1110-5704
African Journal of Urology

Vol. 8, No. 2, 2002
87-93

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY AS MONOTHERAPY FOR STONES IN SOLITARY KIDNEY

K. MADBOULY, E. ELSOBKY, K.Z. SHEIR, I. ERAKY AND M. KENAWY
Urology and Nephrology Center, Mansoura University, Mansoura, Egypt

Objective To evaluate extracorporeal shock wave lithotripsy (ESWL) as a monotherapy for urolithiasis in patients with solitary kidney and to determine the factors that may affect its results.

Patients and Methods Using the Dornier MFL 5000 lithotriptor, 106 patients with solitary kidney (80 men and 26 women) were treated for stone disease. The mean age (± SD) was 44.5 ± 11.1 years (ranging from 18 to 70 years). The causes of monorenia were nephrectomy, the presence of a contralateral non-functioning kidney or a congenital solitary kidney (56.6%, 39.6% and 3.8%, respectively). The mean stone length was 13 ± 5 mm and the mean width was 10 ± 3 mm. Pre-treatment stenting was done in 14 patients to relieve anuria before ESWL. The follow-up data were recorded at 3 months. The statistical analysis was performed using chi-square test to detect the different factors that may affect the stone-free rate.

Results The overall stone-free rate was 84.9%. Sixteen patients (15.1%) were not cleared of stones, including 12 (11.3%) with insignificant gravel of <5mm. There was no significant difference in the stone-free rate between the non-stented patients and those who had received a stent prior to treatment (p=0.83). The only significant factors affecting the stone-free rate were side and number of the stones (p=0.02 for each). High-grade fever was reported in one patient due to partial obstruction and managed with a percutaneous nephrostomy tube and antibiotics. Anuria developed in 6 patients; two were treated by fixation of double J (JJ) stents and ESWL, while ureteroscopy was performed for the other patients.

Conclusion ESWL is a safe and effective modality for the treatment of urolithiasis in patients with solitary kidney. Routine pre-treatment stenting in patients with a solitary kidney is not necessary and has no impact on the stone-free rate. Post-treatment close follow-up is mandatory with careful attention to fragment size and location, serum creatinine and detection of hydronephrosis.

Keywords Extracorporeal shock wave lithotripsy, solitary kidney, second-generation lithotriptors, stone disease

INTRODUCTION

Causes of monorenia are multiple. A congenital solitary kidney accounts for approximately 1/1000 to 1/15000 people[1]. Previous nephrectomy due to lithiasis, tuberculosis, tumors or trauma are the most frequent causes of monorenia[1,2]. Many patients with a previous nephrectomy for urolithiasis will later present with a stone in their remaining kidney[3]. So, treatment of stone disease in patients with solitary kidney should entail removal of the stones with minimal morbidity and damage to the surrounding structures. Since the first report about its efficacy and safety by Chaussy et al.[4] in the early 1980s, ESWL has become the treatment of choice for most renal stones in adults. ESWL has proved to be highly effective with little morbidity[5] and has radically decreased the indication of surgery in patients with solitary kidney[6].

The aim of this study was to evaluate ESWL as monotherapy for stone disease in 106 patients with solitary kidney and determine the factors that may affect the stone-free rate.

PATIENTS AND METHODS

Between 1989 and 1998, 106 patients with solitary kidney were treated for stone disease

Table 1: Patient and Stone Characteristics

Characteristics	No.	%
Sex		
Male	80	75.5%
Female	26	24.5%
Side		
Right	54	50.9%
Left	52	49.1%
Site		
Upper calyx	4	3.8%
Middle calyx	17	16.0%
Lower calyx	31	29.2%
Multiple calyceal sites	9	8.5%
Renal pelvis	30	28.3%
PUJ	3	2.8%
Lumbar ureter	11	10.4%
Pelvic ureter	1	0.9%
Renal Morphology		
Normal	90	84.9%
Dilated system	12	11.3%
Pyelonephritic	4	3.8%
Nature		
De-novo	92	86.8%
Recurrent	14	13.2%
Number		
Single	83	78.3%
Multiple	23	21.7%
Size		
≤20 mm	98	92.5%
≥20 mm	8	7.5%

