Solo Extracorporeal Shock Wave Lithotripsy for Management of Upper Ureteral Calculi With Hydronephrosis

Sushant Wadhera, Rajkumar K Mathur, Sudershan Odiya, Ram Sharan Raikwar, Govindaiyah Girish

Introduction: The aim of this study was to evaluate extracorporeal shock wave lithotripsy (SWL) outcomes as a solo therapy in patients with upper ureteral calculi and varying degrees of hydronephrosis.

Materials and Methods: Eighty patients with upper ureteral calculi and a body mass index between 19.5 kg/m^2 and 22.5 kg/m^2 were included. They were categorized into 4 groups according to the severity of hydronephrosis as seen on ultrasonography and intravenous urography: group 1, no dilatation; group 2, mild dilatation; group 3, moderate dilatation; and group 4, severe dilatation of the pyelocaliceal system. The size of calculi, time to calculus clearance, success rate of solo SWL, and the need for additional therapeutic methods were recorded and compared between the four groups of patients.

Results: The median size of the calculi was 13.5 mm, and the mean time to calculus clearance was 56.0 ± 24.2 days. In 71.3% of the patients, solo SWL was successful in the treatment of the calculi. Twenty-three patients required other therapies including double-J stenting, ureteroscopy, and nephrolithotomy. The patients without hydronephrosis and those with severe hydronephrosis (groups 1 and 4) showed a significant difference in the days to clearance of the calculus (mean, 31.7 days versus 85.6 days; $P < .001$).

Conclusion: Patients with upper ureteral calculi and mild hydronephrosis can be effectively treated with solo SWL therapy. In those with moderate hydronephrosis, clearance takes longer or requires secondary interventions. In patients with severe hydronephrosis, we recommend alternative/adjunctive procedures.

Keywords: shock waves, lithotripsy, hydronephrosis, ureteral calculi, upper ureter

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Department of Surgery, Maharaja Yashwantrao Hospital, Indore, Madhya, Pradesh, India

Corresponding Author: Sushant Wadhera, MBBS, MS Department of Surgery, MY Hospital, Indore, Madhya, Pradesh, India
Tel: +91 989 363 6012
Fax: +91 731 270 2088
E-mail: sushantwadhera@gmail.com

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INTRODUCTION

Modern surgical management of urinary calculi was revolutionary changed by the introduction of extracorporeal shock wave lithotripsy (SWL) in February 1980. Chaussy and colleagues confirmed it as a routine clinical practice in 1982.[1] It has been the preferred treatment of urinary calculi, especially in the kidney and the upper ureter, and it works best with the calculi between 4 mm and 20 mm in diameter.[2-4] Success of SWL depends on factors such as calculus composition, pyelocaliceal height, proximity of the calculus to a bony structure, presence and

degree of hydronephrosis, presence of ureteral obstruction, operator experience, and machine design.[3-6]

There has been a great debate on the efficacy of SWL in a dilated pyelocaliceal system. While some authors claim no difference in the rate of the clearance and time to clearance in these systems, others believe that the time for clearance and success rates are indeed affected by the degree of hydronephrosis.[7-10] We sought to evaluate the efficacy of solo SWL therapy for the treatment of upper ureteral calculi with hydronephrosis focusing on calculus clearance and time needed for clearance. This would help us determine the appropriate management for the patients with upper ureteral calculi and varying degrees of hydronephrosis.

MATERIAL AND METHODS

A total of 80 patients with documented upper ureteral calculi with or without hydronephrosis were included in this study. Upper ureteral calculi were radiographically defined as those located between the ureteropelvic junction and the pelvic brim. We selected patients with a body mass index between 19.5 kg/m^2 and 22.5 kg/m^2 who consented to enroll in the study. A single radiologist evaluated and assigned the patients into 4 groups according to the severity of hydronephrosis on ultrasonography and intravenous urography: group 1, no dilatation; group 2, mild hydronephrosis; group 3, moderate hydronephrosis; and group 4, severe hydronephrosis.[8]

Laboratory tests including complete blood count, leukocyte count, blood glucose, blood urea and serum creatinine, coagulation profiles, and urinalysis and urine culture were performed in all patients. Plain abdominal radiography, ultrasonography, and intravenous urography were performed before the procedure. Patients with a positive urine culture were treated by antibiotics for 2 weeks, and after achieving a negative urine culture, they underwent the procedure. No prophylactic antibiotic was used during or after the procedure. Mild sedatives such as pethidine were needed in a few cases. A first-generation lithotripter (Dornier HM3, Dornier Medizintechnik GmbH, Germering, Germany) was used and an average of 3000 shocks was given at 15 kV to 18 kV. The patients attended a maximum of 4 sessions of SWL. Size of the calculus was recorded before the first procedure and before any subsequent SWL session. The patients received ofloxacin, 200 mg twice a day, and rabeprazole, 20 mg, for 7 days postoperatively. They were recommended to increase their daily water intake up to 3 L to 4 L following the procedure. Follow-up program consisted of plain abdominal x-ray and ultrasonography every 2 weeks for 3 months or until complete clearance of the calculus. The following data were recorded: days from SWL to complete calculus clearance, number of the shock waves, intensity of the shock waves, and number of required sessions.

