Original article

Ureteroscopic manipulation of ureteral calculi: Experience in a regional hospital

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ARTICLE INFO

Article history:
Received 3 June 2011
Received in revised form 28 June 2011
Accepted 21 July 2011
Available online 9 May 2012

Keywords:
holmium laser
lithotripsy
ureteral calculi
ureteroscopy

ABSTRACT

Objective: We report our experience in the treatment of ureteral calculi by ureteroscopic stone manipulation (URS-SM).

Materials and methods: In 2009, 420 patients with ureteral calculi underwent a total number of 438 URS-SMs with a lithoclast, holmium laser, or both. All patients were evaluated by plain radiography, sonography, and excretory urography prior to the operation. Follow-up studies included plain film and sonography that were done immediately and 2 weeks after the operation.

Results: The overall stone-free rate was 95.4%. According to the location of the stones, respective success rates for upper, middle, and lower ureteral stones were 88.4%, 97%, and 100%. The most common cause of failure was stone migration (4.5%).

Conclusion: Ureteroscopic lithotripsy is a trustworthy procedure for treating ureteral calculi of different sizes at all levels, and it can be efficaciously and safely performed in expert hands.

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1. Introduction

Urologic management of urinary calculi has immensely changed in the past 30 years. Various endourological treatment modalities are available for urinary calculi including extracorporeal shock wave lithotripsy (ESWL), ureteroscopic stone manipulation (URS-SM), percutaneous nephrolithotomy, and laparoscopic lithotomy. Although the majority of ureteral calculi can be efficiently treated by ESWL, a substantial number of such calculi still require an invasive approach. URS-SM of ureteral calculi is indicated for failed ESWL, steinstrasse after ESWL, larger stone sizes, radiolucent stones, and lower ureteral stones. In recent years, the advent of smaller-caliber semirigid ureteroscopes (4.5 and 6 Fr) and advances in efficient intracorporeal lithotriptors such as the lithoclast and holmium laser have resulted in high success and low morbidity rates. In this report, we present our results in managing ureteral calculi by semirigid ureteroscopy.

2. Materials and methods

From January to December in 2009, 420 patients with ureteral calculi underwent URS-SM. The procedure was performed by any one of the three urologists in our hospital (Tainan Municipal Hospital, Tainan, Taiwan). Patients’ medical records were reviewed

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Lithoclast Master, EMS Medical, Konstanz, Germany) and/or a holmium:YAG laser (Auriga; WaveLight 30 W, Interkardio, New Delhi, India) under masked general anesthesia. We used the lithoclast with two probes (0.8 mm and 1 mm) and a low-power holmium laser with a 600-μm fiber at 800 or 1200 mJ and an 8-Hz pulse rate. The majority of fragmented stones were left in situ for spontaneous passage, while relatively large stone fragments were removed with forceps. A ureteral catheter (3 or 4 Fr) or double-J stent (4.7 or 6 Fr) was placed in case of ureteral edema secondary to an impacted stone, ureteral injury, impaired renal function, big stone burden, or upward migration of stone fragments. The ureteral catheter or double-J stent was removed a few hours to 2 weeks after surgery. Additional ESWL combined with secondary URS-SM was applied postoperatively for upwardly migrating stone fragments.

### 3. Results

According to the location of the stones, success rates of 430 total one-session URS-SM for upper, middle, and lower ureteral stones were 88.4%, 97.0%, and 100.0%, respectively. In addition, five of the eight patients with unilateral multiple stone locations including steinstrasse achieved a success rate of 62.5%. The overall success rate after one session of URS-SM was 95.4% (418 of 438). These results are summarized in Table 2. Stone migration into the kidney, which occurred in 19 patients with stones located in the upper ureter and one with a stone located in the middle ureter, was the only cause of failure. Of 20 patients (4.6%) who required additional ESWL for an upwardly migrating stone, 17 patients underwent one session of ESWL plus one secondary URS-SM, and three required two sessions of ESWL plus one secondary URS-SM; however, two of these cases were lost to follow-up. Ultimately, the total stone clearance rate was 100% (436 of 436). The rate of double-J stent placement was 86.8% (380 of 438). Table 3 shows complications of URS-SM. The main complication was postoperative fever (0.7%). Postoperative fever in three patients with and hematuria and blood clot retention in one were resolved by supportive treatments and Foley catheterization with normal saline irrigation. Upward migration of a double-J stent was found in one patient, and the double-J stent was removed soon after the problem was discovered. There were no major complications such as ureteral perforation or avulsion.

