgok Turkish Training Program Design" to facilitate the mastering of challenging laparoscopic skills by urologists.

There are four major structural components: video based theoretical session (Fig. 54.1), dry laboratory (Fig. 54.2), wet laboratory (Fig. 54.3), and live surgeries with trainees (Fig. 54.4). Limited numbers of trainees are accepted in each course, and they are divided into three subgroups according to course application order.

The first group participates in a video-based theoretical session (Fig. 54.1), the second group trains in the dry laboratory (Fig. 54.2), and the third group trains in the wet laboratory where live-animal surgery is conducted on pigs. We lay the pigs on the lateral position to use the animals effectively. This gives the opportunity to use the both side of the pigs to perform laparoscopic surgery; such as nephrectomy, pyeloplasty and partial nephrectomy etc. Each group has the opportunity to participate in the same field twice (Fig. 54.3). Three-day-course ends with live surgeries. Trainees perform laparoscopic surgeries in the operating room under the guidance of the mentors on the last day (Fig. 54.4).

FIGURE 54.2 Training in the dry laboratory

Fellowship Programs

Fellowship models and programs are available for the residents and postgraduates in laparoscopic urology [20, 25, 31]. These programs have its own gradual development style from easy to hard procedures and bench models to clinical practice. These programs contain observing and participating procedures under the mentor's guidance in a safe environment. Duration of the fellowships is recommended to last between 3 and 12 months [16, 17].

Society of Endourology in United States, Europe, Asia and South America have different fellowship programs available in laparoscopy. European Society of Uro-Technology (ESUT) has its own fellowship and certification program in Europe. IRCAD-EITS (Strasbourg) is a center where the theory is being given in standardized modules and in animal models [16, 17].

FIGURE 54.3 Third group trains in the wet laboratory where live-animal surgery is conducted on pigs

FIGURE 54.4 Trainees perform laparoscopic surgeries in the operating room under the guidance of the mentors on the last day

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Chapter 55
Tips in Anesthesia for Robotic Surgery

Ayşegül Özgök, Müge Arıkan, and Dilek Kazancı

Abstract In this chapter we aim to provide an overview of the risks and possible anesthesia-related complications during robotic assisted urologic surgery, and tips and tricks to minimize these risks and to manage these complications.

Keywords Anesthesia • Robotic surgery

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Introduction

Robotic laparoscopic surgery provides significant advantages for patient, such as improved cosmetic results and patient satisfactions, less blood loss, minimal pain and ileus, decreased wound complications, shorter recovery time and length of hospital stay. Because of the advantages of this technique, an increasing number of surgical procedures are becoming robot assisted [1].

General Considerations

Anesthetic management in robot-assisted radical prostatectomy (RARP) is primarily related to the pneumoperitoneum in the Trendelenburg position. This combination affects the cerebrovascular, respiratory systems, and hemodynamic balance.

Selection of patients for robot assisted surgery is very important because clinical condition may not give permission for prolonged period in extreme position. Especially, significant cardiovascular comorbidity, cerebrovascular disease, poor pulmonary function, pulmonary hypertension and glaucoma must be considered as independent risk factors [1].

Pre anesthesia evaluation be done carefully, especially for the elderly patients. Optimization of cardiovascular, respiratory, metabolic and other systemic controls must be achieved clearly. Pre-existing neurological deficits should be evaluated as well. It is unclear whether RARP patients have increased risk for ischaemic optic neuropathy, but they should be referred to an ophthalmologist [2, 3, 4].

Patients with significant cardiac disease should have further evaluation. Coronary artery disease patients who had stents should be consulted with cardiologist about antiplatelet and antithrombotic therapy. Antiplatelet therapy might be stopped before surgery or replaced by his cardiologist. In these cases it must be started as soon as possible during postoperative period [5].

Patients who has known with airway difficulties might have some postoperative airway problems. Patients with severe chronic obstructive pulmonary disease should be consulted because of high airway peak pressure required intraoperatively. Increased intra-abdominal pressure along with cephalad movement of the diaphragm resulted in a reduction of the lung functional reserve capacity. Airway peak and plateau pressures increase [6]. Patients who have bullous lung have contraindication due to complication, such as rupture.

Severe hemorrhage is hard to control in laparoscopic surgery. Patients who had abdominal surgery before the RARP operation may have critical adhesions in operation site and have risk of bleeding, therefore, blood for transfusion should be made available for every patient beforehand.

Patient body mass index (BMI) is important because obesity is a significant problem. Obese patients may have difficult airway, higher incidence of cardiovascular, pulmonary diseases and diabetes mellitus.

Anesthesia Technique

Pneumoperitoneum and steep Trendelenburg position require the use of general anesthesia with mechanically controlled ventilation. A general anesthetic technique should be selected that takes into account the patient's history and comorbidities. Anesthesia induction with intravenous anesthetic agents, maintenance with inhaled anesthetic agents, intermittent opioids and muscle relaxant is recommended. Monitoring during the surgery should include ECG, end tidal CO_2 concentration, pulse oximeter, intra-arterial pressure, bispectral index (BIS), temperature monitoring and urine output. If required, defibrillator peds, precordial Doppler, transesophageal echocardiography, near infrared spectroscopy (NIRS), and train of four devices may be instituted.

Two wide intravascular cannulae with extension tubings should be placed to administer anesthetic drugs and fluids intraoperatively. Urine output can be unreliable in urinary

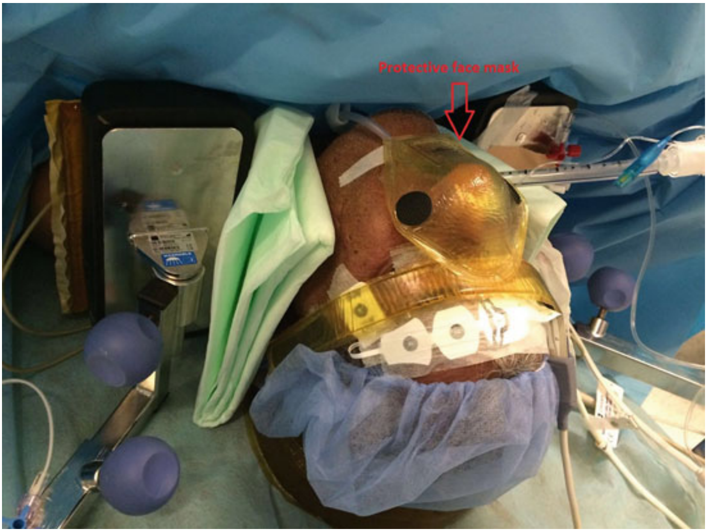

FIGURE 55.1 Patients should be protected from robotic arms and other injuries

tract procedures. Nasogastric tube is required to deflate the stomach is before induction of anesthesia. A central venous catheter is placed for management of fluid balance via monitorization of central venous pressure (CVP). An arterial line must be conducted for continuous monitorization of arterial pressure due to the preoperative cardiac functional status of the patient. The patient should be well strapped to the table to prevent sliding. The endotracheal tube should be carefully taped to the patient to prevent migration.Trendelenburg position can cause endobronchial intubation due to the diaphragm, lungs, and carina to shift cranially. To prevent corneal abrasion, eyes should be closed (Fig. 55.1). Table position should be checked for any strain on monitoring cables, circuit and intravenous tubings before starting operation. The level of CVP and blood pressure should be recorded after patient positioning. [5, 7] (Fig. 55.2).

Pressure-Controlled Ventilation and Positive end expiration pressure [PEEP (5 cm H_2O) + 20 (max)] are recommended

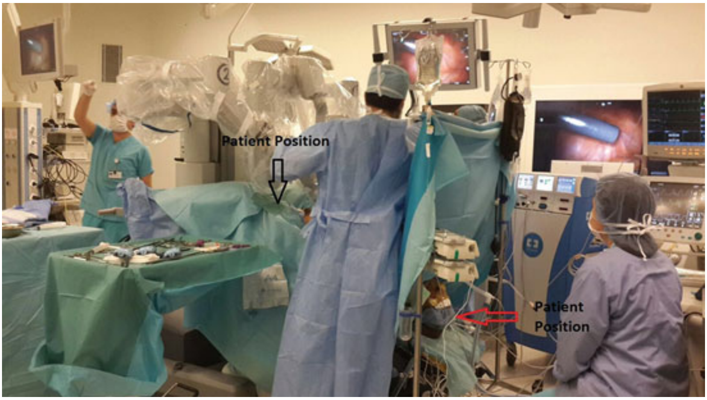

FIGURE 55.2 35–45° Trendelenburg position is given to patient

both for the prevention of atelectasis and barotrauma. It was found to result in greater dynamic compliance and lower peak inspiratory airway pressure, compared with volume-controlled ventilation. Mild hyperventilation is recommended to avoid development of hypercarbia and resultant metabolic and respiratory acidosis.

Complications and Management Strategies

The combination of pneumoperitoneum with the steep Trendelenburg position impairs respiratory mechanics, and it causes severe pulmonary complications such as; atelectasis, pulmonary edema, hypercarbia, and respiratory acidosis.

It should be considered, the pneumoperitonium may cause to vagal nerve stimulation resulting in bradycardia, nodal, atrioventricular dissociation, and asystole. Afterload increases significantly during the pneumoperitoneum. Heart rate and cardiac index increase significantly during RARP [8].

- ***Tips and Tricks***: Arterial vasodilation at the time of pneumoperitoneum may reduce afterload and myocardial oxygen demand.

Intra cranial pressure (ICP) increases during RARP procedure due to increased intraabdominal pressure that stops lumbar venous plexus venous return. Also steep Trendelenburg position increases ICP directly. Patients who had cerebrovascular ischemia or cerebrovascular disorders may develop severe complications result from both Trendelenburg position and pneumoperitoneum originated ICP increase [9]. These may all give rise of deterioration of cerebral oxygenation.

- ***Tips and Tricks***: NIRS monitorization may be useful in these patients groups. Mechanical ventilation strategy should be adjusted to preserve blood gases in normocapnic range and in order to eliminate the risk of increase in ICP [10].

Intraocular pressure (IOP) increases after pneumoperitoneum and the steep Trendelenburg position are established. Surgical duration and $ETCO_2$ are significant predictors of IOP increase in the Trendelenburg position [4]. This increase may be less with propofol than with sevoflurane anesthesia [11].

- ***Tips and Tricks***: Modifed Z Trendelenburg position may have a significant positive effect by lowering intraocular pressure and accelerating its recovery [12].

Pneumoperitoneum causes subcutaneous emphysema (SCE) in about 0.3–3.9 % cases. Risk factors for SCE are end tidal CO_2 levels more than 50 mmHg, multiple operative ports, prolonged operation time, and old patients. Venous gas embolism may be a life threatening complication in some cases. Sudden cardiovascular collapse may occur due to venous gas embolism with changes in caphnographic tracing [3]. Other potential complications of pneumoperitoneum include pneumothorax, pneumomediastinum, and pneumocardium.

- ***Tips and Tricks***: If SCE promotes to prefacial planes it may be indicative a dangerous pneumothorax, pneumomediastinum and pneumopericardium.

Prolonged steep Trendelenburg position and the amount of intravenous fluid given may lead to facial, periorbital, conjunctival, pharyngeal, and laryngeal edema. Using a restrictive fluid management and limiting time in the head-down position may be useful to avoid this complication. The duration of Trendelenburg position should be as short as possible.

- ***Tips and Tricks***: If face swelling, and/or periorbital edema is noticed, the anesthesiologist should perform endotracheal tube cuff leak test before extubation.
- ***Tips and Tricks***: The critical anesthetic concerns of RARP are the physiologic consequences of pneumoperitoneum in the steep Trendelenburg position, restricted access to the patient, hypothermia, venous gas embolism, subcutaneous emphysema, corneal abrasion, laryngeal edema, posterior ischemic optic neuropathy, lower extremity compartment syndrome, and nerve injury.

Teamwork and communication among surgeons, and anesthesiologists are essential to reduce perioperative complications, to improve surgical conditions and patient outcomes.

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Chapter 56
Patient Positioning for Robotic Pelvic Surgery

Andrea Cestari, Francesco Sozzi, and Matteo Ferrari

Abstract Proper patient positioning is one of the first step to avoid perioperative complications during surgery. This appears of pivotal importance especially during robotic assisted surgical procedures since the bulky robotic system requires not only "constrained positioning" of the patient in order to allow the robotic docking, but it also hides the patient to potential checks during the procedure itself. Herein we describe in details the technique of patient positioning and side docking of the robotic arm system routinely employed in our Institution for all cases of robotic pelvic surgery, including radical prostatectomy, radical cystectomy, urogynecological procedures, ureteric reimplantation. Since its introduction we did not experienced any patient positioning related complications and in all cases it was possible to complete the programmed robotic assisted surgical procedure without the need of changing patient position or the robotic docking.

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Keywords Patient positioning • Robotic pelvic surgery

Introduction

Proper patient positioning is one of the first step to avoid peri-operative complications during surgery. This appears of pivotal importance especially during robotic assisted surgical procedures since the bulky robotic system requires not only "constrained positioning" of the patient in order to allow the robotic docking, but it also hides the patient to potential checks during the procedure itself. The progressive diffusion of robotic surgery to treat pelvic pathologies led to the description in the currently available literature of peculiar potential complications related to patient positioning for this kind of surgery [3, 4, 6].

Steep Trendelenburg, together with pneumoperitoneum and low lithotomic position of the patient (typically required to properly dock the robotic arm system) may cause hypoperfusion of the lower extremities, pressure marks, tissue injury, rhabdomyolysis and even compartment syndrome or neurological complications [4].

Incorrect support of the patient at the level of the shoulders and/or head may cause brachial plexus damage with subsequent neurological injuries of the arms [2]; a rare case of post operative alopecia after pelvic robotic surgery has also been recently reported [5] as the sum of incorrect head positioning, local mechanical compression by rigid objects and steep Trendelenburg influencing intraoperative hemodynamics.

Although patient positioning related complications have been reported even by experienced surgeons, it clearly appears that their frequency increases during the learning phases of robotic surgery [1], where prolonged surgical time plays also an important role to implement the risk of such adverse events.

Patient Positioning for Robotic Pelvic Surgery

Herein we describe in details the technique of patient positioning and side docking of the robotic arm system routinely employed in our Institution for all cases of robotic pelvic

Figure 56.1 Prior to enter the O.R. the patient is invited to wear compressive long antithrombotic socks, that will left in place for the following 2 days. Gel or foam pads are positioned under the calves and knees to further reduce compressive complications

surgery, including radical prostatectomy, radical cystectomy, urogynecological procedures, ureteric reimplantation. Since its introduction we did not experienced any patient positioning related complications and in all cases it was possible to complete the programmed robotic assisted surgical procedure without the need of changing patient position or the robotic arm system docking.

(a) All patients entering the operative theater are invited to wear adequate compressive stockings covering the feet and the whole leg up to the inguinal region (Fig. 56.1).
(b) Over the surgical table an air warmed inflatable antidecubitus disposable mattress is positioned (Kanmed Warmcloud – Kanmed – Bromma, Sweden). The advantage of this medical device is to properly warm the patient during the surgical procedure, ameliorating the hemodynamic conditions during pneumoperitoneum and

Figure 56.2 The air warmed inflatable antidecubitus disposable mattress is positioned over the surgical bed and the adequate temperature settled

Trendelenburg position. Moreover, the antidecubitus property of the system reduces the risk of pressure marks and local tissue injury (Fig. 56.2).

(c) The patient is then positioned on the surgical bed in a supine position, properly supporting with gel or foam cushions calves and popliteal cavity in order to further avoid the risk of neurological compression or excessive traction (Fig. 56.2).

(d) After anesthesia induction, a proper designed and custom made cushion (Fig. 56.3) is positioned to support the head and the shoulders of the patient in order to spread the load of the body during Trendelenburg position and avoid any potential compression or injury of the brachial plexus at the level of the shoulders (Fig. 56.4).

(e) With the goal of protecting the hands of the patient and avoid any risk of nervous compressions with potential dramatic sequelae, an examination rubber glove filled

FIGURE 56.3 The custom made cushion specifically designed to support the head of the patient

with air is positioned on both sides of the patient in a "shacking hand" fashion (Fig. 56.5).

(f) Brachial plexus is also preventively protected with the aid of proper padded arm support to be positioned on both side of the patient at the level of the elbow (Fig. 56.6).

(g) The patient is then positioned in the desired degree of Trendelenburg position, with just a slight flexion of the legs in order to reduce the whole body pressure at the level of the shoulders but at the same time avoiding any nervous stretching (Figs. 56.4 and 56.6).

(h) In order to properly check the degree of Trendelenburg position, it can be used either an inclinometer fixed to the bed or a more up-to-date smartphone app, easily downloadable free of charge (like "Tiltmeter" app for iPhone) (Fig. 56.6).

(i) The robotic arm system is then docked to the patient entering from the side of the patient, avoiding the need for lithotomic position, the need for stirrups or other

Figure 56.4 The spread of the load of the body of the patient avoiding any risk for brachial plexus damage is clearly evident with the patient in Trendelenburg position

techniques to split and diverge the legs for allow space for the robot. In details, the daVinci robotic arm system comes into the operative field from patient's left side, forming an angle of about 45° with the main axis of the

Figure 56.5 The hands of the patient are protected employing examination gloves filled with air and positioned in a "shacking hand" fashion

Figure 56.6 The exact degree of trendelenburg is properly checked with the appropriate smartphone app

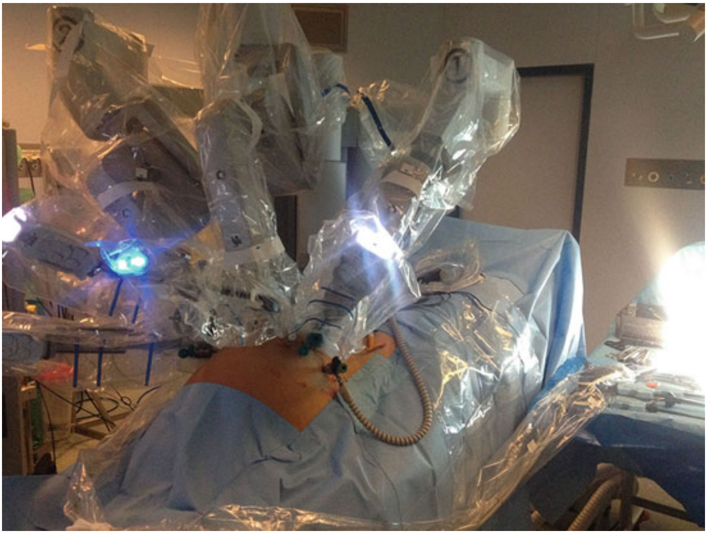

FIGURE 56.7 The robotic arm system is docked to the patient with a "side docking" approach

operative bed, with the vertex at the level of the left anterior superior iliac spine; the assistant surgeon directs the approach remaining on the right side. The robotic arms are then docked by maintaining proper distance between the arms, allowing their correct movement without conflicts (Fig. 56.7).

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Chapter 57
What Is the Best Port Placement for Urologic Laparoscopy?

J.M. Gaya, E. Emiliani, and A. Breda

Abstract Aim of this chapter is to define and explain the best standard port placement for kidney, adrenal, and pelvic organs approach providing advantages and disadvantages respect other ways to do it, based in experience and routine practice.

Keywords Port placement • Urologic laparoscopy

Introduction

It is clear that the way to place the ports should depend entirely on the patient's anatomy, the localization and characteristics of targeted organ, and skills and preferences of the surgeon. After saying that, the aim of this chapter is to define and explain the best standard port placement for kidney,

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adrenal, and pelvic organs approach providing advantages and disadvantages respect other ways to do it, based in experience and routine practice.

Kidney and Adrenal Surgery

Laparoscopic kidney surgery can be executed from transperitoneal and retroperitoneal approach. Arguments in favor of the transperitoneal route are the lager working space, allowing for wider angulation and maneuverability with laparoscopic instruments, and the more accustomed orientation by familiar anatomic landmarks [7], but it requires bowel mobilization to expose the kidney. By avoiding bowel mobilization, retroperitoneoscopy seems to provide a more direct access to the kidney and the renal hilum [3]. Drawbacks are the spatial limitations of the narrow retroperitoneal working space, the lack of view, and the risk of disorientation and causing inadvertent injury [7]. Despite these limitations, the retroperitoneal approach is increasing in popularity, being recommended in patients with previous abdominal surgery, and posteriorly located renal tumors. However, the superiority of the retroperitoneal compared with transperitoneal approach in this cases is still controversial [4, 7, 8, 11].

Transperitoneal Approach

After the patient is positioned, and pneumoperitoneum is induced, we recommend the standardized linear port configuration, as shown in Fig. 57.1: it consists initially on placing three ports (mostly 5-mm due to their proximity) along the pararectal line, ipsilateral to the operative zone. The first trocar is positioned one fingerbreadth below the costal margin (which is a mostly fix landmark even in obese patients), the middle and inferior trocars are placed four fingerbreadths apart, a fourth optional trocar could be places at the tip of the 11–12 rib if necessary. In case of being necessary to remove

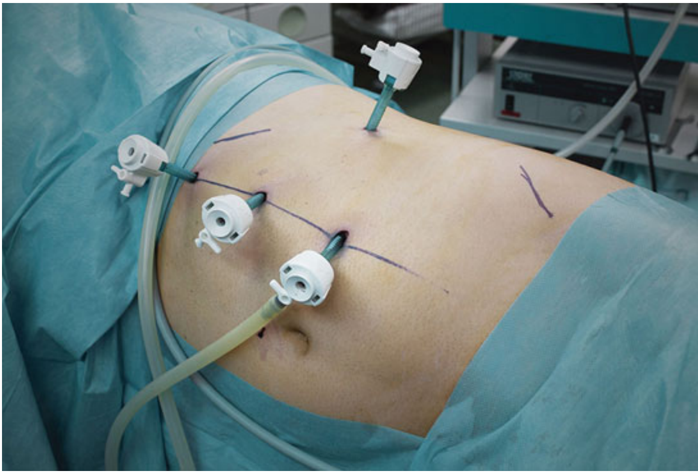

Figure 57.1 "Linear" port configuration for upper urinary tract laparoscopy

the kidney or a big specimen at the end of the procedure, an extra 15 mm trocar can be inserted through a Pfannenstiel incision to introduce a surgical endobag. This single approach has been proven to be a good and safe access for all renal and adrenal surgeries (nephrectomies of all kinds from oncological to living donor, adrenalectomy, nephroureterectomy, pieloplasty, etc.) for both right and left kidneys [6]. With this approach, a 5-mm 30° camera is used, providing good visualization while avoiding increased angles with the working instruments. It is used mostly through the cephalic port, being centered on the renal hilum, for better ergonomics for the surgeon as for the assistant, avoiding cross arms mostly. This technique that may be used for adrenal as for renal surgery with a standardized manner with the same trocar configuration, may help young urologist to learn the technique.

The traditional flank position port placement or diamond-shaped configuration (Fig. 57.2) which consist in placing the camera port at the umbilicus or pararectal up to the umbilicus, and the second and third ports right and left to the

FIGURE 57.2 Standard "diamond-shaped" port configuration for upper urinary tract laparoscopy

camera, respectively, allows a better triangulation to facilitate handling of instruments and suturing. The major inconvenient of this approach is the poor ergonomics that forces the surgeon and the assistant to cross arms as the camera is between two working trocars. Also, this technique cannot be strictly standardized since the surgeon has to vary the trocar placement depending on the location of the targeted area for work and the body mass index of the patient [2].

Retroperitoneal Approach

For the retroperitoneal access, we recommend an open approach, using a 2 cm transverse incision below the tip of 12th rib for the primary port. After a balloon dilator is inserted posterior to the Gerota's fascia and anterior to the psoas muscle and the space is created a 10 to 12 mm trocar-balloon is inserted for the camera. After inspection of the retroperitoneal working space. A 5-mm trocar is placed posteriorly between the inferior border of 12th rib and the lateral border

FIGURE 57.3 Port configuration for retroperitoneoscopy

of erector spinae muscle. A second 10–12-mm trocar is placed anteriorly using digital guidance or under laparoscopic vision about three to four fingerbreadths, anterior to the primary port, along the anterior axillary line. In case a fourth working port is needed for the assistant, we place it lateral to the right hand of the primary surgeon (Fig. 57.3).

Pelvic Surgery

Most of urological surgeries we perform in the pelvis need a transperitoneal approach. Only prostate can be removed using an extraperitoneal access. Nevertheless, the port placement is very similar either transperitoneal or extraperitoneal route.

Transperitoneal Approach

We recommend a five-port technique to work comfortably, with the first being a 12 mm camera trocar, placed infra/peri/supra umbilical, depending on where is localized the main target of the surgery. Upper when we need to work proximally (ureter, lymphadenectomy) and lower when we need to work in the prostate and the urethra. The ports should be placed in a fan distribution with two lateral to the rectus abdominus muscles in a line 2 to 5 cm inferior to the infraumbilical port and two ports at least 3 cm medial to the anterior superior iliac spines (ASIS). The primary surgeon works from the patient's left side through the left iliac and pararectus ports while the first assistant stands on the right and works through the corresponding right-sided ports. The camera operator stands on the right toward the patient's head. Alternatively, the camera operator can be at the head of the operating table, creating more space for the surgeon and the assistant. All ports can be 5 mm, but we recommend a 10–11 mm on the left side in the dominant hand of the main surgeon. This size allows the use of hem-o-locks or other instruments which need wider ports as well as no problems to introduce and remove needles (Fig. 57.4). We would like to point out that, similar to what we do for kidney surgery, we prefer to work in parallel, to avoid crossing arms among the surgeons. For suturing or when access to the right site of the pelvis is difficult from the left side, main surgeon can use momentarily the pararectal port of the assistant, not being necessary a suprapubic trocar in the midline, as described bu some authors in initial series [1, 5]. In some patients with narrow pelvis is not possible to keep the distance among ports, so they need to be placed closer. In this tricky scenario it is very important to remember to gain space between trocars from the same surgeon, but never reduce the space between the camera port and the pararectal ports in order to avoid clashing.

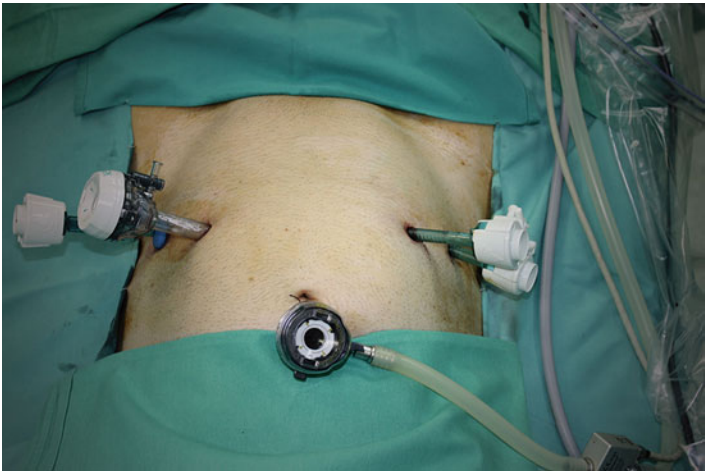

FIGURE 57.4 Port configuration for laparoscopic pelvic urologic surgery

Extraperitoneal Approach

The port placement for this access is more or less the same, being always mandatory because the peritoneum anatomy the placement of all ports under the umbilicus or maximum periumbilical in the case of the camera port. Another difference, is because bowel doesn't need to be retract, sometimes can not be necessary two trocars for the assistant, placing just one 3 cm medial to the ASIS or pararectal if the main surgeon needs to suture [9–11].

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Chapter 58
What Is the Best Port Placement for Urologic Robotic Surgery?

Sameer Chopra, Andre Luis de Castro Abreu, and Andre K. Berger

Abstract The use of robotics has increased in the field of urology since the beginning of the twenty-first century. Laparoscopy has emerged as an alternative to open surgery seeking to mimic its technical aspects and aiming to achieve similar functional and oncological outcomes, and offering faster recovery. The robotic platform is able to provide additional benefits and provide many additional advantages over laparoscopy, such as 3D visualization with high-definition, magnification of up to ten times providing an enhanced view of the operative field, and the EndoWrist® system which provides seven degrees of motion freedom as well as ergonomics. However, to be able to explore these features, it is quintessential that the robotic arm ports are properly placed and robot docking be properly achieved to allow for the full benefits of robotic surgery. Herein, we describe the port placement, robot docking, and the use of four robotic arms for urologic robotic surgery utilized at our institution.

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Keywords Port placement • Robot docking • Robotics • Prostatectomy • Cystectomy • Nephrectomy

Introduction

The use of robotics has increased in the field of urology since the beginning of the twenty-first century. Laparoscopy has emerged as an alternative to open surgery seeking to mimic its technical aspects and aiming to achieve similar functional and oncological outcomes, and offering faster recovery. The robotic platform is able to provide additional benefits and provide many additional advantages over laparoscopy, such as 3D visualization with high-definition, magnification of up to ten times providing an enhanced view of the operative field, and the EndoWrist® system which provides seven degrees of motion freedom as well as ergonomics. However, to be able to explore these features, it is quintessential that the robotic arm ports are properly placed and robot docking be properly achieved to allow for the full benefits of robotic surgery. Herein, we describe the port placement, robot docking, and the use of four robotic arms for urologic robotic surgery utilized at our institution.

Why Use Four Robotic Arms?

While some institutions and urologists continue to use a three arm robotic approach, there are many advantages to using a four-arm approach. When referring to both three and four robotic arms, this is including the robotic arm that holds the camera, thus two versus three working robotic arms can be used during the robotic surgery.

Some of the advantages to using an additional robotic arm are:

- Provides traction during key maneuvers
- Allows for enhanced exposure of key anatomy during tumor dissection

- Allows for retraction of overlying tissue for further exposure
- Diminished dependence on the surgical assistant
- Increased diversity of surgical maneuvers

Some potential disadvantages for the use of a fourth robotic arm are:

- Increased port placement time
- Additional abdominal incision
- Intraperitoneal instrument clashing
- Exterior robotic arm clashing

Port Placement for Robotic Pelvic Surgery

Robotic Radical Prostatectomy

We have previously reported on our port placement for Robotic Radical Prostatectomy (RRP) procedures [1, 6]. Our port placement can be easily replicated for different types of prostatectomy procedures: radical and simple. With the patient in lithotomy and in a steep Trendelenburg position, and pneumoperitoneum is created with a Veress needle. Once this is established, we then utilize a five- to six-port robotic approach with the fourth arm on the right side of the patient and the assistant port on the left (Fig. 58.1). The assistant is positioned to the left side of the patient.

The port placement consists of:

- Four Robotic Ports
  - 1: 12 mm port – Camera
  - 3: 8 mm ports – 4th arm, Right Arm, and Left Robotic Arm
- One to Two Assistant Ports
  - 1: 12 mm port
  - 1: 5 mm port (optional)

The robotic ports are placed four fingerbreadths apart from each other while the assistant port is three fingerbreadths

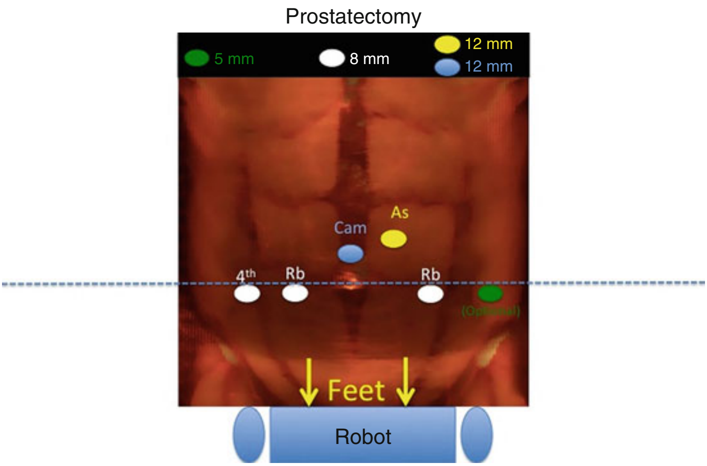

FIGURE 58.1 Port placement for robotic radical prostatectomy. Schematic representation

apart from the camera port. Robotic ports are also placed on a parallel plane slightly below the umbilicus. A 5 mm assistant port is optional and can be utilized for more difficult cases where additional assistance is required. This port placement facilitates optimal utilization of the robot and is an adequate configuration to minimize exterior robotic arm clashing.

Robotic Radical Cystectomy

The gold standard of care for muscle-invasive and refractory non muscle-invasive bladder cancer is radical cystectomy [7]. Like other robot-assisted surgeries, robotic radical cystectomy (RRC) is gaining in popularity. Population-based studies conducted in the US demonstrated that the proportion of RRCs has consistently increased from 0.6 % in 2004 to 12.8 % in 2010, and over 2,101 RRCs have been performed to date [5, 8]. We have previously reported on our technique for RRC [4].

