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Endoscopy *vs.* Extracorporeal Shockwave Lithotripsy in the Treatment of Distal Ureteral Stones: Ten Years' Experience

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ABSTRACT

Background: **The lower third is the location of the great majority of ureteral stones. Treatment of these stones remains controversial: *in situ* extracorporeal shockwave lithotripsy (SWL) *vs.* ureteroscopy (URS).**

Methods: **During the last decade, 633 distal ureteral calculi were treated at our institution using *in situ* SWL (Siemens Lithostar electromagnetic lithotripter) in 395 patients and URS (with 11.5F instrument and ultrasonic lithotripsy) in 228 patients. The patients' age and stone size were similar in the two groups. All SWL therapies were performed on an outpatient basis.**

Results: **The overall success rate was 99% for SWL, and the efficiency quotient (EQ) was 92.4%. The treatment was more effective for <10 mm calculi. In the URS group, there was a 92% overall success rate with an EQ at 91.2%. Compared with SWL, URS was more time consuming, at least for the initial cases; often required intravenous sedation; entailed routine placement of a ureteral stent; and more often led to hospitalization. On the other hand, stone clearance was rapid after URS, although most of the SWL patients were stone free at the end of 6 weeks. The cost was similar in the two groups.**

Conclusion: **We believe that multiple factors should be considered when deciding the most appropriate approach to distal ureteral calculi. *In situ* SWL provides optimal first-line treatment for calculi <10 mm, whereas URS is better reserved for stones >10 mm.**

INTRODUCTION

EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY (SWL) and ureteroscopy (URS) are both effective treatment options for distal ureteral stones.[1] Extracorporeal lithotripsy has revolutionized the therapy of urinary tract calculous disease and is widely recognized as the treatment of choice for most stones in the renal collecting system. It has a high success rate, accompanied by only minor complications.[2] On the other hand, the easy access to the stones of the distal ureter enables the urologist to use endoscopic means with a high success rate, especially for medium-size (4–10-mm) or large (10-mm) stones.[3] There is controversy as to which form of therapy is better suited to the management of lower ureteral stones.[4–6] We report our 10 years' experience, comparing the efficacy of these two methods in the treatment of distal ureteral calculi.

PATIENTS AND METHODS

In the last decade, 228 patients, 179 men and 46 women, 20 to 75 years of age (mean 58 years) with lower ureteral stones (at or below the level of the sacrum), ranging in size from 4 to 25 mm, underwent endourologic treatment. A total of 238 stones were treated, 113 on the right side and 125 on the left. Six patients had bilateral stones, and one patient had a recurrent stone, which was treated at a later date. There were 3 men among the 228 patients (1%) with enlarged prostates, so that access to the stone was impossible using a rigid ureteroscope. These patients underwent successful antegrade stone manipulation. Ureterorenoscopy was normally performed with the rigid 11.5F ureteroscope following dilation—for the initial 50 cases, with flexible, olive-tip metal dilators[7] and subsequently with high-pressure balloons—of the ureteral orifice. The URS removal of the stones was successful via simple basket extrac-

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tion and transureteroscopic ultrasonic or electrohydraulic lithotripsy (Table 1). All patients received epidural anesthesia and were treated as inpatients.

Also, during the last 10 years, 395 patients, 286 men and 109 women, 22 to 76 years of age (mean 56 years) with distal ureteral stones ranging in size from 4 to 20 mm underwent *in situ* SWL on a Lithostar lithotripter. Most patients (324) were treated in the standard supine position, whereas 71 were treated in the prone position. Preoperative evaluation was performed on an outpatient basis, whereas patients were treated without anesthesia and only 32 of them received mild analgesics following lithotripsy. Patients with bilateral or simultaneous treatment of renal and ureteral calculi were excluded from the study. A patient was considered stone free when there was no evidence of stone 6 weeks after the procedure.

All patients were followed at the stone clinic by the attending urologist responsible for the procedure. Cost analysis was based on the cumulative cost of all preoperative and postoperative care, hospital charges, professional fees, and ancillary procedures (nephrostomy or stent placement), as well as any costs resulting from the management of complications, such as subsequent hospitalization.

RESULTS

Ureteroscopic removal was successful for 150 of 166 stones (90%) via simple extraction by a stone basket, in 30 of 33 (91%) by transureteroscopic ultrasonic lithotripsy, and in all 39 by transureteroscopic electrohydraulic lithotripsy. The overall success rate thus was 92% (219/238). The success rate according to stone size is displayed in Table 2.

