

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY IN THE TREATMENT OF URETERIC STONES: EXPERIENCE FROM TAWAM HOSPITAL, UNITED ARAB EMIRATES

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Background: The optimal treatment of ureteric stones, especially the lower ureteric stone, remains controversial. The purpose of this study was to evaluate the role of extracorporeal shock wave lithotripsy (ESWL) in the management of ureteric stones.

Materials and Methods: A total of 99 patients with ureteric stones at different levels were treated with ESWL from 1994 through 1998 at our hospital. All patients were treated using Siemen Lithostar-II Plus Lithotripter. Of the 99 patients, 20 were excluded from the study because they had no follow-up records of their stone-free status. The clearance rates for ureteric stones of the other 79 patients treated were stratified according to the site, size, and number of treatment sessions required per stone. The stone size was determined by the widest diameters. Based on stone size, the patients were divided into two groups: A (≤ 10 mm) and B (11-20 mm).

Results: The overall clearance rate for ureteric stones treated with ESWL, irrespective of its site and size, was 78.5%. The overall clearance rate for size A (≤ 10 mm) stones was 82% and size B (11-20 mm) was 58% regardless of the site of the stone in the ureter. A total of 17 upper ureteric stones were treated with ESWL. The overall clearance rate for upper ureteric stones was 94%. Thirteen patients with mid-ureteric stones were treated with ESWL. The overall clearance rate for the mid-ureteric stones was 92.3%. Forty-nine patients had lower ureteric stones. The overall clearance rate for the lower ureteric stones was 69.3%.

Conclusions: ESWL is safe, effective, noninvasive and a convenient way of treatment for all ureteric stones. The clearance rate for stones in the upper and mid-ureter is above 90%. ESWL being an outpatient procedure without any need for anesthesia or any pretreatment intervention, it should be considered as the first line of treatment for all stones in the upper and mid-ureter. The clearance rate for small stones (≤ 10 mm) in the lower third of the ureter was 73.8% in our study and for these, ESWL may be considered as a primary therapy. For stones larger than 10 mm in the distal third of ureter, the clearance rate was low with a high retreatment rate, and ureteroscopy as primary treatment modality would be more preferable.

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The current management of upper urinary tract calculi is based on stone fragmentation into smaller pieces which are allowed to pass spontaneously, or removed with an endoscope. To achieve this, energy should be transferred to the stone either percutaneously (extracorporeal shock wave lithotripsy) or through an endoscope (intracorporeal lithotripsy). Chaussy et al. in 1980 was the first to report the clinical application of shock wave lithotripsy in the management of kidney stones, and since then the management of nephrolithiasis has undergone a complete revolution.¹ Recent technological developments have

resulted in more advanced lithotripters with shorter focal length and more narrow focal breadth, which help reduce the level of pain and ultimately obviates the need for anesthesia and hospital admission for the procedure. In the newer machines, water cushions coated with acoustic gel are substituted for water baths in earlier models. These "dry" lithotripters may deliver less shock-wave energy to the target, but they make up for this in the ease of patient positioning, including the ability to treat them in the prone position. With the simultaneous development of extracorporeal, percutaneous and ureteroscopic techniques for the management of urolithiasis, open surgery, once the mainstay of treatment, is rarely indicated nowadays.² This study is an analysis of our patients with ureteric stones at different levels treated with ESWL. The clearance rate was analyzed according to the stone size, site and the number of treatment sessions required per stone.

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Materials and Methods

The medical records of 99 patients with ureteric stones at different levels treated with ESWL at Tawam Hospital, Al-Ain, UAE, from 1994 to 1998 were reviewed. Twenty patients were excluded from the study because their follow-up records were incomplete and final imaging was not done to prove that they were stone free. However, 17 of these patients (85%) had comparatively smaller-sized stones, with evidence of stone fragmentation in more than 50% of the cases during the procedure, and were expected to be stone free. A total of 79 patients whose medical records were complete were included in the study. All patients were treated on an outpatient basis with a second-generation Siemens Lithostar II Plus Lithotripter. The age of the patients ranged from 20 years to 80 years, with a mean age of 50 years.

All patients were evaluated before treatment, with plain abdominal x-ray, intravenous pyelogram (IVP), urine culture and sensitivity testing, renal profile and coagulation screening. Renal ultrasound, retrograde pyelography or CT scan was performed only if needed. All patients had plain abdominal film just before the procedure.

Patients with upper ureteric stones were treated in the supine position; those with mid-ureteric stones were treated either in prone or supine position, and patients with lower ureteric stones were treated in the prone position. All the stones treated were radio-opaque and localized using fluoroscopy. The average shock wave delivered per ESWL session was 3000 (range 2000 to 4000) and the average energy used was 3.5 (range 2 to 5). The average fluoroscopic exposure was 2.2 minutes per session. A *Double-J* stent was inserted in 19 of the patients (24%) who had associated hydronephrosis, a large stone or a single functioning kidney. The treatment in all patients was carried out without any anesthesia and as an outpatient procedure. However, 37% of the patients required analgesia. Patients with insufficient stone disintegration underwent repeat ESWL treatment with an interval of at least two weeks between the sessions.

