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RESEARCH ARTICLE

Prediction of success of extracorporeal shock wave lithotripsy in the treatment of ureteric stones

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Abstract *Objectives* To define the factors that affect the success rate of extracorporeal shock wave lithotripsy (ESWL) for the treatment of ureteric stones. *Patients and methods* Between January 2000 and December 2003, 468 patients with ureteric stones underwent in situ ESWL using Storz SL 20 lithotriptor. The results of treatment were evaluated after 3 months of follow-up. Treatment success was defined as complete clearance of the stones. Characteristics of the patients, condition of the urinary tract and stone features were correlated to the success rate to define the significant predictors of success. *Results* At 3-month follow-up, the overall success rate was 394/468 (84.2%). Repeat treatment was required in 239 patients (51.1%). Post-ESWL auxiliary procedures were necessary in 58 patients (12.4%). Post-ESWL complications were observed in 11 patients (2.4%). Only three factors had a significant impact on the stone-free rate, namely stone site, stone width and the presence of a ureteral stent. The stone-free rate was highest for stones located in the lumbar ureter (159/183; 86.9%) and lowest for those in iliac ureter (28/40; 70%) ($P < 0.05$). Stones with a transverse diameter <8 mm were associated with a stone-free rate of 89.9% (248/276), compared to 66.7% (128/192) for those with a transverse diameter of >8 mm ($P < 0.01$). Non-stented patients had a stone-free rate of 89.2% (313/348), compared to 75.2% (85/113) for stented patients ($P < 0.01$). *Conclusions* The site and transverse diameter of the stone and the presence of a ureteral stent are the only significant predictors of success of ESWL therapy for ureteric stones.

Keywords Ureter · Stone · Shock wave lithotripsy

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Introduction

The interventional management of ureteric stones includes ureteroscopic extraction, extracorporeal shock wave lithotripsy (ESWL) and open surgery. The increasing interest in less invasive treatment modalities as well as the development of new generations of lithotriptors have made ESWL the treatment of choice for most ureteric calculi [1]. However, in contrast to endoscopic and open surgical procedures, patients treated by ESWL are not immediately stone-free. Some patients will require repeat sessions of ESWL and others

will have residual fragments that may require auxiliary interventions. Moreover, a small percentage of ureteric stones may not be fragmented by ESWL.

Several factors determining the success of ESWL treatment of ureteric stones have been studied. These include the stone site, size and crystal type on one hand and degree of obstruction, stone impaction and function of the renal unit on the other hand [2].

The aim of the present work is to study the prognostic factors affecting the successes rate of in situ ESWL for the treatment of ureteric stones.

Patients and methods

Patients

Between January 2000 and December 2003, a total of 474 patients with ureteric calculi underwent ESWL at Hamad Medical Corporation using Storz SL 20 Lithotriptor. Of the 474 patients, 468 were available for follow-up and constituted the subject of the present study. The series included 433 males (92.5%) and 35 females (7.5%). Of all patients 86 were Qatari (18.4%) and 382 non-qatari (81.6%). The mean age was 37.5 + 10.7 years (range 2–75 years).

Laboratory investigations included urinalysis, urinary culture and sensitivity tests, serum creatinine determination and a coagulation profile. Radiological investigations included plain abdominal X-ray (KUB) film, gray-scale abdominal ultrasonography (US) and intravenous pyelography (IVP). Non-contrast computerized tomography (NCCT) was used in the diagnosis of lucent stones. Patients with ureteric strictures, coagulopathies or non-functioning kidneys were excluded. With 30 exceptions (6%), all patients were treated on an outpatients basis. These 30 patients were cases of calculus anuria due to obstruction of a solitary kidney and were managed initially by fixation of a double-J ureteric stent or percutaneous nephrostomy (PCN). Of all patients, 253 (54%) had a non-dilated corresponding kidney and 215 (45.9%) had dilated one.

Stones

Features of the treated stones including their site, side, length, width, nature (denovo or recurrent), number and opacity, are summarized in Table 1. The mean length of the stones was 7.7 ± 4 mm (range 4–18 mm) and the mean width was 5 ± 2 mm (range 3–15 mm).

Table 1 Patient characteristics and stone features in relation to success rate

Variable	No.Pts	%	Success rate		*P* value
			N	%	
Age (*years*)					
<40	260	55.6	221	85	NS
>40	208	44.4	173	83.2	
Sex					
Males	433	92.5	364	84.1	NS
Females	35	7.5	29	82.9	
Nationality					
Qatari	86	18.4	72	83.7	NS
Non-qatari	382	81.6	317	83	
Radiologic renal morphology					
Perfect	253	54.1	212	83.8	NS
Dilated	215	45.9	174	80.9	
Congenital anomalies					
No	454	97	376	82.8	NS
Yes	14	3	12	85.7	
Stone site					
Ureteropelvic junction	28	6	24	85.7	<0.05
Lumbar ureter	183	39.1	159	86.9	
Iliac ureter	40	8.5	28	70	
Pelvic ureter	211	45.1	173	82	
Multiple sites	6	1.3	3	50	
Stone number					
Single	431	92.1	353	81.9	NS
Multiple	37	7.9	30	81.1	
Stone length (mm)					
<8	257	54.9	213	82.9	NS
>8	211	45.1	168	79.6	
Stone width (mm)					
<8	276	59	248	89.9	<0.01
>8	192	41	128	66.7	
Stone nature					
Denovo	394	84.2	327	83	NS
Recurrent	74	15.8	59	79.7	
Stone opacity					
Opaque	447	95.5	379	84.8	NS
Lucent	21	4.5	18	85.7	
Ureteric stent					
No	348	74.4	313	89.9	<0.01
Yes	120	25.6	85	70.8	

