Outpatient Treatment of Middle and Lower Ureteric Stones: Extracorporeal Shock Wave Lithotripsy versus Ureteroscopic Laser Lithotripsy

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Abstract

The aim of this retrospective study was to evaluate the efficacy of ureteroscopic lithotripsy (URSL) and extracorporeal shock wave lithotripsy (ESWL) in the treatment of middle and lower ureteric stones. From January 1996 to March 1997, 61 patients treated by URSL and 49 patients treated by ESWL were studied, both were conducted as outpatient procedures. URSL using Holmium laser and semirigid ureteroscope (Fr.8.5) performed under general anaesthesia had single session stone clearance rates of 100% and 95% for middle and lower stones respectively. There were 6 complications including 5 readmissions (2 febrile episodes, 2 severe pain spells, and 1 stent migration) and 1 stricture formation. ESWL using the Dornier MFL 5000 lithotriptor had a single session success rate of 51% and overall success rate of 78% after retreatment (retreatment rate 35%). No significant complication or readmission was noted. Seventy-two per cent of patients required intravenous fentanyl for pain control. The efficiency quotients calculated for the URSL group and the ESWL group were 97% and 58% respectively. In summary, in the treatment of middle and lower ureteric calculi, ESWL carries reasonable success rate, especially with retreatment; and minimal morbidity. On the other hand, URSL is highly effective in rapidly clearing the stones, a low risk of complication is noted. Both can be conducted as an outpatient treatment modality.

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Introduction

Significant technological advances have been made in the management of ureteric calculi. The newer semirigid, fibreoptic ureteroscopes can now be passed with minimal trauma and in many cases without dilatation.[1] Advances in intracorporeal lithotripsy, namely, laser lithotripsy have also facilitated ureteric stone fragmentation while greatly decreasing the possibility of ureteric injury during stone fragmentation and removal.[2-4] The Holmium laser, in particular, provides a very powerful yet safe lithotripsy mechanism.[5] As commented by Winfield,[6] the intrinsic property of the Holmium laser had provided unsurpassed stone fragmentation including calcium oxalate monohydrate and cystine stones which could be difficult even for the pulsed dye laser. These changes allow for rapid, safe and in most cases economic way of stone removal.[7] This is reflected by a number of recent reports of the highly successful Holmium laser lithotripsy.[8-10] It became clear that ureteroscopic lithotripsy should no longer be restricted to the distal ureter, as was the case in the late 70s when the technique was first introduced.

On the other hand, improved technology in extracorporeal shock wave lithotripsy (ESWL) has also facilitated the management of ureteric calculi.[11] When introduced in the early 1980s, ESWL was essentially limited to the management of renal and proximal ureteric stones. However, advancement in lithotripsy design and fluoroscopic imaging has currently allowed successful identification and *in situ* treatment of calculi in the middle as well as the lower ureter.[12-14] Efforts to offer the minimally invasive ESWL technology to the middle and lower ureters have resulted in numerous reports in the literature.[11-15] Success rates vary, and appear to be dependent upon device amongst other factors. A number of reports using second and third generation lithotriptors

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support that ESWL is as efficacious for middle and lower ureteric stones as for kidney and upper ureteric stones.[11,16,17]

The question of what is the most appropriate method for the treatment of ureteric stones in the middle and lower ureter therefore remains.[7,18] We attempt to address this issue by reviewing our patients treated by URSL using the Holmium laser as adjunct to the semirigid ureteroscope and *in situ* ESWL using the Dornier MFL 5000.

Patients and Methods

Sixty-one patients treated by ureteroscopic lithotripsy and 49 patients treated by ESWL for their middle or lower ureteric stones in the period from January 1996 to March 1997 were studied retrospectively. There was no randomization for treatment modality during the study period. Patients were free to choose their preferred treatment modality after clear explanation of the advantages and disadvantages of their modality. The middle ureter was defined as the segment of ureter overlying the sacroiliac joint, and the lower ureter as the segment from the lower border of the joint to the vesico-ureteric junction. The stone size referred to the sum of the maximal stone diameter of individual stones if there were more than one stone; or the length of the continuous stone street in the case of steinstrass. The efficiency quotient (EQ), which was introduced by Clayman and associates, were calculated for each group.[15,19,20] The efficiency quotient was calculated by the formula:

$$\frac{\text{Per cent stone free}}{(\,100\% + \text{per cent retreatment} + \text{per cent auxiliary procedures})} \times 100$$

