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Nightmares in Urology: Open Science

Rectal Perforation During Pelvic Surgery

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Abstract

Rectal perforations during pelvic surgery are rare but serious complications. The occurrence of rectal involvement is generally lower than that of the involvement of other portions of the bowel. The urologic field is responsible for the majority of iatrogenic rectal injuries from pelvic surgery; general and gynecologic surgeries are prone to the occurrence as well, the latter especially in the case of rectal shaving for deep infiltrating endometriosis. Attention should be posed to the prevention of rectal injuries, especially in case of challenging or salvage procedures; some tricks may be recommended to avoid thermal and mechanical damages and to realize a safe dissection. Intraoperative detection of rectal injuries is of paramount importance; once confirmed, immediate management with the closure of the defect is recommended. In general, rectal injuries diagnosed after surgery are liable to significantly worse outcomes than those detected and managed intraoperatively. **Patient summary:** Rectal perforation is a rare but possible complication of pelvic surgeries. The more challenging the procedure (ie, surgery for locally advanced tumors or after radiation therapy), the higher the risk of rectal lesion. Intraoperative management of the injury should be attempted, with direct repair of the defect with or without fecal diversion.

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1. Introduction and context

Iatrogenic bowel injury is a challenging issue that may be a consequence of a wide range of procedures and percutaneous interventions. The small as well as large intestine is

in close proximity to numerous intra-abdominal, retroperitoneal, and pelvic organs; they occupy sizable portions of the abdominal and pelvic cavities, have variable lengths, and are prone to dynamic motion. Urologic, gynecologic, and general surgeries are the most common causes of

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iatrogenic bowel injury [1]. In general, bowel injury may occur during organ dissection, visceral manipulation, or abdominal wall entering/closure.

1.1. Incidence of rectal perforation

Rectal injuries (RIs) during pelvic surgery are rare but severe complications. The rate of RIs is generally lower than the rate of injuries of other portions of the bowel; the majority of studies describes that the rate of small bowel lesions widely exceeds colorectal ones [1,2].

The urologic field is responsible for the major part of iatrogenic RIs from pelvic surgery. Owing to the close proximity with the lower ureter, bladder, and prostate, the rectum is at increased risk of injury during dissection, especially during radical prostatectomy (RP).

In this setting, even if rare, RIs may occur during the dissection of the base or apex of the prostate when the Denonvilliers' fascia is not incised properly. The procedure becomes contaminated and poses the risk of septic complications such as wound infection, rectourethral fistula, peritonitis, and death [3].

Historical series reported an incidence of RIs during RP that ranges from 0.5% to 9%; in this setting, RI occurrence is seemingly higher during the transperineal access [4,5]. When considering open retropubic, laparoscopic, and robotic RP, the incidence of rectal perforation across a single series is summarized in Table 1 [6–20]. It has been argued that the incidence of RIs is unreported in the most recent literature likely due to a lower occurrence [3]. The 2021 European Association of Urology guidelines summarized the rates of overall organ injury during RP, which were 0.4%, 2.9%, and 0.8% during robotic, laparoscopic, and open prostatectomy, respectively [21].

The proximity of the uterus and ovaries to the sigmoid colon, cecum, and rectum increases the risk of bowel injury during gynecologic surgery. As far as gynecologic laparoscopy is concerned, the rectum accounts for 18% of overall bowel injuries. Rectal lesions have been described during hysterectomy for either benign or malignant diseases, for all the approaches (open, laparoscopic, vaginal) and also

with single-site surgery. Few cases are reported also after colposacropexy and tubal sterilization [2]. More recently, a systematic review focused on robotic gynecologic surgery and included a total of 13 444 procedures [22]: overall, a total of 84 bowel injuries were reported for an incidence of one in 160 (0.62%; 95% confidence interval [CI] 0.50–0.76%), ranging from 0% to 5.88% [22]. The most commonly specified location of injury was the rectum (nine cases, 38%) [22]. The authors confirmed that hysterectomy was associated with higher rates of bowel injury than myomectomies, especially if performed for mixed indications. To note, one of the articles included in this systematic review dealt with robotic management of deep infiltrating endometriosis: among 88 patients treated inside their international multicentric study, two cases of RIs were recorded [23]. The rectal shaving technique to obtain maximal removal of deep endometriotic foci may increase the risk of RIs, especially resulting in fistulas or stenosis [24,25].