Success was defined as clearance of the calculus within 3 months after a maximum of 4 sessions and no requirement for adjunctive procedures. Treatment failure was defined as persistence of fragments larger than 3 mm in diameter after 3 months and/or recurrent colic pain after 4 SWL sessions with the need for adjunctive procedures such as double-J stenting, ureterorenoscopy, or nephrolithotomy. The results were evaluated using the *t* test, Mann-Whitney U test, and chi-square test, where appropriate. A *P* value less than .05 was considered significant.

RESULTS

Characteristics of the patients are shown in Table 1. We had 57 out of 80 patients with complete calculus clearance following solo SWL therapy (a success rate of 71.3%). Additional treatments were used in 23 patients (Table 2). Presence of hydronephrosis up to a moderate degree did not affect the success of calculus clearance ($P = .70$), but severe hydronephrosis was associated with failure of solo SWL in all patients. Table 3 demonstrates the final results in each group of hydronephrosis. The time to clearance considerably varied between groups 1 and 2 ($P = .04$). Also, patients in the two extreme groups of the study (group 1 and group 4) showed a significant difference in the days to clearance of the calculus ($P < .001$).

Table 1. Demographic Characteristics of Patients With Upper Ureteral Calculi and Treatment*

Characteristics	Patient Groups				Total
	No Hydronephrosis	Mild Hydronephrosis	Moderate Hydronephrosis	Severe Hydronephrosis	
Number of patients	12	24	32	12	80
Mean age, y	35.7	39.7	32.8	30.3	34.6
Sex					
Male	8	20	24	12	64
Female	4	4	8	0	16
Median calculus size, mm	13.0	12.5	14.0	14.5	13.5
Total SWL sessions	36	72	108	36	252
Median SWL sessions	3	3	3†	3	3

*SWL indicates shock wave lithotripsy
†Twenty patients required 3 SWL sessions, while 12 required 4 sessions.

Table 2. Additional Therapies Required After Extracorporeal Shock Wave Lithotripsy in Patients With Upper Ureteral Calculi

Additional Treatments	Patient Groups				Total
	No Hydronephrosis	Mild Hydronephrosis	Moderate Hydronephrosis	Severe Hydronephrosis	
Number of patients	1	4	6	12	23
Number of treatment sessions	1	4	10	20	39
Treatment modality					
Double-J stent	1	3	4	4	12
Ureteroscopy	…	1	5	12	18
Nephrolithotomy*	…	…	1	8	9

*At our institute, since the facilities for percutaneous nephrolithotomy were not available, open nephrolithotomy was done. Ellipses indicate that the treatment method was not used.

Table 3. Outcomes of Solo Extracorporeal Shock Wave Lithotripsy in Patients With Upper Ureteral Calculi

Parameters	Patient Groups				Total
	No Hydronephrosis	Mild Hydronephrosis	Moderate Hydronephrosis	Severe Hydronephrosis	
Mean time to clearance, d	31.7	38.4	65.3	85.6	56.0
Failures	1	4	6	12	23
Success rate, %	91.7	83.3	81.3	0	71.3

DISCUSSION

The effect of hydronephrosis on calculus clearance following SWL has been under debate. Many studies have shown changes in the ureteral musculature and redistribution of blood flow within the kidney. This would definitely appear to hamper the calculus clearance. Lackner and Barton reported that ureteral obstruction resulted in a progressive decrease in renal excretory function due to rapid redistribution of blood from the medulla to the cortex.[11] Also in 1989, Jones and colleagues studied the effect of obstruction using lithium clearance.[12] Both these studies showed a decrease in both glomerular and tubular function.

Gee and Kiviat reported that obstruction also produced hypertrophy of ureteral musculature and connective tissue proliferation within as fast as 3 days.[13] This leads to decreased peristalsis and decreased pressure, which might lead to decreased migration of the calculus.[13] Kageyama and associates evaluated middle and lower ureteral calculi with moderate or severe hydronephrosis and found poor outcomes in the obstructed systems.[14] Kumar and coworkers showed that an obstructed and dilated system provided a good water

head for fragment separation proximally, but little space for separation distally. Therefore, fragments float in a retrograde direction and are retained as residual calculi.[15] Demirbas and colleagues found that in patients with solitary calculus in the lower ureter, the degree of urinary obstruction caused by the calculus did not affect the success of calculus clearance with SWL.[7] Seitz and coworkers reached the similar findings and concluded that presence or degree of hydronephrosis caused by an upper ureteral calculus did not affect the time of clearance or success rate after SWL.[8] In the study by Iqbal and associates, the patients with severe hydronephrosis were not included and they had a result similar to the study by Demirbas and colleagues.[7,9] Meanwhile, in slight contradiction to these studies, El-Assmy and colleagues conducted a study on the effect of hydronephrosis on calculus clearance following SWL and concluded that in the patients with a solitary lumbar ureteral calculus, even though the degree of hydronephrosis caused by the calculus did not affect the overall treatment success with SWL, the calculi in obstructed systems were associated with a tendency for repeated treatments and a prolonged period of calculus clearance.[10] We had similar findings in our study.