Our port placement for RRC is similar to RRP, with a few differences (Fig. 58.2). The patient is once again placed in

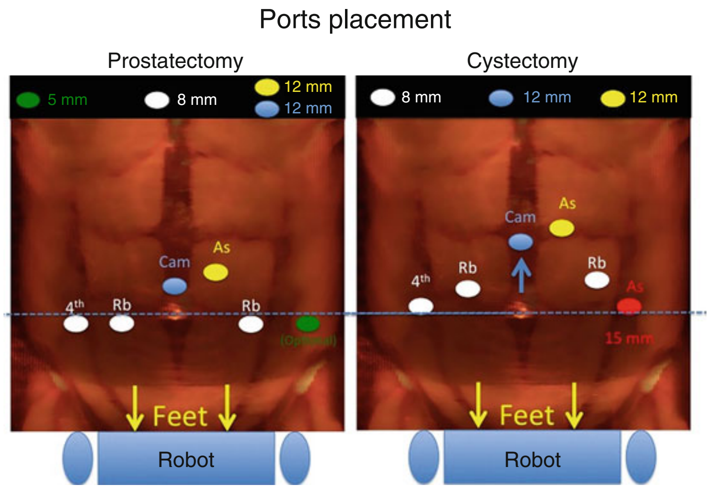

FIGURE 58.2 Port placement comparison for robotic radical cystectomy. Demonstrating difference in port placement position for robotic radical cystectomy versus robotic radical prostatectomy. Schematic representation

lithotomy and in steep Trendelenburg. The port placement consists of:

- Four Robotic Ports
  - 1: 12 mm port – Camera
  - 3: 8 mm ports – 4th arm, Right arm, and Left robotic arm
- Two Assistant Ports
  - 1: 12 mm port
  - 1: 15 mm port

In comparison to RRP, the port placement is considerably more cephalad for RRC; this is attributed to the necessary additional reach required during proximal lymph node dissection and ureteral mobilization. The camera port is placed a hands breadth above the umbilicus while the working robotic ports are in line with the umbilicus. The 15 mm assistant port is placed slightly more caudal and lateral; this positioning provides for improved angulation during stapling for the neobladder.

Port Placement for Robotic Kidney Surgery

Transperitoneal Approach

One benefit to our port placement for robotic transperitoneal renal surgery is that this configuration can be used to treat renal tumors located in upper pole, hilar region, and lower pole. We once again use a four-arm approach with 1–2 assistant ports (Fig. 58.3a, b). The patient is placed in lateral decubitus position. For our nephrectomy robotic surgeries, we utilize the use of 8 mm bariatric robotic ports, which are placed at the costal margin and just slightly cephalad and lateral to the pubic bone. An 8 mm "regular" robotic port is placed two fingerbreadths

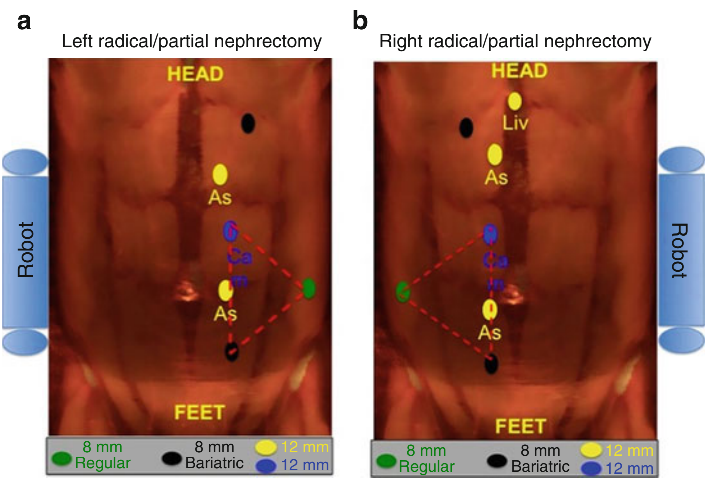

FIGURE 58.3 Port placement for robotic kidney surgery. (**a**) Schematic representation for left kidney surgery. (**b**) Schematic representation for right kidney surgery

above the anterior superior iliac spine and the camera and assistant ports are placed in their traditional locations. To minimize instrument clashing, we aim for an equilateral triangle between the camera port, the lower bariatric port, and the lateral regular robotic port. For right nephrectomy surgery (Fig. 58.3b), the port placement is similar to the left nephrectomy surgical port placement. The difference is the addition of the liver retractor port, which is placed at the xiphoid sternum. An equilateral triangle configuration is once again desired between the lower bariatric robotic port, camera port, and lateral standard robotic port. This configuration allows for optimal use of the four robotic arms while minimizing intra-peritoneal instrument clashing and exterior robotic arm clashing.

Retroperitoneal Approach

The retroperitoneal approach for robotic kidney surgery is less popular than the transperitoneal approach. This may be attributed to the unfamiliarity of the technique to the surgeon, this approach requires a smaller operative field, there are more difficult anatomical landmarks to assist in orienting the surgeon, and the likelihood of increased adipose tissue. This approach is indicated in situations where the patient has had prior transperitoneal surgery, trauma, or inflammation, especially in the quadrant of interest. In addition, the specific location of the renal tumor could make this approach more favorable, for example if the tumor is located in the posteromedial hilum. While it is not used as frequently, there are many advantages to using this approach. Some advantages are:

- Allows for a direct approach and early control of the renal hilum
  - Makes the operation faster
  - Avoids handling of the bowel
- Faster operative time
- Earlier return of bowel function
- Shorter length of hospital stay

Some contraindications for using this approach is:

- Prior major retroperitoneal surgery
- Dense perirenal inflammation/fibrosis (e.g., prior cryoablation or xanthogranulomatous pyelonephritis)
- Musculoskeletal limitations precluding proper positioning
- Very large tumors with extensive collaterals
- Tumors with IVC thrombus
- Abundant perinephric fat with extensive stranding

There is minimal literature discussing a four-arm approach for retroperitoneal kidney surgery [2, 3]. At our institution, while we also utilize a four-arm approach, our port placement is vastly different from the transperitoneal approach. We use a balloon dilator and temporary balloon port to access the retroperitoneum and create the retroperitoneal space. The patient is positioned in full flank (lateral decubitus) position. The table is flexed to allow maximal separation between the costal margin and iliac crest. The 12 mm camera port is placed in the mid-axillary line between the costal margin and iliac crest. The 8 mm robotic ports are placed under direct visualization. The most posterior and medial ports are placed in the posterior axillary line and the anterior axillary line, which are respectively parallel o the camera port. To minimize arm clashing, bariatric robotic ports are used for the most anterior and posterior ports. The fourth arm is in the most anterior port position and the assistant is positioned behind the patient's back (Fig. 58.4).

Robot Docking

Because we use the additional robotic arm, it is imperative to dock the robot and position the arms in the most optimal positioning possible to minimize exterior arm clashing. The robotic arms should be positioned to maximize the "sweet spot" (Fig. 58.5), the maximum angle possible to help prevent

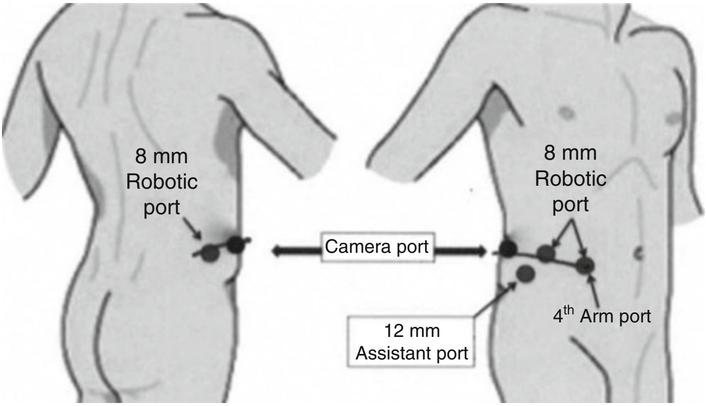

FIGURE 58.4 Port placement for robotic retroperitoneal kidney surgery. Schematic representation

FIGURE 58.5 Robot docking. Optimal arm placement for robotic arms

clashing of the robotic arms during the procedure. For robotic prostatectomy and RRC procedures, the robot approaches the patient in a straight line at the foot of the table. For transperitoneal nephrectomy surgery, the robot is docked on the contralateral side to the kidney undergoing the procedure (i.e., if a left partial nephrectomy, the robot is docked on the right side of the patient). During retroperitoneal renal surgery, the robot comes in from the anterior aspect of the patient's abdomen and from over the patient's shoulder.

Conclusion

Robotic surgery is becoming more popular as more urologists are performing more procedures with a minimally invasive technique. While robotic procedures are becoming more advanced and fine-tuned, one step that cannot be overlooked is the importance of the robotic port placement and robot docking. The port placement is critical for allowing the use of additional robotic arms, allowing for more technically complex surgical techniques to be conducted, while minimizing robotic arm clashing both exterior and intra-peritoneal. The robotic arms should be positioned with maximum separation (maximizing the "sweet spot" of the robotic angle) to prevent clashing of the robotic arms. A four-arm approach can be utilized successfully as long as the correct robotic port placement and robot positioning is employed.

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Chapter 59
How Do You Manage Gas Leak During Laparoscopy?

Rodrigo Frota and Alexander Edwin Teixeira Dias

Abstract The sum of perfectly executed small details results in a successful procedure. Managing properly gas leakages is one of these details. It will result in an adequate exposure of the surgical field. The core tip or message of this brief chapter is to do not underestimate a small leak. Think about it throughout the procedure, remembering that a small weight carried for a long distance can finally be unsustainable.

Keywords Gas leak • Laparoscopy

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Overview

Gas leak is one of the most common issues faced by laparoscopic surgeons. At an initial approach, it does not sound as challenging as other also common problems. However, facing a long and difficult laparoscopic procedure, a persistent CO2 leakage can contribute to surgeon exhaustion and, ultimately, lead to conversion to an open surgery and even worse, to an avoidable accident.

The milestone for an adequate surgical procedure, regardless of the approach chosen, is good exposure. In laparoscopy, adequate pneumoperitoneum is crucial in achieving that goal. Everyone who usually performs laparoscopic surgery can recall a situation in which a “life struggle” is undertaken against an inadequate working space due to a lack of sustainable pneumoperitoneum. Recognizing and being able to manage significant leakages will save precious time and effort.

Our aim instead of present a review of extensive references is to provide practical tips of our daily practice, ready to be tested in real situations.

Tip 1: Attention to Access Technique

The crucial moment to deal with an important leakage is during cavity access and trocar placement. An open access is the preferred choice for many surgeons, including our group. It is vital to minimize skin and aponeurotic incision. We limit our aponeurotic incision to a size that allows us to confirm peritoneal access and provide space to the insertion of a 5 mm trocar, without the trocar shaft or blade. After achieving the pneumoperitoneum, the puncture is safely made with a 10–12 mm trocar, without space for significant air leak. When adequate visualization of peritoneal access demands a wider incision, we usually carry up aponeurosis with non absorbable sutures around trocar insertion site and confirm adequate insufflation previous to proceed with the next function.

If you detect a maintenance of leak around a puncture site, a valuable measure is to obliterate the subcutaneous space with a small Vaseline Lap secured with a skin suture. We prefer lap instead of gauze, because especially in obese patients, the former can de easily missed.

Tip 2: Choose Trocar Properly

Perhaps the most valuable tip in this chapter is one that sometimes does not depend on the surgeon's skill. Laparoscopy is highly dependant on the quality of your surgical material. Specially, trocar valves are prone to dysfunction, and are a common source of leak. Choose a good quality trocar! Have replacements in close hand, either permanent or disposable ones. Always check all trocars valves in the beginning of the procedure, and replace the faulty ones. Insert rough instruments, like clip appliers gently, and act with the same caution when removing them. If you don't have abundant resources, in the best scenario, you may have to deal with that annoying leaking noise throughout the procedure.

Tip 3: Avoid Trocar Displacement

Once again, leaks reflect quality of your instruments. One of the fastest ways of losing completely your pneumoperitoneum is complete displacement of a trocar, during normal removal of instruments. We prefer grooved rather than smooth trocars, significantly less prone to displacement. When a smooth trocar is the one that is available, a secure aponeurotic or skin suture around insufflation valve can prevent non adverted displacement.

Tip 4: Use your Aspirator Gracefully

Although losing pneumoperitoneum during the use of aspirator is not properly a gas leak, some details deserve mention. Firstly, the source of vacuum must be calibrated to an adequate pressure. A very high aspiration pressure can be allowed by some sources, leading to a complete loss of space within a few seconds. Secondly, attention to surgical technique is, as always, very important. Limit the use of the aspirator to fluid collections, avoiding aspiration in free space. When employing the aspiration as a dissecting instrument, avoid simultaneous use of the aspiration.

Tip 5: Insulator

When everything fails, a good insufflator can allows the completion of the procedure. Modern insufflators usually provide CO_2 flow above 15 l/min which can compensate for a small leak. However, one should not rely in that measure as a primary form of dealing with the problem, in face of the risk of running out of gas before the end of the surgery, depending on the duration of the procedure and of the source of CO_2. Despite some manufactures presenting insufflators with a flow rate above 40 l/min, it's rarely achieved in real situations, mainly because of the resistance of the connection devices.

Conclusions

The sum of perfectly executed small details results in a successful procedure. Managing properly gas leakages is one of these details. It will result in an adequate exposure of the surgical field. The core tip or message of this brief chapter is to do not underestimate a small leak. Think about it throughout the procedure, remembering that a small weight carried for a long distance can finally be unsustainable.

Chapter 60
Management of Bleeding During Laparoscopy

Rene Sotelo, Luciano Nunez Bragayrac, and Raed A. Azhar

Abstract In this chapter we provide an overview on strategies and techniques to manage hemorrhagic complications during and after laparoscopic urologic surgery. Preparing for these complications is crucial as accidents could occur at any time. Several tips are provided on the basis of evidence from the literature as well as authors' own experience. Proper patient selection, the experience of the surgeon, meticulous attention to detail and knowledge of the potential complications that are associated with each procedure are the most important factors in minimizing vascular complications.

Keywords Bleeding • Laparoscopy • Management • Vascular injury

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Introduction

Since its introduction in the early 1990s, urological laparoscopy has been increasingly used by urologists in academic medicine and private practice. As a result of increased experience, more complex laparoscopic procedures are routinely performed [14]. Numerous studies demonstrate decreased blood loss, shorter hospital stays and convalescence periods, and lower patient morbidity with laparoscopic surgery compared with open surgery [10]. Laparoscopic surgery has complications, of which vascular injuries are the most frequent; they could occur at any time during the procedure [4, 7, 9, 10, 14, 19]. The overall complication rate in urologic laparoscopy has been described as 1.98–14.6 % [4, 7, 9, 10, 14, 19]. This complication rate includes the time from gaining access to the abdominal cavity through surgery and the postoperative period.

Vascular injuries occur in approximately 1.7 % of cases [7]. Intraoperative vascular injuries are among the most challenging complications. These vascular injuries might occur while gaining access to the abdominal cavity, during the surgery, or in the post-operative period [4, 7, 9, 10, 14, 19]. Permpongkosol et al. studied 2775 cases of urological laparoscopic surgeries; of the complications identified, vascular injuries (19.8 per 1,000) and postoperative bleeding requiring blood transfusion (17.6 per 1,000) were the most frequent [14]. Soulie et al. observed that vascular injury and hemorrhage rates vary between 6 and 13 % in all types of nephrectomy and nephroureterectomy in their series; this finding could be because these surgeries require more dissection around the vascular structures [19]. Colombo et al. found that the most common postoperative complication was hemorrhage, with a rate of 2.7 % [4]. Some studies concluded that the complication rate tended to decrease as surgical experience increased [4, 11, 16]. Ahmed et al. found that the incidence of complications per 100 patients treated demonstrated a statistically significant reduction with surgical experience ($P = 0.007$) [1].

Access Related Vascular Injuries

Nearly 70 % of access-related injuries are vascular [2]. There are three main options for the insertion of the initial port, including the open Hasson technique, the closed access using the Veress needle, or the use of an optical port. The site of insertion depends on the procedure and whether the site is approached trans- or retroperitoneally. The decision to use the Veress needle or to perform open Hasson to establish access is based on the preference and experience of the surgeon. Open insertion is favorable in the presence of intra-abdominal adhesions; alternatively, a 2-mm needle scope might be used [13], and open access should be performed away from previous scars, if possible, because the most common location of adhesions is near previous scars. Breda et al. reported on 12,919 laparoscopic procedures and found a complication rate of 0.27 % for optical trocar access, 0.18 % for the Veress needle, and 0.09 % for the Hasson technique [3]. Although a direct comparison of these techniques is difficult and controversial, the Hasson technique is considered by the majority of surgeons to be the safest technique.

The average distance between the skin of the umbilical region and the aortic bifurcation is 5 cm. The 45° inclination of the trocar towards the pelvis and the absence of lateral deviation are the critical aspects of avoiding trauma to the aorta, inferior vena cava or iliac vessels [21] (Fig. 60.1).

- ***Tip***: In obese patients, the introduction angle of the Veress must be changed from 45 to 90°; this maneuver could avoid vascular injury.

The Veress needle should be carefully examined to ensure that the spring snap mechanism is performing properly. Following the insertion of the Veress needle into the abdomen, the tip of the needle should move freely. An injury should be suspected if intestinal contents, stomach contents or blood are aspirated and if the intra-abdominal pressure with a low gas flow exceeds 15 mmHg. Bleeding from blood vessels in the abdominal wall resulting from the insertion of

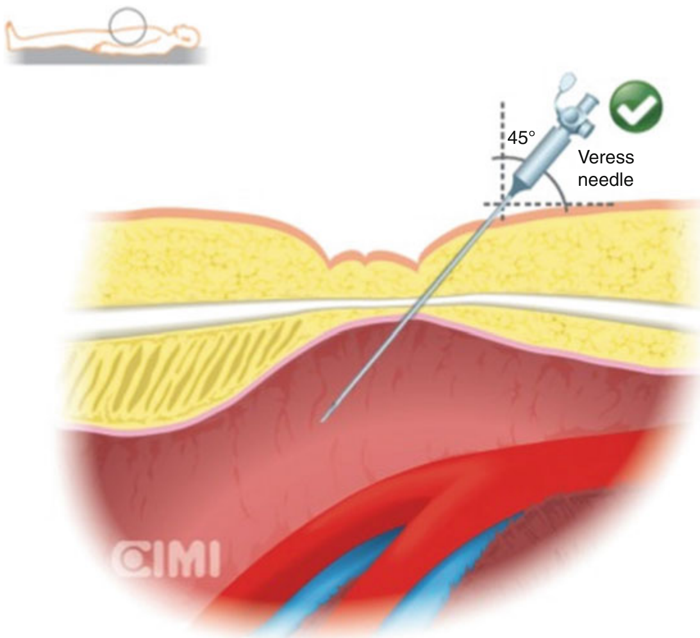

FIGURE 60.1 Insertion of Veress needle with 45° angulation through the umbilicus

the Veress needle or optic trocar could typically be controlled successfully following the insertion of a second trocar by endoscopic coagulation or a circular suture pattern that encloses the bleeding blood vessel [7].

A method for gaining access is with the Veress connected to the pneumoperitoneum equipment; this connection allows for the visualization of increasing pressure while the needle is slowly introduced through the abdominal wall. If the Veress needle is in the correct position, the pressure falls below 5 mmHg, and a click of the needle is simultaneously heard; the introduction of the needle must be stopped, and then the pressure rises. If there are fluctuations in the pressure or if there is doubt regarding the position of the Veress needle, the needle must be aspirated; if blood or intestinal contents are aspirated, the needle should be left in place, and new access should be obtained using an open technique, inspecting the area for damage. The majority of complications caused by the Veress needle could be recognized by direct visualization, including free blood in the abdominal cavity, or more frequently, a retroperitoneal hematoma. If vascular injury caused by the Veress needle is present, the management should be tailored to the specific situation:

1. Small, no expanding hematoma:
   - Control with clips.
   - Verify the placement and continue with surgery.
   - At the end of the surgery, re-check the placement.
2. Expanding hematoma:
   - Insert additional trocars.
   - Insert gauze.
   - Improve the exposure site.
   - Open the hematoma.
   - If the hematoma is difficult to repair laparoscopically, apply compression and perform a laparotomy.

The insertion of the first trocar is typically performed blindly through the incision of the Veress needle in the umbilical region. For this purpose, a shielded trocar is routinely used to minimize the risk of injury. Additional working trocars are inserted through the abdominal wall under laparoscopic vision with the assistance of transillumination. Theoretically, the risk of injury is greatest when inserting the first trocar [7]; for this reason, the surgeon should ensure that the pneumoperitoneum is between 16 and 20 mmHg before inserting the first trocar, and the skin incision should be long enough to allow the trocar to pass without resistance. The active hand that is inserting the trocar should always be prevented from accidentally slipping or protruding too deeply into the abdomen by the contralateral hand on the abdomen of the patient.

All surgeons are familiar with the problem of injuries to the epigastric artery that could be avoided by carefully identifying the vessels using transillumination, which is sometimes difficult in obese patients [21]; competent attention to an injured blood vessel (in this case, an epigastric artery) using clips or sutures is always preferable to extensive endoscopic coagulation [7]. For persistent bleeding, suturing with a straight needle through the abdominal wall encaging the bleeding vessel is very useful. The suture is released 2 days after the initial operative procedure.

Intraoperative Vascular Injuries

The overall risk of intraoperative vascular injuries is 2.3–3 % [4, 22]. The major causes of vascular injuries during surgery are associated with abrupt laparoscopic maneuvers, movements outside of the viewing area, unsuitable identification of the anatomy and instrument failure. Colombo et al. did not identify an association between age, body mass index, ASA (American Society of Anesthesiologists) score, the Charlson Comorbidity Index, the European Scoring System and previous abdominal/pelvic surgery and the development of perioperative complications. Those authors determined that the complication rate tended to decrease as surgical experience increased [4].

Injuries of the large abdominal vessels cause extensive hemorrhaging (Fig. 60.2). In the majority of cases, the only method for controlling this problem is to perform an immediate laparotomy, which is most likely the major reason that every laparoscopic procedure should be performed in an operating room that is fully equipped to handle all aspects of open surgery, including vascular suturing [7].

Major venous injuries have a greater potential for laparoscopic repair. Insufflation pressure is increased to 20–25 mmHg, and additional trocars are inserted if needed; pressure should be applied with a sponge or gauze, and the site of the injury should be widely exposed. The site should be clamped above or below the lesion and repaired; atraumatic graspers could hold the edges together while closure is performed with a running suture requiring skilled assistance [13].

FIGURE 60.2 Posterior hematoma due to abdominal hemorrhage

A large needle with a multifilament suture is easier to tie than monofilament, ensuring that it is easier for the rapid control of bleeding. This issue is controversial because vascular surgeons assert that vessels should not be repaired with multifilament; however, in an emergency, it is easier to tie sutures without memory, and a large needle is easier to visualize in the midst of bleeding. Thus, the ¨rescue stitch¨ is very useful; this stitch uses a CT-1 needle and 6-in. long 0-polyglactin with a Hem-o-lok tied to the end [6] (Fig. 60.3).

Laparoscopic suturing, vascular clip application or the use of an Endo-GIA stapler might be warranted to control bleeding from larger vessels. However, stapler malfunctions have been reported in 1.7–10 % of cases [8, 12]. Hsi et al. found 352 reported failures using laparoscopic hemostatic devices [8]. Of these, 63 % occurred with the use of an endovascular stapling device, 33 % occurred with titanium clips, and 5 % occurred with the use of locking clips. The leading causes of failure were staple-line malformation and clip dislodgment. As a general recommendation, when using locking clips to secure the vessels, it is commonly accepted that at least two clips should be

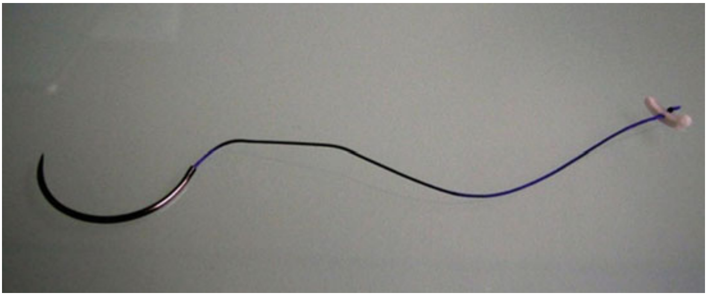

FIGURE 60.3 Rescue stitch

placed on the patient side of the vessels [15]. Additionally, the vessels should be meticulously dissected and isolated to prevent the lymphatics and tissues and the perivessel fat from interfering with the correct clip placement. This latter recommendation does not generally apply to endovascular stapler use. However, if the vessels are transected with an endovascular stapler, particular attention should be taken not to include in the staple line metallic clips that might have been placed close to the vessels. Some authors have shown this problem to be one of the most frequent causes of staple misfire. The cartridge of the endovascular stapler should be carefully inspected before use because the absence of staples in the cartridge has been reported [3, 8, 12].

If bleeding is major and cannot be controlled with an instrument for adequate visualization, hand-assisted device insertion or immediate open exploration is indicated. Maintaining compression with an instrument at the site of an injured vessel would reduce further blood loss and facilitate the rapid identification of the bleeding site upon opening the abdomen [6].

At the end of each procedure and before removing any of the trocars, inspection of the abdominal cavity with decreased pneumoperitoneum to 5 mmHg is mandatory. Additionally, the ports should be removed and the sites should be inspected under direct laparoscopic vision with this minimal insufflation pressure [6, 13].

Postoperative Vascular Injuries

The overall rate of postoperative complications during laparoscopic surgery varies from 1.9 to 8.9 % [4, 10, 14, 19]. The incidence of postoperative vascular complications is very low.

The recognition of a vascular injury might be delayed for several reasons. Compressions by the pneumoperitoneum, vasospasm, or partial ligation are frequent reasons for delayed presentation. Unintentional ligation of an artery could lead to infarction and necrosis of its target organ; this type of injury typically presents in a delayed fashion [20].

Possible symptoms of late vascular complications include, although are not limited to, general malaise, abdominal or flank pain, dizziness or syncope, hypotension, tachycardia, decreasing hemoglobin and hematocrit, gross hematuria, bloody drainage from the drainage site, nausea, vomiting, absent pulses, fever, and renal insufficiency [20]. Therefore, it is important to evaluate the patient during the first 2 or 3 h postoperatively. The heart rate, blood pressure and level of consciousness of the patient should be assessed. Additionally, we inspect for bruises around the trocar sites, in the scrotum or in the perianal region. We assess the postoperative hemoglobin level, drainage speed, and tenderness of the abdomen. Immediate or delayed complications might present in the postoperative period.

Permpongkosol et al. evaluated the complications associated with 2,775 laparoscopic surgeries performed between 1993 and 2005; they found that postoperative bleeding requiring transfusion was one of the four most common complications, with a rate of 17.6 per 1000 [14]. They observed that each procedure had a characteristic profile of complications; kidney surgeries were more strongly associated with vascular postoperative complications, and the laparoscopic nephroureterectomy had the highest rate of vascular complications (5.71 %), followed by laparoscopic donor nephrectomy.

Colombo et al. evaluated the complications of laparoscopic surgery for oncological pathologies and determined that hemorrhage accounted for 2.7 % of postoperative vascular complications [4].

In patients with signs that suggest postoperative bleeding or hematoma, a CT scan with intravenous contrast is preferred. In cases in which the patient is hemodynamically stable, conservative management with serial hemoglobin and hematocrit measurements is the standard of care, with blood transfusions administered according to the medical criteria; in cases in which the patient is unstable, angiography and selective embolization present an option, and consultation with a vascular surgeon should be available, if necessary. Another option for treatment is a further surgical procedure. The safety of the patients is our primary concern, and open surgery would be the best option over a laparoscopic approach in this situation.

Rosevear et al. reported their results from laparoscopic upper tract surgeries; 34 patients (3.7 %) presented with postoperative bleeding, and the decision to re-operate was predominantly based on the clinical criteria in unstable patients [18]. Only 35 % of patients underwent ultrasonography or CT. Overall, 12 % of the patients with postoperative hemorrhaging required surgical re-exploration; the remaining 88 % of the patients were managed conservatively. There were no significant differences in the outcomes between the patients with postoperative hemorrhage treated surgically and those treated conservatively. However, postoperative renal complications were observed more frequently in the patients treated surgically compared with the patients treated conservatively.

Careful operative techniques could help surgeons avoid complications. Improved monitoring of the drainage output and the use of imaging could facilitate the identification of patients who would respond to conservative management without the need for re-exploration [17].

Prevention

Proper patient selection, the experience of the surgeon, meticulous attention to detail and knowledge of the potential complications that are associated with each procedure are the most important factors in minimizing complications [5] (Table 60.1). The establishment of an adequate relationship

Table 60.1 Laparoscopic principles of problem prevention

Patient selection	Identify high-risk patients
Informed consent	Always include the possibility of open surgical intervention with the general and procedure-specific complications
Patient preparation	Type and screen or cross-match (2 units) of blood products
	Include capnometry and pulse oximetry measurements with the other monitors
	Secure and appropriately pad the patient after proper positioning
	Insert a nasogastric tube and a Foley urethral catheter
	Perform full abdominal skin preparation
Properly maintained equipment	Appropriately shielded instruments, electrocautery device, insufflator
Working knowledge of the equipment	Insufflator, irrigator/aspirator, ultrasonic scalpel, argon beam coagulator
Standardized approach to performing the procedure	Assess Veress needle placement
	Monitor the insufflation pressure and establish an adequate pneumoperitoneum
	Prevent uncontrolled excursion of trocars
	Transilluminate the abdominal wall to prevent abdominal wall vessel injury during secondary trocar placement
	Inspect the abdominal contents for potential injuries
	Visually monitor the pneumoperitoneum pressure
	Inspect the primary and secondary trocar insertion sites for any active bleeding
	Establish a consistent laparoscopy team with an experienced surgical assistant and scrub nurse

with the patient, a discussion of the types of complications, including vascular complications, and the possibility of conversion to an open procedure should be addressed. Preparing for vascular complications is crucial because accidents could occur at any time; a sterile tray containing specific vascular repair tools and materials should be available. Adequate training and preparation of the surgical team is fundamental, and an inexperienced surgeon should work closely with an experienced surgeon.

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Chapter 61
Transperitoneal Laparoscopic Radical Nephrectomy: Tips for Challenging Cases

Pierluigi Bove, Valerio Iacovelli, and Fernando J. Kim

Abstract In this chapter we describe the main principles to effectively and safely perform a laparoscopic radical nephrectomy. The technique is described in details, and practical tips to facilitate the procedure are provided.

Keywords Laparoscopic radical nephrectomy • Surgical technique

Introduction

Laparoscopic radical nephrectomy (LRN) is the surgical treatment of choice for patients with T2 tumors and localized masses not treatable by partial nephrectomy. Based on current available oncological and quality of life (QoL) outcomes,

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localized renal cancers are better managed by partial nephrectomy (PN) rather than radical nephrectomy (RN). LRN has lower morbidity than open surgery and oncological outcomes for T1-T2a tumors are equivalent between laparoscopic and open radical approach [1].

Urologic surgeons with advanced laparoscopic skills are now able to manage highly selected patients with locally advanced disease and tumors with renal vein or vena cava thrombi [2, 3].

Preoperative Preparation

Informed consent prior the laparoscopic procedure should inform the patient about the potential risks and benefits of this surgery, including conversion to open surgery, injuries to vessels, nerves and adjacent organs and additional possible surgeries Laboratory and imaging studies should be obtained as indicated by patient's medical history and universal pre-operative evaluation guidelines. Usually, blood products are not requested for this specific procedure but if significant bleeding and coagulation anomalies are identified, type and cross should be ordered prior the surgery. Universal Deep Venous Thrombosis prophylaxis should include hydration, compressive elastic stockings and low-molecular-weight heparin. Antibiotic prophylaxis may be achieved with a single dose of intravenous second-generation cephalosporin, unless allergy is known.

Patient Positioning

The first patient's position is supine to allow intravenous access, induction of general anesthesia and endotracheal intubation. Placement of a Foley catheter and an orogastric tube is useful for decompression of the bladder and stomach, respectively during trocar placement, insufflation and dissection.

The patient is placed in a modified flank position with the operative side tilted up 30–45° using a gel roll or a rolled

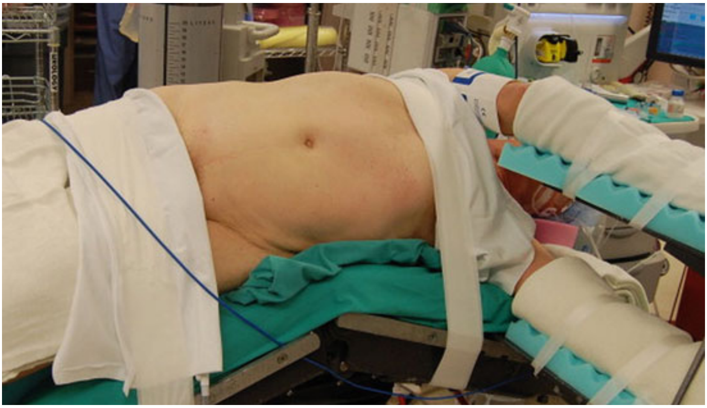

FIGURE 61.1 Patient position

blanket to support the back. The lower arm is placed on a padded armrest and the other arm is flexed at the elbow and rested over a higher padded armrest (Fig. 61.1). Care is taken to pad all pressure points. Wide 3 in. cloth or silk tape is used to secure the patient to the operating table to allow for table rotation during the surgery [4].

The surgeon stands cephalad and contra-lateral to the side of the kidney to be surgically removed, and the first surgical assistant stands caudally next to the surgeon. The laparoscopic cart with the monitor and insufflation pressure monitor is positioned opposite to the surgeons in an ergonomic position. It is important to ascertain the "horizon" view so surgeon's muscle fatigue is not triggered by bad positioning of the monitor. Moreover, the insufflation pressure monitor should be visible at all times so issues with hemodynamics and bleeding can be adjusted accordingly. The scrub technician and instruments table should be positioned opposite to the operative team to facilitate transfer of instruments (Fig. 61.2) and they should have a monitor opposite to them to visualize the procedure and predict the next surgical step.