2. Complication event

2.1. Risk factors for rectal perforation

Several factors have been considered to have an impact on RI occurrence. Most of them are derived from the experience with RP.

1. Prior pelvic surgery (rectal or prostate surgery) or radiation treatment represents factors altering perirectal planes with possible adhesion [1,26]; similarly, in gynecologic robotic surgery, a prior porcine dermis graft may induce dense adhesions in the rectovaginal space [27].
2. Locally advanced tumors, in particular high-risk or locally advanced prostate cancer (PCa) [9,25].
3. Surgeon's expertise and learning curve [28]: The issue arose almost exclusively for open and laparoscopic RP. Heinzer et al [29] addressed open RP and reported a 7.8% rate of RIs in patients who were operated at the beginning of the surgeon's learning curve, compared with 2% among patients who were operated later in their study. Similarly, when considering laparoscopic RP, Castillo et al [30] reported 8% RIs in patients operated during the initial period when surgeons were still familiarizing themselves with the laparoscopic technique. Conversely, Kheternal et al [17] considered a large series of robotic RP (>4000 patients), reporting the absence of any relationship between the incidence of RIs and surgeon's experience [31].
4. Salvage setting: This setting includes RIs occurring after primary treatment of the tumor, that is, after radiotherapy. In the PCa setting, brachytherapy, high-intensity focused ultrasound, or cryotherapy has also been considered as a factor impacting RI occurrence, as well as hormonal therapy for PCa [25]. Historically, RIs during salvage RP may occur in up to 28% of patients [28,32]. RIs are related to the severe periprostatic fibrotic changes that may occur after local treatments. In the more recent robotic RP series, the occurrence of RIs in the salvage setting is comparable with that of the primary settings; however, it should be remarked that such experience is derived mainly from highly experienced surgeons and high-volume centers [33,34].
5. Patient characteristics, that is, obesity and older age, were identified as possible risk factors for iatrogenic bowel injury, but evidence in literature is scarce [1].

Table 1 – Incidence of rectal injuries during radical prostatectomy

First author	Year	Technique	Rate of RI (%)	No.
Borland [6]	1992	Open	1.5	10/1000
Igel [7]	1987		1.3	9/692
Lepor [8]	2001		0.5	5/1000
McLaren [9]	1993		1.2	27/2212
Guillonnet [10]	2003	Laparoscopic	1.3	13/1000
Stolzenburg [11]	2006		0.7	6/900
Katz [12]	2003		2%	6/300
Blumberg [13]	2009		1	2/200
Murphy [14]	2009	Robotic	1	5/400
Patel [15]	2007		0.4	2/500
Yee [16]	2008		0.8	2/251
Kheternal [17]	2011		0.2	10/4400
Novara [18]	2010		1.5	5/415
Wedmid [19]	2011		0.1	11/6650
Hung [20]	2011		1.04	3/288

RI = rectal injury.

6. A very recent transrectal prostate biopsy may alter the plane between the prostate and the rectum. It has been supposed that a time interval of at least 1 mo favors the recovery from inflammation and is thus recommended prior to RP. Ylrdim et al [28] suggested that this waiting period between the biopsy and surgery might result in an easier dissection and lower risk of RIs.
7. Hospital volume and surgeon volume were found to affect the rate of RIs. A study by Barashi et al [35] showed a significantly lower risk of RIs during prostatectomy for high-volume (>43 cases per year) versus low-volume (one to 43 cases per year) institutions (odds ratio [OR]: 0.58; 95% CI 0.46–0.72). More recently, Van den Broeck et al [36] stated that a caseload of >86 procedures per year is associated with a lower complication rate. Similarly, Schmitges et al [37] found that the volume of each surgeon affects RI as well: lower-volume surgeons (seven or fewer cases per year) have an OR for an RI of 3.26 (95% CI 1.93–5.51) compared with very-high-volume surgeons (51 cases per year).

