

Noninvasive management of obstructing ureteral stones using electromagnetic extracorporeal shock wave lithotripsy

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Abstract

Background Extracorporeal shock wave lithotripsy (ESWL) represents noninvasive management of urolithiasis. Since the first HM3 model, technological progress has improved the efficacy and safety of this treatment. The current study aimed to evaluate the role of ESWL as a first-line emergency therapy of renal colic due to ureteral stone with impaired renal function.

Methods This prospective study enrolled all the patients admitted from the emergency room with acute renal colic meeting the following criteria: serum creatinine level ranging from 1.5 to 2.5 mg/dl, hydronephrosis, ureteral stones 6 to 15 mm in size, body mass index less than 30, normal renal function at baseline, and no evidence of urinary tract infection. The patients were submitted to a single-session emergency treatment using Dornier Lithotripter S. Follow-up assessment, performed at 24 and 72 h, included radiologic and ultrasound examinations with renal function serum assessment. The end points were a decrease in creatinine level and a stone-free condition.

Results A total of 40 patients were eligible for the study. The mean creatinine level at admission was 1.93 ± 0.26 mg/dl. After the treatment, renal function recovery occurred for 34 subjects (85%), with a significant global decrease in creatinine levels ($p = 0.00$). The global stone-free rate 72 h after SWL was 67.5% (27/40). The patients with residual fragments were managed using re-SWL ($n = 7$) and endoscopic technique ($n = 6$).

Conclusions Emergency SWL represents an effective tool in the treatment of ureteral stones with hydronephrosis and slight renal impairment. Although complete stone clearance after one treatment still remains a difficult target, the actual role of SWL in the management of acute obstruction is to obtain ureteral canalization and renal function recovery.

Keywords Extracorporeal shock wave lithotripsy · Hydronephrosis · Impaired renal function · Ureteral stones · Urolithiasis

At the introduction of extracorporeal shock wave lithotripsy (ESWL) in the early 1980s, the “end of the stone age” was announced [1]. Because ESWL represents a noninvasive approach for urolithiasis, its worldwide application has changed stone epidemiology. The use ESWL to treat smaller and asymptomatic stones that would have received a watchful waiting strategy has led to a downsizing of urinary stones at diagnosis [1]. Despite this finding, obstructing ureteral stone disease still represents a main cause of hospitalization, especially if accompanied by severe hydronephrosis, fever, or impaired renal function.

It is well known that most stones pass from the urinary tract with only slight discomfort. Otherwise, ureteral calculi larger than 6 to 7 mm realize a spontaneous clearance less frequently than smaller stones. For moderately sized, uncomplicated ureteral stones, ESWL is the treatment of choice [2]. Its role as an emergency treatment has been described in some series [3–5], with good outcomes in terms of stone-free rate.

Because ureteral stones can impair renal function, this study investigated the role of SWL with a novel end point: improvement in creatinine levels before and after SWL. In fact, creatinine is the first parameter that rises in cases of

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renal failure because of acute ureteral obstruction, and this condition often requires an endoscopic approach.

Materials and methods

From January 2005 to June 2006, we considered all the patients admitted to the emergency room for acute renal colic. All the subjects underwent blood testing for leucocytes, urea, creatinine, urine analysis, and culture. Primary imaging was obtained through plain abdominal x-ray and urologic ultrasonography. We included in a prospective study all the cases that met the following criteria: presence of a radio-opaque ureteral stone 6 to 15 mm in size, serum creatinine level ranging from 1.5 to 2.5 mg/dl, moderate to severe hydronephrosis, body mass index (BMI) less than 30, and preliminary normal creatinine levels (no evidence of renal failure at previous blood examination collected within 6 months). The exclusion criteria specified evidence of urinary tract infection, fever, urinoma, and general contraindications to ESWL (pregnancy and coagulation disorders).

The baseline medical treatment for pain included the use of tramadol (50 mg). None of the patients had been treated previously with an expulsive medical therapy such as nifedipine or tamsulosin.

All the patients were submitted to single-session emergency management with ESWL by means of Dornier Lithotripter S (Dornier MedTech Europe GmbH, Germany), a third-generation electromagnetic device. The treatment was performed always within 12 to 48 h after admission. An average of 4,000 hits were administered, with incremental progression of the power to the maximal tolerable dose. In all cases, 60 pulses per minute were applied, according to the most recent literature [6].

Follow-up assessment was performed at 24 and 72 h by means of plain abdominal x-ray and ultrasound examinations with creatinine serum assessment. The primary end point of the study was the rate of patients with a significant decrease in creatinine level. As the secondary end point, we considered the stone-free rate. Interventional procedures (ureteroscopy and/or ureteral stenting) were performed only in cases of persisting renal function impairment.