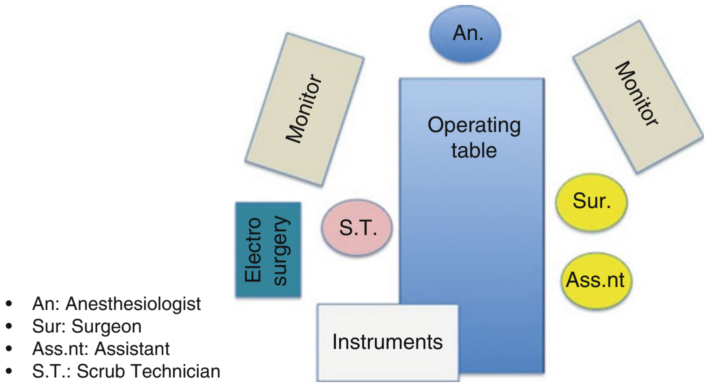

FIGURE 61.2 Room setup

Access and Trocar Placement

With the advent of optical trocars that allow entry visualization may securely use the Veress needle for insufflation, while other may prefer the open access technique is used to place the first trocar (Hasson technique [5]). Both techniques offer similar outcomes and results [6]. One may prefer the open access to the Veress needle in cases of previous surgery to avoid injuries of the underlying anatomical structures (bowel, adhesions, etc.). The first 12-mm trocar is placed 3–4 cm lateral and cranial to the umbilicus (to the edge of the rectal muscle) and it is used to maintain pneumoperitoneum. The skin incisions should be large enough to maintain air seal and allow trocar range of motion. Preferably, one should follow the Langer lines of skin tension (horizontal incisions on the abdomen, except the para-umbilical one which is vertical). Previous surgical scars can be used for specimen retrieval. Pneumoperitoneum is established with an intra-abdominal pressure between 15 and 20 mmHg and can be lowered to 10–12 mmHg depending on patient's hemodynamic stability. A 30° optic is then introduced through the trocar, and the abdomen is inspected for injuries due to insertion of the tro-

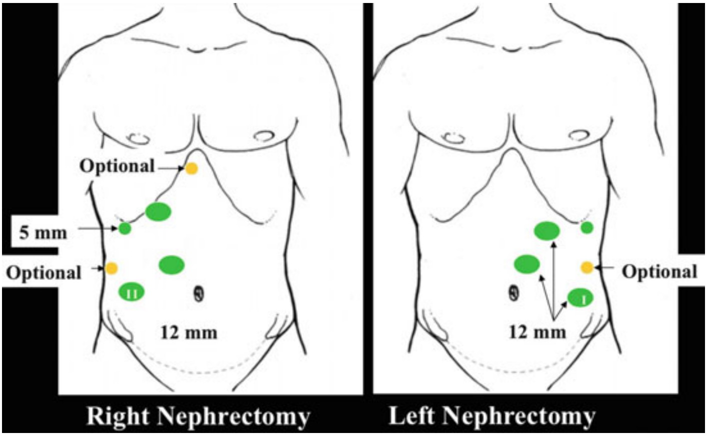

FIGURE 61.3 Trocar placement

car, and to identify adhesions in areas where the secondary ports will be placed. To prevent lens fogging, we use to insert the distal end of the optic into warm sterile water or in a warm and wet gauze before intra-abdominal optic introduction. The optic will allow to place all the other trocars under direct laparoscopic visualization. Operative trocars are than positioned in a traditional *diamond* port configuration (Fig. 61.3); a linear port configuration has been suggested to reduce interaction between the camera holder and surgeon's working envelope [7]. We use disposable 5-mm and 12-mm trocars with blunt obturator tip. Blunt tip may be associated with a lower incidence of injury to intraperitoneal structures and vessels of the abdominal wall as well as a lower risk of postoperative incisional hernias.

The triangulation rule must be followed for the placement of the trocars: four fingerbreadths between the optic trocar and the working trocars and five fingerbreadths between the working trocars.

A second 12-mm trocar is placed lateral to the rectus in the lower quadrant. This incision will allow a Gibson incision at the end of the LRN in order to finally extract the organ.

Once placed, the insufflator line is then moved from the first trocar to the second one to avoid lens fogging.

A third 12-mm and a forth 5-mm trocars are then placed respectively to the anterior axillary line at the level of the first trocar and subcostal position on the edge of the rectus muscle. If liver retraction is necessary during a right-side nephrectomy, a sub-xiphoid skin incision is made and a 5-mm port is introduced to retract the liver.

In obese patients, often all trocars are shifted laterally and cranially [8].

Surgical Technique

Colon Mobilization

For a *left-side nephrectomy*, a plane between the descending colon and the underlying Gerota's fascia is obtained by the incision of the white line of Toldt with endoshears or other laparoscopic cutting device. The differentiation of a darker yellow mesenteric fat medially and the lighter and brighter yellow retroperitoneal fat is pivotal for the dissection that is carried out cranially from the lower pole of the kidney to the

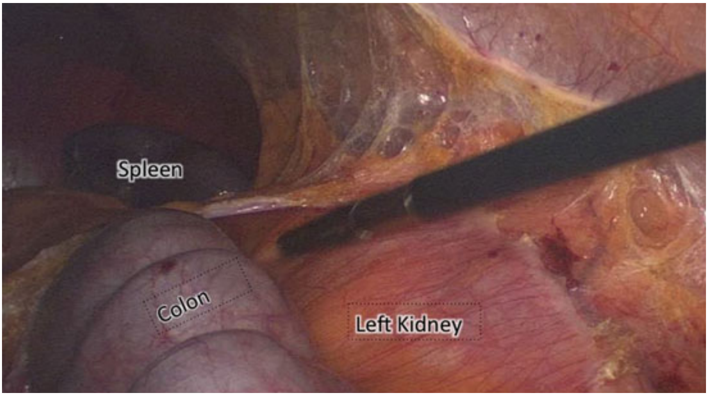

FIGURE 61.4 Exposure of left kidney

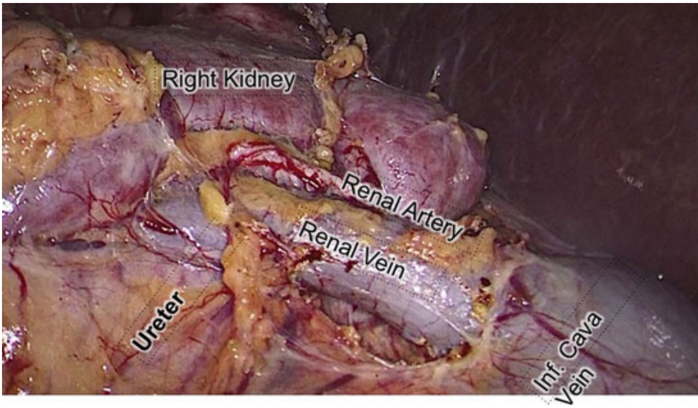

FIGURE 61.5 Exposure of right renal vessels

spleen following the renal convexity on medial side (Fig. 61.4). The splenorenal and lienocolic ligaments are incised, allowing the spleen, the tail of the pancreas and the colon are isolated from the upper pole of the kidney and reflected medially. The Colon is dissected off the Gerota's fascia but the renal attachments are preserved until the end to prevent the kidney falling medially prior to the vessel ligation.

For a *right-side nephrectomy*, a lateral sub-xiphoid port may be helpful to cranially retract the liver using a grasper that is fixed to the abdominal wall. The dissection is carried out following the medial renal convexity, parallel to the lateral border of the vena cava and duodenum. The Kocher maneuver is then performed: the peritoneum is incised at the right edge of the duodenum, the duodenum and the head of pancreas are reflected medially to fully expose the medial portion of the kidney (Fig. 61.5).

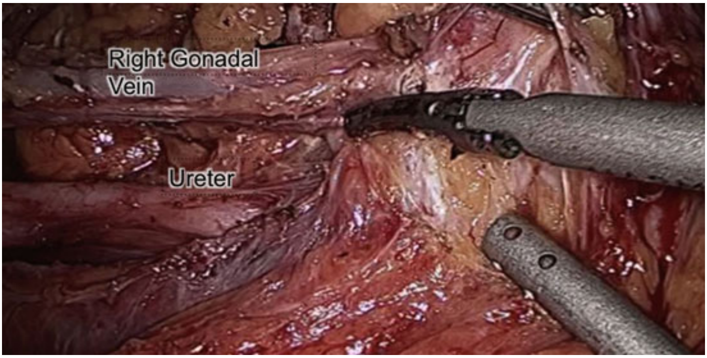

FIGURE 61.6 Right gonadal vein and ureter

Gonadal Vessels and Ureter

Once the colon has been medially mobilized, the gonadal vessels are usually identified. The gonadal vessels are swept medially allowing the identification of the ureter lateral to the gonadal vessel when proximal to the crossing of the iliac vessels (Fig. 61.6). Peristalsis of the ureter can help differentiate between these two structures. Caudally, the ureter is dissected down to the crossing of the iliac vessels. We recommend the Ureter and gonadal vessels not to be divided at this time in order to facilitate dissection towards the renal vessels following the gonadal vessels with the visualization of the psoas muscle posterior to the kidney. One may preserve the superficial layer above the psoas fascia to minimize postoperative thigh numbness due to nerve damage.

Approach to the Renal Hilum

On both sides, the colon is medially retracted and the lower pole of the kidney is firmly elevated. Tracking the course of the ureter or gonadal vein (on left side) allows the identification of the renal hilar vessels. A gentle, layer-by-layer blunt dissection is performed with proper hemostasis and careful clipping of

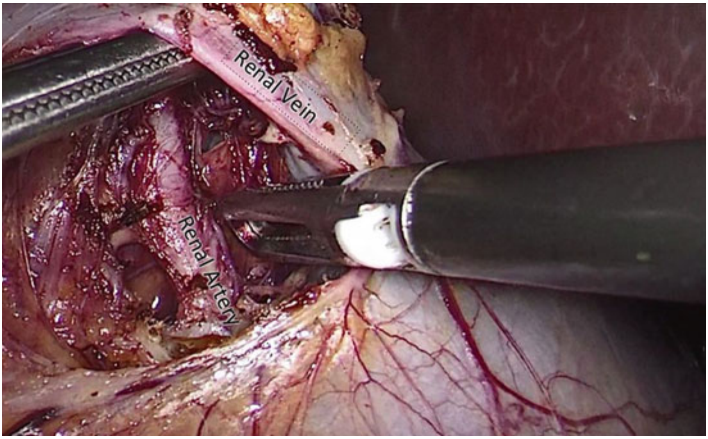

FIGURE 61.7 Dissection of right renal hilum

lymphatic vessels. Clear visualization of the renal vessels are advisable before the vascular clamp or laparoscopic staplers (Vascular load) is deployed (Fig. 61.7). The renal vessels should be individually dissected. The renal vein is often anterior to the renal artery and easily identified due to the gonadal vessels that drains into the renal vein on the left side and the vena cava on the right side. The Renal artery is postero-cranial to the vein and pulsatile (Fig. 61.5); but if an artery is found inferiorly to the renal vein one may expect an upper arterial branch (examine pre-operative imaging studies); Two to three clips (L purple Hem-o-lok®) or a 45-mm vascular laparoscopic stapler should be used on the proximal aspect of the renal artery for ligation. The renal vein should be flattened after the renal artery control, and a 45-mm laparoscopic vascular stapler can be deployed. As an alternative, three clips (Extra Large Hem-o-lok®) can be used on the renal vein. Although controversial "en bloc" renal vessel ligation can be achieved with a 45-mm vascular laparoscopic stapler in cases that adhesions or speed is necessary to safely finish the procedure.

During the left renal vein dissection the lumbar veins that drain posterior to the vessel can be identified and they should be preserved. Dissection of the right renal vein is usually less demanding as lumbar veins are normally absent on this side.

Mobilization of the Kidney

Once the hilar vessels have been divided, the dissection continues posteriorly and superiorly to the upper pole. The attachments of the kidney to the posterior and lateral abdominal wall are released by blunt and sharp dissection conducting careful and proper hemostasis. The adrenal gland can be preserved during the procedure by dissecting it from the superior pole of the kidney and clipping the adrenal vein in cases with no upper pole mass invading the adrenal gland On the right side the adrenal vein is short and often can drain posterolateral into the vena cava and control of this vessel can be challenging. Inferiorly, the ureter is clipped with Large Hem-o-lok® and transected to allow the kidney to be rotated to facilitate incision of the upper pole attachments.

Organ Extraction

The kidney should be removed intact inside an impermeable bag (Endo bag 15-mm) in oncological cases. Different laparoscopic bags are available in the market, but the principle is the same to reduce seeding of cancer cells during organ extraction and reduction of incision site. The bag can be introduced through a small opening of the ilioinguinal incision or midline infraumbilical site. We prefer to perform a lower ilioinguinal muscle-splitting incision (Gibson type). A 4–5 cm hockey stick incision is performed extending from the para-rectal inguinal trocar to the midline running 0.5 cm above the inguinal fold. The external oblique aponeurosis and then the internal oblique muscle are divided in the direction of their fibers. The transversus muscle layer is opened and the kidney is finally removed intact through the incision. No suction drains are necessary.

After removal of the pneumoperitoneum and trocars under vision, the fascia of ports >8 mm are closed with a Polisorb™ 2.0 suture. Ropivacain HCl (Naropin™) 7.5 mg/ml may be injected in the wound prior to the incision or at the time of closure to provide local anesthesia. Subcutaneous closure is accomplished with absorbable suture in an interrupted fashion. Suture closure is generally performed with 3-0 or 4-0 absorbable suture (Vicryl™) in a running subcuticular fashion, to improve cosmetic results. Sterile strips may be applied to the skin.

Postoperative Management

The orogastric tube is removed at the end of the procedure. Pain should be controlled with scheduled oral acetaminophen, or nonsteroidal anti-inflammatory drugs (NSAIDs) if the renal function and coagulation is normal and preserved. Oral diet can be advanced as tolerated. The Foley catheter is usually removed on day 1. The patient leaves the hospital when is stable, tolerating diet and when able to ambulate and transfer out of the bed without issues not present prior to surgery. Usually, patients will be discharged between the second and third postoperative day. Patients should avoid Valsalva maneuver, heavy lifting for 4–6 weeks to prevent herniation through the incision sites.

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Chapter 62
Tips for Safe and Quick Transperitoneal Laparoscopic Nephrectomy

Lütfi Tunç

Abstract To date, the most commonly used method for transperitoneal nephrectomy closely parallels the standard method for open nephrectomy. Few studies have explored alternative techniques. In this chapter, we describe our technique, tips and tricks for transperitoneal laparoscopic nephrectomy. In this technique the kidney's upper pole is dissected before the lower pole. A major advantage is shorter duration of pneumoperitoneum. Patients with cardiopulmonary problems can therefore undergo laparoscopic nephrectomy with less risk. Transperitoneal laparoscopic right nephrectomy, which is generally considered to be a difficult procedure due to anatomy of the structures involved, is made easier through this approach, which makes use of the Morrison space.

Keywords Kidney • Kidney neoplasms • Nephrectomy • Laparoscopy • Minimally invasive surgical procedures

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Introduction

Laparoscopic nephrectomy was first performed in 1991 with a transperitoneal method [3]. Since then, many centers have reported their results regarding the advantages of a laparoscopic approach compared with open techniques [2, 5, 6]. However, in most studies to date, the method used for transperitoneal nephrectomy closely parallels the standard method for open nephrectomy [4], and few studies have explored alternative techniques for transperitoneal laparoscopic nephrectomy [7–9].

In this chapter, we describe our technique, tips and tricks for transperitoneal laparoscopic nephrectomy. The main difference from the open and standard transperitoneal laparoscopic techniques is that the renal pedicle is approached and dissected from the direction of the kidney's upper pole.

Patient Preparation

A transurethral Foley catheter and a nasogastric tube are inserted and the patient is placed in the lateral 70° decubitus position.

Port Placement

Three ports are used for either right or left nephrectomy, and they form a triangle on the abdomen (Fig. 62.1). First, we mark the site where the most cephalad port will be inserted. This site is 2 cm lateral to the rectus muscle and 1 cm inferior to the costal margin. Relative to this site, at 3–5 cm inferior and 1–2 cm medial to it, another site is marked. This will be the site of the camera port. The third site is 8–10 cm lateral to the umbilicus. After the sites are marked, a 1 cm incision is made in the skin at the camera port site. Scissors are used for blunt dissection down to the

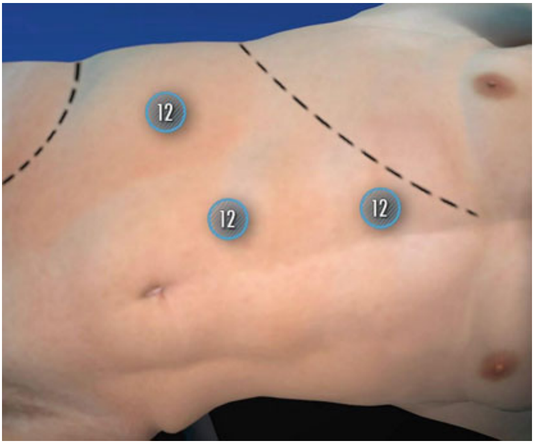

FIGURE 62.1 Port placement for right sided nephrectomy. The *numbered circles* indicate the ports, all of which are 12 mm in diameter

fascia. A 1–2 mm incision is made in the fascia. A Veress needle is inserted here and is gently advanced into the abdomen while the skin is retracted to lift the peritoneum away from the abdominal organs. A pneumoperitoneum of 14 mmHg is created. As soon as the Veress needle is removed, a blunt tip 12 mm trocar is inserted in its place. Following the insertion of the camera, two other 12 mm blunt trocars are inserted under direct visualization.

Surgical Technique for Right Kidney Nephrectomy

Incision of the Peritoneum Under the Liver

To expose the upper pole of the kidney, it is necessary to incise the peritoneum immediately under the liver, from the beginning at a location 10–15 cm medial to the triangular ligament and continuing laterally to the ligament itself (Fig. 62.2).

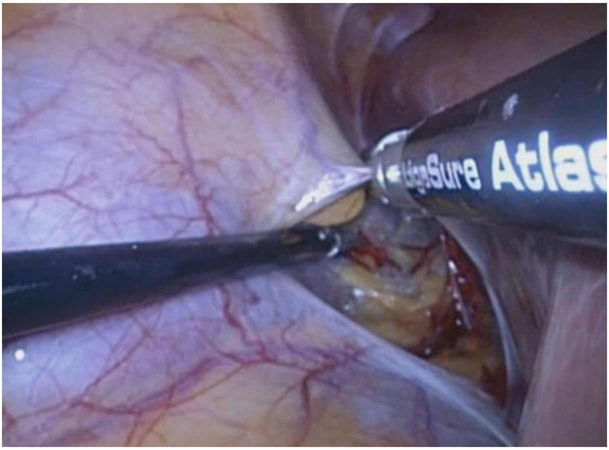

FIGURE 62.2 Right laparoscopic nephrectomy. Incision of the peritoneum under the liver

Mobilization of the Colon

Incision of the peritoneum is extended inferiorly, parallel to the vena cava. During this step, the colon is minimally retracted medially. In right-sided nephrectomy, only the colon covering the lower pole of the kidney needs to be moved. The duodeneum is carefully mobilized medially.

Dissection on Kidney's Upper Pole

At the level of the renal pedicle, the Gerota fascia and the connective tissue anterior to the renal pedicle are dissected mechanically and with bipolar energy along the vena cava to the upper pole.

When the renal vein and the vena cava can be clearly seen, the superior side of the junction of the renal vein and the vena cava is further dissected. During this step, we use blunt dissection with blunt tipped instruments (bipolar, aspirator or dissector). At this junction we pass superior to the renal vein

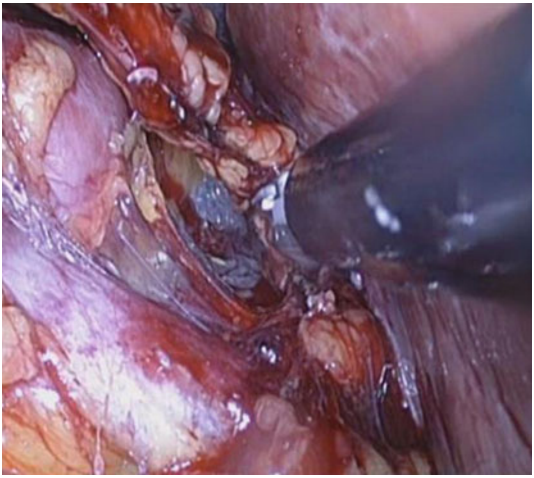

FIGURE 62.3 Right laparoscopic nephrectomy: entrance into the Morrison space (hepatorenal recess or subhepatic recess that separates the liver from the right kidney)

and lateral to the vena cava to enter the Morrison space (hepatorenal recess or subhepatic recess) (Fig. 62.3), which is the anatomical space bounded by the liver, the posterior part of the upper pole of the right kidney and the lateral surface of the vena cava. This anatomical space is generally not mentioned in textbooks of urological surgery. In the presence of the pneumoperitoneum, entry into this space provides easy detachment of the right kidney's upper pole from the surrounding structures.

If the adrenal gland will be left in place, the right hand instruments (atraumatic grasper, aspirator, etc.) retract the adrenal gland laterally and superiorly while the tissue between the adrenal gland and the kidney is dissected with the bipolar. In this way the adrenal gland is completely separated from the upper pole of the kidney. If the adrenal gland will be removed, then the adrenal vein that joins the vena cava is exposed. With the left hand instrument in the Morrison space, the kidney and the adrenal gland are retracted laterally and with the right hand instrument (bipolar energy source, e.g., Ligasure 10 mm Atlas) the adrenal vein is sealed and divided. During this dissection, other adrenal gland vessels in the area are dissected. As a result of this dissection, the upper pole of the kidney and the adrenal gland are completely freed from the surrounding structures.

Dissection of the Kidney's Lower Pole

The lower pole is dissected from the surrounding tissues to expose the psoas muscle, the ureter and the inferior side of the renal pedicle.

Ligation and Division of the Renal Artery and Vein

The renal artery and vein are dissected and skeletonized with the bipolar instrument and the aspirator (Fig. 62.4). Then, on the renal artery, usually three Hem-o-Lok clips are placed

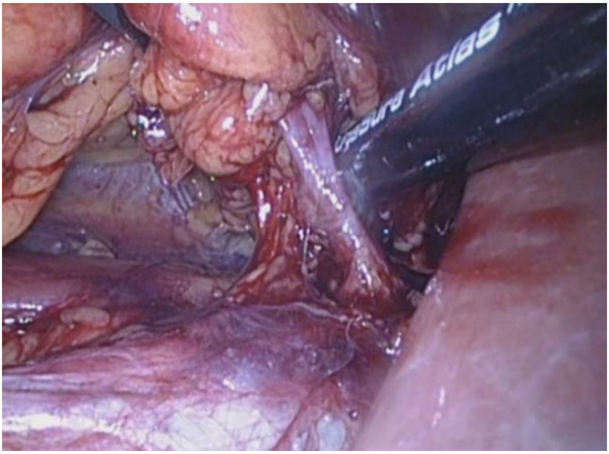

FIGURE 62.4 Right laparoscopic nephrectomy: dissection of the renal pedicle (renal artery and vein)

(two on the part that will remain in the patient, and one on the part that will be removed with the kidney). Next, the renal vein is ligated with Hem–o-Lok clips (two on the part that will remain in the patient, and one on the part that will be removed with the kidney) or the vascular stapler, depending on the anatomy and the diameter of the vein.

Another choice is *en bloc* ligation, performed with the vascular stapler on the renal artery and vein together. *En bloc* ligation with the vascular stapler in patients with multiple arteries and/or veins detected during renal pedicle dissection is preferred. *En bloc* ligation is also used when the operation should be completed quickly, for example in patients who are elderly or those who have cardiopulmonary diseases and therefore should undergo the shortest possible pneumoperitoneum. In our series of patients who have undergone en bloc ligation, arteriovenous fistula has not been detected [1].

Division of the Ureter and Complete Freeing of the Kidney

Finally, the ureter is exposed, two Hem-o-Lok clips are placed on the ureter as distally as possible, and the ureter is transected between the clips. After the kidney is freed from all surrounding tissues, it is placed in an endobag and removed.

Surgical Technique for Left Kidney Nephrectomy

Patient preparation and port placement are the same as described above for right kidney nephrectomy.

After the ports are placed, an incision is made along the Toldt line, enabling the colon to be medialized from the level of the spleen to the iliac vessels.

Then, to expose the upper kidney pole, we dissect the splenocolic ligament and splenorenal ligament. For this dissection,

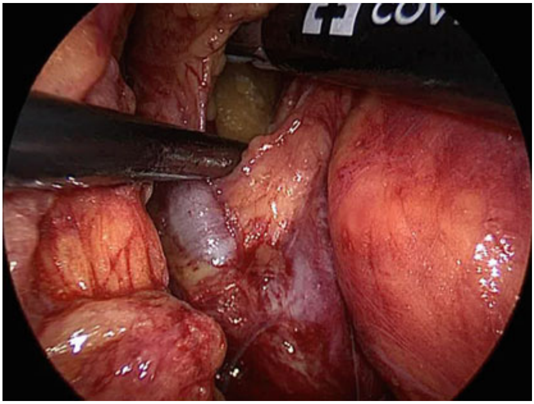

FIGURE 62.5 Left laparoscopic nephrectomy: the space bounded by the adrenal vein, renal vein, and the kidney

blunt tipped bipolar instruments are preferred (e.g., Ligasure 10 mm). If the adrenal gland will be left in place, then the junction of the adrenal vein and the renal vein is exposed with blunt dissection, and through the space bounded by the adrenal vein, renal vein, and the kidney, the dissection is extended deeply toward the psoas muscle (Fig. 62.5). With the left hand instrument (atraumatic grasper, aspirator, etc.), the adrenal gland is retracted laterally and superiorly while the tissue between the adrenal gland and the kidney is dissected with the bipolar. In this way the adrenal gland is completely separated from the upper pole of the kidney. If the adrenal gland will be removed, then after the adrenal vein and renal vein junction is exposed, the dissection towards the psoas is begun in the space bounded by the adrenal vein, renal vein, and the vena cava. Then with bipolar cautery, the tissue and vessels medial and superior to the adrenal gland are dissected.

Dissection of the kidney's lower pole, ligation and division of the renal artery and vein, ligation and division of the ureter, and completion of the nephrectomy are the same as described above for right kidney nephrectomy.

Conclusions

Laparoscopic nephrectomy can be performed quickly and safely via dissection that starts at the upper pole of the kidney. A major advantage of this technique is its shorter duration of pneumoperitoneum. Patients with cardiopulmonary problems are at increased risk of complications when undergoing pneumoperitoneum, so a shorter operative time reduces this risk in these patients. Transperitoneal laparoscopic right nephrectomy, which is generally considered to be a difficult procedure due to anatomy of the structures involved, is made easier through this approach, which makes use of the Morrison space.

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Chapter 63
The Single Knot Running Vesico-Urethral Anastomosis

Simone Albisinni, Fouad Aoun, and Roland van Velthoven

Abstract Over 10 years have passed since the introduction of the single-knot running vesicourethral anastomosis technique and today this still seems a valid and safe option. Though with minor modifications, the technique is now widely applied by many surgeons involved in minimally invasive urologic surgery.

Keywords Laparoscopy radical prostatectomy • Vesico-urethral anastomosis • Van Velthoven technique

History and Problems Related to VUA

The quest for the application of laparoscopy to radical prostatectomy started in 1992, when Schuessler et al. first pioneered such intervention: the procedure however was associated with long operative times and did not show major significant clinical advantages compared to the open approach [37]. Several years after, in 2000, Guillonneau et al. and Abbou et al. reported their stepwise techniques with operative

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times between 4 and 5 h, in addition to reasonable oncologic and functional results [1, 14].

As such, laparoscopic prostatectomy began to be performed in different excellence centers across Europe and USA; nonetheless the procedure was and is complex, and, especially in the years prior to the vast distribution of the DaVinci robotic system, the learning curve was steep, requiring approximately 50 procedures to be mastered [8, 43]. Specifically, the vesico-urethral anastomosis has always been a crucial, time consuming step of major difficulty [8, 12, 37].

In the beginning, interrupted sutures had been proposed by the first pioneers of this intervention [14, 31]. Guillonneau and Vallencien proposed throwing two posterior stitches at 5 and 7 o'clock, then 6 stitches at 1, 2, 4, 8, 10 and 11 o'clock. With a total of seven separate knots, these techniques were incredibly complicated and long, and therefore running suture methods began to be explored. Hoznek et al. in 2000 reported their method of performing a running VUA: two hemi-circumferential sutures, one anterior and one posterior, are thrown respectively from 3 to 9 o'clock (posterior), and from 2 to 10 o'clock (anterior). This technique necessitates four intracorporeal knots, and in its first report required on average 31 min to be completed [20]. Gaston and Piechaud popularized the "Bordeaux technique", a single running suture which starts at the 3 o'clock position and continues in a clockwise direction [6]; this method has been modified by Pansadoro et al. to reduce the number of intracorporeal knots to only one and facilitate the throw of the posterior stitches [11]. However, notwithstanding the multiple attempts to simplify the technique, the VUA was and is today still terribly challenging, especially for novice laparoscopic surgeons. The reasons are numerous: first, laparoscopic intra-corporeal suturing and knot-tying is one of the most complicated technical gestures that a surgeon must learn during his training. Albeit training programs and simulators, indeed many young surgeons struggle when it gets to intra-corporeal knot tying, notably in the vesico-urethral anastomosis were forehand and backhand stitches must be placed. Second, the anatomic position of the urethra makes the vesico-urethral anastomosis a naturally complicated procedure: especially in men with a narrow and/or deep pelvis, placing the urethral stitches may be incredibly challenging. Finally, laparoscopic radical prostatectomy, especially in the beginning of a surgeon's learning curve, is a long and wearing procedure. Therefore, surgeons find themselves to face a complex step in the procedure (i.e., the VUA) after several hours of concentration and difficult dissection, boosting the VUA's complexity.

In 2000 in our center we introduced a single-knot running VUA, today more known as the Van Velthoven technique. Its initial series was published in 2003 [44]. This technique requires only one intracorporeal knot, it allows a water-tight approximation of the bladder neck to the urethra and is easily teachable. As such, although many variations have been proposed and are currently in use in centers worldwide [22, 25, 39], this technique has been widely accepted by many urologists and is frequently used today to perform VUA [26].

The Single Knot Running Vesico-Urethral Technique

The basic principle of a good vesico-urethral anastomosis is to obtain without tension and/or traction a precise alignment of the urethra with the preserved or reconstructed bladder neck. The key point is to obtain a non-ischemic, watertight anastomosis that prevents urinary leakage without compromising the integrity of the external sphincter. The method should be cost effective, easy to learn and perform and should not be time consuming. The quality of the vesico-urethral anastomosis is responsible for preventing urinary leakage and stricture formation, and consequently for preserving continence. The success of a vesico-urethral anastomosis therefore depends upon meticulous attention to detail and the optimization of technical factors that affect anastomotic integrity. The single-knot running vesico-urethral anastomosis respects this principle and has become a commonly used method of reconstruction [44].

The technique begins by inspecting the bladder neck with careful attention to ureteral orifices. The degree of bladder neck preservation will dictate the length of the suture. It varies accordingly between 12 and 20 cm. The running suture is prepared extracorporally by tying together the two ends of a twin dyed 6 in. sutures of 3-0 Monocryl RB-1 (Ethicon, USA). The second step is to identify the urethral stump. Sometimes the urethral stump is too short and retracts into the pelvic floor musculature, or is positioned deep underneath the symphysis pubis, so that visualizing and placing the anastomotic sutures in laparoscopy could be difficult. A simple trick to facilitate suturing is to exert an external perineal pressure with a sponge stick at the bulbar urethra during the initial throws of the suture, thus everting the urethral stump. The running stitch is initiated by placing both needles outside-in through the bladder neck and inside-out on the urethra, one needle at the 5:30-o'clock position and the other needle at the 6:30-o'clock position. The sutures are run from the 6:30 and 5:30-o'clock positions toward the 9:00 and 3:00-o'clock positions, respectively. After two throws through the urethra and three throws through the bladder are completed, the sutures are cinched down with gentle traction on each thread simultaneously or alternately, bringing the bladder neck as a unit tightly into position with the urethra. This approximation provides a secure posterior wall with no gap visualized between sutures and allows a 20F catheter to be placed into the bladder. A transition suture is completed at the 11:00 -o'clock positions, by taking an extra bite on the urethra, going outside in. The transition suture allows the stitch to now exit the bladder on its outer surface. The sutures are continued to the 12:00-o'clock position and tied to each other. This solitary intracorporeal knot now, like the initial extracorporeal knot, rests on the exterior of the bladder. If discrepancy persists between the diameters of the bladder neck and urethra, an anterior tennis racket-type closure is performed. If the ureteral orifices are close, a posterior tennis racket-type closure is advised. The balloon on the 20F catheter is filled with

10 mL of water; the bladder is irrigated until clear with approximately 60 mL of sterile water. A drain is placed and is usually removed on the first postoperative day. The catheter is normally left in place for 5 days and is removed after documenting on a cystogram a watertight anastomosis.

In analysis of three different vesico-urethral anastomotic techniques in laparoscopic radical prostatectomy by Teber et al. [41], the single knot running anastomosis was associated with a significantly decreased anastomotic and overall operative time compared to interrupted and modified interrupted technique. The median time to perform a single knot running anastomosis laparoscopically was 15.3 min (range 11–31) in their series. The reduction in requirement for knot-tying may enable surgeons with limited suturing experience to master this difficult technical step, unavoidably located at the end of a challenging procedure. Furthermore, the system of symmetric loops act as a block and pulley mechanism, thereby enabling approximation of the dorsal part of the anastomosis to be carried out without tension or traction. In addition, it is not possible to perform an interrupted anastomosis without using two needle drivers and at least 6 suture materials. The single-knot running technique proves that even with a single needle driver, a running stitch with two suture materials is still possible. Of note, the cost of two Monocryl 3-0 RB-1 suture materials per procedure is approximately 7€ and the cost saved per procedure by using only one robotic needle driver in RALP is around 220€. The savings achieved by this technique associated to a decrease in overall operative time reduce the global cost of an economically consuming operation.