URSL: URSL was performed as an outpatient procedure under general anaesthesia in the day surgery centre (The ambulatory surgery service was limited to American Society of Anesthesiologists—ASA Class I or II patients). Preoperative stenting was generally not performed. The Wolf Fr.8.5 semirigid ureteroscope (8713.31 compact ureteroscope with 4.8 Fr. instrument channel) was used to access the ureter, without ureteric dilatation wherever possible. Holmium laser lithotripsy (Versa Pulse Select; Coherent, Palo Alto, CA) was performed using 365 μm fibre at a power setting of 0.5 to 1.4 J/5 Hz until complete fragmentation was obtained. Occasionally, the Dormia's basket was also used to retrieve small fragments. Patient were discharged upon complete recovery of the anaesthesia. Dologesic tablets each containing dextropropoxyphene 32.5 mg + paracetamol 320 mg were prescribed four times a day. Treatment success was defined as complete clearance of stone in one sitting. Internal double J stents were inserted in a liberal manner. In general, they were removed in the day surgery centre within four weeks using the flexible cystoscope under local anaesthesia. For patients with high kidney stone load which required subsequent ESWL, the stents would be left in place for up to six weeks. In the study period, an intravenous urogram or ultrasonography was arranged for all patients to assess for possible stricture formation or persistent hydronephrosis.

ESWL: The Dornier MFL 5000 lithotriptor is a third generation lithotripsy unit introduced in 1988.[17,21] It is a spark-induced lithotriptor system with shock waves triggered by an electrode. The shock waves are focused by a semi-ellipsoid and transmitted through a water cushion. Dual localization system, namely fluoroscopy and ultrasonography, is available.

ESWL was conducted on an outpatient basis. Stones were localised primarily by fluoroscopy. Majority of patients were treated in the prone position. Intravenous fentanyl 0.05 to 0.1 mg were given for pain control upon request. Upon completion of the session, patients were observed for a period of 2 hours before their discharge from the lithotriptor unit. Dologesic tablets were prescribed as in the URSL group. They were followed up at 2 weeks, 4 weeks, 8 weeks and 3 months post-therapy. Successful ESWL was defined as complete stone clearance, based on a good quality kidney ureter bladder film (or intravenous urogram, if indicated), anytime before or at the third month of follow up. For patients with good initial fragmentation, they would be monitored for complete clearance at three months. Retreatment would be offered for patients with minimal or partial fragmentation seen at the fourth week of follow up. After retreatment, they were followed up for another 2 months for complete stone clearance. Retreatment failure as determined at the end of this period would be treated by ureteroscopic lithotripsy (or other modalities where appropriate).

Results

The sex, age, stone location and size distribution for the two treatment groups are shown in Table I. There was no significant difference in distribution in sex, stone

TABLE I: PATIENTS' DEMOGRAPHICS AND STONE PARAMETERS

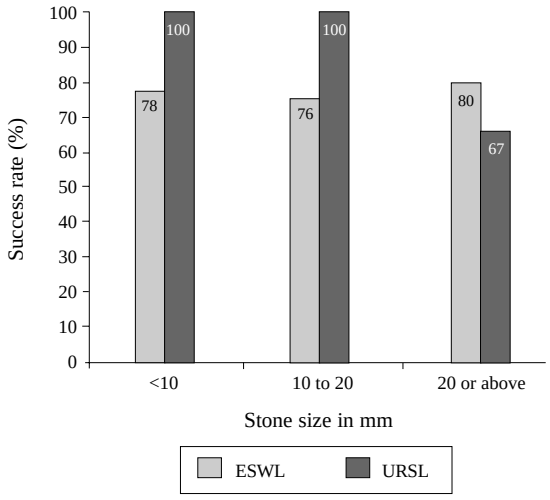
Parameters	ESWL	URSL	Remarks
Sex (M/F)	36 / 13	35 / 26	ns
Mean age (range) [y]	54 (20 to 84)	47 (21 to 73)	P <0.05
Level (middle/lower)	18/31	18/43	ns
Mean size (range)	12 (5 to 47)	11 (5 to 45)	ns
<10 mm	23	34	
10 to 19 mm	21	21	
20 mm or above	5	6	

Anova's test for age and size. Chi-square test for sex and level.
ESWL: extracorporeal shock wave lithotripsy;
URSL: ureteroscopic lithotripsy; ns: not significant

TABLE II: TREATMENT OUTCOMES OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY AND URETEROSCOPIC LITHOTRIPSY

	ESWL	URSL
Success rate—middle	78	100
Success rate—lower	77	95
Overall success rate—single session	51	97
Overall success rate—after retreatment	78	100
Efficiency quotient	58	97

ESWL: extracorporeal shock wave lithotripsy;
URSL: ureteroscopic lithotripsy



ESWL: extracorporeal shock wave lithotripsy (including treatment)
URSL: ureteroscopic lithotripsy (single session)
Fig. 1. Success rate in relation to size of stone.

size and location between the two groups. Patients receiving URSL were significantly younger (P <0.05; Anova's test). The success rates and efficiency quotient are shown in Table II.