Follow-up of the patients consisted of plain abdominal film, ultrasound study or IVP in 2 weeks to 3 months after completion of the treatment. All the patients were followed up in the clinic until they were stone free, or until an alternative treatment method was applied. The patient was declared stone free if their KUB/IVP was normal after the treatment. Five patients with pre-treatment radio-opaque stones and hydronephrosis were declared stone free when their post-treatment plain abdominal x-ray (KUB) and ultrasound scan were normal.

Of the 79 patients 17 (21.5%) had stones in the upper ureter, 13 (16.4%) had mid-ureteric stones and 49 (62%) had stones in the lower ureter. The patients were divided in to two groups according to the stone size: group A (≤ 10 mm) and group B (11 mm-20 mm). There were 67 patients (85%) in group A and 12 (15%) in group B.

TABLE 1. Number of ESWL sessions per ureteric stones.

Site	Size*	ESWL sessions					
		I	II	III	IV	V	>V
Upper ureter	A	7	2	3	1	–	–
	B	1	1	1	1	–	–
Mid ureter	A	6	6	–	–	–	–
	B	1	–	–	–	–	–
Lower ureter	A	24	7	7	3	1	–
	B	1	4	1	–	–	1
Total		40	20	12	5	1	1
		50.6%	25.3%	15%	6.3%	1.25%	1.25%

*A= ≤ 10 mm; B=10-20 mm.

Results

The overall clearance rate was 82% for size A stones and 58% for size B stones, regardless of the site of the stone in the ureter. The overall clearance rate for upper, mid- and lower ureteric stones, irrespective of the stone size, was 94%, 92.3% and 69.3%, respectively. About 50% of ureteric stones were cleared after a single treatment session while the other half required more than one session (range 2 to 7 treatment sessions per stone) (Table 1). Seventeen patients had stones in the upper ureter, 13 patients had mid-ureteric stones and 49 patients had stones in the lower one-third of the ureter. Of the total patients with upper ureteric stones 13 (76.4%) had size A stones while 4 patients had (23.6%) had size B stones. The clearance rate for size A stones in upper ureter was 100%, and 46% of the patients required an average of three treatment sessions per stone (range 2 to 4). Also, 75% of the patients with size B stones in the upper ureter required an average of three sessions per stone (range 2 to 4), with a clearance rate of 75%. The clearance rate for size A stones in the mid-ureter was 91.6%, and 50% of the patients received two treatment sessions per stone. Only one stone in the mid-ureter was size B, and that was cleared after the first treatment session. The clearance rate for size A stones in the lower ureter was 73.8%, and 42.8% of the patients received an average of 2.8 treatment sessions per stone (range 2 to 5). Also, 85.7% of the patients with size B stones in the lower ureter received an average of 2.7 treatment sessions per stone (range 2 to 7), with a clearance rate of 42.8% (Tables 1 and 2).

Discussion

The treatment options for ureteric calculi consist of conservative approach of spontaneous clearance of the stones, ESWL, endoscopic manipulation, and open surgery. Spontaneous clearance of ureteric calculi depends mainly on the stone size and, to a lesser extent, on other factors like observation time. The incidence of spontaneous passage of ureteric calculi of about 4 mm in diameter is reported to range between 59% and 69%, and decreases markedly with increase in stone size, with the spontaneous elimination of stones about 6 mm being exceptional and frequently accompanied by complications like recurrent intractable

TABLE 2. Clearance rate of ureteral stones treated with ESWL (total number of stones =79).

Site	Size	No. of stones	% received >1 ESWL session	Average no. of sessions per stone received >1 treatment	Clearance rate (%)
Upper ureter	A	13	46	3	100
	B	4	75	3	75
Mid-ureter	A	12	50	2	91.6
	B	1	—	—	100
Lower ureter	A	42	42.8	2.8	73.8
	B	7	85.7	3	42.8

A=10 mm; B=11-20mm; average number of shock waves per session=3000 (range 2000 to 5000); average energy =3.5 (range 2 to 5).

pain, obstruction and infection.^{3,4} In our study, the treatment of ureteral stones using ESWL were delayed for at least two weeks after the diagnosis. The chances of spontaneous passage was less likely to affect the clearance rate for the treatment.

ESWL is an effective, noninvasive and convenient way of treatment for urolithiasis. Pre- or post-ESWL indwelling stents may only be required for stones with gross hydronephrosis or for a solitary kidney. ESWL treatment in adult patients is carried out without anesthesia and therefore as an outpatient procedure. All the patients in our study were treated without any general or regional anesthesia, and only 37% received analgesia.