Complications of the Single-Knot Running VUA

As any surgical step in radical prostatectomy, the VUA is characterized by possible complications. The surgeon must master the technique of VUA to reduce these events, which however remain inevitable, as normal in surgery.

An anastomotic leak is short term complication following vesico-urethral anastomosis and is associated with significant morbidity including postoperative ileus, infection, metabolic abnormalities, and prolonged hospital stay and urinoma formation with potential risk of anastomotic disruption. The long term relevance of an anastomotic leak is controversial in the literature. Surya et al. suggested that prolonged urine leaks are a risk factor for anastomotic stricture [40]. They suggest that prolonged urinary leakage results from an anastomotic gap which heals by second intention, thereby causing scarring and anastomotic stricture. By contrast, other studies have reported no significant increase in anastomotic stricture due to leakage [36, 41, 48].

However, the presence of pelvic drains removing extravasated urine may have biased these studies towards finding no effect of postoperative anastomotic urine leak on long term morbidity. The reported incidence of anastomotic leak with single knot running sutures has been very variable ranging from 0 to 7.5 % [16, 33] in series of surgeons using the single-knot running technique. In a study by Cohen et al. urine leak was significantly reduced in the group of single knot running sutures compared to the interrupted technique [7]. Teber et al. also demonstrated significantly less dorsal urine leak with the Van Velthoven technique than with interrupted sutures [41].

Anastomotic strictures are a late, Clavien grade III complication of radical prostatectomy. Most surgical series in which the single-knot method was used to perform VUA report stricture rates ranging from 0 to 3 % [16, 19, 23, 33, 41]. Significant morbidity may be associated with the development of an anastomotic stricture, including infection, urinary retention, the need for additional invasive surgery and future incontinence [13]. While several factors have been associated with the development of anastomotic stricture, its exact pathophysiology remains poorly defined. Both technical and patient-related factors have been implicated in their development [17]. The type of vesico-urethral anastomosis plays a major role. Excessive narrowing of the anastomosis and/or lack of mucosal apposition at the time of the procedure are known risk factors [3, 10]. Ischemia of the bladder neck and/or the membranous urethra could explain higher rates in older patients with peripheral vascular disease [3]. Smoking, diabetes, hypertension, obesity, chronic renal insufficiency and coronary artery disease were also associated with anastomotic stricture in large scale observational studies [10]. Too much tension on the anastomosis could also lead to ischemic stricture formation. Postoperative radiation is another well-known cause of anastomotic stricture by inducing ischemia and fibrosis [3, 10, 29]. The single knot running technique is associated with a low (0–3 %) risk, [16, 19, 33, 41], due to several technical factors: it creates a direct wide vesico-urethral alignment with an end to end mucosal apposition, and ischemia is also reduced by the running "funneling parachute" anastomosis.

Complex Situations

Minimally invasive radical prostatectomy is always challenging. However, there are particular situations in which the dissection and the reconstructive phase of the intervention can be particularly complex. Regarding VUA, major challenges can arise when prostatectomy is performed after another primary prostate cancer treatment (i.e., radiation therapy, HIFU, cryoablation), or after prostate surgery for benign prostatic enlargement. Indeed, these are all situations in which dissection is very complicated, particularly that of the bladder neck, as surgical planes are usually blended together and massive fibrosis is present. Frequently in these situations the bladder neck is excessively opened, with a consequent mis-match of the bladder neck and the urethra. To face this problem, the bladder neck can be reconstructed with a posterior or anterior tennis-racket. Moreover, if there has been exposure to radiation or thermal energy, tissue healing is usually impaired and the risk of post-operative complications is therefore elevated. This should be kept in mind by the surgeon, especially for what concerns urine leakage and anastomotic strictures. An in depth analysis has been performed by Ouzaid et al., who retrospectively analyzed 2215 patients undergoing LRP or RARP with the Van Velthoven technique. After a median follow-up of 43 months, anastomotic strictures occurred overall in 30 (1.4 %) patients, and both previous radiotherapy and previous transurethral resection of the prostate (TURP) were significant predictors of such adverse even [29].

Series describing functional outcomes of salvage RALP after primary treatment (radiation, brachytherapy, HIFU) confirm that complications following such procedure are frequent [4, 9, 21, 34, 45]: the largest of these series, recently published by Yuh et al., analyzed complications and functional outcomes of salvage RALP in 51 men with recurrent prostate cancer. Complication rate was elevated (25 % minor complications; 43 % major complications), and regarding anastomosis, 18 % of patients experienced a urinary leakage and 16 % an anastomotic stricture [45]. Eandi et al. also reported outcomes in 18 men undergoing salvage RALP: 33 % of patients had a leak requiring prolonged drainage (mean 38 days), and 17 % developed an anastomotic stricture [9]. As expected, post-operative continence rates were low, with 33 % of men being pad-free after a median of 7 months. Similarly, Boris et al. reported one anastomotic leakage and one stricture in a series of 11 men undergoing salvage RALP [4].

Data regarding functional results of minimally invasive radical prostatectomy after prostate surgery for benign prostatic enlargement are even scarcer than for salvage RALP. A group from India recently published a study in which 26 men with previous TURP underwent RALP, and compared them to a cohort of 132 men undergoing RALP with no history of prostatic surgery [15]. In their work the authors point out the multiple difficulties associated with RALP in these patients, as the thickening of the bladder wall (a discrepant thickness of walls of the bladder and the urethra may determine difficulties in the VUA), difficult bladder neck dissection, increased periprostatic adhesions, difficulty in individuating the ureteral orifices with increased risk of injure and poor healing of the vesico-urethral junction. Indeed they found not only increased per-operative difficulties (which reflected in an increased blood losses and increased conversion to open surgery), but also worst post-operative functional outcomes: a prolonged urine leakage and an anastomotic stricture was found in 11.5 % and 14 % of men in the post-TURP group, respectively.

Although feasible, surgeons must keep in mind that patients with prior treatment for prostate cancer or surgery for benign prostatic enlargement represent a true challenge, even for experts in the field of minimally invasive prostatectomy. Regarding the VUA, these patients present difficulties as a consequence of the frequently imperfect bladder neck conformation and of poor tissue healing, with a consequent increase in risk of anastomotic complications such as a prolonged urine leakage and a stricture.

Barbed Sutures

In the first description of the single-knot running VUA technique we were using two 3/0 poliglecaprone-25 absorbable monofilament sutures (Monocryl™) tied at their end, and the median time required for performing the anastomosis was 35 min (range 18–80) [44]. Today performing the single-knot VUA has become an easier and faster task, which usually requires about 15 mins in expert hands and 30 min for novice surgeons [8, 16, 42]. This amelioration is the consequence of different innovations: first, the robotic platform has incredibly eased the throwing of stitches, and second unidirectional and bidirectional barbed sutures are increasingly being used to facilitate the task of VUA [16, 23, 30]. Barbed sutures are characterized by small barbs which allow the suture to run only in one direction, without losing tension if the sutured is not held during the throw of successive stitches.

V-LOC™ has been commercialized by Covidien and is characterized by a high density of barbs, 20/cm, and unidirectionality: at the end of the suture is a small loop which serves to lock the suture after the first throw. As such, when used for VUA, two V-LOC™ are used and locked together at their ends. V-LOC is designed such that the first 3 cm of thread after the needle are non-barbed: this allows the surgeon to undo a stitch if it is misplaced. V-LOC™ is available in 2/0, 3/0 and 4/0, with two types of absorbable materials (90 and 180, referring respectively to the average absorption time) and one non-absorbable texture. Quill™, by Angiotech Pharmaceutics, is a barbed suture available either in uni- or bi-directional form: the bi-directional suture has 2 needles at its ends, with barbs oriented in opposite direction in the two halves of the suture, starting from a transition point at the center. Quill™ sutures have 8 barbs per centimeter, disposed in a helical pattern to allow equal distribution of strength. The bidirectional Quil™ device is available in absorbable and non-absorbable materials and its size ranges from 4–0 to 2. The equivalence in biocompatibility and strength of barbed sutures compared to standard sutures has been demonstrates in different animal studies [32, 47], making these sutures a very interesting option for VUA.

Numerous investigators are exploring uni-and bi-directional sutures in the context of VUA, with the objective to evaluate a possible faster surgical time, and eventually evaluate long-term functional outcomes of these sutures compared to standard absorbable monofilaments. Specifically, Tewari et al. analyzed 50 men in which VUA was performed with a V-LOC™ and 50 men in which a polyglecaprone suture (Monocryl™) was used. They found that V-LOC significantly reduces anastomotic time: however, given the difference was ~5 min, the clinical significance of such time saving is questionable [42]. Similarly, Moran et al. tested a bidirectional barbed suture (Quill™), comparing it to Monocryl™, finding minimal differences in time and in surgeon security score [27]: although the Quill™ suture was faster to deploy (17.3 vs. 19.2 min), and the security score by the surgeon was greater, also in this case it is important to bear in mind clinical and not only mathematical differences. Sammon et al., at the Vattikuti Institute in Detroit, performed a randomized controlled trial with 64 men undergoing robotic prostatectomy. When performed with a barbed suture, the VUA was terminated faster, though no difference in leaks or bladder neck contractures were found compared to standard suture [35]. Hemal et al. attempted to compare standard, V-LOC and Quill sutures: however, unfortunately they interrupted their trial in the Quill™ arm, as the configuration of the needle (3/8, diamond tip) was considered inadequate for VUA after five cases. Confronting V-LOC™ to Monocryl™, the authors reported shorter operative times (8 vs 14 min) and higher surgeon comfort with the V-LOC [16]. Zorn et al. in a prospective randomized trial, evaluating Monocryl™ vs V-LOC™ in 70 men, found that barbed sutures reduced reconstruction time (13.1 vs. 20.8 min; $p < 0.01$), and the need to readjust suture tension or to place additional sutures was greater in the standard monofilament group. Moreover, after an average follow-up of 6.2 months, no leakage nor anastomotic stricture was observed in the V-LOC group, and continence rates were similar across the two groups (88 vs. 92 %, $p = 0.70$) [50]. In a prospective cohort study with 12 months of follow-up, Massoud et al. compared VUA performed with interrupted Vicryl™ stitches to VUA with a continuous V-LOC™ suture [24]: it is of note that after 1 year, no difference in anastomotic stricture rate requiring internal urethrotomy (2.5 % in each group) was found across the two groups. Moreover, continence rates at 12 months were comparable in the two arms (97.5 % with V-LOC™ vs 95 % with interrupted sutures, $p = 0.368$).

The two major concerns associated with barbed sutures are costs and the possibility of increased tissue inflammation leading to late complications after VUA. Regarding costs, indeed barbed sutures are more expensive than standard threads: in Europe, a V-LOC suture costs around 17€, making VUA material cost approximately 34€, compared to 7€, which is roughly the cost of two Monocryl™ 3/0 sutures. Though this may seem a small difference compared to the global cost of a minimally invasive prostatectomy, indeed in a time of economic crisis it cannot be neglected. Regarding tissue inflammation, there is no evidence that barbed sutures determine its increase [28, 46]. Nonetheless, long-term functional outcomes after barbed-suture VUA are awaited, albeit encouraging short term results [23, 42, 49].

Indeed some surgeons may prefer barbed sutures while performing VUA, as they are self-cinching, do not require intracorporeal knot tying and can save time and reduce technical complications. Nonetheless, the method utilized for VUA most frequently remains the one we described 10 years ago [44]: new materials, same technique.

Future Perspectives and Conclusions

Today, surgeons across the world perform VUA in multiple manners. However, many of them have readapted the original single-knot running technique, making minor modifications [2, 5, 22, 25, 39]. Indeed in the opinion of many surgeons, continuous sutures seem more appealing than separate stitches [26, 38]. We recently conducted a worldwide internet survey, asking urologists involved in minimally invasive surgery several questions regarding our technique (*in press*). Overall, it appeared that our technique has been widely accepted, and many urologists consider it a well-established technique in urology. Although the results of such survey are encouraging, further research will probably lead us to advance and develop better, faster and easier techniques for VUA, which especially in the pure laparoscopic approach, remains a step of major difficulty. In this setting, an interesting research was conducted by Hruby et al.: these investigators in 2007 described a novel tissue apposing device to perform VUA and tested it on a pig model [18]. This device, developed by American Medical Systems (Minnetonka, MN), is similar to a Foley catheter with 2 sets of opposing retractable nitinol tines which approximate the bladder neck to the urethra, thereby eliminating the need for suturing. In their animal model, this system not only was significantly faster than standard VUA (12 vs 41 min), but it was also associated with a reduced fibrotic reaction. As it happened in colo-rectal surgery, it is possible that in the near future we will see mechanic transurethral devices that aid in performing VUA, however to date the work of Hruby et al. represents, to our knowledge, the only attempt in such direction.

In conclusion, over 10 years have passed since the introduction of the single-knot running VUA technique and today this still seems a valid and safe technique for VUA. Though with minor modifications, the technique is now widely applied by many surgeons involved in minimally invasive urologic surgery.

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Chapter 64
Tips and Tricks for Erectile Function Preservation During Robot Assisted Radical Prostatectomy

Thomas Maubon and Eric Barret

Abstract Key anatomical landmarks and technical nuances to allow an optimal preservation of sexual function during robot assisted radical prostatectomy are reviewed by the authors in this chapter.

Keywords Denonvilliers fascia • Erectile function • Neurovascular bundle • Robotic radical prostatectomy

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The Main Principles

Anatomy Basics: Our Schematic Concept

To prevent mechanical and thermal injury during dissection of the neurovascular bundle (NVB) [2, 9], the appropriate plane needs to be developed based on its anatomical relationship with the periprostatic fascial plane. To understand these planes, a complete knowledge of the anatomy of the pelvic fascial structures is necessary [4, 6, 7, 10]. The periprostatic fascial anatomy is complex, and due to the lack of consensus between urologists, it is important to simplify this anatomy in order to make surgery reproducible despite individual anatomic variations. The lateral pelvic fascia (LPF) consists of two layers represented by the levator ani fascia (LAF) (parietal) and the prostatic fascia (PF) (visceral). The Denonvilliers fascia (DF) [8] runs posterior to the prostate separating the rectum from the seminal vesicles (SVs) and the prostate. On axial sections these three fasciae create a triangle occupied by the bulk of the cavernous nerves as shown in Fig. 64.1. This schematic conception of the fascial anatomy makes the procedure consistently reproducible giving very good results with respect to potency and cancer control at our institution.

NVB Dissection

The dissection plane will be guided by preoperative data: percentage of total number and length of positive core, data derived from MRI regarding extraprostatic extension, rectal examination, age of the patient and potency prior to surgery (IIEF5 score). We perform an antegrade approach for robot assisted radical prostatectomy (RARP) as previously described by other authors, with an interfascial nerve-sparing [1, 3, 5]. An experience assistant who is capable of aiding in exposure of the dissection planes is essential to successfully completing this step. Maintaining

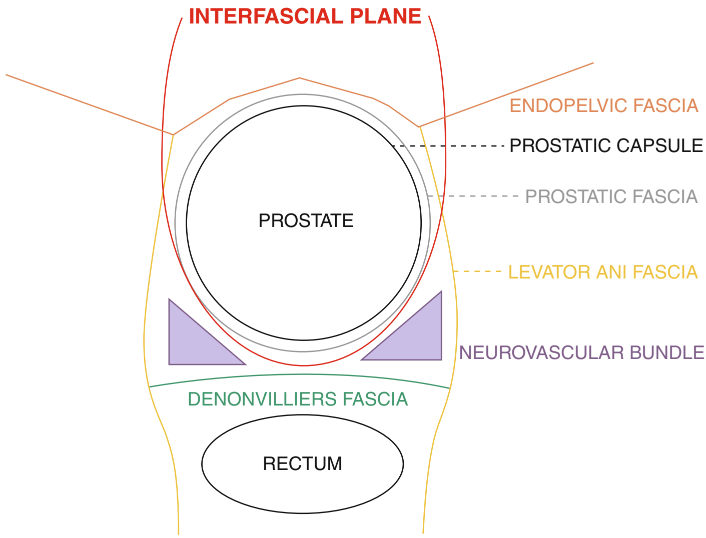

FIGURE 64.1 Schematic axial view of prostatic fascial anatomy

a bloodless surgical field and paying close attention to the prostatic contour will also aid in precise dissection of the bundles.

The Technique

Posterior Dissection

While maintaining an intact endopelvic fascia (EPF), the third arm robotic grasper retracts both SVs anteriorly while the assistant provides countertraction on the posterior aspect of the bladder wall in order to create vertical tension on the DF. This fascia is then incised horizontally just below its attachment to the posterior aspect of the prostate. The dissection starts medially in the reticular connective tissue underneath and follows the prostatic fascia (above) towards the apex, avoiding cautery in order to prevent rectal injury and preserve the apical neural components. DF is then retracted posteriorly by the assistant using gentle downward pressure and the dissection is extended laterally to the lateral pedicle fat pad proximally and to the vein distally that provides the land mark for the medial border of the NVB. The apical dissection will be continued after releasing NVB bilaterally in order to achieve greater mobility of the prostate and to securely dissect the posterior apex.

Control of the Lateral Pedicle

This is one of the most critical aspects of the procedure, and identification of the lateral edge of the prostate is the key for precise dissection. We begin by incising the EPF on the anterior aspect of the prostate at 2 o'clock on the right and at 10 o'clock on the left, from the puboprostatic ligament distally to the base proximally. We then open the avascular plane between the PF and the LAF on the lateral aspect of the prostate going from the incision towards the external aspect of the NVB. The robotic grasper lifts the prostate ventrally and laterally in the controlateral direction and the assistant gently retracts the bladder in order to stretch the pedicle and facilitating accurate exposure and subsequently division. The division of the pedicle is performed close to the prostate, Hemolock® clips are applied the proximally and the bipolar is used to control back bleeding from the prostate. This meticulous separation is necessary, because there is no clear border between the vessels and neural component.

Release of NVB

Once the prostate is freed from the vascular pedicle, it becomes more mobile and can be rotated to expose the triangle containing the NVB (Fig. 64.2). The exposure remains the same as previous step. It is important that the assistant retracts the bladder gently without creating any direct coun-

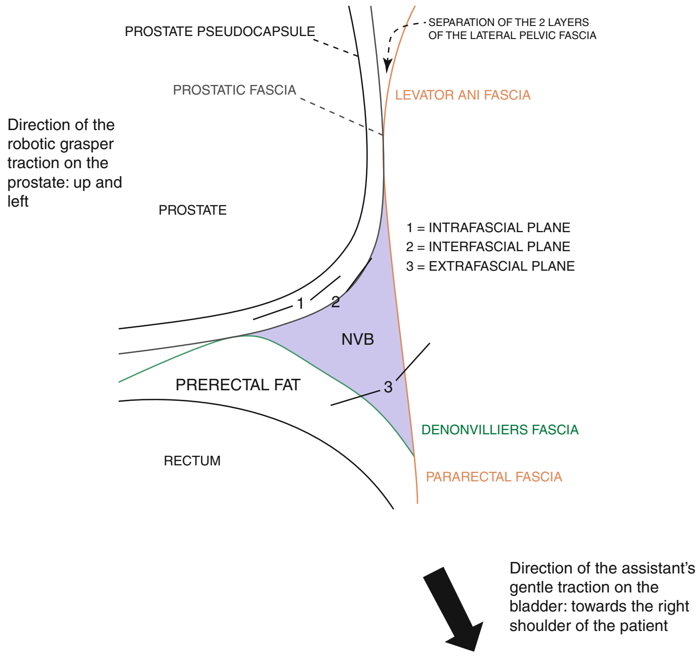

FIGURE 64.2 Schematic axial view of the NVB anatomy

tertraction on the NVB. The interfascial plane is the plane between the NVB and the prostatic fascia. Here, irrigation and suction from the assistant can be useful in identifying the contour of the prostate. It is crucial to remain directly on the surface of prostatic fascia to avoid inadvertent capsular incision. Once this triangle leaves the prostate, the dissection appears very elegant and usually can be performed by gently pushing the prostate away from the NVB. The fixed placement of the robotic grasper is helpful at this point of the procedure preventing excessive traction on the NVB with blunt dissection. Transcapsular vessels are usually found on the way to the apex, they usually can be cut without any coagulation. The subsequent retraction of these small vessels generally stops the bleeding. The procedure is identical on the left side with the exception that the assistant maintains traction on the prostate, and the robotic grasper provides the gentle traction on the bladder. Once the release of the NVB is done laterally, we proceed with the release of the posterior aspect of the apex. This provides a safe landmark for the subsequent division of the urethra. It is important to avoid any electrocautery at the apex due to confluence of the NVB in this region and the adjacent sphincter. Furthermore the bleeding usually stops when the anastomosis is complete.

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Chapter 65
Tips to Preserve Continence During Robotic Radical Prostatectomy

Bernardo Rocco, Elisa De Lorenzis, and Angelica Anna Chiara Grasso

Abstract While incontinence and impotence are the two major drawbacks of radical prostatectomy, incontinence seems to be the problem that troubles patients most, even if it occurs less frequently than impotence. The prevalence of urinary incontinence after radical prostatectomy can be influenced by preoperative patient characteristics, surgeon experience, surgical techniques and methods used to collect and report data. In this chapter we will focus on surgical tips to improve continence recovery during robot assisted radical prostatectomy (RARP), analyzing the procedures step by step.

Keywords Radical prostatectomy • Robotic surgery • Robotic prostatectomy • Urinary continence • Prostate cancer • Surgery technique • Continence

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Introduction

According to the American Urological Association (AUA), the reported risk of urinary incontinence post-radical prostatectomy (RP) ranged from 3 to 74 % [1]. Nevertheless, the definition itself of “continence” is not standardized and univocal (0 pad/safety pad/0-1 pad). Despite the lack of randomized studies comparing robot-assisted radical prostatectomy (RARP) and open radical prostatectomy (ORP), there is a trend towards faster recovery of continence with the robotic approach. In a 2012 meta-analysis a statistically significant advantage in favor of RARP compared to ORP and laparoscopic radical prostatectomy (LRP) was demonstrated in terms of 12-month urinary continence recovery [2].

Factors Impacting on Continence

The prevalence of urinary incontinence after RP can be influenced by preoperative patient characteristics, surgeon experience, surgical technique, and methods used to collect and report data.

One fundamental aspect for the surgeon is the perfect knowledge of the anatomy and the consequences of the removal of the prostate on the static system of the pelvis; therefore the aim of the reconstructive phase is to restore the pelvic anatomy and the urinary support system.

In this chapter we will focus on surgical tips during RARP to improve continence recovery.

Access to the Urethra and Length of Membranous Urethra

As suggested by von Bodman et al. and Hakimi et al., both the membranous urethral length and volume on preoperative MRI, and a longer intraoperative urethra, are predictors of continence recovery [3, 4].

Another tip that has been correlated with higher continence rates at 3 months is the placement of the puboperiurethral stitch (12-in monofilament polyglytone suture on a CT-1 needle) after the ligation of the DVC [5] described this technique, which advantages are the anterior support to the striated sphincter and the stabilization of the posterior urethra that can aid in the preservation of the urethral length during the dissection of the prostatic apex.

Access to the Urethra: Key Points

- maximal preservation of urethral length
- stabilization of the posterior urethra with the puboperiurethral stitch

Approach to the Dorsal Venous Complex (DVC)

Lei et al. in 2011 published the first description of selective suture ligation of the DVC during RARP [6]. In the first step an athermal, sharp division of prominent DVC components is performed to identify the avascular plane anterior to the urethra and the pillars of Walsh laterally. In the second step a selective suturing of DVC is performed followed by the anastomosis using a 3-0 Vicryl cut to 23 cm on a CT- 3 needle. This sequence minimizes instrument changes. The selective suture ligation of the DVC, compared to suture ligation prior to athermal DVC division, was associated with better urinary function and continence at 5 months, shorter operative times and similar positive surgical margins (PSM).

Approach to the Dorsal Venous Complex: Key Points

- constant pneumoperitoneum (15–20 mmHg)
- athermal DVC division and then selective ligation of DVC
- ligature of the DVC is beneficial for surgeons in their learning curve

Bladder Neck Preservation

Anatomically, the bladder neck (BN) is represented by three muscular layers: the inner longitudinal layer, the middle circular layer and the outer longitudinal layer.

Careful dissection of the prostatovesical junction can maintain most of the circular muscle fibers of the BN, accelerating the return of urinary continence [7].

In our technique the BN is identified by a cessation of the fat extending from the bladder at the level of the prostatovesical junction. The bladder is dissected off the prostate in the midline using a sweeping motion of the monopolar scissor while visualizing the bladder fibers. The full thickness of the posterior BN should be incised at the junction between the prostate and the bladder. The dissection is directed posteriorly and slightly cranially to expose the seminal vesicles.

Bladder neck preservation (BNP) is one variation of the BN dissection that has been associated with advantages like a lower risk of BN contracture [8] and earlier return to postoperative continence, but it has been postulated that it may increase the likelihood of PSM [9].

The first randomized, controlled, single blind trial comparing patients undergoing complete BNP with controls without preservation during ORP and RARP found that BNP was associated with significantly higher early and overall continence rates, and better quality of life outcomes without compromising cancer control [10]. In 2014, Lee et al. proposed a “graded” BNP during RARP, from grade 1 (wide BN dissection that necessitates BN reconstruction) to grade 4 (tight as possible BN dissection) [11]. The author underlined that a too distal dissection may compromise oncologic control by leaving residual prostatic tissue; a too proximal dissection may leave a large BN necessitating time-consuming BN reconstruction. In this study, BNP was an independent predictor of continence at 3 months, but not at 1 year; there was no difference among the four groups in PSM rates.

Bladder Neck Reconstruction

BNP is not possible in all patients. In these circumstances, some have shown improved urinary continence with bladder neck reconstruction (BNR). In case of large prostate and/or median lobes or previous endoscopic resection of prostate, a wide BN is frequently created.

In these cases, it is essential to protect the ureteral orifices and to reduce the BN diameter before the vesico-urethral anastomosis. The BN plication stitch (a single suture to plicate the BN in a figure of 8 fashion after the vesicourethral anastomosis) proposed by Lee et al. was associated with shorter mean time to reach total continence and higher total continence at 1 month and 12 months [12]. Patel's team described a modified transverse plication for BNR: a bilateral plication over the lateral aspect of the bladder. The suture begins laterally and runs medially until the BN size matches that of the urethra [13].

Bladder Neck Preservation and Reconstruction: Key Points

- BN reconstruction is brief, simple, ergonomic and effective

Nerve Sparing Technique

Although the rhabdosphincter receives direct innervation from the pudendal nerve, an association between nerve-sparing (NS) approach and urinary continence after RP has been noted [14]. One explanation can be the combination of neural preservation as well as delicate tissue handling during NS procedure. The association between NS and improved continence recovery has been demonstrated in many studies including both ORP and RARP [15–18].

In our technique the approach to the NS is usually retrograde. The periprostatic fascia is incised at the level of the apex and mid-portion of the prostate. Delicate and athermal spreading of the tissue on the lateral aspect of the prostate will allow the prostatic capsule and the neurovascular bundle (NVB) to be identified. The plane between the NVB sheath and the prostate capsule is relatively avascular, therefore no energy or clipping is required close to the path of the NVB. As the dissection proceeds in a retrograde fashion, the NVB can clearly be seen being released off the prostate.

Nerve Sparing Technique: Key Points

- delicate and athermal dissection of neurovascular bundles can improve continence recovery

Apical Dissection

Approach to the prostatic apex represents a critical moment in RP, because of the position deep in the small pelvis of the apex as well as its close connection to the DVC, sphincter and rectum [19]. A considerable part of the external urethral sphincter is located between the apex of the prostate and the colliculus seminalis [20].

In our technique, apical dissection is performed after complete mobilization of the prostate with a 30° binocular lens directed downwards. After the division of the DVC, the prostate is separated from the urethral sphincter by a blunt dissection and cut with the scissors without energy. The tissue covering the prostatic part of the sphincter is pushed cranially until the underlying longitudinal smooth muscle becomes visible. The anterior part of the urethra is then transected until the transurethral catheter becomes visible. Complete dissection of the apex and urethra is facilitated by the robotic magnification. For a better visualization of this region the surgeon can change the telescope using a 30° upward-facing lens in combination with a retraction of the prostate [21].

Apical Dissection: Key Points

- after complete mobilization of the prostate with a 30° binocular lens directed downwards
- Caveat: in preoperative high-risk tumors and when full functional-length urethral sphincter preservation is intended, frozen sections in this area could reduce PSM rate.

Posterior Reconstruction of the Rhabdosphincter

In 2006, Rocco F et al. proposed a technique for restoration of the posterior aspect of the rhabdosphincter which demonstrated to shorten time to continence in patients undergoing ORP [22]. In 2008, Coughlin et al. [23] and then Coelho et al. [24] applied the posterior reconstruction of the rhabdosphincter (PRR) to RARP.

Premise for the execution of the PRR is the Denonvillier's fascia dissection and preservation. We perform the reconstruction using two 3-0 poliglecaprone sutures (on RB-1 needles) tied together. The free edge of the remaining Denonvillier's fascia is approximated to the posterior aspect of the rhabdosphincter and the posterior median raphe using one arm of the continuous suture. As a rule, four passes are taken from the right to the left and the suture is tied. The second layer of the reconstruction is then performed with the other arm of the suture approximating the posterior lip of the BN (full thickness) and the vesicoprostatic muscle, to the posterior urethral edge and to the already reconstructed median raphe. This suture is then tied to the end of the first suture arm.

A recent systematic review showed that the PRR improves early return of continence within the first 30–45 days after RP; furthermore, trend towards lower leakage rates has been found in patients who received the PRR [25].

Double Layer Posterior Reconstruction of the Rhabdosphincter: Key Points

- First layer: the free edge of Denonvillier's fascia is approximated to the posterior aspect of the rhabdosphincter
- Second layer: the posterior lip of the bladder neck and vesicoprostatic muscle are sutured to the posterior urethral edge

Urethrovesical Anastomosis

The urethra and bladder are reapproximated using a continuous suture as in the technique described by Van Velthoven [26]. Two 20 cm 3-0 Monocryl sutures on RB1 needles of different colors are tied together. The posterior urethral anastomosis is performed firstly with one arm of the suture. Three passes are made through the bladder and two passes through the urethra and the suture is pulled straight up in order to bring the bladder down. The posterior anastomosis is continued in a clockwise direction from the 5 to 9 o'clock position obtaining adequate bites of tissue. This is followed by completion of the anterior anastomosis with the second arm of the suture in a counter clockwise fashion.

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Chapter 66
Radical Prostatectomy for Locally Advanced Prostate Cancer

Ali S. Gözen, Yiğit Akın, and Jens J. Rassweiler

Abstract Herein we present our tips and tricks to effectively perform radical prostatectomy for locally advanced prostate cancer. We will mainly focus on the laparoscopic technique, based on our own experience.

Keywords Locally advanced prostate cancer • Radical prostatectomy

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Introduction

Prostate cancer (PCa) is most common solid organ cancer in men worldwide [11]. The prostate specific antigen (PSA) and digital rectal examinations are essential tools for screening of PCa. However, 30–40 % of the patients are diagnosed in locally advanced stages (cT3) [1].

Radical prostatectomy (RP) is gold standard for organ confined PCa [2]. Laparoscopic RP (LRP) and robotic assisted laparoscopic RP (RALP) are contemporary minimally invasive options for organ confined PCa, as indicated by the European Association of Urology (EAU) Guidelines [12]. On the other hand, surgery for cT3 PCa remains controversial [13]. We recently published a study on LRP with high numbers of cT3 PCa patients [8, 9]. Herein we present tips and tricks for RP in cT3 PCa patients, mainly for LRP.

Patient Selection

Patients with cT3 PCa have to be informed about advantages, disadvantages, and complications of all recommended treatment modalities such as surgery, radiotherapy (RT) and hormone therapy (HT). Additionally, it should be claimed that LRP might not be sufficient to control the cancer, and that adjuvant RT and HT might be needed after surgery.

Distant metastases should be checked carefully by using the current diagnostic tools like bone scintigraphy, prostate specific membrane antigen (PSMA) and positron emission tomography (PET) scan.

Oncological and Functional Results

Nerve sparing surgery should be applied as much as surgeon can do without compromising oncological safety. We perform cystography before taking urethral catheter. The cT3 PCa patients' continence and erectile dysfunction rates are comparable with cT2 PCa patients' rates [8, 9]. Nonetheless, functional results would be better in LRP and/RALP.

Surgical Tips and Tricks

Surgery for cT3 cases has to be more radical and aggressive dissections are needed when compared with organ-confined PCa cases in order to achieve sufficient oncological safety (i.e. to provide negative surgical margins).