Sixty-one patients (35 males and 26 females) with a mean age of 47 years (range 21 to 73 years) received ureteroscopic laser lithotripsy for their middle (18) and lower (43) ureteric stones. The mean stone size measured 11 mm (range 5 to 45 mm). These included 39 single stones, 17 multiple stones and 5 steinstrass.

The ureter was accessed without dilatation in 57 cases, the remaining 4 patients required a balloon dilatation prior to the ureteroscopy. Complete stone clearance was achieved in single session in 59 patients, including all 18 patients with middle and 41 (out of 43) patients with lower ureteric stones. The lithotripsy was staged in 2 patients with lower ureteric steinstrass in view of the prolonged operative time. Double J stents were left *in situ* and repeat procedures at 4 weeks were successful in achieving complete stone clearance in both of them. For the whole group, the mean operative time including anaesthetic time was 58 minutes (range 15 to 150 minutes). The stent insertion rate was 72% for a mean period of 4.3 weeks (range 2 to 6 weeks).

TABLE III: COMPLICATION OF TREATMENT

Modality	Complication	Time	Treatment
URSL	Severe pain	Day 1	Admission, IM injection
	Stent migration	Day 2	Admission, cystoscopic removal
	Fever	Day 2	Admission, IV antibiotics
	Severe pain	Day 3	Admission, IM injection
	Blocked stent	4th week	Admission, Stent removal
	Stricture	3rd month	Balloon dilatation
ESWL	Severe pain	Day 2	A & E, IM injection
	Severe pain	Day 3	A & E, IM injection

URSL: ureteroscopic lithotripsy; ESWL: extracorporeal shock wave lithotripsy; IM: intramuscular; IV: intravenous; A & E: attendance at Accident & Emergency Department

All patients were discharged the day of operation. Five patients required an unscheduled readmission to the hospital. These included two patients readmitted for severe pain not controlled by the oral analgesia prescribed. One patient had a distal migration of the stent presenting as urinary incontinence and necessitated emergency removal of the stent using flexible cystoscope. One patient developed fever which was controlled with intravenous antibiotics. Another patient was admitted on the fourth week postoperatively for fever due to a blocked stent which was removed and the fever settled with intravenous antibiotics. The last complication was a stricture formation detected by intravenous urogram performed at 3 months after the endoscopic procedure, the stricture resolved after a ureteric dilatation using a balloon dilator. This was in the same patient who required a staged procedure for her lower ureteric steinstrass, which in turn was a failure of ESWL in the first place.

Forty-nine patients (36 males, 13 females) with mean age of 54 years (range 20 to 84 years) received ESWL. Eighteen stones were located in the middle ureter, and 31 were in the lower ureter. Thirty-seven patients had single stones, 6 had multiple stones and 6 other patients had steinstrass. ESWL was proceeded in 47 patients with successful localisation of stone. Intravenous analgesia was requested by 34 patients during the therapy (72%, 34/47). The average number of shock waves delivered was 3572 (range 898 to 7541); the average maximal voltage was 23kV. Two patients had lower ureteric stones that could not be localised by fluoroscopy or ultrasonography during the scheduled session. One of them received a ureteroscopy and the other had a spontaneous passage of stone, they were both regarded as failures of ESWL in the subsequent calculation. The single session success rate of ESWL was 51% (25/49); after retreatment in 35% of patients, the overall clearance rate was 78% (38/49). The success rates for middle and lower ureteric stones were 78% and 77%, respec-

tively. The efficiency quotient (overall) of ESWL was 58 (78% / 100% + 35%). There was no major complication or unscheduled readmission, but haematuria of various degree and ureteric colic upon stone passage was common. Two patients presented to the Accident and Emergency Department for severe pain after the therapy, but hospital admission was not required.

Discussion

The optimal management of ureteric calculi has been the subject of ongoing debate.[7,18,22,23] However, as clinicians, we must be critical about what we can offer, based on objective assessment, with an understanding of the limitations and merits of his / her particular institute.

The overall success rate for middle and lower ureteric stones using ESWL were 78% and 77%, respectively. This is consistent with our earlier experience.[24] Our results are comparable with other series using the same extracorporeal shock wave lithotriptor.[17,21,25,26] Ehreth and associates conducted a multicentre study comparing ESWL for kidney and upper ureteric stones to middle and lower ureteric stones. They reported stone free rates (at follow up of 90 days) of 83% in the middle and lower ureteric stones group and 67% in the kidney and upper ureteric stones group respectively. It is noteworthy that in their series 18.5% of patients required regional or general anaesthesia, and 75% required analgesia. Only 72% of our patients required analgesia (intravenous fentanyl), and the rest did not require any medication during the procedure.[27] It is impressive that ESWL using the MFL 5000 had satisfactory success rate that is comparable to major series and that minimal analgesia was required.

