Does the degree of stone-induced hydronephrosis affect the outcome of shock-wave lithotripsy in patients with proximal ureteral stones?

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Background
Shock-wave lithotripsy (SWL) is an effective, well-established approach for treating ureteral calculi. Some studies have shown that patients with collecting system obstruction and ureteral stones had lower stone-free rates after SWL than patients with nonobstructed stones. In contrast, other studies acknowledge that stone-induced urinary obstruction does not decrease success with SWL for ureteral stones. The purpose of this study was to assess whether the degree of stone-induced hydronephrosis in patients with solitary proximal ureteral stones influences the outcome and clearance rates after SWL.
Patients and methods
This prospective study included 30 patients, with solitary proximal ureteric stones and different degrees of hydronephrosis, who were treated with SWL. Patients were divided into three groups according to the degree of stone-induced hydronephrosis. Group 1 (33.33%) had mild dilation, group 2 (33.33%) had moderate dilation, and group 3 (33.33%) had severe dilation. The Dornier MFL 5000 lithotripter was used to treat the patient groups. The results were compared in terms of stone-free rates, number of shock waves, number of sessions, incidence of complications, number of secondary interventions, and time to stone clearance.
Results
The average stone size was between 8 and 18 mm. The overall success rate was found to be 80% in patients with severe back pressure compared with 90 and 86.6% success rate in moderate and mild hydronephrosis groups, respectively (P=0.749). Furthermore, there was no statistical significance between the three studied groups regarding clearance time (P=0.721).
Conclusions
The degree of hydronephrosis secondary to proximal ureteral stones of between 6 and 20 mm has shown not to affect the duration till stone clearance or overall treatment success following SWL treatment.

Keywords:
extracorporeal shock-wave lithotripsy, hydronephrosis, shock-wave lithotripsy, ureteric stones

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Background

Shock-wave lithotripsy (SWL) is an effective, well-established approach for treating ureteral calculi [1]. Researchers have established that many factors affect the outcome of SWL for ureteral stones, namely stone size, site, content, impaction, skin to stone distance, and stone-induced urinary obstruction [2].

Ureteral obstruction results, not only in reduced renal function, but also in decreased ureteral peristalsis and reduced pressure affecting ureteral stone migration [3]. It remains controversial whether hydronephrosis affects the outcome in extracorporeal shock-wave lithotripsy (ESWL).

Some studies have shown that patients with collecting system obstruction and ureteral stones had lower stone-free rates after SWL than patients with nonobstructed stones [4]. In contrast, other studies acknowledge that stone-induced urinary obstruction does not decrease success with SWL for ureteral stones [5–8]. Due to this preceding controversy, this study was undertaken to verify whether the degree of stone-induced urinary obstruction affects the outcome result of SWL in patients with solitary proximal ureteric stones.

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Patients and methods

This is a prospective nonrandomized study conducted between December 2014 and December 2015 at Ain Shams University Hospitals and included 30 patients, with proximal ureteral calculi, treated at our center. Our institutional ethics committee had reviewed and approved the designed study protocol.

The degree of hydronephrosis attributable to the stone was evaluated by grayscale ultrasonography, performed by two urologic specialists, who also assessed all intravenous urograms before SWL. Patients with proximal ureteral stones of 6–20 mm in length and located above the upper border of the sacroiliac joint were included in the study. The stone size was measured as the largest diameter on plain abdominal films. The criteria for exclusion were prior stone manipulation, ureteral strictures, serum creatinine more than 2 mg/dl, single or nonfunctioning kidneys, congenital renal abnormality causing hydronephrosis, stone multiplicity, radiolucent stones, pregnancy, and coagulopathy.

The evaluation prior to ESWL covered history, clinical examinations, plain abdominal radiograph, and ultrasonography. Excretory urography was performed if the serum creatinine level were less than 2 mg/dl. Laboratory investigations included urinalysis, urinary culture and sensitivity tests, serum creatinine measurement, and a coagulation profile. Patients were assigned to one of three groups according to the degree of stone-induced urinary obstruction. Group 1 (33.33%, n=10) had mild dilation of the urinary system, group 2 (33.33%, n=10) had moderate dilation of the urinary system, and group 3 (33.3%, n=10) had severe dilation of the urinary system.