- ***Extended pelvic lymphadenectomy* –** Bilateral and meticulous extended pelvic lymphadenectomy (ePLND) is indicated in these cases. An ePLND includes removal of lymphatic nodes up to the iliac bifurcation and might result in improved survival rates [3]. In the cT3 PCa cases the PLND can be extend till the common iliac and presacral lymph nodes [7]. Surgeons should consider postoperative complications including lymphocele, thus, careful dissections and to control lymphatics are important.
- ***Wide dissection of prostate*** – Dussinger et al. reported that wide dissections might successfully decrease the rate of positive surgical margins without any increased morbidity [5]. Additionally, it depends on prostate's and also cancer's anatomy. If the cancer involves apex, a wide dissection may be associated with negative surgical margin.
- ***Extraperitoneal Heilbronn Technique with wide excision of neurovascular bundle at the level of apex*** – Extraperitoneal Heilbronn technique provides early access to prostate [6]. In case of cT3 PCa, we perform wide excision of neurovascular bundles at level of apex especially in the apical tumor involvement cases. Bladder neck has to be widely dissected without attempt any bladder neck sparing if the tumor is located in basis of prostate. Besides, pedicles of prostate have to be widely excised in a close proximity to neurovascular bundles (Fig. 66.1).
- ***Transperitoneal Techniques*** – Transperitoneal techniques can provide a wide excision of pelvic and iliac lymph nodes. Tewari et al. described a novel transperitoneal

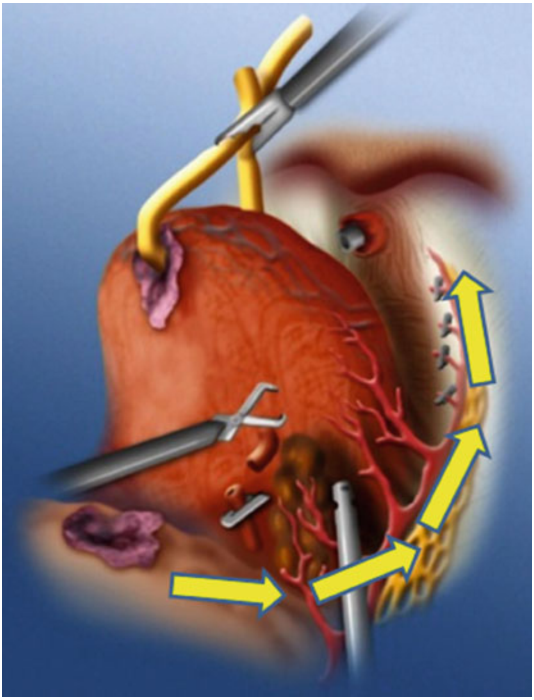

FIGURE 66.1 Wide excision of neurovascular bundle at the level of apex – In case of cT3 PCa, we perform wide excision of neurovascular bundles at level of apex especially in the apical tumor involvement cases. Bladder neck has to be widely dissected without attempt any bladder neck sparing if the tumor is located in basis of prostate. Besides, pedicles of prostate have to be widely excised in a close proximity to neurovascular bundles

RALP technique for visualizing the apex of prostate during RALP [15]. Curto et al described early access to seminal vesicles with a wide and radical excision for providing negative surgical margins at the first step and help to determine the dissection line [4]. Nevertheless, the aim of RP is similar in terms of widely excision of prostate and providing negative surgical margins in case of cT3 PCa via extraperitoneal or transperitoneal routes.

- ***Surgeon experience and volume*** – Vara et al.reported better oncological results with robotic surgery with growing surgical experience especially among higher volume surgeons [17]. The RALP and notably LRP are definitively not for beginners for cT3 PCa cases and have to be performed by experienced high volume surgeons.

Discussion

An increasing number of cT3 PCa patients have been recently undergone RP. Recently, Touijer et al. reported open RP in selected patients with advanced stage PCa [16]. We previously reported LRP in T3 PCa patients with similar overall survival rates with T1 and T2 PCa patients [8, 9]. Additionally, RALP series on T3 PCa patients are increasing with high volume patients.

LRP and RALP are promising minimally invasive treatment options in T3 PCa patients [10]. These can provide similar oncological and functional results with open surgery [8, 9]. However, patients can recover faster than open surgery with well-known advantages of minimally invasive surgeries. On the other hand, there is a still financial problem in RALP in terms of robot and its arms are still expensive [8, 9]. Thus, LRP is one step ahead but it needs more practice and is difficult to perform for beginners in laparoscopy. Additional therapies may be needed after surgery [14]. Side effects of these should be discussed with patients and their partners. The HT may reduce sexual desire and can cause to erectile dysfunction. The RT may cause to some bowel and voiding problems. Nevertheless, patients should be informed for all these above.

Despite the limited data above, and we know that the importance of cancer specific survival in PCa. However, similar overall survival rates can be provided in cT3 PCa patients with cT1 and cT2, by LRP in terms of well-known advantages of laparoscopy [8, 9]. Finally, LRP is a plausible surgical option like upon surgery providing considerable oncological and functional results in advanced stage PCa.

Conclusions

LRP seems to be effective and safe in patients with cT3 PCa. Technical difficulties may occur, but similar overall survival rates with cT1 and cT2 can be provided in cT3 patients. Additional therapies may be needed after surgery. LRP can be a reasonable part of treatment in cT3 PCa patients with well-known advantages of laparoscopic surgery.

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Chapter 67
Practical Solutions for Challenging Robotic Prostatectomy Cases

Raj Satkunasivam and Monish Aron

Abstract Robot Assisted Laparoscopic Radical Prostatectomy (RALP) has gained widespread uptake as the most common technique in the surgical management of Prostate Cancer (PCa). RALP is currently applied to a broad range of patient phenotypes, and one may encounter challenging variants in normal anatomy but also past surgical scenarios that pose technical challenges. As the indications for RALP have also become broadened to the inclusion of high-risk disease and salvage scenarios, so too is the requirement for technical adaptation of the robotic surgeon. Herein we present challenging scenarios and practical solutions related to variations in normal anatomy, prior surgery, high risk prostate cancer and salvage RALP.

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Keywords High risk prostate cancer • Median lobe • Obese patients • Previous surgery • Robotic radical prostatectomy

Introduction

Robot Assisted Laparoscopic Radical Prostatectomy (RALP) has gained widespread uptake as the most common technique in the surgical management of Prostate Cancer (PCa) [21]. RALP is currently applied to a broad range of patient phenotypes, and one may encounter challenging variants in normal anatomy but also past surgical scenarios that pose technical challenges. As the indications for RALP have also become broadened to the inclusion of high-risk disease and salvage scenarios, so too is the requirement for technical adaptation of the robotic surgeon [24].

Herein we present challenging scenarios and practical solutions related to variations in normal anatomy, prior surgery, high risk prostate cancer and salvage RALP.

Challenging Anatomic Scenarios

Large Prostate Volume or Narrow Pelvis

A large prostatic volume and/or narrow pelvis can make specific steps of the RALP particularly challenging owing to a limited working space (Fig. 67.1a). Opening of the endopelvic fascia, and maneuvering delicately to ligate the dorsal venous complex is hindered in this situation. This is further confounded by the presence of large peri-prostatic veins that can cause troublesome bleeding if not manipulated with care. Lastly, decreased mobility directly impacts the dissection of the posterior bladder neck, pedicles and nerve sparing. Even with the most optimal scenario, a large bladder neck requiring reconstruction may not be avoidable.

In our experience, meticulous, deliberate dissection with good traction and counter-traction is essential to achieving a good outcome. Our port placement has been a five-port robotic approach with the fourth arm on the right side of the patient and the assistant port on the left. Having a grasper available in both the left and right side allows for optimal traction and counter-traction, even with limited working space. Additionally, the assistant port can be used to provide cephalad traction on the bladder.

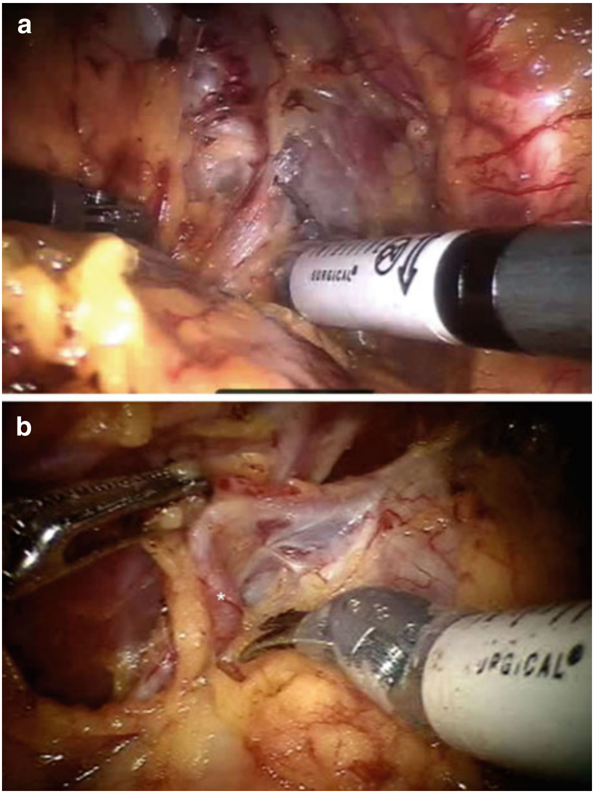

Fig. 67.1 (**a**) Large prostate gland resulting in decreased working space. (**b**) Lateral Accessory Pudendal Artery (APA) running along the prostate surface but below the endopelvic fascia (*)

Large Intravesical Prostatic Lobe (IVPL)

An enlarged median lobe, the most common form of an intravesical prostatic lobe (IVPL), has been found in 8–19 % of RALP patients [10, 11, 15]. Early recognition and meticulous management of a large IVPL can avoid inadvertent complications during RALP. These pitfalls include injury to ureteral orifices, amputation of the lobe, creating a large bladder neck, thinning the bladder wall and potentially causing a detrusorotomy (i.e. "buttonholing" the bladder).

The presence of a large IVPL should be anticipated preoperatively on the basis of history, digital rectal exam and trans-rectal ultrasound measurement of prostate volume. After the anterior bladder neck is divided, it is imperative to identify a large IVPL by gentle retraction on the bladder neck. Recognition that the Foley catheter is deviated away from midline provides an early clue for the presence of a large IVPL. The use of a 30° down scope optimizes identification of a large IVPL.

Our approach to a large IVPL is the use of a "rescue stitch" for retraction anteriorly out of the bladder lumen [1]. This stitch consists of a 6-inch long 0-polyglactin suture on a CT-1 needle with a *Hem-o-lok clip* tied to the tail end. It is deployed through the IVPL from distal to proximal, in a parasagittal plane, using a robotic needle driver, with the clip placed and manipulated to sit snugly against the distal aspect of the lobe (Fig. 67.2). The fourth robotic arm can then be used to retract the IVPL towards the pubic symphysis, delivering the IVPL from the bladder lumen and providing an unobstructed view of the posterior bladder neck. The amount of retraction stitches is typically one, however, up to three can be deployed; one for each intravesical lobe. Dynamic retraction of the IVPL (or lobes) facilitated by retraction sutures allows clear definition of the posterior bladder neck to facilitate unobstructed posterior bladder neck incision and ongoing retrovesical dissection until the vas and seminal

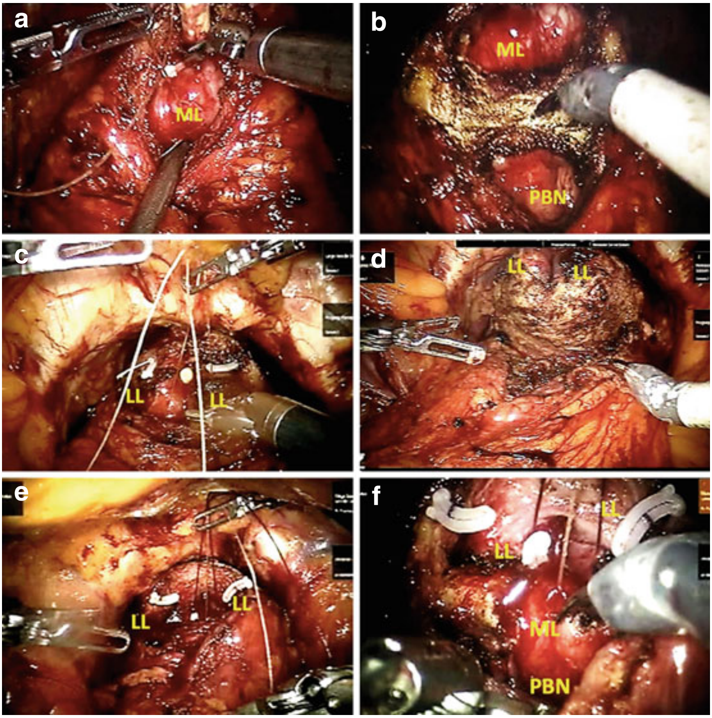

FIG. 67.2 Deployment of the Rescue Stitch for the management of intravesical lobes. (**a**) A single stitch deployed through a median lobe (*ML*). (**b**) The stitch retraction provides excellent visualization of the posterior bladder neck (*PBN*). (**c**) Two stitches are deployed through lateral lobes (*LL*). (**d**) Final view of the dissected intravesical lateral prostate lobes. (**e**) Stitch deployment through two lateral lobes and a median lobe. (**f**) Closer visualization: Note that the prostate lobes are lifted up and the posterior bladder neck can be safely approached

vesicles are reached. In our experience, this technique allows for meticulous dissection aided by dynamic retraction and avoids trauma to IVLPs caused by direct grasping. Additionally, it maintains a relatively small bladder neck and the need for subsequent reconstruction of the bladder neck is minimized.

Accessory Pudendal Artery

Erectile function preservation not only requires preservation of the neurovascular bundles, but also preservation of anomalous vasculature that supply the cavernosal bodies. This is particularly highlighted by the incidence of vascular insufficiency which can also contribute to post operative erectile dysfunction [14]. Accessory pudendal arteries (APA) arise above the levator ani and head to the penis infra-pubically. The overall incidence of APA is approximately 30 % and can be sub classified into apical and lateral locations. The magnification permitted in robotic surgery and awareness for APAs should be used for identification. Overall, 80–90 % can be preserved [19, 20]. Lateral APAs that run over the endopelvic fascia should be released from surrounding fat and pushed laterally. More care is required, however, for lateral APAs that run along the prostate surface but are below the endopelvic fascia (Fig. 67.1b). The critical maneuver is to incise endopelvic fascia medial to the course of the APA, and push the APA laterally towards the pelvic sidewall and out of harm's way. Vessel loops can be utilized to provide traction and the extent of dissection is only to free up the APA such that the extirpative part of the operation can be carried out without harm to the artery [20]. Apical APAs must be carefully dissected out since they may appear to be heading into the prostatic apex but are in fact running parallel to the course of the dorsal venous complex (DVC). Directly incising the DVC while aided by the tamponade effect of pneumoperitoneum can facilitate separation of the APA from the DVC, as well as identification of branches of the APA heading towards the prostate that require control.

RALP in Obese and Morbidly Obese Patients

The rate of obesity (body mass index (BMI) $\geq$ 30 kg/m^2) has been increasing, which is troublesome since these men will present with higher grade tumors and are also at higher risk for biochemical recurrence [2, 7]. Obesity can pose further challenges intraoperatively, including ventilation difficulty in Trendelenburg position, risk of positioning injury and compartment syndrome [16]. Careful positioning is critical including adequate padding of pressure points and use of large size lithotomy-stirrups (Fig. 67.3). We utilize extra long bariatric trocars, including camera and robotic ports in obese patients. While Veress needle entry is safe, we typically make an adequate incision to expose the fascia clearly and to provide counter-traction. Port placement should be carefully planned noting that there will be a longer distance form skin to operative field and that the deeper and narrowed true pelvis seen in the obese can co-exist with exostosis of the symphysis pubis [3, 13, 25]. One should anticipate decrease working space related to increased peri-prostatic and perivesical fat as well as larger prostate glands in obese men [13]. Deployment of an extra assistant lateral port (5 mm) can be useful to provide cephalad

Fig. 67.3 Morbidly obese patient undergoing RALP. Patient habitus poses unique positioning, laparoscopic access and robotic technical challenges

traction on the bladder and to assist with lymph node dissection. In addition, the pelvic floor is often pushed caudally in obese men by the intra-abdominal weight, leading to increased distance between the bladder neck and membranous urethra, and this combined with decreased space in the pelvis due to large amounts of pre-vesical fat makes the vesico-urethral anastomosis challenging. We usually excise the prevesical fat to create more room in the pelvis, and employ directed perineal pressure to facilitate the anastomosis.

Challenging Post-surgical Scenarios

Intra-abdominal Adhesions

Although a past history of trans-peritoneal surgery is predictive of intra-abdominal adhesions, the extent of adhesions encountered is not directly correlated or predictable based on the timing, extent and amount of past surgeries (Fig. 67.4a). Thus, while Veress needle entry is certainly feasible, a lower threshold to converting to open laparoscopic access should be maintained. Open laparoscopic access should be established with the selection of the entry point being the furthest away from the area of prior surgery. A pitfall of open entry is that there is a persistent leak around the port site. This can be circumvented by using a balloon port to establish an air-tight seal (Fig. 67.4b). If extensive lysis of adhesions is to be performed to allow precise robotic port placement, this is best done laparoscopically to begin with. Once enough room has been created to place robotic ports, the remaining lysis of adhesions can be completed robotically, if necessary.

Prior Transurethral Resection of the Prostate

RALP following prior transurethral resection of the prostate (TURP) poses unique challenges with overall increased risk

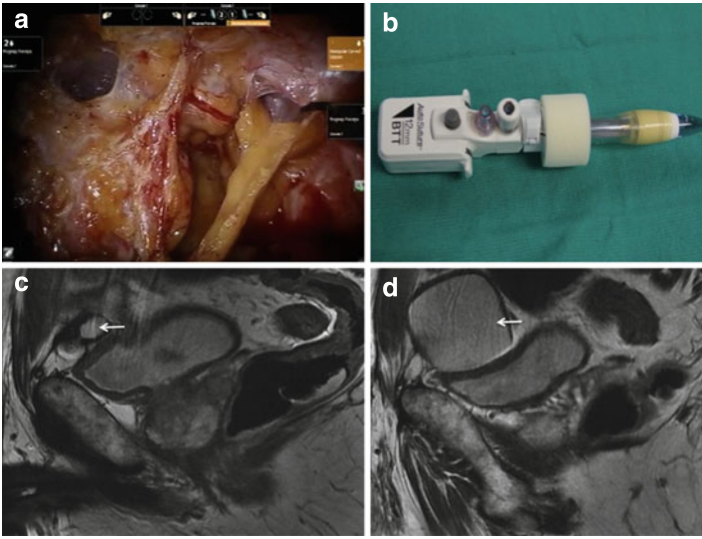

FIG. 67.4 (**a**) Extensive intra-abdominal adhesions. (**b**) Balloon port device use to establish an air-tight seal after open entry. (**c**, **d**) Sagittal T2-weighted Pelvic MRI demonstrating full penile prosthesis reservoir (*arrow*) in close anatomic relation to the bladder

of incontinence and erectile dysfunction [8]. One may anticipate the presence of peri-prostatic adhesions that make the procedure more difficult. Difficulty may be encountered in identifying the posterior bladder neck, while paying close attention to also identifying potentially close ureteric orifices.

It has been our approach to perform pre-operative cystoscopy to identify the anatomy of the bladder neck and proximity of the ureteric orifices. Consideration should be given to the placement of bilateral ureteric stents to aid in transvesical identification of ureteric orifices. Additionally, intra-operative identification can be facilitated by IV Indigo Carmine to ensure the bladder neck incision is appropriately spaced away from the ureteric orifices. Care must be taken during the urethro-vesical anastomosis as well to avoid inadvertent incorporation into the anastomosis or obstruction of the ureteric orifices.

Prior Artificial Urinary Sphincter or Inflatable Penile Prosthesis

The presence of a reservoir supplying an artificial urinary sphincter (AUS) or inflatable penile prosthesis (IPP) may obscure visualization and dissection of the bladder anteriorly. While the reservoir is typically placed in the space of retzius, it may also be located in the pre-peritoneal space. The most conservative approach is to deactivate the device, remove the reservoir, complete the RALP then subsequently replace the reservoir after re-prepping the patient. Return of the reservoir could be delayed for a longer period post-operatively as well. This conservative approach has been advocated as inadvertent injury or contamination to the reservoir or connecting tubing may render the device inactive, obviate subsequent surgery, or risk device infection that requires eventual explanation. Moreover, this view has also found support since the reservoir may directly be obstructive to an open radical retropubic prostatectomy [5].

RALP can be carried out without the need for preoperative reservoir removal in select patients [6, 17]. Moreover, compared to open retropubic radical prostatectomy, RALP may in fact be considered a safer approach, since it affords direct visualization of the reservoir and port placement is located further from potential device tubing that can be injured in the open technique [22]. Our approach in this situation has been to proceed with RALP with the reservoir in situ. The reservoir volume can be decreased if it is obscuring visualization of the target anatomy, by partial activation of the device.

Patient history should be obtained regarding the placement and functioning of the device. The site of the reservoir can be determined by past operative notes, or physical exam to identify the abdominal scar, including an exam under anesthetic to identify the direction of device tubing from the scrotal pump to either the right or left lower quadrant. While we do not routinely perform cross-sectional imaging in all patients, CT or MRI can be helpful for surgical planning (Fig. 67.4c, d). An AUS should be deactivated at the start of the case to prevent injury during urethral catheterization and avoid any risk of erosion from an activated cuff. Intraoperatively, since the AUS reservoir is smaller (23–25 mL) than the IPP reservoir (65–100 mL) even when full, it does not significantly obscure visualization. Conversely, the much larger IPP reservoir can obscure part of the pelvis.

Visualization can be optimized by careful, blunt retraction of the reservoir towards the anterior abdominal wall using the fourth robotic arm and activating the device partially to decrease the volume in the reservoir. There is often a pseudo-capsule that forms around the reservoir that should be respected during dissection. Electro-cautery can be safely used around the device. Throughout the case, the surgeon and assistant must pay careful attention to the reservoir, particularly when sutures are inserted and retrieved. At the end of the procedure the IPP or AUS can be cycled with direct visualization of the reservoir to ensure normal functioning and to rule out occult damage. Post-operatively, Rehman et al. have advocated that an IPP should not be used for 6-weeks to prevent stretching of the urethro-vesical anastomosis [17].

Prior Inguinal Hernia Repair with Mesh

The presence of mesh used in the repair of inguinal hernias may elicit a strong inflammatory reaction with obliteration of the space of retzius and dense adherence of the bladder to mesh. The general approach to avoid inadvertent cystotomy during dropping the bladder in a transperitoneal RALP is to stay close and "hug" the undersurface of the mesh [12]. If a mesh plug has been used, care must be taken not to drop the plug down with the bladder.

RALP for High Risk Prostate Cancer

In the era of PSA-based screening, approximately 15–26 % of men will present with prostate cancer having high risk features, which portends increased risk of biochemical recurrence and metastatic disease [4, 23]. While the definition of high risk disease is not widely consistent, most studies use Gleason Grade 8–10 and/or D'Amico High Risk category in their definition. The application of RALP to high-risk disease has demonstrated comparable outcomes to open surgery, although the follow up period is limited. In a systematic review by Yuh et al., RALP for high risk disease was associated with a 35 % positive margin rate, and a 3-year biochemical recurrence-free survival ranging from 45 to 86 % [24].

Surgical planning is critical prior to RALP for high-risk disease. This includes assessment of resectability by rectal examination, and appropriate staging to assess whether the PCa is truly organ confined. For disease that is locally confined, pelvic MRI is useful in preemptively identifying locally advanced disease and extent, including extracapsular penetration. Our practice has been to cystoscopically assess the bladder neck for resectability and appreciate the position of the ureteric orifices. Neo-adjuvant androgen deprivation can be utilized to downsize the prostate, and resectability should be re-assessed after a period of treatment.

In our experience, bilateral ureteric stents placed at the beginning of the case aid in identification of the ureteric orifices during bladder neck transection and subsequent vesico-urethral anastomosis. In large anterior tumors, the prostate should be carefully de-fatted, or a cap of peri-prostatic fat should be left on the prostate. Incision of the bladder neck should be done cautiously, ensuring that a sufficient margin is achieved. If there is a suspicion of bladder neck involvement, intra-operative frozen section analysis should be utilized to facilitate bladder neck revision. The decision for nerve sparing is based on pre-operative risk of extra-capsular extension as well as intraoperative assessment of tissue quality and suspicion. Nerve sparing in high risk disease does not appear to compromise oncologic outcomes [24]. Our approach has been to offer nerve sparing surgery to candidates based on individualized risk and utilize intra-operative frozen section analysis to guide the extent of nerve-sparing. We have previously demonstrated the utility of robotically-manipulated intraoperative transrectal ultrasound (TRUS) in patients that included lesions with pathologic extracapsular extension (Fig. 67.5a) [9]. Relevant intraoperative TRUS findings can be conveyed to the surgeon in real time, particularly when a suspicious lesion is in close proximity during neurovascular bundle or apical dissection. Intraoperative TRUS can additionally help better define the apical anatomy, including apical protrusion to help tailor the dissection strategy for the apex (Fig. 67.5b).

Extended lymph node dissection (ELND) is critical in high risk disease since approximately one-third of patients will harbor metastatic disease [24]. Careful use of electrocautery, along with *hem-o-lok* clips as necessary are the underpinnings of a robotic lymph node dissection. It appears the robotic technique is equivalent, with rate of symptomatic lymphoceles being 3 % [24]. While the extent of lymph node dissection is controversial, dissection should always include the external and internal iliac vessels and within the obturator fossae [2], and in the opinion of some authors, should ideally extend to the ureter crossing the common iliac vessels (Fig. 67.6a).

Salvage RALP

Biochemical failure with pathologic documentation of residual/recurrent disease following radiation therapy is the typical scenario for utilizing RALP for local control of prostate cancer. RALP can also be applied to scenarios where other modalities have failed, including high-intensity focused ultrasound (HIFU), cryotherapy, and proton beam therapy.

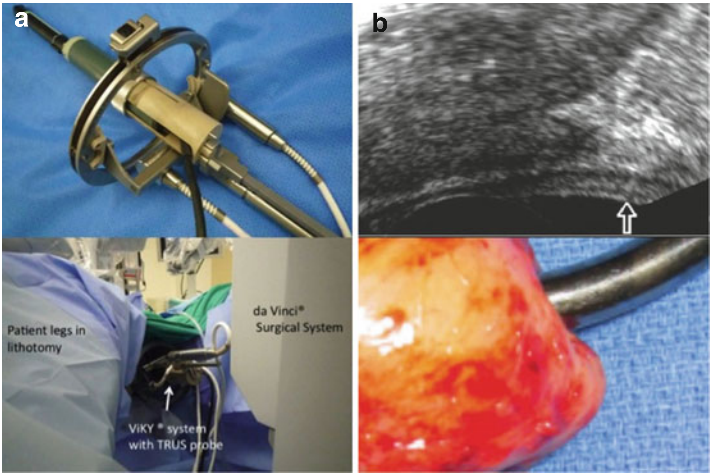

FIG. 67.5 (**a**) Robotic TRUS arm used for intra-operative TRUS navigation (**b**) Detection of apical protrusion by intra-operative TRUS navigation

Salvage RALP is particularly challenging owing to radiation induced fibrosis and obliteration of tissue planes (Fig. 67.6b) [18]. Great care must be taken for pre-operative counseling, including discussing potentially significant complications including rectal injury (including potential diverting colostomy), recto-urethral fistulas and bladder neck contractures. Risk of urinary incontinence and erectile dysfunction and the potential need for additional therapy for these morbidities should be discussed.

In our experience, we typically use an anterior-approach for salvage prostatectomies. Once the posterior bladder neck has been divided, great care must be taken in the dissection of the retrovesical space. Sharp dissection is used to release the rectum in the midline. Nerve sparing is only reserved for patients that demonstrate a discernible plane. The prostate is carefully rotated at the time of the apical dissection such that any posterior rectal attachments can be released sharply. Once the specimen has been removed, rectal wall integrity should be assessed by rectal

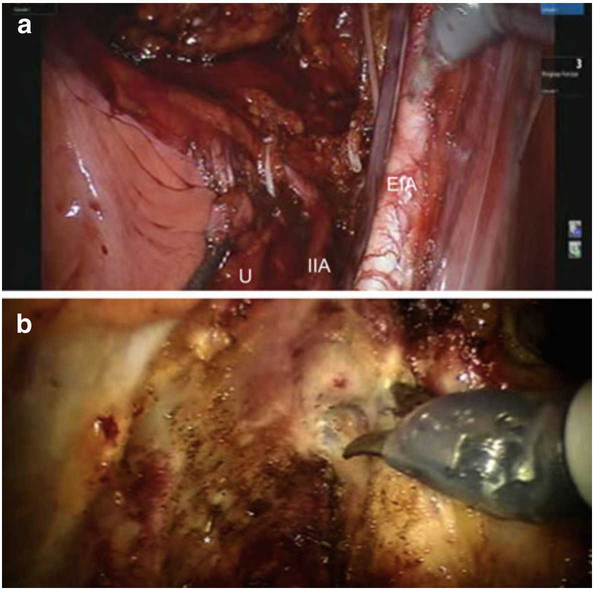

Fig. 67.6 (**a**) Completed right-sided Extended Pelvic Lymph Node Dissection template for high-risk prostate cancer. *EIA* external iliac artery, *IIA* internal iliac artery/hypogastric artery, *U* ureter (**b**) Salvage RALP following brachytherapy with post-radiation fibrosis and brachytherapy seed (*) in operative field

examination by the bedside assistant during simultaneous visual inspection. Furthermore, the pelvis can be filled with saline irrigation and the rectum can be insufflated with air using a bulb-suction device to further ensure a rectal injury is not missed.

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Chapter 68
Robotic Radical Cystectomy and Urinary Diversions: Step-by-Step Technique

Franco Gaboardi, Giovannalberto Pini, and Nazareno Suardi

Abstract Robot assisted radical cystectomy (RARC) experience is increasing worldwide, minimizing surgical insult, resulting in postoperative morbidity reduction while offering greater ergonomics for the surgeon. In this chapter, we will cover technical tips and tricks to perform a RARC.

Keywords Bladder cancer • Robot-assisted radical cystectomy

Introduction

Radical cystectomy (RC) represents the gold standard treatment for muscle invasive bladder cancer (MIBC), and remains a complex multi-step surgery irrespective of surgical

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approach, being associated with a high rate of complications [3, 14]. With the purpose of reducing such morbidity, minimally invasive approaches have been settled and the 2015 EAU-guidelines [16] consider laparoscopic radical cystectomy (LRC) with extracorporeal urinary diversion (ECUD) a viable option. However, LRC has never gained wide acceptance in the urological community due to long operative time, to the difficulties related to both extended PLND and urinary diversions reconfiguration.

Following our first series reported in 2001 [1, 5] about 50 cases were necessary to standardize the technique [10–12] and with the advent of robotic surgery, we naturally set up in 2007 a radical cystectomy program (RARC) [9].

Up to date RARC experience is increasing worldwide, minimizing surgical insult, resulting in postoperative morbidity reduction while offering greater ergonomics for the surgeon. Several meta-analyses demonstrated that RARC decreases blood loss and reduces overall complication rates, resulting in reduced transfusion rates, shorter time to normal diet and length of stay (LOS) [6, 15], without compromising oncologic safety as compared to open surgery [13]. Several urinary diversions have been described, but only limited randomized clinical trials (RCT) performed by few hyper-specialized tertiary referral centers stressed the advantage offered by intracorporeal urinary diversion (ICUD).

In this chapter, we will cover technical tips and tricks to perform RARC.

Patient Selection

The exclusion criteria for RARC include: (a) persisting sign of locally advanced/frozen pelvis cancer, extensive lymph node involvement, after neoadjuvant chemotherapy (cT3-4 disease); (b) the presence of contraindications to laparoscopy and steep Trendelenburg position (30°): ASA score > 3, severe cardiac and/or lung insufficiency.

Enhanced Recovery Protocol

In order to reduce peri-operative stress response and to aid faster patient recovery we regularly apply an Enhanced Recovery Protocols (ERP) [2, 3]. Our multidisciplinary team regularly suggests the patient preoperative smoking cessation, weight lose and physical activity. The ERP protocol advises no preoperative mechanical bowel preparation, early postoperative nasogastric and drainage tubes removal as well as early feeding and patient mobilization.

Patient Position and Ports Configuration

RARC is commonly performed via a 6-port laparoscopic approach. Supraumbilical optical port position allows performing an easier extended pelvic lymphnode dissection (e-PLND) (Fig. 68.1a) as well as easy identification and isolation of the ureters.

In case of extracorporeal urinary diversion (ECUD) reconfiguration, we insert through a 6 cm supraumbilical incision a medium size Alexis laparoscopic system (Alexis O wound protector/retractor and laparoscopic cap; Applied Medical, Rancho Santa Margarita, CA, USA) in order to allow faster specimen removal (Fig. 68.1b) easier bowel exteriorization, wound protection and effective pneumoperitoneum restoration to perform ileal-urethral anastomosis when a neobladder is created.

Whenever a 12-mm endoscopic stapler is planned (ICUD), we adopt the Karolinska technique [7] by inserting a 12-mm

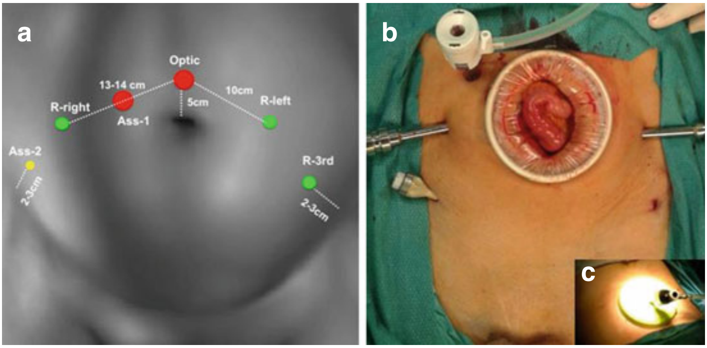

FIG. 68.1 Ports configuration. (**a**) Classic 6 port approach (**b**) Trocars and Alexis wound retractor placed supraumbilically (**c**) Alexis Laparoscopic Cap allowing pneumo-peritoneum creation

trocar placed in the left iliac fossa. The fourth 8-mm robotic trocar will be inserted through this trocar as long as necessary.