However, it must be noted that, the second and third generation lithotriptors (including Dornier MFL 5000) are probably less powerful than the prototype HM3 device.[20,28,29] This can be a trade-off for allowing treatment to be conducted with minimal analgesia. Retreatment to increase the number of shock waves delivered had enhanced the success rate. Our retreatment rate of 35% is rather high, and a liberal retreatment policy has significant implications including financial and logistic issues. If the institute can provide retreatment within a reasonable time frame and the patient is agreeable for it, retreatment is probably still advisable in many occasions. However, the disease status, in terms of obstruction of the urinary system need to be taken into consideration, and early endoscopic intervention is fully justified in a significantly obstructed system, especially after failing an initial attempt of ESWL, where delayed endoscopic intervention had led to loss of renal units.[29]

In fact, high success rates had been reported for ureteroscopic laser lithotripsy especially for the distal ureter. Previously, the pulsed dye laser was commonly used.[2-4,23] Erhard and Bagley, in their preliminary report of the urological applications of the Holmium laser in 1995, commented that the laser is highly successful and extremely save.[8] When compared to pulsed dye laser, the Holmium laser has the same effect regardless of the composition of the calculus. Cystine and monohydrate oxalate stones which could be difficult to fragment using the pulsed dye laser are fragmented by the Holmium laser.[6] It is also more efficient when compared to other modalities especially if the stone load is heavy.[30] We in fact had the experience that the laser is so effective in "vaporising" the stone that repeated retrieval using the Dormia's basket is often not required, understanding that reintroduction of the ureteroscope can sometimes be difficult and traumatic. Yet, the tissue penetration property of the laser is so low that perforation or injury to the ureter is minimised. As reflected by the present series, no perforation had been encountered. In this institute, the availability of the Holmium laser had significantly enhanced the success rate for ureteroscopic lithotripsy compared with our previous success rate of 85% and perforation rate of 4% (both related to electrohydraulic lithotripsy) for lower ureteric stones using a conventional endourologic techniques which included ultrasonic lithotriptor, electrohydraulic lithotriptor and Swiss lithoclast.[27]

Because of the small fibre size of the laser, and the improvement of fibreoptics, small calibre semi-rigid scopes can be used for ureteroscopic lithotripsy. They have been refined to allow direct access of the ureter without the need of preoperative stent insertion or balloon dilatation immediately prior to the ureteroscopy.[1] The implication is such that they will not require any additional stenting procedure prior to the ureteroscopy, and dilatation related pain and possible complication (stricture) could be avoided. The scopes are also rather durable and allow certain degree of torque thus enhancing access to the more proximal ureter even in male patients. URSL can therefore be offered for stones other than the lower ureter, irrespective of the gender. Assess of the ureter and localisation of the stones are no longer reasons for failure in this series.

The liberal use of internal stenting had also been significant in allowing the procedure to be conducted as an outpatient procedure. The current stent insertion rate of 72% is much higher than our previous stent insertion rate of 47%, where many of which were in fact external stents that had necessitated in-hospital stay postoperatively. Erhard and associates[31] reported similar experience of switching from external stents to internal stents and promoting the procedure to be conducted on an outpatient basis.

The issue remains whether the higher efficiency quotient for URSL (97%) compared with ESWL (58%) is the sole or primary consideration for choice of treatment option. Its calculation takes both the rate of retreatment

and the rate of secondary intervention into consideration. However, obvious enough, the impact of retreatment by ESWL and retreatment by URSL is very different, and various auxiliary procedures differ in the magnitude of invasiveness. The procedure-related morbidity is also not taken into account in such calculation. It is noteworthy, however, efficiency is emerging as a more and more important parameter in the cost containment in current health care provision. There are in fact many patients who will opt for the more definitive (URSL) rather than the least invasive (ESWL) technique, especially if they were responsible for the cost of treatment.

Patients receiving URSL were significantly younger. It was possible that younger, working patients tended to opt for URSL because of rapid clearance. Alternatively, the policy of ambulatory surgery limiting to ASA I or II patients could have shifted the distribution of age. This issue could not be ascertained from the current study. But undoubtedly, outpatient URSL is very safe in low surgical risk patients. The treatment options to be offered should therefore be unbiased and as practical as possible in relation to the merits and limitations in a particular setting and the patient's preference.

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