2.2. Technical considerations and tricks for the prevention of RIs

During pelvic surgery, a careful and sharp dissection of the rectum should always be pursued together with avoidance of entry into the perirectal fat; the assistant may aid the procedure holding the rectum posteriorly with a suction irrigation tip [26,28]. During RP, apical dissection of the prostate with the separation of the rectourethralis muscle is the step mostly prone to RIs; at this site, the apex of the prostate should be dissected carefully by separating the recto-urethralis muscle from the posterolateral angle to prevent iatrogenic lesions (Table 2) [17].

Thermal damage is the second most common cause of intraoperative bowel injury and may pass unrecognized especially during minimally invasive surgery [3]. Avoiding the use of monopolar energy sources is of paramount importance; in the area, application of bipolar energy source is preferred to limit the risk of visceral and vascular injuries, according to Karadag et al [3]. Thermal diffusion during deep endometriosis shaving has been recognized as the main cause of delayed necrosis of the shaved area, thus leading to delayed rectal fistulas [25].

Usually, thermal damage of the bowels frequently results in more extensive damage than expected. A full investigation of the abdomen and operating field should be performed at the beginning and at the end of the procedure, to rule out any visceral or vascular injuries, as suggested by Karadag et al [3].

During laparoscopy, thermal injury can also result from discarded energy transfer into the operational field or an unrecognized current outside of the surgeon's view [3,38]. Unintended activation may cause direct application of the energy. Insulation breaks along the instruments are another cause of electrosurgical injury for either laparoscopic or robotic surgery [3]. To prevent these occurrences, checking of instruments and active monitoring of their location in the operative field can minimize this risk [3,38].

Mechanical bowel injuries have been reported too, and may be the consequence of unintended movements of laparoscopic and robotic instruments outside the operative field. To prevent these injuries, insertion of instruments into the peri-

Table 2 – Summary of technical tricks and recommendation for the prevention and early diagnosis of rectal injuries

Setting	Recommendation
Preoperative	Accurate knowledge of the case and possible risk factors for rectal injury (ie, local staging and salvage setting) [1,9,25–29]
Intraoperative	Careful and sharp dissection of the rectum; the assistant may aid the procedure holding the rectum posteriorly with a suction irrigation tip [26,28] Preference for the use of bipolar energy, possible avoidance of monopolar energy [3,25,38] Avoiding unintended activation of instruments with direct application of energy; checking of the instruments before surgery to recognize insulation breaks [3,38] Active monitoring of the location of instruments in the operative field; fourth arm always under vision during robotic surgery [3,38] Full investigation of the abdomen and operating field at the beginning and at the end of the procedure to rule out any injury [3] Final check for rectal integrity in procedures at risk for rectal lesions; this is obtained by filling the rectum with air via a rectal catheter while filling the pelvic area with sterile saline; the presence of bubbles within the saline represents a rectal or bowel leakage requiring immediate management [3,26,33]
Postoperative	Active monitoring of the patient and suspicion of rectal injury in case of abdominal pain, hypotension, fever, tachycardia, peritonitis, leukocytosis, and/or leukopenia; fast management of injury in case of drainage of enteral contents through the skin, urethra, or vagina, or fecal incontinence [1]

toneal cavity should be performed under visual guidance; laparoscopic instruments should not be left inside the cavity if not used, and the fourth arm, during robotic surgery, should always be placed in a visible, safe location.

In the salvage setting of robotic-assisted laparoscopic prostatectomy, several issues of complexity can be encountered. Endopelvic fascia dissection could be challenging due to pelvic side fibrosis ipsilateral to focal treatments; in these cases, opening of the endopelvic fascia at the prostate base where the space between the prostate and the levators is less vascular may facilitate the dissection toward the apex [39]. In general, a prior radiation treatment may alter the plane between the rectum and the prostate, with a lack of prerectal fat and adhesions [39]. In these cases, the dissection can be improved by the use of a toggling 30° camera, with a 180° upward rotation to improve the visualization and safety of the cold dissection. The general loss of tissue vascularization may impair the vitality of tissues involved in the vesicourethral anastomosis; in this setting, acellular and resorbable scaffold graft can be used to as a reinforcement and support [39].

Finally, after complex procedures involving rectal dissection or shaving, an intraoperative check for rectal integrity can be recommended. This is obtained by filling the rectum with air via a rectal catheter while filling the pelvic area with sterile saline; the presence of bubbles within the saline represents a rectal or bowel leakage requiring immediate management [3,26,33].