at the ESWL unit of the Mansoura Urology and Nephrology Center. The patients' age ranged from 18 to 70 years (mean age 44.5 ± 11.1 years). 80 patients were men and 26 were women. The causes of monorenia were nephrectomy of a non-functioning kidney in 60 patients (56.6%), the presence of a contralateral non-functioning kidney in 42 (39.6%) and a congenital solitary kidney in 4 (3.8%). Pre-treatment evaluation included a complete clinical history, a complete blood picture, liver function tests, serum creatinine, prothrombin time, partial thromboplastin time and urine analysis. Any patient with bleeding disorders, obstructed kidney or severe uncontrolled urinary tract infection (UTI) was excluded. Excretory urography (IVU) and renal ultrasonography (US) were performed pre-operatively for all cases. A normal configuration of the kidney was observed in 90 patients, while a mild dilatation of the pelvicalyceal system was noticed in 12 cases. Pyelonephritic changes were detected in four cases. All patients were treated on an outpatient basis.

Radiolucent stones and single stones larger than 2 cm in diameter were excluded. All the stones were radio-opaque. The stone length was measured in the maximum diameter. In the case of multiple stones, the sum of the lengths of the individual stones was measured. The mean length was 13 ± 5 mm (range 5 – 30 mm), while the mean width (perpendicular diameter) was 10 ± 3 mm (range 4 – 22 mm). Most of the stones (92.5%) were 2 cm or less in maximum diameter. A single stone was detected in 83 patients and multiple stones in 23 patients. Fourteen patients had a past history of open surgery for stone disease. Other stone characteristics are illustrated in Table 1.

All treatments were carried out using the Dornier MFL 5000 lithotriptor (Dornier MedTech GmbH, Germering, Germany) which has an underwater spark gap electrode and a focusing rotatory ellipsoid. All patients underwent ESWL monotherapy in situ without auxiliary procedures except for 14 patients who had presented with obstructive anuria. In these 14 patients, JJ stents were fixed to relieve obstruction; then, after normalization of serum creatinine, ESWL was performed. Sedoanalgesia in the form of 100 μg/kg meperidine HCl was given for all patients.

The therapy was usually started at a low power (14 KV) until the patient became familiar with the sound and sensation of the shocks; the power was then increased in steps up to a maximum of 22. The interval between the sessions was >1 week. The mean number of sessions was 2.3 ± 3.3 ranging from 14 to 22 KV.

After the first session, the patients were reviewed on a weekly basis using serum creatinine, plain X-ray film (KUB) and renal ultra-

Table 2: Univariate Analysis of the Impact of Patient and Stone Characteristics on the Stone-Free Rate

Variable	Stone-Free Rate		Failure of Stone Clearance		P-Value
	No.	%	No.	%	
Sex					
Male	69	86.3%	11	13.8%	
Female	21	80.8%	5	19.2%	0.5
Side					
Right	50	92.6%	4	7.4%	
Left	40	76.9%	12	23.1%	0.02
Site					
Renal	75	82.4%	16	17.6%	
Ureteral and PUJ	15	100%			0.07
Width					
≤10 mm	64	83.1%	13	16.9%	
>10 mm	26	89.7	3	10.3%	0.4
Length					
≤10 mm	35	87.5%	5	12.5%	
>10 mm	55	83.3%	11	16.7%	0.56
Nature					
De novo	78	84.8%	14	15.2%	
Recurrent	12	85.7%	2	14.3%	0.92
Number					
Single	74	89.2%	9	10.8%	
Multiple	16	69.6%	7	30.4%	0.02
Stenting					
None	78	84.8%	14	15.2%	
JJ stent	12	85.7%	2	14.3%	0.65
Renal feature					
Normal	76	84.4%	14	15.6%	
Dilated	10	83.3%	2	16.7%	
Pyelonephritis	4	100%			0.83

sound to assess the fragmentation, the presence of obstruction and the need for re-treatment. The patients were instructed to monitor the daily urine output and to come to the hospital in case they noted any decrease in its amount or suffered high-grade fever and/or persistent loin pain. This was continued until complete stone clearance or failure of stone disintegration. Follow-up data were collected and analyzed at the 3-month visit.

Different patients and stone characteristics were assessed in relation to the stone-free rate using the chi-square test to evaluate significance, with differences considered statistically significant when $p \leq 0.05$.