Extended Pelvic Lymph Node Dissection (ePLND)

We routinely perform PLND as the very first step of RARC as it allows the identification and preparation of the principal anatomical landmarks (ureters, vas deferens, hypogastric and vesical vessels) and sets-up the cystectomy part of the procedure. By lifting up umbilical ligament, bladder can be easily translated ensuring better exposure of iliac and obturator areas.

An extended or super-extended template is adopted (Fig. 68.2). From an oncological point of view we are keen to remove all lymph nodes with an en-block fashion trying to avoid any nodal incision and manipulation in order to avoid disease spread during the procedure.

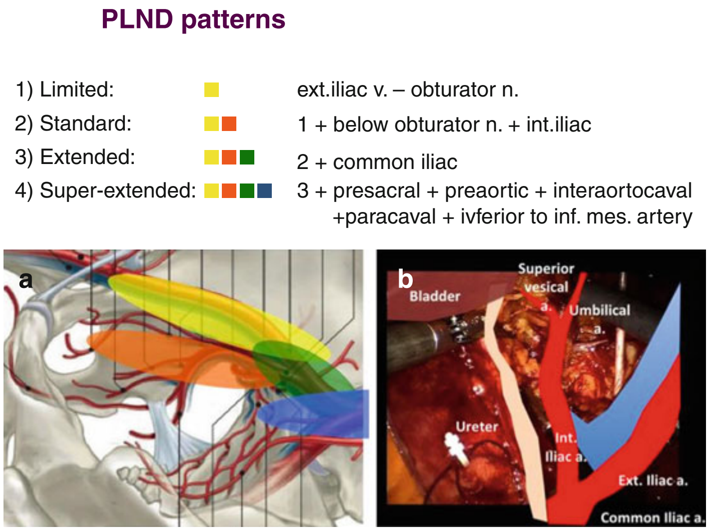

Fig. 68.2 Pelvic Lymph-node dissection patterns. (**a**) The limits of Extended PLND. Cranial border: ureter and common iliac artery; lateral border: psoas muscle and genitofemoral nerve; medial border: umbilical artery, peritoneum and bladder; distal border: Cloquet lymphnode. The limits of Superextended PLND extended + presacral area (**b**) PLND allows the identification and preparation of the principal anatomical landmarks (ureters, vas deferens, hypogastric and vesical vessels) and sets-up the cystectomy

Robotic Radical Cystectomy

Ureters are bilaterally identified at their crossing on the iliac vessels and carefully dissected towards the bladder. It is mandatory to handle ureters with care and to prevent the excessive skeletonization in order to preserve vascular integrity and therefore avoiding the dreaded risk of ureteral stenosis at follow-up. For oncological reasons the section of the ureters should always performed through 2 hem-o-lok clips (Weck Surgical Instruments, Teleflex Medical, Durham, NC, USA) and the most cranial clip has a pre-placed tie, which will facili-

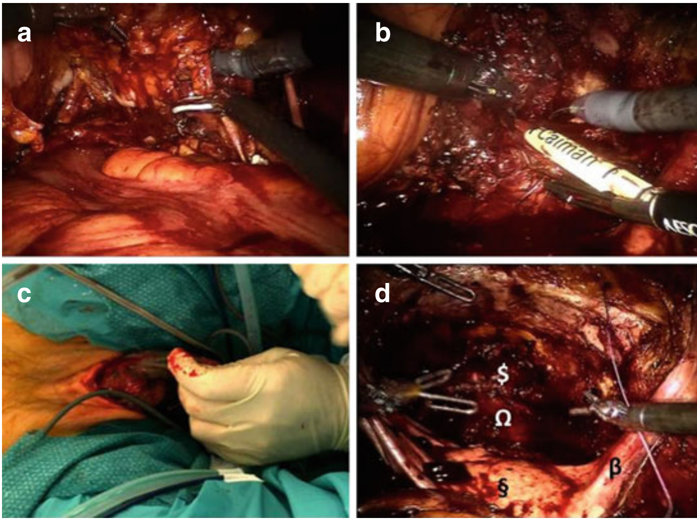

FIG. 68.3 Robotic radical cystectomy. (**a**) Pedicle section with Ultrasonic SonoSurg G2 (Olympus Corp., Tokyo, Japan). (**b**) Pedicle section with Advance Bipolar Caiman vessel Sealer (Bbraun, Aesculap, Center Valley PA, USA). (**c**) Transvaginal extraction of the specimen. (**d**) Female sexual-sparing approach: After suture of the anterior vagina wall ($), uterus (§), cervix (Ω) and fallopian tubes (β) are shown

tate subsequent handling of the ureters. Intraoperative frozen section of distal ureteric-margin is always performed.

Prior to the bladder "take down" (Retzius space opening), the posterior space dissection allows the preparation of vesico-prostatic pedicles and the development of the recto-prostatic space. A transverse peritoneal incision at level of Douglas will lead to seminal vesicle and prostatic base dissection reaching the recto-urethralis muscle. Vesico-prostatic pedicles are commonly transected by the assistant using vessel-sealer devices (Fig. 68.3a, b). In case of nerve-sparing procedure an antegrade, energy- and traction-free approach is performed as commonly adopted during radical prostatectomy.

In female patients, a transvaginal-retractor facilitates the dissection of the recto-vaginal plane. A transvaginal extraction of the specimen (Fig. 68.3c) is performed in case of ICUD. In case of a sexual-sparing approach the ovaries, fallopian tubes, uterus, and cervix, and most of the vaginal wall may be completely spared (Fig. 68.3d).

Robotic Intracorporeal Ileal Conduit

Once the cystectomy part has been completed, the robot is undocked and the Trendelenburg position is minimized. Bowel manipulation should be performed with caution, avoiding direct grasping with robotic instruments. Pro-grasp forceps and needle driver can exert extremely high-force leading to direct or delayed intestinal lesion or mesentery bleeding. A coordinated work with the assistant is necessary, in order to reduce tensions through the synchronous use of two atraumatic Johan Grasping and Cadier robotic forceps. The left ureter is generally passed below the sigmoid. A 20 cm long ileal segment is isolated (Endo-GIA 60) and ileo-ileal side-to-side anastomosis (Fig. 68.4a) is obtained (Endo-GIA 60 + 45). Some author described near infrared fluorescence after injection of indocyanine green [8] or lighting from urethra with cystoscope [4] in order to obtain a better visualization of the mesenteric vascular arcade. Ureters are spatulated for 1.5–2 cm and catheterized with Single-J inserted percutaneously. An "head-to-head" (Wallace I) uretero-ileal anastomosis (Fig. 68.4b) is performed after extraction of single-J through the isolated bowel tract. Ileocutaneous-stoma is performed only after the final decompression of pneumoperitoneum (Fig. 68.4c).

Mixed Intra-extracorporeal Ileal Neobladder

We routinely perform a double folded ileal neobladder as previously described in a mixed ECUD – ICUD technique [5]. Around 40 cm of ileum is harvested, and following uretero-enteric anastomoses (Fig. 68.5a–c) the neobladder is replaced in the abdomen and pneumoperitoneum is

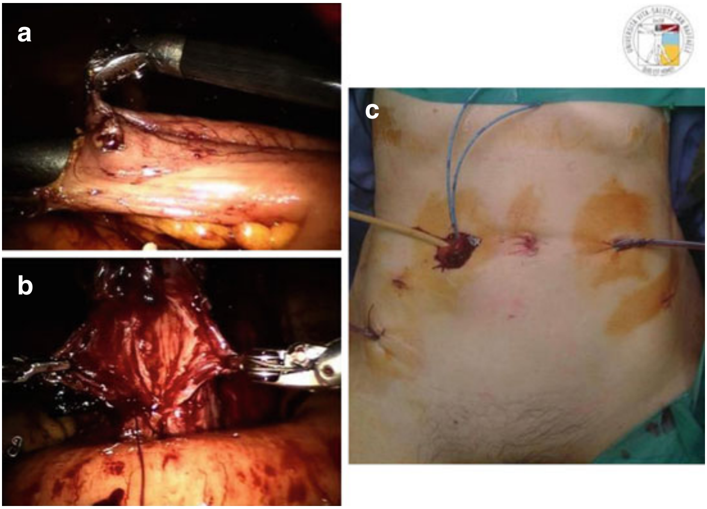

Fig. 68.4 Robotic intracorporeal (ICUD) ileal conduit. (**a**) Bowel anastomosis: ileo-ileal side-to-side anastomosis. Application of two stapplers (Endo-GIA 60 mm and 45 mm, Covidien Autosuture, Mansfield, MA, USA) confers a wide anastomosis mouth. (**b**) Wallace I plate: Ureters are spatulated for 1.5–2 cm and then a Wallace type I plate is performed with 4-0 polydioxanone suture and then catheterized with Single-J inserted percutaneously. (**c**) Final aspect of ileal conduit (Bricker) stoma in a female patient. Single J's will be removed in postoperative day (POD) 10–12. Drain-tubes are removed in POD 2 and 3. A 22-ch Foley catheter is maintained into the stoma to prevent possible urinary-retention due to intestinal oedema

restored. At this stage it may be difficult to perform the anastomosis due to various drawbacks. A tension-free urethro-ileal anastomosis is key to proper healing process and to prevent anastomotic leakage. Maximizing urethral length together with the adoption of different tricks such as pressure on the perineum as well as incision of peritoneum above the mesentery aim at reducing the tension and thus at shortening the distance between the urethra and neobladder.

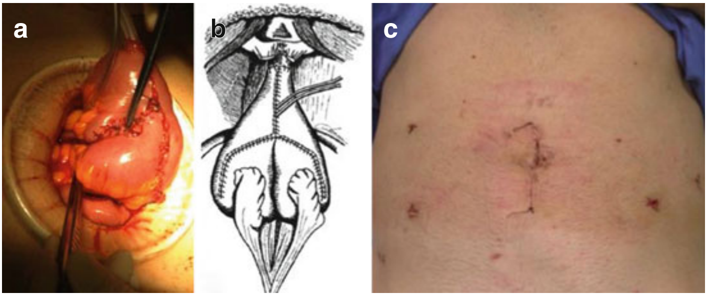

FIG. 68.5 Extracorporeal (ECUD) ileal orthotopic neobladder and intracorporeal urethra-neobladder anastomosis. (**a, b**) ECUD neobladder**:** detubularized ileal segment is modeled according to U configuration; posterior wall is completely sutured; ureteric anastomosis is then bilaterally performed. A further folding of ileum completes the anterior wall. (**c**) Postoperative aspect

Conclusions

RARC and urinary diversion represent a complex multi-steps procedure and we warmly suggest to stress adequate planning, proper mentoring system, institution of ERP and establishment of a full dedicated double team.

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Chapter 69
Tips for Ideal Urinary Diversion

Jens J. Rassweiler, Ali S. Gözen, Marcel Fiedler, and Jan Klein

Abstract In this chapter we aim to provide practical tips and tricks on the best way to perform an intracorporeal or extracorporeal urinary diversion after robotic assisted or laparoscopic radical cystectomy.

Keywords Radical cystectomy • Ileal conduit • Neobladder • Urinary diversion

Introduction

Laparoscopic and robot-assisted radical cystectomy has become an established procedure in the management of muscle-invasive bladder cancer being accepted in the actual

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EAU-guidelines [2]. In a recent ESUT-study 18 % of patients were female [1], but the number is increasing due to higher proportion of smoking women.

Advantages of minimally invasive approaches to accomplish the ablative part are well accepted, however, *urinary diversion* may still remain a source of postoperative complications. Furthermore, the *form of urinary diversion* has significant impact on quality of life [1–3, 5–10]. Here, the benefits of the complete intra-corporeal technique versus an extracorporeal laparoscopic-assisted approach extending the incision required for removal of the specimen are still controversial [1, 6–8]. There is no consensus, which approach offers the best option for the patients. Thus, the decision of form of urinary diversion should be taken individually for each patient.

Type o f Urinary Diversion

The choice of urinary diversion depends on various factors, such as age, patient compliance, local extension of disease distinguishing between continent and incontinent diversion. The most popular form of incontinent diversion represents the ileal conduit (Table 69.1). In selected case with one functioning kidney, uretero-cutaneostomy might be an option. Continent urinary diversion includes a modified ureterosigmoidostomy with creation of a reservoir (Mainz-Pouch II), ileal neobladder, and various forms of pouches attached to the umbilicus.

Whereas an ileal conduit can be performed in almost every patient, ileal (sigmoid) neo-bladder requires some preliminaries: (i) the tumor has not infiltrated the bladder neck, (ii) the patient is able to manage the use of the neobladder including possibility to self-catheterize. A pouch can be also created is almost all situation, however, it represents a complex procedure and requires also the ability to self-catheterize [1].

Patients have to be informed about *all variations of urinary diversion*. For this purpose, we administer an enema of 300 cc of physiologic sodium chloride solution transanally and record the time, patients can hold this in the rectum. If the holding time is below 60 min, the patient should not undergo a continent diversion using a sigmoid pouch (i.e. Mainz-Pouch II). The use of ureterosigmodostomy without pouch has been abandoned. Additionally, we place a urostoma bag filled with 200 cc of normal saline on the right side of the body to check the appropriate position of the stoma of an ileal conduit (Fig. 69.1). Since the rate of hypercontince of a neobladder in women may reach up to 30 %, women should be mentatlly and physically able to perform self-catheterization.

Patient Preparation

Initially, bowel preparation included oral self-administration of 2 liters of electrolyte lavage solution during 2 days before the surgical procedure. However, we have changed this to a only administration of laxatives the day before surgery. It is important to hydrate the patient adequately during the preoperative night (i.e. 1500 ml electrolyte solution i.v.).

Table 69.1 Distribution of urinary diversion in ESUT-study on laparoscopic cystectomy [2]

Urinary diversion	**N**	**Comment**
Ileal-conduit	345 (69 %)	Most commonly used
Ureterocutanostomy	10 (2 %)	In selected cases (ie. single kidney), old patients
Mainz- Pouch II	8 (2 %)	Mainly in women
Orthotopic neobladder	128 (25 %)	Mainly in male patients
Continent pouch (Kock, Indiana)	12 (2 %)	Mainly in women

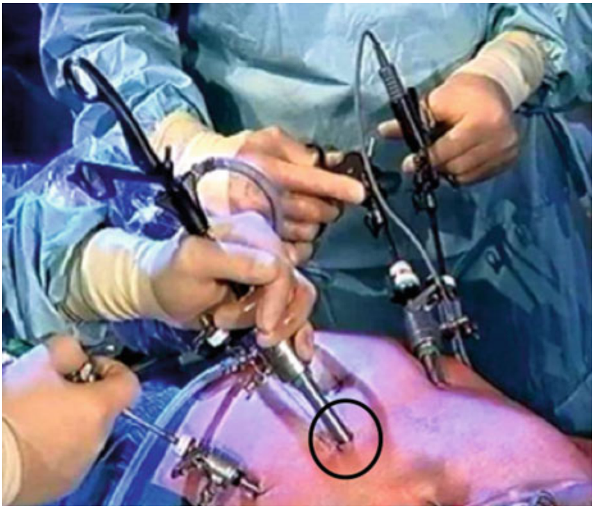

FIGURE 69.1 Port placement for laparoscopic anterior exenteration – the right medial trocar entrance is used for the urostoma (*black circle*)

Antibiotic prophylaxis with a cephalosporin (2×2 g) and metimazole (3×500 mg) is initiated intraoperatively for 5 days and low molecular weight heparin (4000 units) is administered preoperatively and until the postoperative day 15.

Technique of Urinary Diversion

Equipment

The technique is challenging, requiring state-of-the art laparoscopic or robot-assisted infrastructure and expertise (Table 69.2). We use a five- or six-port transperitoneal approach (Fig. 69.1). Standard laparoscopic surgical equipment with few special instruments is required (Table 69.3),

TABLE 69.2 Laparoscopic urinary diversion – technical steps and options

Operative step	Options	Comments
Transposition of ureter	Ileal-Conduit	Not for sigmoid-bladder or ureterosigmoidectomy
	Ileal-Neobladder (Studer-technique).	Not for Ileal-Neobladder (Hautmann-technique, Y-bladder)
Creation of reservoir	Intracorporeally	Technically difficult
		Stapler for GI-Anastomosis
		V-lock for neo-bladder
	Extracorporeally	Via mid-line incision
		Open technique
Ileal-conduit	Intracorporeally	Stapler for GI-Anastomosis
		Laparoscopic suture
	Extracorporeally (lap-assisted)	Via mid-line incision
		Open technique
Ureteral anastomosis	Intracorporeally	Sigmoid/Ileal-neobladder
		Sigmoid-pouch
		Ileal conduit
	Extracorporeally	Ileal neobladder (Studer)
		Ileal-pouch
Urethral anatomosis	Intracorporeally	All continent diversions (as first step)
		After re-insufflation (as last step)
	Extracorporeally	With laparoscopic pre-placed stitches

Table 69.3 Laparoscopic pelvic anterior exenteration – equipment

Standard laparoscopic equipment	
High flow insufflator/Air Seal	1
300 W Xenon light fountain	1
HD-camera (Karl Storz)	1
10 mm 30° laparoscope	1
Trocars	
10–12 mm trocars	2–3
5 mm trocars (reusable trocars preferred)	3
Instruments	
Laparoscopic Metzenbaum scissors, 5 mm	1
Laparoscopic bipolar forceps, 5 mm	1
Laparoscopic endo-dissectors, 5 mm	2
Laparoscopic right-angle-dissector, 10 mm	1
Laparoscopic atraumatic prehension forceps	2
Laparoscopic suction irrigation canula	1
Laparoscopy bags (i.e. Storz-Extraction Bag, 800 cc)	1
Surgical endoscopy 5–10 mm clips appliers	1
Needle-holder (i.e. Duffner, Storz), for both hands	2
Endo-GIA30-stapler (i.e. Covedien)	
Optional:	
Harmonic scalpel (i.e. Ultracision, Ethicon), 10 mm device	1
Ligasure® (ie. Covedien) 5–10 mm forceps	1

including an endoscopic stapler (i.e. Endo-GIA) for control of the pedicles of the bladder and eventually for the intracorporeally performed intestinal anastomosis. At the « left Mac Burney » point a 12 mm diameter port is used, which can also be used to ease the retrieval of pelvic lymph nodes after dissection. At the true right Mac Burney point, another 12 mm trocar is placed to accept larger instruments (i.e. 10 mm-clip-applicator, right-angle dissector, needle with reducer-sheath, Endoscopic stapler) if necessary. Two 5 mm trocars are placed at the horizontal level of the navel, lateral to the 10/12 mm trocars.

Laparoscopic/Robot-Assisted Ileal-Conduit

Completely Intra-corporeally Construction of Ileal Conduit

First step represents transposition of the left ureter (Fig. 69.2a, b). Subsequently a 20-cm ileal segment is isolated by use of an endoscopic stapler (Fig. 69.2c). Ileo-ileal anastomosis is accomplished with anti-mesenteric side-to-side stapling and closure of the remaining opening by endoscopic suturing. Then, the distal end of the ileal segment is pulled out via an enlarged trocar incision in the right lower abdomen and sutured to the skin. Via the so created uro-stoma, single-J-stents can be introduced, and both ureters are stented and sutured to the ileal conduit in a modified Wallace-type (Fig. 69.2d) technique or individually using interrupted sutures, according to the Bricker's technique.

- ***Tips and Tricks**:* Try to minimize the length of the ureter to reduce the risk of postoperative ureteral stenosis due to insufficient blood supply. Insertion of the single-J-stents can be alleviated by use if a flexible cystoscope introduced through the uro-stomy.

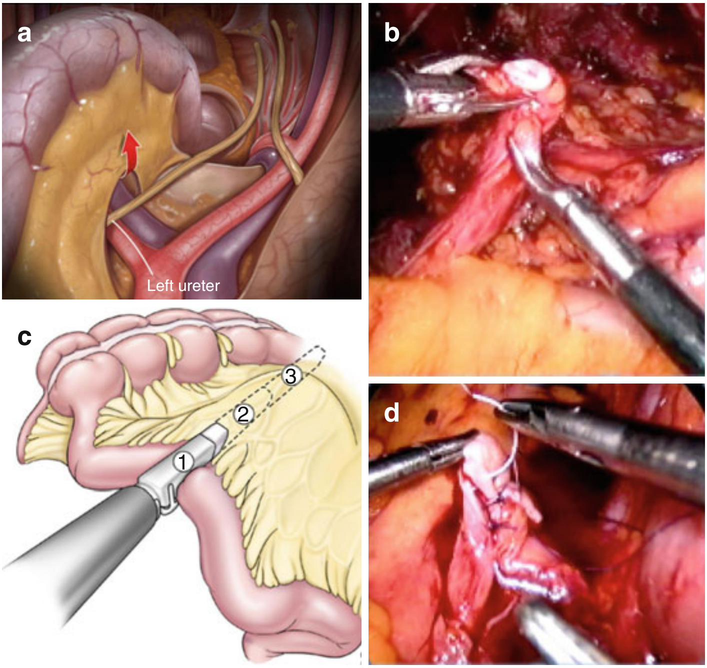

Figure 69.2 Technical steps of laparoscopic intra-corporeal ileal-conduit. (**a**) Transposition of the left ureter under the meso-sigma, which is facilitated by the previous extended pelvic lymph node dissection (Level I and II). (**b**) Spatulation of the ureter. (**c**) Isolation 20 cm terminal ileum using endoscopic staple. (**d**) Wallace end-to-side anastomosis of both ureters

Extracorporeal Creation of Ileal Conduit

The extended peri-umbilical mini-laparotomy for retrieval of the specimen is used for the isolation of the 20-cm segment of the distal ileum in an open technique (Fig. 69.3a, b). The ileo-ileal anastomosis is performed by interrupted or continuous seromuscular stitches, and the ileum is brought back into the abdominal cavity. Next step represent the

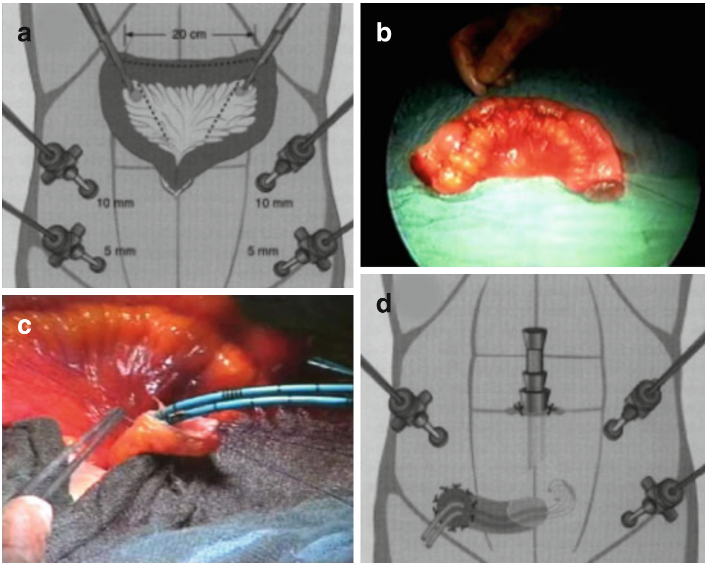

FIGURE 69.3 Technical steps of laparoscopic-assisted extra-corporeal ileal-conduit. (**a**) Isolation of the ileal segment via a sub-umbilical incision using open technique. (**b**) Isolated ileal segment, the ileo-ileal end-to-end anastomosis has been performed and the restored ileum carefully replaced intraabdominal. (**c**) Uretero-ileal anastomosis performed in an open technique. (**d**) After accomplishing the urostoma, the abdomen is reinsufflated to check the correct position of conduit and anastomosis

uretero-ileal anastomosis using an open technique (Fig. 69.3c). Subsequently, the 10 mm trocar incision in the right lower abdomen is used as uro-stomy (Fig 69.3d): the trocar incision has to be enlarged allowing pulling of the distal conduit end through the wound, and suture it to the rectus fascia and skin. After placement of two single-J-stents the ileal segment is manipulated back into the abdominal cavity, the periumbilical incision is closed, and the pneumoperitoneum re-established.

Intracorporeal Uretero-Ileal Anastomosis

Alternatively the uretero-ileal anastomosis can be performed laparoscopically or robot-assisted, the already transposed left ureter is sutured to the right one in a Wallace fashion (i.e. Vicryl 3/0, RB1-needle). Then both ureters are stented by insertion of the single-J-stents, and sutured to the ileal conduit using interrupted or continuous sutures.

- ***Tips and Tricks****:* The separate use of two trocar incisions offers the advantage of a better cosmetic result of the urostoma, and thus minimal problems with the adhesive plates. Cover the uretero-ileal anastomosis with peritoneum to minimize the risk of fistula formation with the small bowel anastomosis.

Laparoscopic/Robot-Assisted Orthotopic neo-Bladder

This procedure represents the second most frequently applied technique of urinary diversion following laparoscopic radical cystectomy in males (Table 69.1), however in females it cannot be applied in most cases due to involvement of the bladder neck and urethra.

Extra-Abdominal Construction of the Ileal Neobladder

The orthotopic neobladder is created by suturing antimesenteric opened small bowel together to form a new bladder. Like usually, a 55- to 60-cm segment of ileum located 15 cm away from the ileocecal junction is isolated and detubularized, leaving intact a proximal 10-cm isoperistaltic afferent Studer limb segment. As a function of surgeon's preferences, an Hautmann's ileal bladder can be built as well and the bowel prepared accordingly (i.e. with two 5-cm limbs). Continuity of the small bowel is restored outside the body through the incision made for specimen retrieval. Subsequently, a spherical neobladder is constructed extracorporeally. The anterior wall of the reservoir is closed by a running suture (i.e. PDS 3/0 with straight needle; Vicryl 3/0 ; SH-needle) ; the caudal part of this closure is left open in view of the neo-vesico-urethral anastomosis.

Uretero-Ileal-Anastomosis

A termino-terminal uretero-ileal anastomosis is then performed through the same incision, according to Wallace or to Bricker. Ureters are intubated with 8 Fr. smooth catheters temporarily attached to the posterior wall of the pouch with fastly absorbable sutures (Vicryl rapid ® *2/0)*. Both catheters are exteriorized through the anterior wall of the pouch, and subsequently, will be passed through the abdominal wall.

Urethral Anastomosis

When the neobladder is ready, it is placed into the abdomen and the mini-laparotomy is closed. The 10-mm-trocar is replaced in an *infra-umbilical position* and the pneumoperitoneum re-established. After positioning the ileal neo-bladder in its orthotopic position a neo-vesico-urethral anastomosis is started between the ileal orifice and the urethral stump using a single-knot technique according to van Velthoven, thus minimizing the tension of the tissue (Fig. 69.4). The suture is started at 6 o'clock on the ileal edge of the suture ; two 6–7 inches of 2/0 PGA monolayer threads knotted together are used ; two hemi-running sutures are then built until 12 o'clock where the only knot tied intracorporeally is done. When this suture is completed, a Jackson-Pratt drainage is placed into the pelvis ; the tube is exteriorized through a trocar hole in the right fossa.

- ***Tips and Tricks**:* The most significant problem of extracorporeal laparoscopic neobladder represents the tension on the urethra-neobladder anastomosis. The following maneuvres might be useful:
- Start with a posterior reconstruction suture similar to the Rocco-stitch to adapt the posterior part of the neobladder-neck to the central raphe (i.e. recto-urethralis muscle). The use of barbed suture (i.e. Quill, V-lock) might also be helpful to reduce the tension. Incision of the mesenteric peritoneum may increase the length of the mesenterium. Use optimal perineal push to expose the urethral stump. Reduction of the pneumoperitoneum (i.e. to 12 mm Hg) respectively of the Trendelenburg position might be also helpful to reduce the tension on the anastomosis, but may also impair the endoscopic vision.

Intra-corporeal Laparoscopic or Robot-Assisted Neo-bladder

The entire neo-bladder can be also performed laparoscopically as a sigmoid-neobladder. Most experience exists with

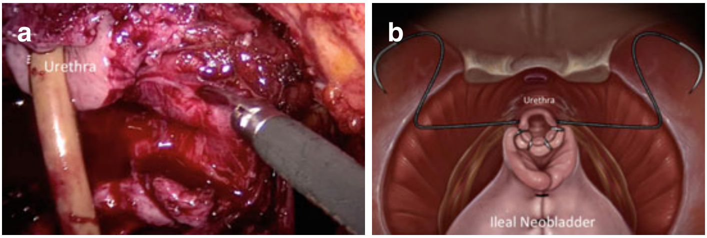

FIGURE 69.4 Laparoscopic assisted extracorporeal neo-bladder. (**a**) Posterior dissection of the female urethra providing a long urethral stump. (**b**) Urethro-vesical anastomosis using van Veltoven-technique as last step of the procedure

the ileal-neobladder replicating the Studer-technique including mainly seven steps (Table 69.4). Evidently, this represents a very complicated procedure even with the assistance of the Da-Vinci-robot. The main advantage represents the fact, that the first step includes urethro-ileal anastomosis (Fig. 69.5) thus minimizing the tension on anastomosis.

Laparoscopic Assisted Sigmoid-Pouch (Mainz-Pouch II)

The Mainz-Pouch II has been used frequently in women, due to the problems of "hypercontinence" with ileal neobladders ranging up to 30 % of the patients. However, this technique requires adequate control of the anal sphincter. The procedure can be performed completely laparoscopic or laparoscopic-assisted creating the sigmoid-pouch via a 10 cm- midline incision respectively using a Pfannenstiel-incision.

- ***Tips and Tricks***: When using the Mainz-Pouch II-technique you have to perform a sacropexy of the pouch to minimize the risk of formation of a pouch-vaginal fistula.

Table 69.4 Surgical steps of robot-assisted intra-corporeal laparoscopic orthotopic neo-bladder

Choice of longest ileal segment and urethro-ileal anastomosis
Isolation of 60 cm ileal segment using endoscopic stapler
Ileao-ileal anastomosis using endoscopic stapler
Anti-mesenterial incision of ileal segment preserving the distal end for uretero-ileal anastomosis
Continuous suture of posterior wall of neo-bladder
Closure of anterior wall of neo-bladder
Stenting of both ureters
Uretero-ileal anastomosis

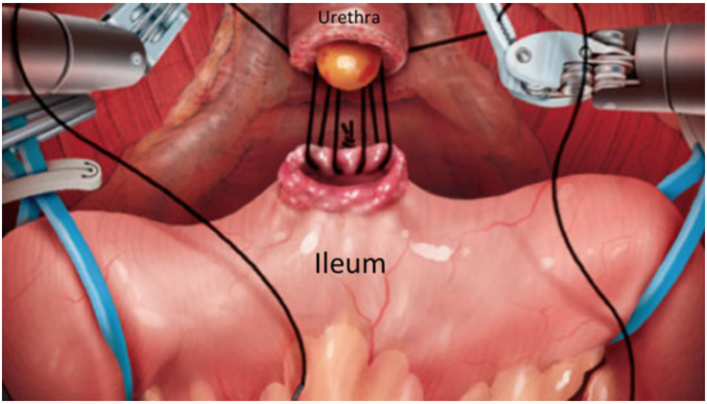

FIGURE 69.5 Robot-assisted intracorporeal neo-bladder: Anastomosis between urethra and ileal loop ad first step of urinary diversion

Postoperative Management

In the first night, all patients were monitored on the intensive care unit for vital parameters monitoring and adequate pain management. Parenteral nutrition was continued until complete oral feeding (i.e. day 3–5). The drains are removed after reduction of secretion below 50–100 ml. On day 10 and 11, the ureteral stents are removed. Following a cystogram, the urethral catheter of neo-bladders is removed on postoperative day 14–18, after 48 h of intermittent clamping every 2 h.

Discussion

There is still the debate, whether the urinary diversion should be performed completely intracorporeally or extracorporeally extending the incision required for removal of the specimen. In women, the specimen can be extracted transvaginally. Thus, an additional incision becomes necessary. The main argument against the entire laparoscopic approach represents the technical difficulty of the procedure including bowel anastomosis, uretero-intestinal-anastomosis, stent placement which may be very time-consuming with the hazard of severe postoperative complications. Even in the hand of the most experienced surgeons the OR-times are very long, which also adds to the associate trauma of the procedure [4].

Still ileal-conduit is mostly performed, since it is easier to perform and patients do not suffer from diurnal and mainly nocturnal incontinence or even hypercontinence in women. Nevertheless, one may still encounter some complications when doing the procedure intracorporeally or extracorporeally, such as a fistula between conduit and ileum at site of intestinal anastomosis.

Moreover, it is important to follow all surgical steps established in open surgery to minimize the risk of complications. When using a sigmoid-pouch (Mainz-Pouch) for urinary diversion, we did not perform a sacropexy of the pouch, which resulted in formation of a sigmoidal-vaginal fistula.

To perform urinary diversion extracorporeally has the advantage of a significantly shorter operating time. Thus, the combination of laparoscopic cystectomy with extracorporeal ileal-conduit may represent an ideal form of minimally invasive surgery for such extended cases. This can be nicely demonstrated when using the Wickham Wheel [11] (Fig. 69.6).

In the future, further experience with robot-assisted radical cystectomy and urinary diversion may alleviate to perform the procedure [3, 8]. This could include the use of easier-to construct neo-bladders (i.e. T-pouch, Y-pouch), the use of absorbable staplers and better suturing techniques.