3. Complication management

3.1. Timing, characterization, and diagnosis

Rectal perforation can be stratified by the timing of diagnosis, thus defined as early (intraoperative identification

of the lesion) or delayed (postoperative diagnosis). When detected during surgery, recognition of a bowel injury simply involves the visualization of a defect in the bowel wall or the extrusion of fecal contents [1,40]. Sometimes, an intraoperative endoscopy may confirm the lesion as an air leak test and may help identify the site of perforation [1].

The approximate length of an RI detected during RP is described by two author groups. In the open series by Topaktas et al [41], RI = 10, with the lesion size ranging from 1 to 3 cm, whereas on the robotic series by Kheterpal et al [17], RI = 10, with the length of the injury ranging from 0.3 to 2 cm.

Unlike early detection, postoperative presentation of an RI could be variable and diagnosis can be more difficult [1,22]. Symptoms of a delayed diagnosis of rectal perforation may include abdominal pain, hypotension, fever, tachycardia, peritonitis, and septic shock [22]; leukocytosis and/or leukopenia can be typical signs. Drainage of enteral contents through the skin, urethra, or vagina, or drainage of urine through the rectum or fecal incontinence are pathognomonic too [1]. Generally, the mean time to diagnosis of a delayed RI is 2.1–3.5 d and ranges from 0 to 13 d [1].

The literature is quite controversial as to when iatrogenic bowel injuries are most commonly diagnosed across different procedures [1]. During RP, the majority of RIs are recognized and managed intraoperatively, being performed with an open, laparoscopic, or robotic approach [12,13,31,40]. As far as gynecologic surgery is concerned, most of the bowel injuries during robotic procedures are diagnosed intraoperatively (87%) [22]. On the contrary, during laparoscopic gynecologic surgery, 42% of bowel injuries are detected postoperatively [2]. Thus, it has been speculated that robotic surgery carries the advantage of improved optics secondary to the three-dimensional high-definition capacity of the robotic platform.

Once an RI is suspected in the postoperative course, an upright abdominal x-ray may reveal free air. After percutaneous gastrostomy tube placement, free air on x-ray had 100% sensitivity and 96% specificity for bowel injury, especially when the subdiaphragmatic air pocket was >2 cm or did not resolve within 72 h, according to Leevan et al [1,42].

Then, computed tomography (CT) may confirm the presence of bowel injury; the choice of contrast administration may be made on a case by case basis, with consideration for the patient's clinical status and location of suspected injury, as stated by Leevan et al [1,42]. Triple-phase contrast CT has 98% specificity for intra- and extraperitoneal visceral injuries; CT with endovenous contrast had only 90% sensitivity and 96% specificity, but avoids delays related to enteral contrast administration [1,43]. If required, a flexible sigmoidoscopy or colonoscopy may also be of importance to confirm the possible site of bowel injury after pelvic surgery. Leevan et al suggest that when an injury ends up with a suspicious urorectal fistula, cystoscopy, retrograde urethrogram, pelvic magnetic resonance imaging, and barium enema versus CT with rectal contrast should be considered for diagnosis and surgical planning [1,44].

3.2. Management of rectal perforation

Treatment of RIs depends on the timing of diagnosis, extent of the defect, and clinical performance of the patient. There are no randomized prospective studies or algorithms for decision-making; however, according to the most recent review on the topic by Leevan and Carmichael [1], studies on primary repair versus diversion (colostomy) failed to report worse outcomes for primary repair.

As a general rule from the trauma literature, when an iatrogenic injury is small and recognized intraoperatively, the primary repair of the defect is generally appropriate [1].

Early management of RIs can be accomplished with a minimally invasive approach and depends on surgeon's experience [1,3,17]. Kheterpal et al [17], reporting on ten cases of RIs out of >4400 RPs, detected and managed all iatrogenic lesions intraoperatively. In this setting, the repair should be performed after prostate removal [31,41].

The operative field should be irrigated copiously with saline or povidone iodine [3,17,41]. The rectal defect should be exposed clearly [3,17], and the margins identified clearly by means of digital rectal examination or a metallic bougie [3]. The rectal wall is closed in two layers (inner mucosa and outer seromuscular layer) with 2-0 or 3-0 polyglactin sutures [3,17].