* NS = non-significant, Chi Square Test

Technique

All patients underwent in situ ESWL monotherapy using the same lithotriptor (Storz SL 20). This lithotriptor uses electromagnetic waves for shock wave generation, water cushion for coupling, a parabolic reflector for shock-wave focusing and fluoroscopy for stone localization.

Ureteric double-J stents were placed in 113 patients (24%) prior to ESWL. Indications for ureteric stents were solitary kidney, a severe degree of obstruction and calculus anuria.

A total of 462 patients received sedoanalgesia in the form of Fentanyl (1.5 μg/kg). General anesthesia was required in six children. Patients were treated in the supine position for stones in the lumbar ureter and in the prone position for iliac and pelvic stones. Retrograde ureterography or IVP were used to localize radiolucent stones.

Follow-up

Patients were reviewed one week after the first session using KUB and renal US to assess fragmentation and the presence of renal obstruction. Repeat treatment was carried out if inadequate fragmentation of the stone was observed. If there was no response after three sessions, the case was considered ESWL failure. Follow-up continued using KUB and renal US every two weeks until there was complete stone clearance. Radiolucent stones were followed up using NCCT. All follow-up data were collected and analyzed after the 3-month visit. Success was defined as the absence of residual stones.

Statistical analysis

Patient characteristics and stone features were correlated to the stone-free rate using the chi square test. P value of <0.05 was considered significant.

Results

Repeat treatment was needed in 239 patients (51.1%). Among the re-treatment group, 119 patients (25.4%) required more than two sessions to ensure complete stone disintegration. The mean number of sessions per stone was 1.8 ± 1.2 (range 1–4). The mean number of shocks per stone was 3810 ± 608 (range 3000–4000). The mean voltage was 20 ± 1.5 KV (range 18–24).

The overall stone-free rate was 84.2% (394/468) at 3-month follow-up. Post-ESWL auxiliary procedures were required in a total of 58 patients (12.4%) as shown in Table 2. Post-ESWL complications were encountered in 11 patients (2.4%), as shown in Table 3. All complications were successfully treated by double-J stenting of the ureter, ureteroscopy, PCN or endoscopic meatotomy.

Stone site had a significant impact on the success rate; stones located at the pelviureteric junction and lumbar ureter had better success rate than those located distally and at multiple sites ($P < 0.05$, Table 1). Moreover, stone width significantly affected the success rate; a width of < 8 mm had a remarkably higher stone- free rate (89.9%) compared with a success rate of only 66.7% for stone width of >8 mm ($P < 0.01$, Table 1). In addition, the success rate in patients with no ureteric stent was significantly better than in those with ureteric stenting (89.9% vs 75.2, respectively, $P < 0.05$, Table 1).

Other studied factors including age, sex, nationality, radiological renal morphology, stone number, stone length, stone nature (de-novo vs recurrent) and stone opacity had no significant impact on the success rate (Table 1).

Table 2 Post-ESWL auxiliary procedures

Procedure	No. Pts	%
Double-J stent	16	3.4
PCN	2	0.4
Ureteroscopy	40	8.6
Total	58	12.4

Table 3 Post-ESWL complications

Complication	No. Pts	%
Hematoma	2	0.4
Massive hematuria	4	0.9
Steinstrasse	4	0.9
Anuria	1	0.2
Total	11	2.4

Discussion

The overall success rate of 84.2% in the present series is matching with similar previous studies that reported stone-free rates of 80–90% for the treatment of ureteric calculi by ESWL [1–4]. We defined only three factors that had a significant impact on the success rate, namely stone site, transverse diameter of the stone and the presence of a ureteral stent.

In our study, the success rates for stones located in the lumbar, iliac and pelvic ureters were 87, 70 and 82%; respectively ($P < 0.05$). These results are in agreement with Mogensen and Andresen [5] who reviewed outcomes in 199 patients with ureteric stones who were treated with a second generation lithotriptor. The stone-free rate at 3 months after ESWL in patients with upper calculi was 86% and the corresponding rates for patients with middle and lower calculi were 76.7% and 81.8%, respectively [5]. Our results are also matching with Hofbauer et al. [6] who evaluated the treatment outcome of 1259 ureteric stones. The success rate of in situ ESWL was 98, 71 and 84% for stones in the lumbar, iliac and distal ureter, respectively [6]. Overall, 85% of the ureteric units were free of stones within 3 months [6]. On the other hand, few authors [7, 8] have reported better success rates for iliac and pelvic stones compared with lumbar stones.