Statistical analysis was performed using the SPSS statistical software (SPSS, Inc., Chicago, IL, USA). A descriptive analysis of all the variables was performed. The comparison between variables was completed using the paired-sample *t*-test procedure. A significance level of 0.05 was chosen for all the tests.

Results

A total of 40 patients (28 men and 12 women) with a mean age of 41.4 ± 7.87 years (range, 30–56 years) were

eligible for the study. The mean stone size was 9.1 ± 2.39 mm (range, 6–15 mm). In 25 patients, the stones were located in the lumbar ureter. In the remaining patients, the stone location was distal to the iliac vessels. The mean creatinine level at admission was 1.93 ± 0.26 mg/dl (range, 1.5–2.4 mg/dl). None of the patients reported diabetes or impaired renal function before the acute hospital admission. All of them received regular hydration (1500–2000 ml/day) before and after SWL treatment.

The SWL session was performed with 4,000 hits (range, 3,300–4,500 hits). Only 8 of 40 patients required an additional therapy with tramadol for pain. After SWL monotherapy, the creatinine level in the entire cohort of patients was 1.36 ± 0.34 mg/dl ($p = 0.00$). For 34 of 40 patients (85%), renal function was normal (mean creatinine levels, 1.24 ± 0.14 mg/dl; $p = 0.00$).

The global stone-free rate 72 h after SWL was 67.5% (27/40). Of the 13 patients with residual fragments, 6 with residual renal failure underwent ureteroscopy with stone retrieval. The remaining 7 patients were submitted to an additional treatment with SWL. No side effects related to either shock wave lithotripsy or the endoscopic approach were noted.

Discussion

Urinary stone disease with renal colic and hydronephrosis is a frequent urologic event. Ureteric stones have a high probability of spontaneous passage if adequate therapy is performed. Alpha-receptor antagonists or calcium-channel blockers are the most recently invoked remedies in the treatment of ureteric stones, together with steroidal or nonsteroidal antiinflammatory agents [7, 8].

The optimal active therapy for ureteric stones remains controversial. Ureteroscopy and ESWL both are associated with high efficacy and low side effects [9–12]. Furthermore, if we distinguish between proximal and distal ureteral stones, outcomes may differ significantly due to these different approaches. In fact, for proximal ureteral stones, ureterorenoscopy and ESWL seem to be comparable among the different series. In contrast, ureteroscopy is recommended for the treatment of distal ureteric stone, thus resulting in earlier fragment clearance [12].

Despite the different opinions in the reported series, SWL still remains an effective tool in the management of ureteral stones [1, 2]. Its role as an emerging treatment represents a topic just described in the recent international literature, with promising outcomes reported [3–5]. Tligui et al. [5] reported a stone-free rate ranging from 79% to 83%, according to the location of the stone, with emergency SWL used for recurrent acute renal colic. In published series, the stone-free rate after SWL is

considered the main end point of all the experiences, without concern about renal function that can be adversely affected by hydronephrosis. Srivastava et al. [13] described the role of ESWL in renal units with impaired function, concluding that SWL outcomes are comparable with those found in normal renal units.

We present the first study that considers the levels of serum creatinine and its eventual decrease as a marker of ESWL efficacy. We realized renal function normalization for 85% of the patients, with a significant decrease in creatinine levels for the entire cohort of patients. In urologic practice, an interventional procedure with urinary drainage (either nephrostomy tube or ureteral stent) usually is recommended for cases of ureteral stone associated with impending renal deterioration [14]. In our study, the rationale of the first inclusion criterion (ureteral stones larger than 6 mm) is to minimize the potential risk of spontaneous passage that may lead to a natural creatinine normalization. Management of these stones using ESWL has avoided a great number of endourologic procedures, giving the patient a noninvasive and almost painless treatment.

The preceding outcomes can be supported by a sort of “ex novo canalization” of the ureter. The partial fragmentation or different positioning of the stone after SWL makes the urinary load pass along the ureter, with immediate improvement in renal function parameters. Actually, a normalization of creatinine levels can be evident even in cases for which the stone-free condition was not completely obtained within 48 to 72 h after ESWL. Normal renal function with a remaining ureteral stone or fragments allowed us to manage the clinical case in a conservative way, with medical therapy or repeated and deferred ESWL.

Conclusions

Emergency SWL represents an effective tool in the treatment of ureteral stones with hydronephrosis and slight renal function impairment as well as serum creatinine at 1.5 to 2.5 mg/dl. Although complete stone clearance with one treatment still remains a difficult target, the actual role of ESWL in the management of acute obstruction is to obtain ureteral canalization and renal function recovery.

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