### 4. Discussion

#### 4.1. ESWL versus URS for treatment of ureteral calculi

With regard to the minimally invasive management of ureteral calculi, ESWL is considered a highly efficacious, noninvasive, anesthesia-free method for the majority of cases. The success rate of ESWL is affected by several factors, such as the stone size, location, and composition, lithotriptor type, surgeon’s experience, secondary procedures applied, and particularly the retreatment rate.7 Huang and colleagues2 compared the cost-effectiveness of treating ureteral stones between ESWL and URS-SM in a Taipei City hospital. On the one hand, ESWL for ureteral calculus usually achieved good results only at the expense of repeated treatments and with the use of auxiliary procedures. On the other hand, post-ESWL fragment expulsion was often accompanied by colic and other urinary symptoms, sometimes lasting several days, which can result in significant discomfort to patients. In their study, ESWL had higher medical costs than URS-SM.3 In 2007, the American Urological Association and the European Association of Urology (AUA/EAU) published guidelines for managing ureteral stones.4–6 The authors concluded that both ESWL and URS-SM are appropriate first-line therapies in healthy, nonpregnant adults who have unilateral ureteral calculi with no other stones that require treatment, and who have normal contralateral renal function. There is no difference in the rates of complications between these two treatment modalities. A meta analysis of 244 studies demonstrated that URS-SM was associated with higher stone free rates than ESWL for stones of all sizes, with the exception of proximal ureteral stones of less than 1 cm, for which ESWL was slightly more effective than URS-SM.5 AUA/EAU guidelines6 state that ESWL is the recommended first-line treatment for stones of ≤1 cm in the proximal ureter, while the optimal treatment for stones of > 1 cm remains to be determined with ESWL and URS both being acceptable options. A single institution retrospective review of 5133 URS procedures in 4512 patients with lower ureteral calculi demonstrated the safety and efficacy of this procedure, with a 94.6% stone free rate.7 Major intraoperative and postoperative complications were very rare, with a ureteral avulsion rate of 0.35% and a ureteral stricture rate of 0.23%.7 They also documented that improvements in URS design, accessories, techniques, and experience had led to a significant increase in the success rate and a decrease in the complication rate. Bapat and colleagues8 compared success rates and complications of URS with a pneumatic lithoclast and holmium laser lithotripsy in managing upper ureteral stones in 394 patients. They concluded that fragmentation rates of holmium laser-assisted URS were better in the upper ureter.8 In their opinion, laser lithotripsy with a slender semirigid URS was the favored modality for management of upper ureteral stones of <2 cm in patients with a short duration of symptoms.8

#### 4.2. URS-SM for ureteral calculi in our experience

Our study of 438 URS-SM procedures in 420 patients revealed an overall 95.4% clearance rate for ureteral stones. The clearance rates of lower (259), middle (33), upper (138), and multiple (8)
ureteral stones were 100%, 97%, 88.4%, and 62.5%, respectively. Upward stone migration in 4.6% patients was the only reason for failure of the procedure. Kijvikaik and colleagues\(^4\) noted that failure of URS-SM in the proximal ureter was often associated with stone migration into the renal pelvis and calices. The introduction of the holmium laser, which is effective in fragmenting any kind of stone, has tremendously increased the efficacy of intracorporeal lithotripsy and has now become the most accepted modality of URS-SM. The degree of retropulsion depends on the energy source used, with electrohydraulic and pneumatic lithotriptors causing a greater degree of retropulsion than do lasers.\(^9\) In our experience, a slender semirigid ureteroscope (4.5 or 6 Fr) in combination with a low-power holmium laser (800 mJ at 8 Hz) produced the best results. Furthermore, various strategies and devices were developed to prevent stone retropulsion during lithotripsy. For example, placing patients in the reverse Trendelenburg position with lateral rotation, decreasing the irrigant pressure and flow rate, and initially hitting the stone peripherally have all shown promising results. Several stone occlusion devices such as the Stone Cone (Boston Scientific, Natick, MA, USA) and NTrap (Cook Urological, Spencer, IN, USA) were recently introduced to avoid stone retrograde migration and assist in fragment extraction. We have tried to use the NTrap device to jammed the wire mesh net of the device, hindering net retrieval to entrap stones; however, the disintegrated stone fragments assist in fragment extraction. We have tried to use the NTrap device in preventing stone retropulsion, which is not traumatic to the ureter.\(^10\)

4.3. Double-J stenting after URS-SM

The placement of an indwelling ureteral stent after URS-SM is required to relieve postoperative pain due to obstruction caused by ureteral edema or stone fragments and promptly establish urinary flow from the kidneys to the bladder. In addition, stents may facilitate fragment passage, allow dilatation of the ureter for subsequent procedures if necessary, promote healing, and prevent sterciform stricture formation.\(^11\) In consideration of the positive contribution of stenting, we almost always use a ureteral stent (86.8%) or catheter (7.5%) after the procedure unless stone fragments are removed completely by the forcesp or basket. According to the most recent AUA/EAU guidelines,\(^2\) strong indications for stent placement are suspected ureteral injury, ureteral stricture, a solitary kidney, renal insufficiency, and a large residual stone burden. As a result, the decision of whether or not to place a stent can only be made by the surgeon at the time of the operation. In uncomplicated cases, it seems that a ureteral stent might not be necessary.

4.4. Future of URS-SM

The introduction of flexible URS has led to new dimensions in diagnosing and treating upper urinary tract lesions, especially urinary tract calculi. Krambeck and colleagues\(^12\) described a modern series of URS-SM at the Mayo Clinic (Rochester, MN, USA) that included over 350 flexible URS procedures and 1000 patients. The stone free rate of this procedure in the proximal ureter was 91.7%, which is comparable with reported ESWL success rates. The overall complication rate in that series was 1.8%, with a 0.2% stricture rate. Currently available flexible URSs have thinner tips assisted by an access sheath, which facilitates quick access into the ureter. The durability of these devices continues to improve, as do the optics, especially with the introduction of digital technology.\(^13\) However, high costs for the purchase and repair of flexible URS limit its clinical role in our institution due to economic considerations. In the future, innovative advances in technology and the durability of these instruments and devices will likely provide excellent results in managing upper urinary tract problems in a minimally invasive fashion.

5. Conclusion

Ureteroscopy is a highly effective, safe, and feasible treatment modality for ureteral calculi, and it has demonstrated high success rates and low complication rates. Our study results are similar to those in the literature, which indicates that our accumulated experiences have made us skilled at treating ureteral calculi using this method. With continued advances, flexible ureteroscopy should play important roles in diagnosing and treating upper urinary tract diseases.

Conflicts of interest statement

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

References