Fetner et al. [9] found a statistically significant relation between stone size and success rate. Our results are similar to that of Abdel-Khalek et al. [1], we observed that only the transverse diameter of the stone had a significant impact on the stone-free rate. This may be due to impaction of the stone in the ureteral lumen; i.e. the transverse diameter of the stone increases with less expansion space around it, so that it is difficult to disintegrate. The American Urological Association Ureteral Stones Clinical Guidelines Panel [10] reported that, for proximal ureteric stones, the success rate for in situ ESWL was 87% for stones <10 mm and 76% for stones >10 mm. For distal ureteric stones, the success rates were 85% and 76% for stones <10 and >10 mm, respectively.

In our study, we found that double-J ureteric stents significantly decreased the success rate. Currently, there is a general consensus that the insertion of a double-J stent does not improve the results of ESWL [1, 11]. In an experimental study, Ryan et al. [12] showed that ureteric stents impair ureteric peristalsis and/or trap large fragments thus delaying stone clearance. Moreover, double-J stents are associated with some morbidity in the form of discomfort, urgency and even hematuria. However, the use of a double-J stent may be required in patients in whom the stone is causing a severe degree of obstruction and is mandatory in patients with a solitary kidney [11].

A recent study [13] compared the clinical outcomes after ESWL in 156 patients with radiolucent and 203 with radiopaque ureteric stones. They reported that the stone-free rate 3 months after treatment, the complication rate and the number of auxiliary procedures did not differ between radiolucent and radiopaque ureteric stones. In our study, a limited number (21 patients) of radiolucent ureteric stones were treated: we obtained a success rate of 85.7%, vs 84.8% for radioipaque ureteric stones; a difference of no significant value.

All stones in our series were treated in situ. Several investigators reported no significant difference in success rates for in situ versus push-back ESWL [1, 6, 8]. Ureteral manipulations using the push-back technique require anesthesia and are associated with a 5.1% ureteral perforation rate [8].

Conclusions

The overall success rate of Storz SL 20 lithotriptor for treatment of ureteric stones is 84.2%. Post-ESWL auxiliary procedures were required in 12.4%. The re-treatment rate is 51%. The overall major complication rate is 2.4%. Factors affecting success rate are the site and transverse diameter of the stone and the presence of ureteric stent.

References

1. Abdel-Khalek M, Sheir KZ, Elsobky E, Showkey S, Kenawy M (2003) Prognostic factors for extracorporeal shockwave lithotripsy of ureteric stones: A multivariate analysis study. Scand J Urol Nephrol 37:413–418

2. Azm TA, Higazy H (2002) Effect of diuresis on extracorporeal shockwave lithotripsy treatment of ureteric stones. Scand J Urol Nephrol 36:209–212
3. Gnanpragasam VJ, Ramsden PD, Murtly LS, Thomas DJ (1999) Primary in situ extracorporeal shock wave lithotripsy in management of ureteric calculi: results with a third generation lithotriptor. BJU Int 84:770–774
4. Ilker NY, Alican Y, Simsek F, Turkeri LN, Ahdas A (1994) Ureteral extracorporeal shock wave lithotripsy utilizing the Dornier MFL 5000. J Endourol 8:13–14
5. Mogensen P, Andrsen JT (1994) Primary in situ extracorporeal shock wave lithotripsy for ureteral calculi. Scand J Urol Nephrol 157(Suppl):159–163
6. Hofbauer J, Tuerk C, Hobarth K, Hasum R, Marberger M (1993) ESWL in situ or ureteroscopy for ureteric stones. World J Urol 11:54–58
7. Ehtet JT, Drach GW, Arnett ML, Barrett RB, Govan D, Lingeman J et al (1994) Extracorporeal shock wave lithotripsy: multicenter study of kidney and upper ureter versus middle and lower ureter. J Urol 152:1379–1385
8. Rauchenwald M, Colombo T, Petritsch Vilits P, Humber G (1992) In situ extracorporeal shock wave lithotripsy of ureteral calculi with the MPL 9000 lithotriptor. J Urol 148:1097–1101
9. Fetner CD, Preminger GH, Seger J, Lea TA (1988) Treatment of ureteric calculi by extracorporeal shock wave lithotripsy at multi-user center. J Urol 139:1192–1195
10. Segura JW, Preminger GM, Assimos DG, Dretiler SP, Kahn RI, Lingeman JE et al (1997) Ureteral Stones Clinical Guidelines Panel Summary report on the management of ureteral calculi. The American Urological Association. J Urol 158:1915–1921
11. Whitfield HN (1999) The management of ureteric stones. Part II: Therapy. BJU Int 84:916–921
12. Ryan PC, Lemon GM, Melean PA, Fitzpatrick JM (1994) The effects of acute and chronic JJ stent placement on upper urinary tract motility and calculus transit. Br J Urol 74:434–439
13. Buchholz NP, Van Rossum M (2001) Shock wave lithotripsy treatment of radiolucent ureteric calculi with the help of contrast medium. Eur Urol 39:200–203