Patients were followed up with plain radiographs (KUB films) on the day after the procedure, and they were asked to return for another KUB film together with ultrasound examination 1 and 6 weeks after discharge from the hospital. Stone clearance was seen during the immediate postoperative time of 48 hours in all patients treated successfully by URS. Accessory measures such as ureteral catheters or double-J stents were used in all patients for 48 to 72 hours postoperatively, whereas nephrostomy tubes were placed in two patients (0.8%) with ureteral obstruction after migration of a ureteral catheter. Complications such as ureteral lesion and perforations were observed in four patients (1.7%) and were treated conservatively with indwelling ureteral stents. Four patients suffered urinary retention postoperatively that resolved after intermittent catheterization, and two developed a ureteral stricture that resolved after balloon dilation. Two patients (0.8%) had SWL after unsuccessful endoscopic management. The stone-free rate and efficiency quotient (EQ) for URS were 92% and 91.2%, respectively. With the day of the procedure considered as hospital day 1, the ureteroscopy patients averaged 2.25 days (range 2–7 days) in the hospital.

TABLE 1. ENDOUROLOGIC METHODS USED FOR TREATMENT OF DISTAL URETERAL STONES

Method	*No. Pts (%)*
URS + basket extraction	159 (70)
URS + ultrasonic lithotripsy	31 (14)
URS + electrohydraulic lithotripsy	35 (16)

TABLE 2. SUCCESS RATE ACCORDING TO STONE SIZE

Stone Size (mm)	*Endoscopy (%) (N = 238)*	*SWL (%) (N = 395)*
<5	18/18 (100)	181/181 (10)
6–10	39/41 (95)	188/188 (100)
11–15	145/158 (92)	20/23 (87)
16–20	13/15 (87)	2/3 (67)
21–25	4/6 (67)	–

In the SWL group, a total of 368 of the 395 patients (93%) had stone disintegration in one session and were stone free 6 weeks after the procedure. In 23 patients (6%), a second session was applied, and only 4 patients (1%) had unsuccessful second sessions. The success rate according to stone size is seen in Table 2. A KUB film was obtained at the end of the SWL session to assess fragmentation. Patients were asked to return for another KUB film together with ultrasound examination 1 week after SWL treatment. If significant fragments were still seen, the patient was instructed to return for a second SWL session or to be followed up for the next 6 weeks with a KUB film and an ultrasound scan. If there was no radiologic evidence of stone 6 weeks after the procedure, the patient was considered stone free. All failures were managed by ureteroscopic lithotripsy and stone basket extraction. The overall success rate was 99% with one (93%) or two (6%) sessions, and the EQ was 92.4%. The average energy used to fragment the stones was 4123 shocks (range 4100–4400 shocks) at 15 to 19 kV (mean 16.8 kV).

Complications encountered during SWL were nausea and vomiting in three patients and dysrhythmia in seven. All patients were managed conservatively. Complications after SWL included mild hematuria in 127 patients, renal colic in 60 patients, which necessitated mild analgesics, and fever >38°C in 17 patients, which was managed with intravenous fluids and antibiotics and by drainage of the urinary tract if obstruction was identified.

A comparison between the two techniques is shown in Table 3.

The overall average cost for SWL and URS therapy was similar, and no statistically significant difference was identified.

DISCUSSION

Significant technological advances have been made in managing symptomatic lower ureteral calculi in recent years. Extra-

TABLE 3. COMPARISON OF PRIMARY INTERVENTION WITH URS OR SWL

	URS	*SWL*
Mean procedure time (min)	63	37
Mean hospital stay (days)	2.25	0 (outpatient)
Successful procedure, including repeats (%)	219/238 (92)	391/395 (99)
Failure (%)	19 (8)	4 (1)
Serious complications (%)	6/238 (2.5)	–
Accessory procedures (%)	2/238 (0.8)	6/395 (1.05)

corporeal lithotripsy with or without a stent, URS with stone extraction or intracorporeal lithotripsy, and open or laparoscopic ureterolithotomy are the options available for treatment of a stone at the distal ureter. Small stones are more likely to pass[8] and more likely to be flushed out when using endoscopic techniques. They are also more difficult to localize using the X-ray or ultrasound imaging systems of the lithotripters. In comparing SWL and URS as treatment modalities, several factors should be considered, including the number of treatments needed to obtain a stone-free state, the duration of hospitalization, the need for anesthesia, required secondary procedures, complication rate, and cost.

The management of the distal calculi continues to evoke much controversy at this time. Extracorporeal lithotripsy has rapidly gained wide acceptance, extending to the treatment of lower ureteral stones. Selli and Carini reported on 70 patients presenting with lower ureteral stones that were treated with SWL using a Dornier HM3 lithotripter.[9] All but one patient had additional endoscopic maneuvers before treatment, and the overall success rate was 94.2%, with three patients having retained fragments and one requiring open operation. Chaussy and Fuchs, using the HM3 machine, treated 44 lower ureteral stones, excluding eight in women of childbearing age and three in patients with ipsilateral kidney stones.[10] Only 16 of the 33 remaining patients had successful *in situ* SWL treatment.