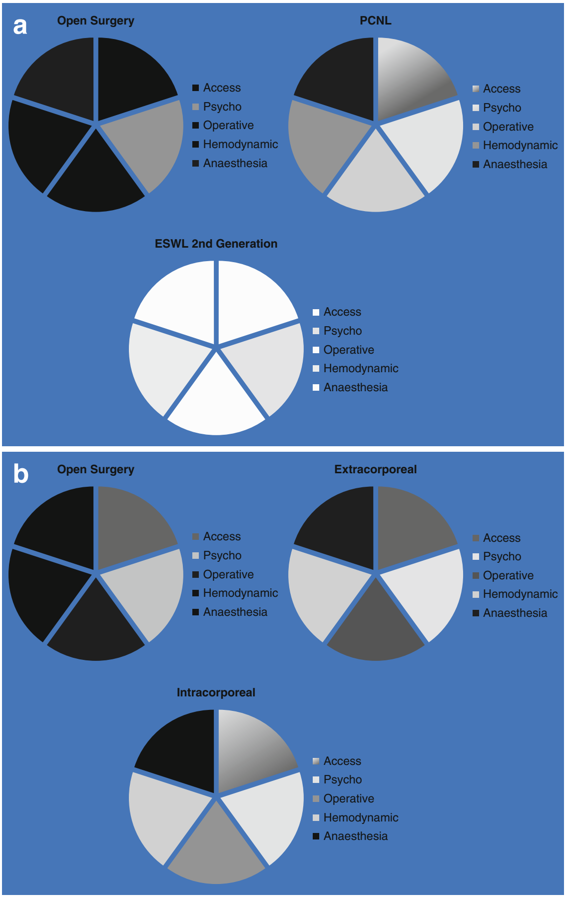

FIGURE 69.6 The impact of minimally invasive techniques on the outcome of the procedure (According to Wickham [11]). (**a**) The introduction of percutaneous nephrolithotomy (PCNL) and extracorporeal shock wave lithotripsy (ESWL) significantly improved all five relevant aspects of a surgical procedure (*white* = no problems, *black* = significant problems). (**b**) The introduction of extracorporeal and intracorporeal radical cystectomy with urinary diversion has also reduced some of the five aspects, but on the other hand the associated morbidity might be increased (*white* = no problems, *black* = significant problems)

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Chapter 70
Robotic and Laparoscopic Anderson-Hynes Dismembered Pyeloplasty: A Practical Approach

Luis Felipe Brandao, Oliver S. Ko, and Robert J. Stein

Abstract Laparoscopic and robotic pyeloplasty can be performed effectively and reproducibly by using approaches and techniques as we describe herein. Availability of robotics may be especially useful to obviate the need to perfect complex suturing technique and for more technically challenging procedures such as secondary pyeloplasty.

Keywords Robot assisted laparoscopy • Pyeloplasty • UPJ obstruction

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Introduction

Since Schuessler, et al. reported their initial experience with laparoscopic pyeloplasty (LP), minimally invasive techniques have become the prevailing approach for treatment of ureteropelvic junction obstruction (UPJO) [5]. Despite the less invasive nature of endoscopic options, pyeloplasty is associated with significantly higher success rates and remains our preferred approach for treatment of primary UPJO [6]. Several options are available for pyeloplasty depending upon anatomy. For a UPJO without crossing vessel, a Fengerplasty using a Heineke-Mikulicz incision and repair is an option. For a high insertion, a Y-V plasty can be considered. For any etiology of UPJO, an Anderson-Hynes dismembered pyeloplasty can be performed and is in fact our preferred approach for all primary and redo pyeloplasties.

In this chapter we describe our standard approach to UPJO and our techniques, tips, and tricks for completing primary and secondary LP and robotic pyeloplasty (RP).

Evaluation and Indications for Repair of UPJO

UPJO is denoted by hydronephrosis with a normal caliber ureter on axial imaging. Review of computed tomography should also note whether concurrent ipsilateral nephrolithiasis is present. A diuretic radionuclide scan is indicated for evaluation of differential renal function as well as severity of obstruction. Indications for repair of UPJO include symptoms such as chronic pain or pain with caffeine, alcohol, or high volume fluid intake (Dietl's crisis), infection, loss of kidney function, or nephrolithiasis. We typically observe patients with incidentally discovered hydronephrosis with none of the indications listed above by performing serial diuretic radionuclide scans. For patients with very poor ipsilateral renal function and one of the other indications above we suggest simple nephrectomy.

Recognition of a crossing vessel prior to endopyelotomy can be critical due to the higher rate of failure and increased risk of hemorrhagic complication [4]. As our preferred technique is minimally invasive Anderson-Hynes pyeloplasty for primary UPJO, we do not routinely obtain angiographic imaging (MR or CT) to identify if crossing vessels exist. Instead we are alert to the high incidence of crossing vessels (approximately 50 % of cases) and if encountered we take great care to preserve them while dissecting the UPJ. It is also extremely important to note that a crossing lower pole renal artery is almost always accompanied by a lower pole vein and therefore two vessels should be recognized and not just one.

Approach and Port Placement

Both LP and RP are reasonable options for minimally invasive pyeloplasty and with sufficient experience either approach can be expertly performed. Comparison of success rates and complications are quite similar between the two techniques [1]. Despite this, in areas where robotics has gained popularity, as at our center, the majority of cases are being performed with the Da Vinci robot. This likely is due to the greater ease in performing the dissection and sutured reconstruction and may in part explain a trend toward a larger number of patients undergoing pyeloplasty compared to endoscopic treatments. Robotics may indeed allow a greater number of surgeons to offer a minimally invasive approach to pyeloplasty compared to the laparoscopic approach with its steep learning curve and poor ergonomics. Of course the benefits of robotics must be weighed against the concerns of elevated costs, an issue that continues to be addressed in the literature [1, 2].

For both RP and LP we standardly place the patient in dorsal lithotomy position following endotracheal intubation and perform a retrograde pyelogram to ensure no other ureteral pathology and confirm the diagnosis of UPJO. A 4.7 Fr × 26 cm double J ureteral stent is then positioned over a guidewire. A narrow stent is used to facilitate later anastomotic suturing which may be more difficult with a bulkier stent. The patient is then placed in 60° modified flank position with the side ipsilateral to the UPJ pathology up. A double arm board is used and the patient is taped after all pressure points are padded and an axillary roll is placed.

We typically use a transperitoneal access for the procedure and this will be described here. Our standard port positioning for right and left sided LP (Fig. 70.1a, b) and right and left sided RP (Fig. 70.2a, b) are shown.

For laparoscopy we usually gain access with a Veress needle and subsequent 12 mm port at the junction of the line between the umbilicus and anterior superior iliac spine (ASIS) and the lateral edge of the rectus muscle. A 5 mm port is placed two fingerbreadths below the costal margin on the lateral rectus line and a 5 mm camera port is placed four fingerbreadths below this. A 5 mm assistant port is placed laterally after the ureter is identified. A closed bowel grasping instrument is introduced through the assistant port and is used to retract the lower pole of the kidney while the UPJ and renal pelvis are dissected.

For robotic procedures access and initial 12 mm port placement for the camera is gained at the lateral rectus line at the level of the 11th rib. A robotic port is placed two fingerbreadths below the costal margin and the second robotic port is placed 4 fingerbreadths above and medial to the ASIS. A 12 mm assistant port is placed medially. The robot is then docked over the patient's back and directly perpendicular to the operating table. (Fig. 70.3).

Robotic and Laparoscopic Instrumentation

For robotic procedures, in order to limit costs, we only utilize three robotic arms and typically use 1 each of an 8 mm ProGrasp forcep, a Hot Shears monopolar curved scissor, and a Large

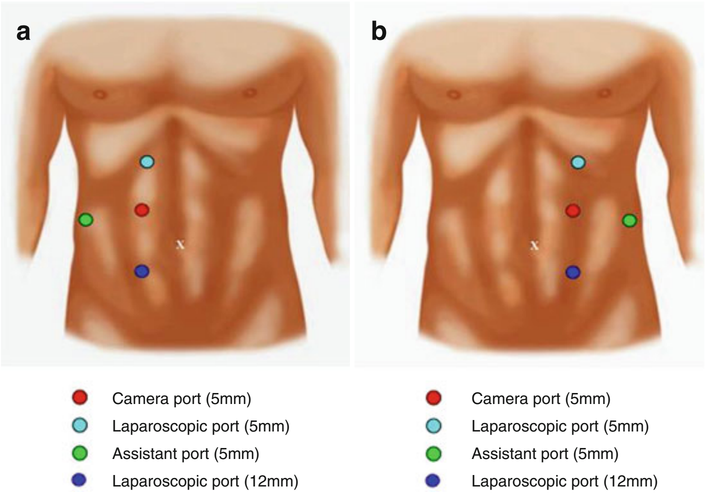

FIGURE 70.1 (**a**) Right-sided port configuration for laparoscopic pyeloplasty (**b**) Left-sided port configuration for laparoscopic pyeloplasty

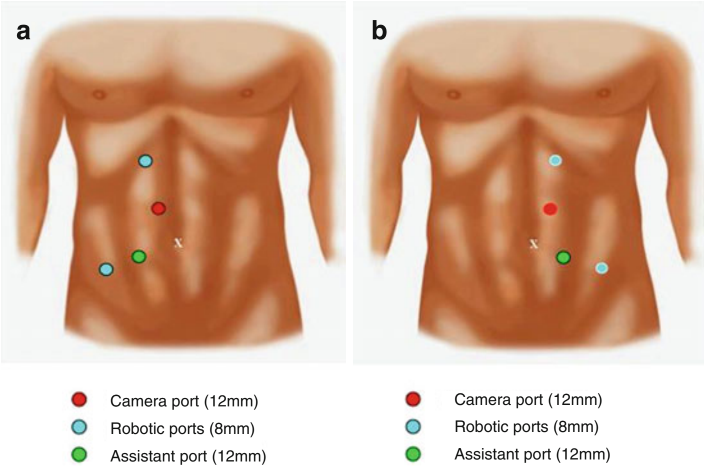

FIGURE 70.2 (**a**) Right-sided port configuration for robotic pyeloplasty (**b**) Left-sided port configuration for robotic pyeloplasty

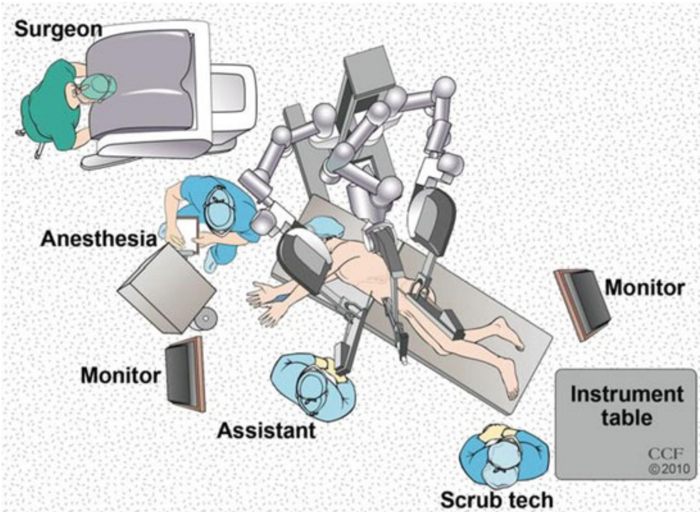

FIGURE 70.3 Room setup and robot positioning

Needle Driver. We have found that use of only one needle driver is sufficient for precise completion of the anastomosis.

For laparoscopic procedures we typically utilize a small bowel grasper, laparoscopic shears, laparoscopic hook, and needle drivers. A laparoscopic suction-irrigator can be used for dissection in addition to keeping the surgical field clear. We use 1 each of a dyed and undyed 4-0 vicryl suture on an RB-1 needle cut to 5 inches to complete the anastomosis. A 4.7×26 cm double-J ureteral stent is placed initially as described above and a closed suction drain is placed through the most caudal port site at the end of the procedure.

Step-by-Step Procedure

Dissection and Ureteral Identification

The colon is mobilized medially except in a rare case of a pediatric or extremely thin patient for which a transmesen-

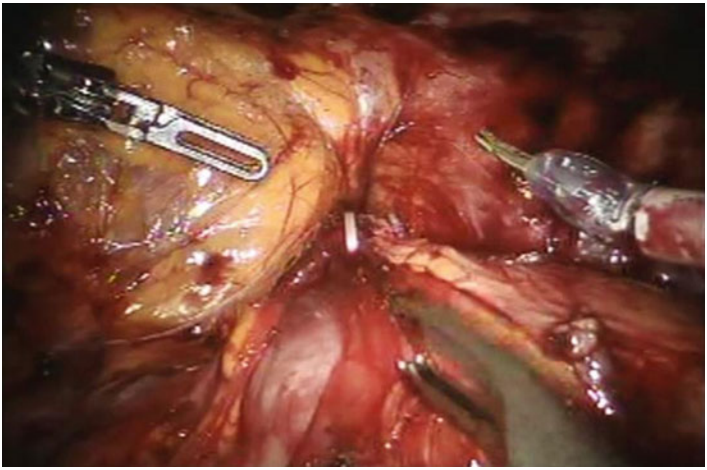

FIGURE 70.4 Robotic pyeloplasty: retraction of Gerota's fascia using a hem-o-lok clip

teric approach can be elected. On the right side the duodenum is Kocherized. We then enter Gerota's fascia just lateral to the inferior vena cava (IVC) on the right side or aorta on the left side. After identifying the psoas muscle, the edge of Gerota's fascia is grasped and the ureter and gonadal vein are gently swept medially with the laparoscopic suction until both are noted. The gonadal vein is then allowed to drop medially and the ureter with some surrounding tissue is retracted laterally. During laparoscopic cases we usually place the lateral 5 mm assistant port at this point in order to allow an assistant to retract the ureter laterally with a bowel grasper. Robotically, we tend to use Hem-o-Lock clips (Weck Surgical Instruments, Teleflex Medical, Durham, NC) in order to secure Gerota's fascia to the sidewall for lateral retraction (Fig. 70.4).

Laparoscopically we use hook cautery and robotically we use the Hot Shears in order to dissect Gerota's fascia cranially to the UPJ. As the surgeon approaches the UPJ, great care must be taken to identify and carefully dissect any crossing vessels that may be present. As discussed earlier, usually crossing accessory lower pole vessels include both an artery and vein and we typically aim to preserve both. We then dissect all surrounding tissue and the rind from the proximal ureter, UPJ and renal pelvis (Fig. 70.5). If dissection of the renal pelvis is too aggressive or if tissue further from the renal pelvis is dissected, then the surgeon risks transecting a branch renal vessel.

Dismembering of the UPJ

We then dismember the UPJ and spatulate the ureter laterally as the blood supply to the ureter originates medially (Fig. 70.6). If further spatulation of the renal pelvis is required this is performed medially.

Anastomosis

We create a running anastomosis using 4-0 vicryl suture on an RB-1 needle. A dyed suture is used to complete half of the anterior anastomosis initially and an undyed suture is then used to complete the posterior anastomosis. We begin the anastomosis laterally by passing the dyed suture through the pelvis and then through the end of the spatulation of the ureter and tying a knot. This suture is then run on the anterior side of the anastomosis by grasping the needle with a forehand configuration for approximately four throws (Fig. 70.7). We then place the distal curl of the stent in the renal pelvis. The assistant (robotically or laparoscopically) then grasps the end of the anterior suture and elevates it in order to display the posterior side of the anastomosis to the surgeon. The surgeon then grasps the undyed 4-0 vicryl needle with a backhand grip and passes it through the lateral renal pelvis and ureter at the distal point of spatulation right next to the original knot of the dyed suture. A knot is tied and the suture is run by grasping the needle with a backhand configuration until the posterior anastomosis is completed. The anterior

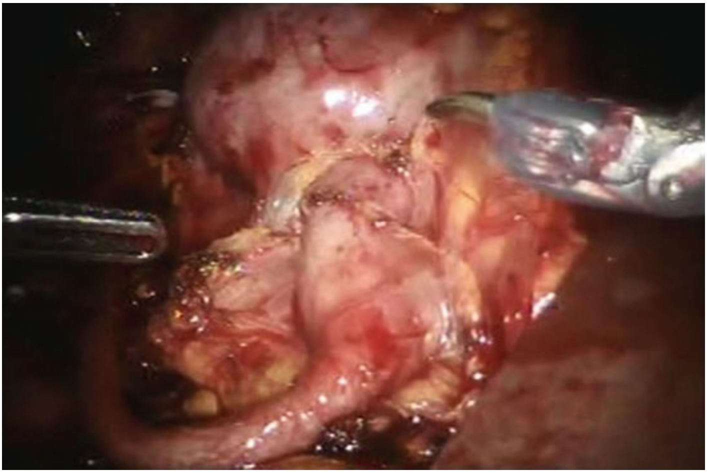

FIGURE 70.5 Robotic pyeloplasty: proximal ureter, UPJ, and renal pelvis dissected

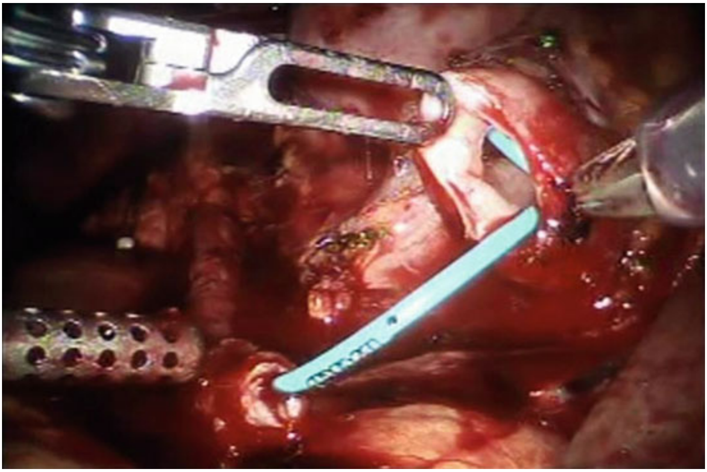

FIGURE 70.6 Robotic pyeloplasty: UPJ dismembered

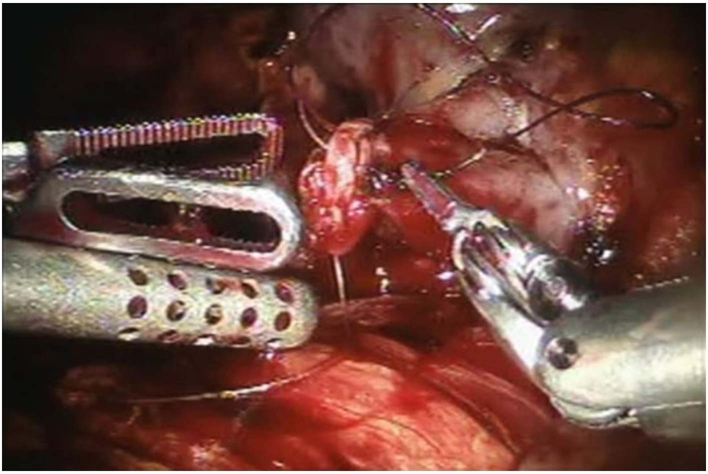

FIGURE 70.7 Robotic pyeloplasty: suturing of anterior anastomosis

anastomosis is then completed using the dyed suture and the sutures are tied together. It is important to note that for both sutures, the initial ureteral passes should incorporate very little mucosa so that the anastomosis is not narrowed. A closed suction drain is placed prior to closing.

Renal Pelvis Tailoring

For the majority of cases renal pelvic tailoring is likely unnecessary. In cases with a large redundant pelvis in which reduction is elected we excise a medial portion of the renal pelvis. The resection is started at the medial cut edge of the dismembered pelvis and carried cranially until we are in close proximity to the renal vessels. Great care must be taken to identify and not damage any renal infundibula. The UPJ anastomosis is then completed as previously described. If the dissected renal pelvis tissue is completely excised, the upper edge of the pelvotomy may retract posterior to the renal vessels and repair may be difficult. Therefore we keep the dissected renal pelvis tissue attached by a small stalk cranially and use this as a handle to place our first sutures for repair of the defect. The dissected tissue may then be completely excised and we continue to use a running 3-0 barbed suture to repair the remaining large pelvotomy. This repair is continued caudally until we reach the completed UPJ anastomosis.

Pyelolithotomy

One or multiple stones may be present in the renal collecting system and can be managed robotically, laparoscopically, or endoscopically. We generally create a wide pelvotomy when dismembering and use a laparoscopic bowel grasper or a robotic ProGrasp in order to probe the collecting system in attempt to identify, grasp, and remove the stones. The robotic EndoWrists can be very helpful during this step. If probing is unsuccessful we usually narrow the pelvotomy with a running suture medially so that the pelvis will hold irrigation and distend during attempts at endoscopic pyelolithotomy. A flexible cystoscope is then introduced through one of the port sites and guided into the renal pelvis. A stone basket is used for stone manipulation. The UPJ anastomosis is then completed as previously described.

Secondary UPJ Repair

Pyeloplasty following previous attempted pyeloplasty or endoscopic intervention can be challenging. Although these cases may be approached laparoscopically, use of robotic instrumentation provides a distinct advantage in our experience. Careful planning must be carried out prior to determining the approach. Adequate function should be documented with a radionuclide scan, and the length of stricture should be noted on retrograde pyelogram or endoscopically. If the stricture is longer than 3–4 cm then a straightforward repair may be difficult and consideration of a spiral flap if there is a large redundant pelvis, ileal interposition, or autotransplantation should be considered.

If pyeloplasty is elected we generally position the patient without any flex in the bed as we attempt to reduce separation of the ureter and renal pelvis as much as possible. Complete dissection of the scar surrounding the UPJ, proximal ureter, and renal pelvis is of the utmost importance in order to ensure proper identification of the site of stricture. If complete dissection is not carried out it is possible to dismember the incorrect area and therefore lose enough ureteral length that pyeloplasty may not still be possible.

In our experience with sufficient dissection it has always been possible to identify the site of stricture without needing intraoperative aids such as ureteroscopes or lighted stents. Dismembering should then occur through the scarred segment directly so no pelvis proximally or ureter distally is unnecessarily sacrificed. Preservation of ureteral length is essential to creating a successful repair. The ureter should then be spatulated laterally and the renal pelvis medially until the lumen is wide. In nearly all cases the eventual anastomosis will be on some tension. Therefore standardly we use 2–3 interrupted 3-0 vicryl sutures to join the peripelvic tissue to periureteral tissue so that tension on the eventual anastomosis is decreased as much as possible. We usually then create a running anastomosis as described above but if there is some tension, an interrupted anastomosis may be more secure.

Postoperative Care

The postoperative course is managed in a standard fashion for the majority of patients. The Foley catheter is removed in the morning of the 1st postoperative day and the fluid from the drain is evaluated for creatinine level that evening. If the drain creatinine level is same as serum the drain is removed the next morning and the patient is discharged. The stent is removed in 4 weeks and a lasix renal scan is obtained 1–2 months thereafter. We do not routinely follow patients with successful repair after 1 year as late failures are likely to be symptomatic [3].

Conclusions

Laparoscopic and robotic pyeloplasty can be performed effectively and reproducibly by using approaches and techniques as we have described. Availability of robotics may be especially useful to obviate the need to perfect complex suturing technique and for more technically challenging procedures such as secondary pyeloplasty.

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Chapter 71
Renal Reconstruction Techniques for Renal Tumors in Various Locations

Jayram Krishnan, Homayoun Zargar, and Jihad Kaouk

Abstract The use of the robotic surgical platform facilitate renal reconstruction during partial nephrectomy. It is important to follow standardized surgical steps that have been proven to provide excellent outcomes. Using the techniques and principles described in this chapter, robotic partial nephrectomy can effectively and safely perform for a wide range of indications.

Keywords Renal reconstruction • Robotic partial nephrectomy • Technique • Renorraphy

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Introduction

Partial nephrectomy has become the gold standard technique for the management of small renal masses. Minimally invasive nephron sparing surgery started in 1993 with the first case perform laparoscopically for benign indications. Subsequently, laparoscopic partial nephrectomy for oncologic indications became more popular, but the procedure itself was technically challenging requiring it to be performed exclusively by experienced laparoscopic surgeons. The advantages of robotic surgery include three-dimensional stereoscopic vision, tremor filtration and articulating wrist motion allowing rapid intracorporeal suturing and excellent renal reconstruction that was difficult with laparoscopy. These advantages have encouraged the widespread use of robotic surgery for partial nephrectomies. Many centers are now pushing the limits by performing robotic nephron sparing surgery (NSS) on larger, more complex tumors in difficult locations. There are reports of large hilar tumors being managed with robotic NSS in the literature [9].

Use of Imaging for Surgical Planning

All patients undergoing NSS should have high quality cross sectional imaging preoperatively. This will allow assessment of hilar anatomy including renal vasculature as well as tumor location. If possible, contrast enhanced imaging should be employed in order to assess tumor characteristics. Magnetic resonance imaging may be useful to distinguish if a renal mass has cystic components and if the lesion is amenable to NSS. Primarily cystic renal masses can be challenging and may require gentle manipulation of the kidney during mobilization and larger borders of resection in order to preserve the integrity of the lesion. If the lesion is posteriorly located on cross sectional imaging, you may consider using a retroperitoneal surgical approach. Robotic retroperitoneal NSS requires a thorough knowledge of retroperitoneal anatomy and can be challenging due to the confined space and clashing of instruments.

A useful tool for location and complexity assessment of renal masses is the R.E.N.A.L. scoring system developed Uzzo and colleagues [10]. This is a reproducible standardized classification system that quantitates the salient anatomy of renal masses. Using this score, surgeons can assess the complexity of renal masses prior to surgical management. The score standardizes the reporting of solid renal masses and appears to effectively stratify lesions by treatment type [3]. Another scoring system that is routinely used is the PADUA system. The PADUA score is a simple anatomical system that can be used to predict the risk of surgical and medical perioperative complications in patients undergoing nephron sparing surgery [5].

Patient Positioning and Port Placement

For transperitoneal robotic NSS, patients are placed in the modified flank position at approximately 60°, with the table partially flexed. The abdomen is insufflated to 15 mmHg with a Veress needle at the lateral border of the rectus at the level of the twelfth rib and serves as the site of the 12-mm camera port. An 8-mm port is placed at the lateral border of the ipsilateral rectus muscle, about 3 cm below the costal margin. A second 8-mm port is placed approximately 5–7 cm cephalad to the anterior superior iliac spine. An assistant 12-mm port is placed along the lateral border of the rectus muscle in the ipsilateral lower abdominal quadrant (Fig. 71.1b). For right-sided cases, a 5-mm port is placed in the subxiphoid area for liver retraction (Fig. 71.1a). The robot is then positioned over the patient's shoulder with the camera oriented approximately in line with the renal vessels (Fig. 71.2). A 30° down-scope is used along with the prograsp robotic grasper in the other hand for retraction with either the monopolar scissors or hook in the primary hand [7].

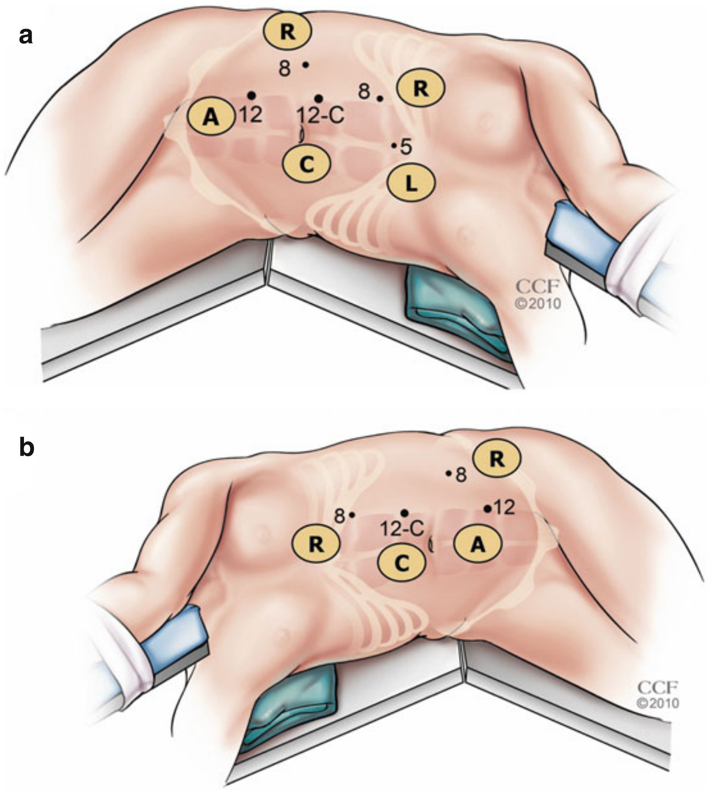

FIGURE 71.1 Port configuration for transperitoneal robotic partial nephrectomy: (**a**) right side; (**b**) left side

For retroperitoneal robotic cases, patients are placed in the full flank position at approximately 90°, with the table fully flexed. Petit's triangle, or the space above the iliac crest along the mid-axillary line is developed. Finger dissection is performed to confirm entrance into the retroperitoneum and palpation of the psoas muscle is crucial for verification. At this time, the balloon dissector is placed and the retroperitoneal space is developed with 400 cc of air. The balloon port is placed and the robotic scope is placed for verification. Once

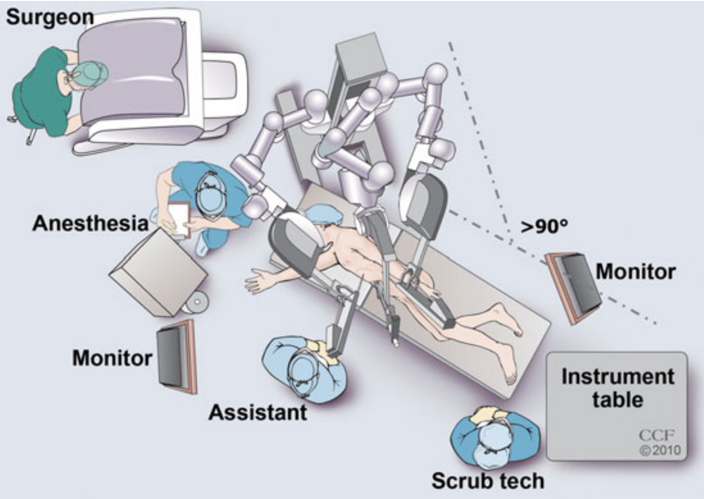

FIGURE 71.2 Robot docking during transperitoneal robotic partial nephrectomy

the space is verified, CO_2 insufflation can be attached. There is also the option of replacing the balloon dissector and placing an additional 400 cc of air. A robotic port is placed along the posterior axillary line slightly cephalad to the balloon port. Using the camera and the suction tip, the peritoneal reflection is gently and slowly peeled away from the anterior axillary line where the next ports are placed. Along this line, the robotic port is placed at the level of the balloon port and the assistant 12 mm port is placed four fingerbreadths above the robotic port (Fig. 71.3). The robot is then docked directly above the head of the patient.

Renal Lesion Exposure

It is essential to have full exposure of the lesion with an adequate normal parenchymal margin prior to reconstruction. We prefer to mobilize the kidney within Gerota's fat so

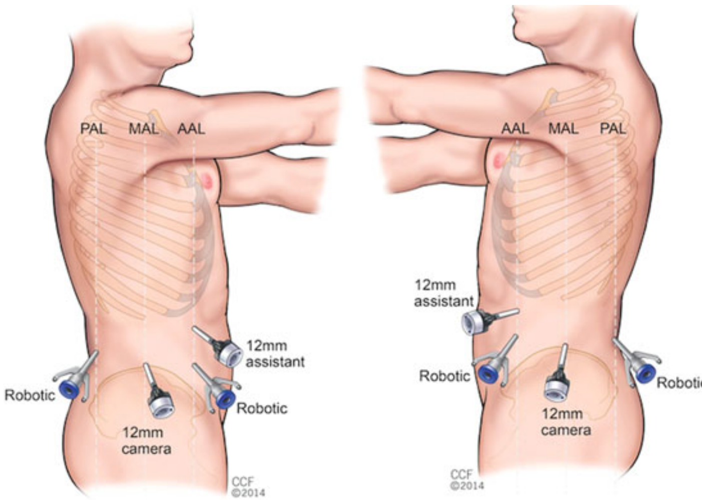

FIGURE 71.3 Port configuration for retroperitoneal robotic partial nephrectomy

that we have complete access to normal parenchyma during renal reconstruction. After the hilum has been identified, we routinely open Gerota's fascia anteriorly during transperitoneal cases with careful attention given to the location of the ureter. Gerota's fat and fascia should be opened in manner that it can be reapproximated after reconstruction with hem-o-lock clips. On posterior tumors where a retroperitoneal approach is employed, it is feasible to open the Gerota's only in the vicinity of the tumor.

Control of the Renal Hilum

Robotic NSS is most commonly performed with utilization of warm renal ischemia. Preoperative cross sectional imaging preferably with contrast enhancement is extremely helpful for surgical planning. Depending upon the complexity of the lesion, the renal artery and/or vein can be controlled.

Many surgeons control the hilum using various techniques. In our experience, we prefer the bedside assistant placed bulldog clip appliers (Fig. 71.4a). Some surgeons use an additional port with placement of a laparoscopic satin sky clamp (Fig. 71.4b). Other commonly used methods include robotic controlled bulldog clips and the use of vessel loops (modified Rommel tourniquets). We recommend exposure of all renal hilar vessels prior to tumor excision in case of emergency situations. Clamping of only the renal arterial flow is ideal in smaller lesions in favorable locations where venous retrograde bleeding would not interfere with adequate tumor excision. This is also useful in situations where multiple arteries are present only the vessel responsible for supplying the vicinity of the tumor is clamped and the remainder of the renal blood flow drains through the open renal vein. This principle has been expanded to included superselective arterial clamping, that involves dissection through the renal parenchyma to the artery that is supplying only the tumor [4].