ESWL has been demonstrated to be safe, effective, and an easy way of treating urinary calculi, however, its role in the treatment of ureteric calculi needs to be defined. In 1984, Chaussy and Schmiedt using a Dornier HM3 lithotripter reported a 95% stone-free rate for the proximal ureteral calculi treated *in situ* without prior manipulation.⁵ The other option for the treatment of upper ureteric stones is to push the stone back into the kidney and bang it. In 1986, Lingeman et al.⁶ and Liang et al.⁷ in 1989 reported that ureteral calculi treated *in situ* required a significantly high energy and less fragmentation rate than the push-back-and-bang procedure (87% vs. 99%). They also reported that auxiliary procedures were required more often than the stones being manipulated back into the renal pelvis before lithotripsy. However, pushing the stone back into the kidney is also an interventional procedure with its own risks, with a failure rate ranging from 28% -50%.^{8,9} In our study, we had a 94% overall clearance rate for the upper ureteral stones without any intervention. In 19 patients (24%), a *Double-J* stent was inserted prior to treatment but it was only for those with severe hydronephrosis or a solitary kidney.

Retrograde ureteroscopic stone manipulation is not recommended as the primary treatment for stones in the proximal ureter because of its associated complications and poor retrieval rate.^{10,11} Percutaneous antegrade ureteral calculus extraction or manipulation for the stones in the upper ureter has a reported success rate of 90%.^{12,15} It is recommended only if the stone cannot be managed with either ESWL or standard retrograde ureteroscopic technique. In our hospital, the success rate for mid-ureteric stones was 92.3%, which is similar to that for stones in the

upper one-third of the ureter. Like others, we recommend ESWL as the first line of treatment for upper and mid-ureteric stones of less than 20 mm in diameter.

The management of stones in the lower ureter is still controversial. Generally, the treatment for stones in the distal ureter is either ESWL or ureteroscopic manipulation. Depending on the availability of the equipment and expertise, one or the other therapy is given the priority. The success rate for ESWL treatment of distal ureteral calculi varies from 53% -96%,¹⁴⁻¹⁶ and re-treatment rate varies from 10% -30%.¹⁷

The clearance rate for distal ureteral stones treated with ESWL is significantly affected by the stone size. The overall clearance rate for distal ureteral calculi in our series was 69.3%. The clearance rate for size A (≤ 10 mm) stones was 73.8% while it was only 42.8% for stones 11-20 mm in diameter. The overall retreatment rate for distal ureteral stone was 49.7% in our study. The re-treatment rate for stones 10 mm or less in diameter was 42.8%, while it was 85.7% for 11-20 mm in diameter stones (Table 2).

The surgical intervention rate after ESWL treatment for ureteric stones in all locations is reported to be 7%.¹⁸ Although we did not report any complications, post-treatment ureteric colic due to stone fragments, ecchymoses of the skin, bleeding and urinary tract infection do occur.

Ureteroscopy as a primary treatment modality for distal ureteral calculi is highly effective, with reported success rates in excess of 90% in different reported studies.^{14,19,20} The disadvantage of ureteroscopy is that it is an invasive procedure and requires general or regional anesthesia. Added to this is the fact that it has a 0.5% -10% complications rate.^{15,19} However, the availability of new ureteroscopes with better optics and smaller diameter has made it possible to carry out the procedure without any anesthesia. The smaller diameter scopes also do not require ureteral orifice dilation, so there is a decrease in long-term complications, with the result that postoperative indwelling stents are no longer needed. With the advent of laser lithotripter (Holmium Laser), the success rate of ureteroscopy in the treatment of distal ureteral calculi has further improved, and more importantly, the complication rate has reduced significantly.²¹

In our study, the clearance rate for stones of ≤ 10 mm in diameter in the lower ureter was 73.8%, and 42.8% of the patients required more than one treatment session. The

clearance rate for larger stones (11 mm-20 mm) in the lower third of the ureter dropped to 42.8%, and 85.7% of the patients required more than one treatment session. Therefore, for stones in the distal one-third of the ureter, as primary therapy, we recommend ESWL for stones ≤ 10 mm in diameter and ureteroscopy for stones more than 10 mm in diameter. Patients' wishes in deciding the modality of treatment are important and should be offered an informed choice.

In conclusion, ESWL is an effective, noninvasive and convenient way for the treatment of ureteric stones. The ESWL clearance rate for stones in the proximal two-thirds of the ureter is above 75%, and therefore, it should be the preferred method of treatment. For distal ureteric stones less than 10 mm in diameter, the clearance rate is more than 70% and ESWL can be considered as a primary treatment, while for stones larger than 10 mm in diameter, endoscopic removal should be the preferred treatment.

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