A single study reported on the closure of the rectal wall with three layers—rectal mucosal layer, outer seromuscular layer, and perirectal surrounding tissue, closed separately with absorbable running suture (2-0 monocryl). Moreover, a pedicled omental flap with vascular supply was mobilized and placed between the rectum and the bladder to support the repaired tissue [41].

The integrity of the closure should finally be checked with retrograde rectal injection of air, as described earlier [3,40]. Broad-spectrum antibiotics should be administered postoperatively, for up to 5–7 d, as suggested by Karadag et al [3]. Oral liquids can be given the day after surgery, and a diet can be initiated after passing flatus [17,37].

The majority of the intraoperative closure was healed without colostomy [3,10,17,31,41]. Despite the absence of definite guidelines, when dealing with general gastrointestinal lesions, a fecal diversion should be considered in case of a need of bowel resection [3]. The use of omental interposition between the rectum and vesicourethral anastomosis has been suggested in case of primary repair, to serve as a barrier to urea and the acidic pH of urine that would otherwise inhibit healing of the rectal wound [6,17,41]. It is important to note that the quality of the rectal repair is crucial for primary healing.

Once the detection of an RI is delayed, there is no defined algorithm of management in the literature. In general surgery, rectal anastomotic leaks are managed with drainage and fecal diversion [45]. In some cases, localized abscesses deriving from rectal anastomotic leaks can be drained percutaneously [1]. Historically, RIs after perineal prostatectomies have been treated successfully with a simple supportive medical therapy that included antibiotics, given that conservative management of RIs below the peritoneal reflection has so long been considered feasible [1,46].

Fistulas between the excretory system and the rectum may derive from surgical injury and represent a challenging issue. In such cases, colostomy, urinary diversion, and delayed repair/reconstruction represent the management providing a higher success rate [1,43,47]. A vascularized tissue flap can also be used [43,46]; some authors described the transposition of the gracilis muscle in patients with prior radiation or as a salvage procedure after failed attempts at repair [48].

In general, RIs diagnosed after surgery suffered significantly worse outcomes than those detected and managed intraoperatively [1]. Actually, when diagnosed lately, patients undergo more surgical procedures and require longer length of stay [2,26,49]. Two review articles considered overall bowel lesions and found that mortality rate for intraoperatively detected lesion is 0–1.7%, whereas mortality rates for lately detected and managed bowel lesion are 3.2% and 7.7% [2,49]. Similarly, during RP, failure to recognize and immediately treat a bowel injury may result in a high mortality rate of up to 3% [26,31].

This consideration applies to all fields of pelvic surgery. In the review article on laparoscopic gynecologic surgery by Llarena et al [2], a delayed diagnosis of bowel injuries can result in significant morbidity and mortality; indeed, the authors concluded that a postoperative recognition of an RI requires high clinical suspicion given the variable patient presentations.

Currently, it is difficult to state whether a surgical approach is safer than another as far as RIs are concerned. From the current review, it could be assumed that the robotic one is seemingly associated with a lower rate of iatrogenic rectal lesions.

However, a correct classification of bowel injuries is often missing. Picerno et al [22] found that more than half of the bowel injuries were reported imprecisely, without mentioning whether the bowel injury is a serosal injury, enterotomy, or perforation, stating that the lack of a definition of bowel injury means that the number of injuries may be either over- or under-reported.

A correct reporting of intraoperative complications is of paramount importance and will provide the basis for the prevention and management of this occurrence.

4. Conclusions

Rectal perforations during pelvic surgery are rare but serious complications. Caution should be posed to avoid iatrogenic injuries, especially in case of challenging or salvage procedures; similarly, early detection of the lesion should be pursued in case of a suspicion. Actually, management of an RI can be accomplished with—or during—minimally invasive surgery. In general, RIs diagnosed after surgery suffer significantly worse outcomes than those detected and managed intraoperatively; surgeons and clinicians should be aware of possible late presentations, requiring more surgical procedures and longer length of stay.

Conflicts of interest: The authors have nothing to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.euros.2022.04.006>.

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