RESULTS

The overall stone-free rate was 84.9%. In sixteen patients (15.1%) the stones could not be cleared; these included 12 patients (11.3%) with insignificant gravel of <5 mm. Treatment failure was considered in 4 patients for whom percutaneous nephrolithotripsy (PCNL) was carried out to clear one pyelic and three lower calyceal stones. The presence or absence of a ureteral stent during the treatment was not important as regards the treatment result (P=0.83). The univariate analysis showed a significant relationship between the stone-free rate and the side and number of the stones (P=0.02 for each). Table 2 illustrates the correlation between the stone-free rate and the different factors.

Mild to moderate renal colic and slight haematuria for one or two days after the treatment were reported by most of the patients and were managed conservatively. No peri-renal haematoma or fluid collection was detected by regular follow-up ultrasound. One patient developed high-grade fever and partial obstruction that did not respond to intensive antibiotic treatment, but cleared up after insertion of a percutaneous nephrostomy tube for drainage of the kidney. After stabilization of his condition, ESWL therapy was continued with the nephrostomy tube left in place until complete clearance of the stone fragments was achieved. Anuria developed in 6 patients (6.5%), with rising serum creatinine due to the presence of pelvic steinstrasse in three, a stone in the pelvic ureter in one and a stone in the lumbar ureter in two patients. Ureteroscopy and removal of the stones were carried out in those patients with steinstrasse and stones in the pelvic ureter. The two patients with obstructing stones in the lumbar ureter were managed by insertion of JJ stents until the end of the ESWL therapy.

Follow-up IVU studies three months after the end of the treatment showed no deterioration in the renal function or configuration in all patients. Furthermore, normalization of the pelvicalyceal system was observed in 10 out of 12 patients with a pre-treatment dilated system and mild residual dilatation in the pelvicalyceal system of the remaining two.

DISCUSSION

The most common cause of solitary kidney (monorenia) is a previous nephrectomy[1,4]. When urolithiasis is the cause of nephrectomy, new calculous disease often occurs in the contralateral kidney, frequently requiring re-operation. Also, urolithiasis has a well-known recurrence rate regardless of the method of surgical treatment. Therefore, the least invasive form of therapy is desirable[2,8]. Among the different methods of treatment of stone disease, ESWL represents the least traumatic and most effective treatment option. It is estimated that renal parenchymal loss after ESWL is well under 1% of the total cortical surface[9]. Our results confirm the efficacy of ESWL for the management of stone disease in solitary kidneys. The stone-free rate in our patients (84.9%) compares favourably with the results of SWL in patients with solitary or second functioning kidneys reported in the literature[2,5].

Indwelling pre-ESWL ureteral stenting is usually poorly tolerated by the patients. Episodic or constant flank discomfort, bladder urgency, spasm or incontinence and one or more episodes of gross haematuria have been reported by one third of the patients[10]. Also, stents may cause obstruction by themselves[10]. Furthermore, Karlsen et al.[8] reported that there was no significant difference between stented and non-stented patients with regard to the changes in the glomerular filtration rate and effective renal plasma flow following ESWL. Our results showed that there is no difference between the stented and non-stented patients with regard to the stone-free rate. Similar results were reported by Preminger et al.[11]. In our study, ureteral stenting before ESWL was not routinely used; it was applied to relieve obstruction before starting shock wave therapy. At the same time, the incidence of post-ESWL obstruction in non-stented patients was minimal (6.6%).

The reported incidence of sepsis following ESWL is less than 1%[12], so routine administration of prophylactic antibiotics is not necessary[13,14]. However, during stone fragmentation, bacteria may be liberated which in the presence of shock wave-induced local tissue trauma will allow bacteria in the urine to enter

the blood stream. Moreover, when overt or subtle obstruction by fragments is added, the risk of urosepsis increases dramatically[15]. In this study, prophylactic administration of antibiotics was not necessary except in one patient with high-grade fever and partial obstruction where a nephrostomy tube was inserted and an intensive course of antibiotics was given.

The univariate analysis showed that the significant factors affecting the stone-free rate were the stone side and number. Stones located on the right side had a higher stone-free rate than the left-sided ones. This has been suggested to be due to a longer left ureter[15], an increased incidence of vascular multiplicity and an abnormal rotation of the left kidney[16] which may hinder stone clearance.