Of the 80 patients in the present study, 68 had varying degrees of hydronephrosis. In the group with mild hydronephrosis, the mean time to clearance was 38.4 days, while in the group with moderate hydronephrosis, it was 65.3 days. Group 4 did not show any calculus clearance following SWL and all the patients needed additional therapies such as double-J stenting, ureteroscopy, and/or nephrolithotomy. Also, in the group with moderate hydronephrosis, 6 patients needed additional therapies (either single or in combination). In the group without hydronephrosis, only 1 patient experienced failure of solo SWL therapy and required double-J stenting. In the group with mild hydronephrosis, 4 patients required interventions, 3 of whom passed the calculus by double-J stenting followed by SWL and 1 required ureteroscopic evacuation.

CONCLUSION

Our findings showed that patients with upper ureteral calculi and no or mild hydronephrosis can be effectively treated by solo SWL therapy, and those with moderate hydronephrosis can undergo SWL as a single therapy, but the time taken for calculus clearance is much longer and these patients may require further interventions. We do not recommend solo SWL therapy in patients with severe hydronephrosis; alternative or adjunctive procedures may be needed in these patients.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Chaussy C, Schmiedt E, Jocham D, Brendel W, Forssmann B, Walther V. First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. J Urol. 1982;127:417-20.
2. Tiselius HG, Ackermann D, Alken P, Buck C, Conort P, Gallucci M; Working Party on Lithiasis, European Association of Urology. Guidelines on urolithiasis. Eur Urol. 2001;40:362-71.
3. Segura JW, Preminger GM, Assimos DG, et al. Ureteral Stones Clinical Guidelines Panel summary report on the management of ureteral calculi. The American Urological Association. J Urol. 1997;158:1915-21.
4. Anagnostou T, Tolley D. Management of ureteric stones. Eur Urol. 2004;45:714-21.
5. Lingeman JE, Newman DM, Mertz JH, et al. Extracorporeal shock wave lithotripsy: The Methodist Hospital experience. J Urol. 1986;135:1134-7.
6. Leveillee RJ, Carey RI. Extracorporeal shock-wave lithotriptors: why newer may not be better. Nat Clin Pract Urol. 2006;3:76-7.
7. Demirbas M, Kose AC, Samli M, Guler C, Kara T, Karalar M. Extracorporeal shockwave lithotripsy for solitary distal ureteral stones: does the degree of urinary obstruction affect success? J Endourol. 2004;18:237-40.
8. Seitz C, Fajkovic H, Waldert M, et al. Extracorporeal shock wave lithotripsy in the treatment of proximal ureteral stones: Does the presence and degree of hydronephrosis affect success? Eur Urol. 2006;49:378-83.
9. Iqbal S, Gupta NP, Hemal AK, et al. Impact of power index, hydroureteronephrosis, stone size, and composition on the efficacy of in situ boosted ESWL for primary proximal ureteral calculi. Urology. 2001;58:16-22.
10. El-Assmy A, El-Nahas AR, Youssef RF, El-Hefnawy

AS, Sheir KZ. Impact of the degree of hydronephrosis on the efficacy of in situ extracorporeal shock-wave lithotripsy for proximal ureteral calculi. Scand J Urol Nephrol. 2007;41:208-13.

11. Lackner H, Barton LJ. Cortical blood flow in ureteral obstruction. Invest Urol. 1970;8:319-23.
12. Jones DA, Atherton JC, O'Reilly PH, Barnard RJ, George NJ. Assessment of the nephron segments involved in post-obstructive diuresis in man, using lithium clearance. Br J Urol.1989;64:559-63.
13. Gee WF, Kiviat MD. Ureteral response to partial obstruction. Smooth muscle hyperplasia and connective tissue proliferation. Invest Urol. 1975;12:309-16.
14. Kageyama S, Hirai S, Higashi Y. [An investigation of factors associated with failure of extracorporeal shock wave lithotripsy for ureteral calculi]. Hinyokika Kiyo. 2000;46:371-6. Japanese.
15. Kumar A, Kumar RV, Mishra VK, Ahlawat R, Kapoor R, Bhandari M. Should upper ureteral calculi be manipulated before extracorporeal shock wave lithotripsy? A prospective controlled trial. J Urol. 1994;152:320-3.