Use of Cold Ischemia Techniques

Cold ischemia has been well developed in open NSS where traditionally there has been access to the entire hilum and kidney for cooling. There have been few reports of combining minimally invasive approaches with cold ischemia techniques. In the laparoscopic era, Kaouk and colleagues placed ice slush intracorporeally using an endoscopic bag around the kidney [6]. Rogers and colleagues have placed

Key Points: Before Tumor Excision

- Prior to hilar clamping, 12.5 g of intravenous Mannitol is given for renal protection by encouraging osmotic diuresis.
- Expose the entire hilum including all vessels prior to tumor excision in care of emergency situations.

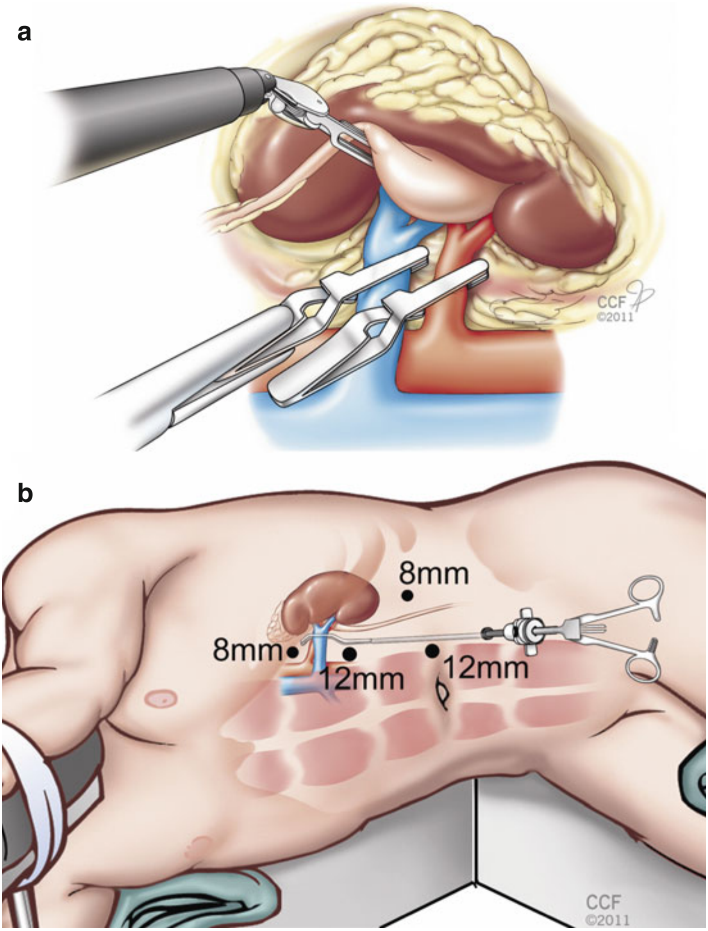

FIGURE 71.4 Hilar clamping: (**a**) using Bulldogs; (**b**) using a Satinsky clamp

ice robotically with the use of a Gelport [12]. Recently, our group developed an ice introduction system that can be used for robotic NSS transperitoneally or retroperitoneally [8].

Tumor Excision

We perform intraoperative intracorporeal renal ultrasound prior to excision of every lesion. This helps to assess the depth of the tumor and parenchymal margins (Fig. 71.5). We utilize the cold shears to excise the tumor as this will minimize electrocautery effect on margins. If there are large vessels encountered during excision, the assistant may place Hem-o-Lok clips or the console surgeon may place robotic Hem-o-Lok clips. Attention must be given to ensure negative margins and this can be achieved with an adequate parenchymal and/or renal sinus fat borders. Excessive suctioning can decrease pneumoperitoneum leading to pooling of blood on the tumor bed, therefore it should be used only when vision is impaired during excision (Fig. 71.6).

Kidney Reconstruction

Renal parenchyma is fragile tissue that requires gentle handling during reconstruction. Excessive torque during suturing may lead to fracturing of the parenchyma with subsequent weakening of the suture line. The capsule of the kidney also adds an additional layer of support to the suture line. We have adopted the "sliding clip" technique for all of our renal reconstruction (Fig. 71.7). This technique was originally described by Bhayani and colleagues and has been proven to be an effective and reliable hemostatic closure of all renal defects [2]. This technique depends on effective communication between the console surgeon and the bedside assistant during reconstruction. The Hem-o-Lok clips keep sutures in place allowing the surgeon to freely place the subsequent stitch. It also allows for a suture line that has equivalent tension along the edges of the renal parenchyma.

The deep layer suture is a 20-cm 2-0 Vicryl suture on an SH-1 needle with a knot and Hem-o-Lok clip applied one centimeter from the free end. This layer is used as a running suture of the tumor excision bed to oversew larger vessels as well as entries into the collecting system. The suture is

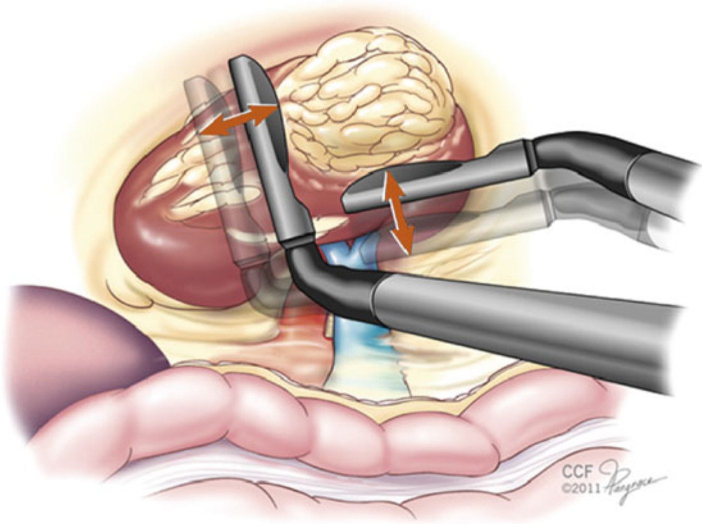

Figure 71.5 Laparoscopic ultrasound during robotic partial nephrectomy

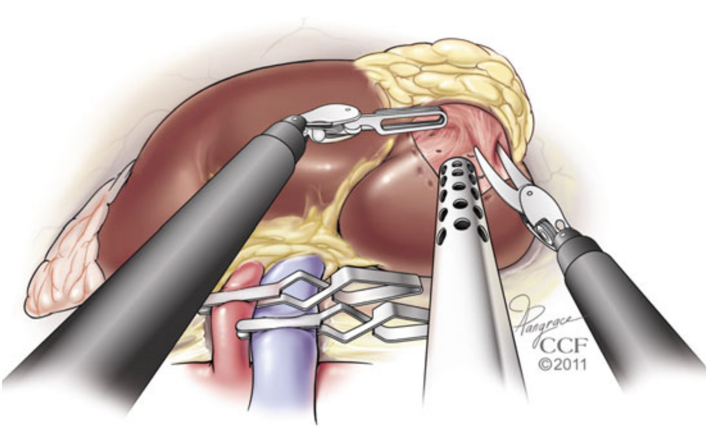

Figure 71.6 Tumor resection

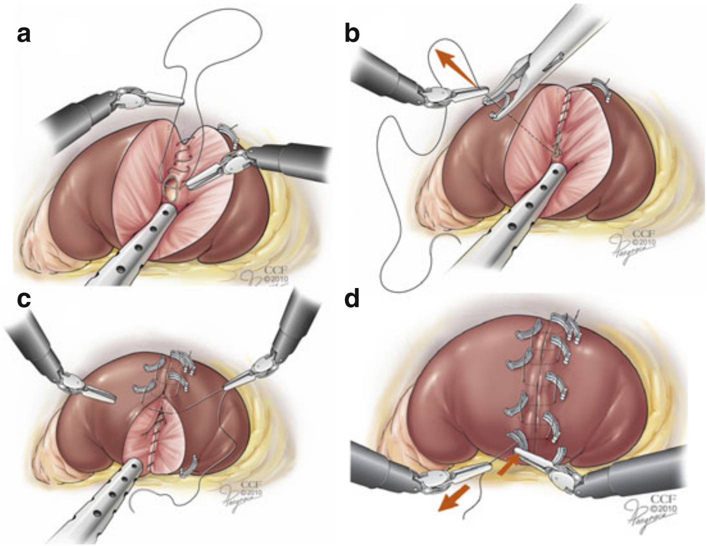

FIGURE 71.7 Renorraphy

brought through the renal capsule with the final throw and secured with two sliding Hem-o-Lok clips. The superficial layer is used to reap proximate the renal capsule is using a continuous, horizontal mattress 0-Vicryl suture on a CT-1

Key Points: Renorrhaphy

- Standard renorrhaphy is performed in two layers using robotic needle drivers or one Prograsp and one needle driver.
- Constant communication between the console surgeon and the bedside assistant is required for successful NSS.
- It is helpful to review the operative strategy with the operating room staff prior to clamping of the renal hilum to ensure that all equipment and sutures are readily available during excision and reconstruction.

needle (20 cm) with a sliding Hem-o-Lok clip placed after each suture is passed through the capsule.

Exophytic Lesions

Lesions that are completely exophytic can be reconstructed with one single suture layer. These lesions may also be excised and reconstructed without clamping the main renal vessels. We employ a technique known as "sequential suturing" where the 0 Vicryl suture is placed concurrent with the resection of the lesion. This allows for precise placement of suture with immediate hemostasis avoiding global ischemia to the kidney [11]. Alternatively, once the lesion is completely removed, the superficial 0 Vicryl suture can be placed with precision (Fig. 71.8).

Mesophytic and Endophytic Lesions

Deeper lesions require more involved reconstruction techniques. Historically, attention was given to closure of the collecting system separate from the parenchymal vessels, but we have found that there is no difference in surgical outcomes or the incidence of arteriovenous fistulas and hematuria. Deep layer suturing begins beyond the edge of resection and is used to control vessels and collecting system defects in a running fashion. The last suture is brought out through the parenchyma and two Hem-o-Lok clips are placed and cinched down to the renal capsule.

Hilar Lesions

Lesions at the renal hilum are deep and frequently involve the major renal vessels or main branches requiring extensive meticulous reconstruction. At our institution, we have developed an effective method to approach hilar reconstruction known as the V-hilar suture (VHS) renorrhaphy

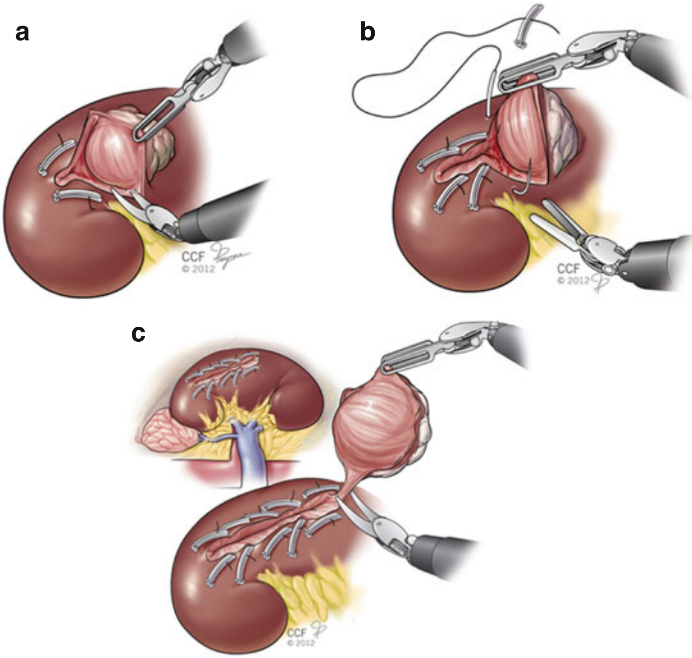

FIGURE 71.8 Zero ischemia robotic partial nephrectomy: sequential preplaced suture renorrhaphy technique

technique [9]. The "V stitch" involves 2 interior 2-0 Vicryl sutures from a vertex to an opposing apex of renal parenchyma using the sliding-clip technique. This is followed by an 0 Vicryl horizontal mattress renorrhaphy to reapproximate the edges of the renal defect towards the hilar vessels (Fig. 71.9).

Use of Hemostatic Agents

There has been no benefit noted in the use of hemostatic agents after renal reconstruction [1]. If there is any concern for inadequate hemostasis after restoring blood flow to the

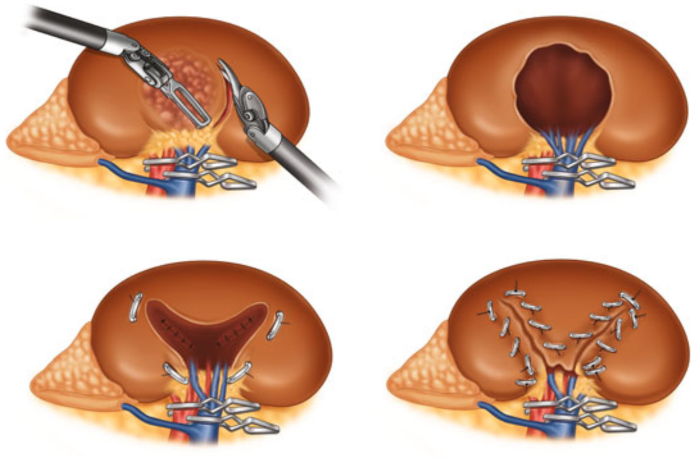

FIGURE 71.9 VHS technique

kidney, then hemostatic agents can be used at the comfort level of the surgeon. At our institution, we have moved away from the use of Surgicel bolsters during reconstruction. There are many reports of the use of fibrin sealants after reconstruction and these can be used at the discretion of the surgeon.

Key Points: Post Reconstruction

- Lower pneumoperitoneum to 5 mmHg and observe the reconstruction bed if any concern of hemorrhage.
- Reapproximate Gerota's fascia after reconstruction – as this will provide an additional layer protection in case of parenchymal edge oozing from the reconstruction site. This also replaces the kidney into a pseudo-retroperitoneal position that allows future NSS more feasible with decreased adhesions.

Conclusions

Due to the advantages of the robotic surgical platform, most NSS is performed using this modality. It is important to maintain standardized surgical methods that have been proven to provide excellent outcomes. Using the above techniques, the surgeon can effectively and safely perform robotic NSS with successful renal reconstruction.

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Chapter 72
Use of Surgical Navigation During Urologic Surgery

Tobias Simpfendörfer, Gencay Hatiboglu, Boris Hadaschik, Michael Müller, Hans-Peter Meinzer, Jens J. Rassweiler, and Dogu Teber

Abstract Surgical navigation, image guided surgery or computer assisted surgery describe more or less the same idea of computing und presenting pre- and intraoperative data from any source in real time to help surgeons doing their work better or easier. Among acoustic and visual presentation methods augmented reality is most spread and seems to be most accepted among the users. Data sources are mainly imaging methods like 3D-ultrasound, MRI, CT and others as well as optic, acoustic, magnetic or mechanic tracking methods. There are many published navigation

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systems for diagnostics and therapy in urology. Especially methods using screens like prostate biopsy or laparoscopy are ideal to integrate augmented reality. But also open surgery can profit by navigation. Mostly the systems are still under development and not jet applied by routine. After an introduction to the basic steps of surgical navigation which are preoperative imaging, intraoperative imaging and tracking four promising applications and their integration into daily practice are presented.

Keywords Navigation • Tracking • Augmented reality • Computer assisted surgery

Preoperative Imaging

On the basis of thin-slice CT, MRI, PET/CT or ultrasound special software programs allow display of data in three dimensions and image fusion. Information from different modalities regarding same anatomical regions can then be displayed on a single image. These images represent the basis for planning the procedure, but intraoperative image acquisition is mandatory for surgical navigation [1, 11–13].

Intraoperative Imaging

Ultrasound or 2D fluoroscopy via percutaneous, transrectal or laparoscopic [2, 7–9] access are often used modalities in urology. To integrate preoperative images they have to be fused with intraoperative images whereas the here used devices are often hand-held [1, 11, 12] and not able to acquire 3D-data unless they are not tracked. The fusion of soft-tissue imaging is challenged by permanent moving and deformation of organs, here non-rigid image-to-image registration is used.

Tracking

To use different input sources at the same time like imaging devices, instruments or organs, their positions has to be tracked in real time and presented in one single coordinate system. Optical tracking devices visually recognize predefined shapes, colors or reflections. Therefore, mostly two cameras are used to gain spatial information by means of triangulation from navigation aids that are mounted to the structures to track [13].

Marker-based tracking is a special type of visual tracking. It utilizes the information of monocular video like endoscopes and navigation aids attached near the region of interest. Prior calculation of endoscope's tips' position and orientation the 3D configuration of navigation aids and target structures has to be detected by previous (mostly intraoperative) imaging [1].

Electromagnetic tracking systems track small coils within a generated magnetic field [4]. No direct visual connection between the coil and generator is necessary. However, interference by ferromagnetic objects like instruments or surgical table as well as a short distance of the magnetic field limits its application. Acoustic tracking uses supersonic piezoelectric emitters and sensors. The emitters are placed at patient site or instruments so relative positions to sound receivers are estimated [8, 9].

Image Guided Prostate Biopsy

Meanwhile, several platforms are presented in order to increase accuracy and diagnostic certainty of prostate biopsy [3, 6]. For example, multiparametric MRI of the prostate is fused with intraoperative transrectal ultrasound. The navigated puncture follows a transrectal or perineal approach (Fig. 72.1). Due to non-rigid manual or semi-automatic registration is used the key point of this procedure is the fusion of preoperative and intra-

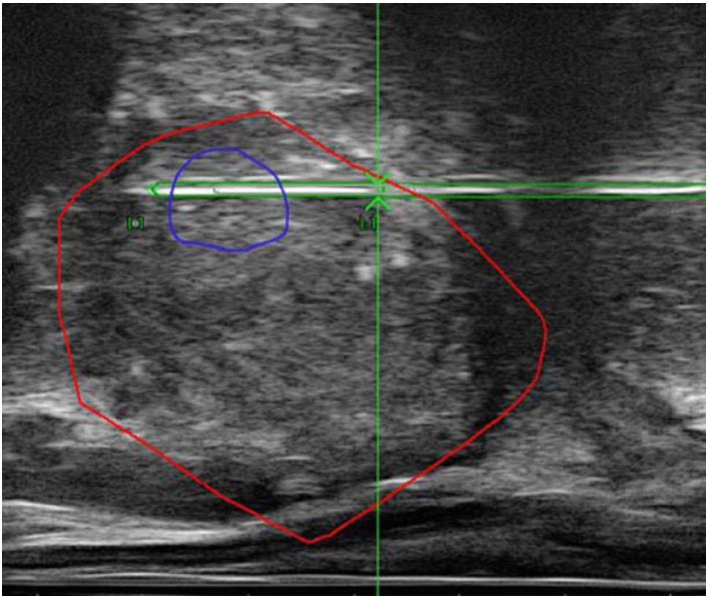

FIGURE 72.1 Image guided prostate biopsy. MR segmented prostate (*red*) and tumor suspect region (*blue*) fused with live transrectal ultrasound. Biopsy needle inserted according to planed biopsy corridor (*green/gray*)

operative imaging with different deformation of the prostate. Little registration errors can lead to relevant diagnostic failure. Therefore long training and supervising is necessary, e.g., to acquire intraoperative TRUS image with the same pressure on prostate as it appears on MRI.

Tablet Computer Assisted Nephrostomy

To place nephrostomy catheter or to perform percutaneous nephrolithotomy the application guides the puncture of the collecting system [8, 9]. Preoperative CT scan in prone position on PCNL cushion is performed while four to five colored skin stickers where already placed around the target area serving as

FIGURE 72.2 Tablet computer assisted nephrostomy. Four navigation aids are attached to patient's skin lying in prone position during puncturing the collecting system. Tablet computer shows augmented reality image superimposing kidney, vessels, renal calyces and pelvis underneath patient's skin

navigation aids. Intraoperatively, the tablet computer's camera had to film navigation aids and puncture needle. Via WiFi a server calculates navigation information and sends data back for display on screen of the used tablet computer in real time (Fig. 72.2). The surgeon gets an augmented reality image visualizing kidney, collecting system, predefined target structures and puncture corridor. So performed kidney puncture showed reduction of radiation exposure.

Navigated Prostatectomy

The introduced system uses needle shaped navigation aids [10]. Their shafts and the 3D configuration of prostates boarder and especially the neurovascular bundles are

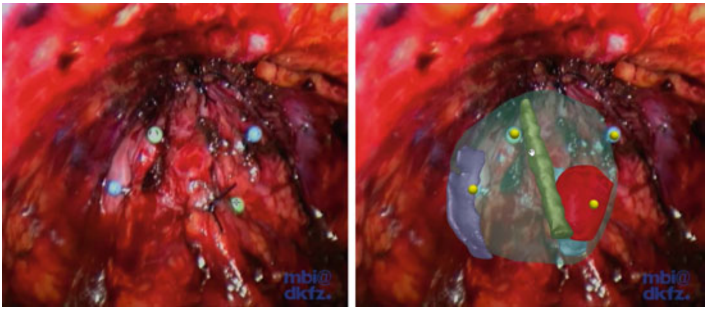

FIGURE 72.3 Navigated Prostatectomy. Plain laparoscopic prostatectomy image with four navigation aids inserted into the prostate (*left*). Augmented reality image (*right*) with navigation aids (*yellow*), prostate's boarder (*green*), left neurovascular bundle (*blue*), urethra (*green*) and biopsy positive region superimposed

identified via intraoperative TRUS. The colored heads of the needles are used for marker-based tracking (Fig. 72.3). For the first steps of surgery, in particular during apical dissection, it could be shown significant lower rate of positive margins with only minimal longer OR time. Due to deformation and rotation of the prostate, the systems use is limited to first dissecting steps.

Hybrid Fluoroscopy Assisted/Navigated Partial Nephrectomy

Based on MR or CT data, 3D segmentation of kidney, renal vessels, renal tumor and the surrounding structures are created preoperatively. For marker based tracking a Dyna-CT (Siemens Medical Solutions, Erlangen, Germany) acquires intraoperative anatomy and navigation aids for augmented reality visualization [5, 11, 12]. Furthermore, with the help of fluoroscopy deformed anatomy during dissection can be registered (Fig. 72.4).

FIGURE 72.4 Hybrid fluoroscopy assisted/navigated partial Nephrectomy. Plain laparoscopy image of kidney and five inserted navigation aids around a barely exophytic kidney tumor (*right*). Augmented reality image superimposing the tumor boarder (*red, upper left screen*) and fluoroscopy image (*lower left screen*)

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Chapter 73
Nuances of Extraperitoneal Laparoscopy

Panagiotis Kallidonis, Evangelos Liatsikos, Iason Kyriazis, Minh Do, and Jens-Uwe Stolzenburg

Abstract The retroperitoneal and extraperitoneal pelvic approach are related with advantages in terms of avoiding intraperitoneal adhesions from previous surgery, formation of new intraperitoneal adhesions and tamponade of any urine or blood leakage extraperitoneally. Retroperitoneal renal surgery has been associated with shorter operative and hospitalization times. In the case of partial nephrectomy, the retroperitoneal approach is preferred by the majority of the surgeons for the management of tumors

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located at the posterior surface of the kidney. The anatomy related to the retroperitoneal and extraperitoneal approach does not represent a challenge to the urologist. Some important tricks in the trocar placement and anatomical orientation should be considered. Every surgeon should have knowledge of these advantages and disadvantages as well as the anatomy in order to set the appropriate indication and to perform surgery without access related difficulties.

Keywords Retroperitoneal • Extraperitoneal • Laparoscopic access • Prevesical • Nephrectomy • Prostatectomy • Adrenalectomy

Introduction

Since the first description of laparoscopic transperitoneal nephrectomy by Clayman et al., laparoscopy has gained ground and has been established for the surgical management of several urological conditions [7, 19]. Procedures such as radical, simple and partial nephrectomy, pyeloplasty, prostatectomy, adrenalectomy are efficiently performed by laparoscopic technique [2, 5, 6, 9, 20, 27].

The performance of surgery in the case of laparoscopy is based on the use of different approaches to the organ of interest. Practically, the laparoscopic procedures are categorized to two different approaches based on the establishment (transperitoneal) or not (extraperitoneal, retroperitoneal) of access in the peritoneal cavity. The majority of the laparoscopic urologic procedures can be performed by either transperitoneal or extraperitoneal/retroperitoneal approach [2, 6, 11, 20, 23, 24].

Both approaches have advantages and disadvantages [11, 15].

Creation of Space and Trocar Placement in Extraperitoneal Laparoscopy

Upper Urinary Tract Surgery- Retroperitoneal Approach

Transperitoneal laparoscopy practically uses a pre-existing anatomical structure (the peritoneal cavity) as the working space for the performance of procedures. The retroperitoneal/extraperitoneal space should be practically created by the surgeon. The retroperitoneal space for surgery of the upper urinary tract could be developed by finger dissection of the posterior pararenal space and insertion of the secondary trocars under digital guidance. The posterior pararenal space represents the virtual space located between the transversalis and the Gerota's fascia. Another method includes the initial finger dissection and the use of a dilation balloon [15]. During the balloon dissection, the inspection of the created space is possible and the surgeon is assured that the correct planes are being developed. Moreover the trocars could be placed under direct vision. The camera is placed at the tip of the 12th rib or 1 cm dorsally. Two trocars are placed on the posterior axillary line and one trocar on the anterior axillary line (Fig. 73.1a). Some investigators have reported the use of an additional trocar on the anterior axillary line [15].

Trocar insertion in the retroperitoneal approach is not associated with any vascular injuries if the camera placement takes place at the aforementioned position [13]. Bleeding from the abdominal wall is rare in the case of this approach [28]. The possibility of bowel injury is minimized with the retroperitoneal access and is lower in comparison to the transperitoneal access [11, 15]. The selection of the retroperitoneal approach has been advocated in cases of previous extensive open abdominal surgery [15, 29].

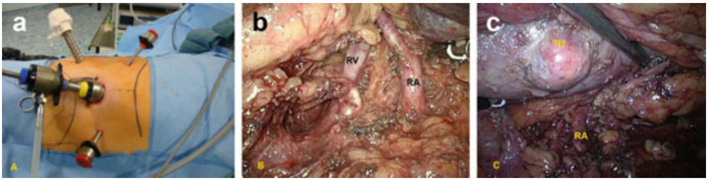

Figure 73.1 (**a**) The trocar placement for the performance of retroperitoneal partial nephrectomy. This is a left sided procedure. The iliac spine and coastal margin are marked. The camera trocar is placed on the tip of the 12th rib on the midaxillary line. (**b**) Intraoperative image from a case of left retroperitoneal partial nephrectomy. The renal vessels are prepared and ready to be clamped. The direct access to the renal artery is an advantage of the retroperitoneal laparoscopy. (**c**) Intraoperative image from a case of left retroperitoneal partial nephrectomy. The renal vessels are prepared and ready to be clamped. The tumor is visible and is located in the posterior medial surface of the kidney. Tumors located on the posterior side of the kidney are appropriate for retroperitoneal approach. The latter approach provides direct access to the tumor. An extended mobilization of the kidney from the surrounding tissue, which is required in the case of the transperitoneal approach, is avoided

Pelvic Surgery: Extraperitoneal Approach

The extraperitoneal (prevesical) space is usually developed through an infraumbilical incision. Finger dissection and enlargement of the space by the use of the optic or a balloon take place [1, 27, 32, 33]. The camera trocar is then positioned. The trocar placement has some variations among the described techniques. The authors favor the placement of the trocars according to Stolzenburg et al. [32, 33]. In short, the camera trocar is placed through a right infraumbilical incision. Four other trocars are placed under direct visual control; a 12-mm trocar in the left iliac fossa 3 cm medially to the anterior superior iliac spine, a 5-mm trocar in the right iliac fossa at a mirror position to the previous trocar, a 5-mm trocar on the hypothetical line between the umbilicus and the right iliac spine approximately at lateral margin of the rectus abdominis. Another 5-mm trocar is placed 3 cm caudally to the crossing of the aforementioned hypothetical line with the left lateral margin of the rectus abdominis. The placement of the lateral left trocar should be as described 3 cm away from the iliac spine. Placement of the trocar closer to the iliac spine would result in clashing of the respective instrument to the bone pelvis. The performance of the anastomosis is performed with triangulation of instruments by some groups [27]. The surgeon is using the medial left and right trocars to perform the anastomosis. The authors favor the performance of all tasks by the surgeon with instruments inserted through the left trocars [32, 33]. The use of triangulation is considered to be easier for the performance of anastomosis. Nevertheless, the use of only the left trocars by the surgeon allows the assistant to be able to use two instruments during the anastomosis.

Advantages-Disadvantages Related to the Retroperitoneal Access

There is evidence showing that the retroperitoneal approach has advantages in terms of hemodynamic and cardiopulmonary parameters [12, 15]. Any postoperative fluid collection such as urine or blood or infected fluids is restricted in the retroperitoneal space and significant complications such as chemical or infectious peritonitis are avoided with the retroperitoneal access [14–16, 22]. Transperitoneal urologic laparoscopy has a risk of adhesion formation up to 22.2 % [25], while the retroperitoneal approach has a distinct advantage since the intraperitoneal space is completely avoided [15]. In addition, the retroperitoneal access allows a more direct access to the kidney without requiring any bowel mobilization [26]. Postoperative shoulder pain represents a complication of the transperitoneal approach and is never encountered in the retroperitoneal procedures [8, 10, 15, 31]. Postoperative pain and hospital stay have been shown to be lower in the case of the retroperitoneal approach in a number of comparative studies ([15, 20]; Fan 2012). Recent meta-analyses on studies comparing retroperitoneal and extraperitoneal radical and partial nephrectomies have concluded to advantages of the retroperitoneal access in the length of hospital stay [11, 26].

Disadvantages of retroperitoneal access are the spatial limitation of the narrow retroperitoneal working space which results in the reduced visualization of the field. In addition, there is always the risk of disorientation due to the above issues [26]. The argument that "the retroperitoneal anatomic orientation is not as familiar to many surgeons" should be considered as theoretical as the urologists are familiar with the latter space due to the performance of many procedures by lumbotomy [15, 36]. Morbid obese patients could be managed by the retroperitoneal approach despite the controversial reports of different investigating groups [20, 21].

Advantages-Disadvantages Related to the Extraperitoneal Pelvic Access

The performance of procedures in the prevesical extraperitoneal space is associated with similar advantages to the retroperitoneal approach regarding the tamponade of any bleeding and urine out of the peritoneal cavity and the avoidance of intra-abdominal adhesions after previous surgery. Space limitations do not apply in the case the extraperitoneal access as the space is adequate for the performance of surgery [38]. Obesity and morbid obesity do not pose contraindications for the extraperitoneal approach [17, 18]. Disadvantage is the lack of access higher to the bifurcation of the iliac vessels which does not allow the performance of extended pelvic lymphadenectomy [17, 18]. Moreover, the incidence of lymphocele formation after a pelvic lymphadenectomy is higher in the case of the extraperitoneal approach and the fenestration of the peritoneum is necessary in order to decrease minimize the incidence of the above complication [35]. The literature includes a number of studies comparing the transperitoneal and extraperitoneal approach without concluding to the best possible approach [3, 4, 30].

Anatomical Considerations

The most important landmark for retroperitoneal surgery is the identification of the psoas muscle regardless of the side that the procedure is performed. The psoas should always represent the "floor" of the operative field. If the orientation of the surgeon is lost intraoperatively, the psoas should be identified again and then proceed with the procedure. The Gerota's fascia is easily identified using the psoas muscle as a guide. The ureter and the gonadal vessels are very often identified during the initial balloon dilation. On the left side, the ureter and the gonadal vessels are identified and preparation of these structures leads to the renal hilum which could be also identified by the pulsation of the renal artery. On the right side, the Gerota's fascia is incised and the vena cava is identified. The cephalad dissection leads to the right renal pedicle. The ureter could be also used as a guide to the renal hilum during the right sided dissection [36].

The retroperitoneal access is considered to be more appropriate for the approach to the posterior side of kidney, for example the excision of a renal tumor located posteriorly. For the approach to the anterior surface of the kidney has been advocated that the transperitoneal approach is more efficient [15]. A recent meta-analysis showed that the majority of the partial nephrectomies were performed by the retroperitoneal access when a posterior renal tumor was managed and by the transperitoneal approach when an anterior one was excised. The results showed that the retroperitoneal approach had an advantage in terms of operative time when compared to the transperitoneal approach. Nevertheless, the authors concluded that the selection of the approach is based on the preference of the surgeon and several parameters should be considered such as the location and technical complexity of tumor [26].

The extraperitoneal approach to the pelvis allows direct access to the prostate and bladder as well as the external iliac vessels without requiring dissection of the bladder from the anterior abdominal wall or any peritoneal dissection. During the preparation of the extraperitoneal space, the initial finger dissection should take place just over the posterior rectus muscle sheath. During the balloon dilation, the important landmarks are the visualization of the epigastric vessels on the lateral sides of the dissection and the pubic bone in the middle. The posterior wall of the pubic symphysis should be in the 12 o'clock position of the endoscopic image by the camera holder. The anatomy related to the prostate and bladder remains the same regardless of the approach [34, 37].

Conclusions

The extraperitoneal and retroperitoneal approaches are related with advantages and disadvantages. Every surgeon should have knowledge of these advantages and disadvantages as well as the anatomy in order to set the appropriate indication and to perform surgery without access related difficulties.

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