Although the stone size has been shown to influence significantly the stone-free rate after shock wave lithotripsy[14,17], our study has failed to identify any significant impact of the stone size on the stone-free rate. This observation may be due to the fact that the maximum diameter of the majority of the stones (92.5%) was 2 cm or less. However, regarding the stone burden, patients with single stones had a higher stone-free rate than those with multiple stones (P=0.02). A large stone burden requires more treatment sessions and more shock waves, and it is directly related to the possibility of urinary tract obstruction after ESWL[11,14].

Also the stone site showed no significant impact on the stone-free rate of our patients, but it showed a great tendency towards a better stone-free rate for ureteral compared to renal stones (P=0.07). This confirms the findings of other authors[18].

Finally, Zanetti et al.[19] showed that effectiveness, tolerability or complications after ESWL were the same for patients with a solitary kidney and those with a second functioning kidney. Post-ESWL obstruction remained an important issue. It was found to be the most important factor causing deterioration of the renal function early after ESWL and possibly causing chronic effects[20]. For this reason, a close follow-up is essential to ensure an early detection and prompt management of obstruction.

In conclusion, ESWL monotherapy is an effective and safe option for treating patients with stone disease in a solitary kidney; it offers the advantage of less morbidity and better tolerability. This study documents that the majority of patients with a solitary kidney do not present extraordinary problems and do not need additional auxiliary procedures. However, careful attention to post-treatment fragment size, fragment location, serum creatinine and an early detection of obstruction are essential in this high-risk group of patients.

REFERENCES

1. Ruiz Marcellan FJ, Ibarz Servio L, Roman Dalmau M. Treatment of lithiasis in the patient with a solitary kidney. *Eur Urol* 1988, 15:13.

2. Kulb TB, Lingeman JE, Coury TA *et al.* Extracorporeal shock wave lithotripsy in patients with a solitary kidney. *J Urol* 1986, 136:786.

3. Cohen ES, Schmidt JD. Extracorporeal shock-wave lithotripsy for stones in solitary kidney. *Urology* 1990, 36:52.

4. Chaussy C, Brendel W, Schmiedt E. Extracorporeally induced destruction of kidney stones by shock waves. *Lancet* 1980, 2:1265.

5. Drach GW, Dretler S, Fair W *et al.* Report of the United States Cooperative Study of Extracorporeal shock wave lithotripsy. *J Urol* 1986, 135:1127.

6. Tolley DA, Downey P. Current advances in shock wave lithotripsy. *Curr Opin Urol* 1999, 9:319.

7. Karlsen SJ, Berg KJ. Acute changes in renal function following extracorporeal shock wave lithotripsy in patients with a solitary functioning kidney. *J Urol* 1991, 145:253.

8. Gunasekaran S, Donovan JM, Chvapil M, Drach GW. Effects of extracorporeal shock wave lithotripsy on the structure and function of rabbit kidney. *J Urol* 1989, 141:1250.

9. Bregg K, Riehle RA. Morbidity associated with indwelling internal ureteral stents after shock wave lithotripsy. *J Urol* 1989, 141:510.

10. Preminger GM, Kettelhut MC, Elkins SL, Seger J, Fetner CD. Ureteral stenting during extracorporeal shock wave lithotripsy: Help or hindrance? *J Urol* 1989, 142:32.

11. Report of the American Urologic Association Ad Hoc Committee to study the safety and efficacy of combined technology of percutaneous lithotripsy and non-invasive lithotripsy. Baltimore:American Urologic Association, 1986.

12. Petterson B, Tiselius HG. Are prophylactic antibiotics necessary during extracorporeal shock wave lithotripsy? *J Urol* 1990, 144:15.

13. Kattan S, Husain I, Elfaqih SR, Atassi R. Incidence of bacteremia and bacteriuria in patients with non-infection-related urinary stones undergoing extracorporeal shock wave lithotripsy. *J Endourol* 1993, 7:449.

14. Roth RA, Bechmann CF. Complications of extracorporeal shock wave *lithotripsy and* percutaneous nephrolithotomy. *Urol Clin N Amer* 1988, 15:155.

15. Miller OF, Kane CJ. Time to stone passage for observed ureteral calculi: A guide for patient education. *J Urol* 1999, 162:688.

16. Geyer JR, Poutasse EF. Incidence of multiple renal arteries on aortography. *JAMA* 1962, 182:118.

17. Lingeman J, Newman D, Mertz J *et al.* Extracorporeal shock-wave *lithotripsy*: The Methodist Hospital of Indiana experience. *J Urol* 1986, 135:1134.