Clayman et al[11] developed the EQ, which measures the need for retreatment and ancillary procedures and is calculated as:

$$\%\ \text{stone free}/(100\% + \%\ \text{retreatment} + \%\ \text{ancillary procedures}) \times 100\%$$

In a series of 868 patients treated with the HM3, an overall success rate of 95% was reported with an EQ of 82%.[1] The stone-free rate for the second-generation lithotripters is 85% to 96%. However, the efficiency rating is only 70% to 74% because of the higher rates of retreatment and ancillary procedures. Our results were closer to these studies, with a 99% stone-free rate and an EQ of 92.4%, whereas Netto et al, with a Lithostar device, reported a stone-free rate of 92% and an EQ of 83%.[12]

Although stone-free rates with SWL for lower ureteral calculi are now very good, URS approaches a 100% success rate in experienced hands.[13] Morse and Resnick[14] noted a success rate of 81% with URS and a complication rate of 12.5% using an 11.5F rigid Storz ureteroscope. Netto and associates[15] reported an overall success rate of 95.7% with a rigid 11.5F ureteroscope. In another series, those same authors reported stone-free rates of 98.1% and 95.6% after one ureteroscopic procedure with a stone basket and lithotripsy, respectively. In our series, the stone-free rate with URS was 92% and the EQ was 91.2%. Improvements in technology have resulted in smaller telescopes and better ancillary tools, so as to decrease the number of problems. Today, an indwelling ureteral stent or ureteral dilation may not be required for URS.[16,17] Other authors noted that URS for distal ureteral stones is well tolerated with intravenous sedation in select patients.[18] Currently, all our patients undergo distal URS under regional anesthesia, using a 6.9F semirigid ureteroscope and pneumatic lithotripsy for all stones. Technological advances and operator expertise have resulted in performance of this procedure on an outpatient basis without the need for postoperative ureteral stenting. These results will be clarified in the future. Most of the complications occurred early in the series, and the morbidity of the procedure is considerably less now than 10 years ago. Stone clearance was accomplished rapidly in the URS group, whereas most of the SWL patients were stone free at the end of 6 weeks' time.

Much has been written about the cost of SWL being much greater than that of URS.[19,20] Kapoor et al[19] showed that all hospital-related costs, including professional fees, totalled a mean of $7320 for SWL and $4568 for URS for similar types of stones. Grasso and coworkers[21] reported that operative costs are similar if only SWL monotherapy is considered. However retreatment, subsequent patient office visits, and maintenance of the equipment are factors weighed against SWL. Nesbitt and Drago[22] showed that the costs for SWL came to $6700 compared with $3300 for URS. Anderson et al[1] and Clayman and colleagues[11] confined their attention to the HM3 lithotripter, finding the incurred cost for SWL to be $8539 and for outpatient URS $6801. However, two thirds of these patients needed to be admitted, increasing the overall cost of URS to $8263. The authors acknowledged the higher retreatment rates with the second-generation lithotripters. Anderson et al[1] reported that *in situ* SWL in a Lithostar lithotripter cost more if additional treatments or procedures were required to make patients stone free, an additional cost of roughly $2000 per patient. In our series, the overall cost for *in situ* SWL using a Lithostar machine and URS with a 11.5F rigid Storz ureteroscope was similar.

Although a 28% retreatment rate has been reported[1] using Lithostar lithotripters, we observed only a 6% retreatment rate among our patients in order to become stone free. This difference may be attributable to the fact that our average stone was smaller than those reported in other series.[6,15]

Treatment of distal ureteral stones remains controversial. Extracorporeal lithotripsy has contributed to a large extent to the treatment of ureteral calculi as a noninvasive technique.[10] An 88% success rate was obtained with the *in situ* treatment of ureteral stones using the Siemens Lithostar.[23] Moreover, the patients' tolerance for the treatment, the brief hospital stay, short convalescence, and low incidence of complications favor the use of SWL with the Siemens Lithostar as the method of choice for lower ureteral stones <10 mm. For stones >10 mm, those that look hard radiologically or are known to be cystine, radiolucent stones, and, possibly, stones in women of childbearing age, URS, a minimally invasive technique, offers an effective and well-tolerated alternative to SWL. Improvements in ureteroscope design, accessories, and technique have led to an increase in the success of URS.

In conclusion, multiple factors need to be considered for efficacious management of distal ureteral calculi. We believe that patient occupation, cost, distance from home, patients' opinion, and the expertise and equipment of the treating urologist (mobile lithotripters, lasers) are factors that have a significant influence in the final decision about the treatment modality.

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