18. Jimenez Verdejo A, Arrabal Martin M, Mijan Ortiz J, Sanchez Tamayo J, Lopez-Carmona Pintado F, Zuluaga Gomez A. Treatment of lithiasis in patients with one kidney by extracorporeal shock wave lithotripsy. *Arch Esp Urol* 1998, 51:709.

19. Zanetti GR, Montanari E, Guarneri A, Trinchieri A, Mandressi A, Ceresoli A. Long-term follow-up after extracorporeal shock wave lithotripsy treatment of kidney stones in solitary kidneys. *J Urol* 1992, 148:1011.

20. Gad HM, Sheir KZ, Hamza G. Effect of shock wave lithotripsy (SWL) to one kidney on bilateral renal function. *Egyptian Journal of Radiology and Nuclear Medicine* 2000, 31:1119.

Editorial Comment:

The results obtained in this study should be taken with some precautions, because this is a selected group of patients (stones < 2 cm, no urinary tract obstruction in most of the cases, close follow-up after ESWL was possible). Not all patients with stones in solitary kidneys fulfil these criteria. ESWL as monotherapy for stones in solitary kidneys should be considered only if these criteria are fulfilled.
The study reported that "stone site showed no significant impact on the stone-free rate". The authors cited on reference (no. 19) which reported no effect of stone location on the stone-free rate after ESWL, although most authors agree that the stone site (upper -, middle or lower calyx) does have an influence on the success rate.
The incidence of post-ESWL obstruction is 7.5% in this series (7 out of 92 patients). This is not a small percentage, particularly in solitary kidneys. The disadvantages of routinely inserting double-J stents in solitary kidneys should be weighed against this complication.

Ahmad S. Bedair, M.D.
Kasr El Aini Faculty of Medicine, Cairo

RESUME

Objectif Evaluer la lithotritie extra-corporelle en monothérapie des lithiases urinaires sur rein unique et de déterminer les facteurs pouvant influencer ses résultats. **Patients et Méthodes** Utilisant un lithotripteur de type Dornier MFL 5000, 106 patients avec un rein unique (80 hommes et 26 femmes) ont été traits pour lithiases. L'âge moyen était de 44,5 ans $\pm$ 11,1 (ET), variant de 18 à 70 ans. L'étiologie des reins uniques était soit une néphrectomie, un rein controlatéral non fonctionnel ou un rein unique congénital, respectivement dans 56,6 %, 39,6% et 3,8%. La longueur moyenne du calcul était de 13$\pm$5 mm pour une largeur moyenne de 10$\pm$3 mm. Une montée de sonde pré-opératoire a été réalisée dans 14 cas. Les données du suivi ont été relevées à 3 mois. L'analyse statistique a été faite utilisant le test du Chi 2 afin de déterminer les facteurs pouvant influencer le taux de guérison. Résultats Le taux global de guérison était de 84,9%. Seize patients avaient des calculs résiduels (15.1%), dont 12 (11.3%) avec des fragments négligeables de moins de 5 mm. Il n'avait pas de différence significative dans le taux de guérison entre les patients qui ont eu une montée de sonde pré-opératoire et ceux qui n'en ont pas eu (p=0.83). Les facteurs significatifs influençant le taux de guérison étaient le côté et le nombre de calculs (p=0.02 pour chaque facteur). Une fièvre élevée a été notée chez un patients ayant eu une obstruction partielle. Elle a été traitée par mise en place d'une sonde de néphrostomie percutanée et une antibiothérapie. Une anurie s'est développée chez 6 patients. Deux ont été traités par montée d'une sonde JJ et lithotritie extra-corporelle, tandis qu'une urétéroscopie a été réalisée chez les autres patients. **Conclusion** La lithotritie extra-corporelle est une méthode sure et efficace dans le traitement des lithiases urinaires sur rein unique. La montée de sonde préopératoire systématique n'est pas nécessaire parce que n'ayant aucun impact sur le taux de

guérison. Une surveillance post est requise avec une attention particulière pour la taille et le siège des fragments, la créatininémie et le dépistage d'une dilatation des cavités pyélo-calicielles.

All correspondence to be sent to:

Khaled Madbouly, M.D.
Mansoura Urology and Nephrology Center
Mansoura
Egypt