Technique

All patients underwent SWL using the Dornier MFL 5000 lithotripter (Dornier MedTech GmbH, Germering, Germany).

All patients were treated in the prone position. All patients received sedoanalgesia, either as meperidine hydrochloride (1 mg/kg) and/or fentanyl (1.5 g/kg). Therapy usually began at a low power of 14 kV and gradually increased to 24 kV. A total of 3000 shocks were delivered at each session, or until complete fragmentation of the stone occurred as judged by fluoroscopy.

Follow-up

Patients were reviewed within 2 weeks following their first session to assess fragmentation using plain abdominal radiographs. If inadequate fragmentation of the stone was observed, repeat treatment was performed immediately. Duration interval between the repeated treatment sessions were always the same for the different hydronephrotic groups. If after three sessions no clearance of the stone had been detected, this was considered an SWL failure. Follow-up examinations included plain abdominal radiograph and renal ultrasonography every 2 weeks to the end of the follow-up period.

All patients were evaluated after 3 months with noncontrast-enhanced computed tomography to assess the stone-free status The number of days to stone clearance was calculated from the first SWL session to the date of the radiologic evaluation, on which the stone-free status was confirmed. Complete clearance of the stones with no residual fragments or fragments less than 4 mm was defined as a success.

Statistical analysis

The collected data was analyzed and chartered as appropriate. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Sciences; SPSS Inc., Chicago, Illinois, USA), version 16 for Microsoft Windows.

Results

This study included a total of 30 patients diagnosed with solitary proximal upper ureteric stones. Patients were divided into three equal groups:

Group 1: includes 10 patients with proximal ureteric stone and mild hydronephrosis.
Group 2: includes 10 patients with proximal ureteric stone and moderate hydronephrosis.
Group 3: includes 10 patients with proximal ureteric stone and severe hydronephrosis.

We found that nine (30%) patients required only one session, including three (30%) in group 1, three (30%) in group 2, and three (30%) in group 3. Two sessions were required in 12 (40%) patients, including four (40%) in group 1, five (50%) in group 2, and three (30%) in group 3. Three sessions were required in nine (30%) patients, including three (30%) in group 1, two (20%) in group 2, and four (40%) in group 3. This was a statistically insignificant difference (P=0.884) (Table 1).

Subsequently, the overall success rate was found to be 86.6% in patients with mild back pressure. Patients with moderate back pressure success rates were 90% and patients with severe back pressure success rates were 80%. None the less this was a statistically insignificant difference (P=0.749) (Table 2).

Table 1 Comparison between the three studied groups regarding the number of sessions

Number of sessions	Group 1 [*n* (%)]	Group 2 [*n* (%)]	Group 3 [*n* (%)]	χ^2 test	
				χ^2	*P* value
One	3 (30)	3 (30)	3 (30)	1.167	0.884
Two	4 (40)	5 (50)	3 (30)		
Three	3 (30)	2 (20)	4 (40)		

Table 2 Comparison between the three studied groups regarding the outcome

Outcome	Group 1 [*n* (%)]	Group 2 [*n* (%)]	Group 3 [*n* (%)]	χ^2 test	
				χ^2	*P* value
Failed	1 (10)	1 (10)	2 (20)	0.577	0.749
Success	9 (90)	9 (90)	8 (80)		

Table 3 Comparison between the three studied groups regarding complications

Complications	Group 1 [*n* (%)]	Group 2 [*n* (%)]	Group 3 [*n* (%)]	χ^2 test	
				χ^2	*P* value
Noncomplicated	10 (100)	9 (90)	8 (80)	2.222	0.329
Complicated	0	1 (10)	2 (20)		

Table 4 Comparison between the three studied groups regarding clearance time

	Clearance time		One-way ANOVA test	
	Mean±SD	Range	*F*	*P* value
Group 1	21.44±5.70	15–30		
Group 2	19.33±5.10	15–30	0.345	0.721
Group 3	19.38±7.46	12–35		

ANOVA, analysis of variance.

There were in total four nonsuccessful cases remaining. These were treated as follows: two patients received additional ESWL sessions and two patients underwent ureterolithotomy for stone clearance.

Complications observed during the study are mentioned below. Steinstrasse was observed in two (6%) patients; one observed within group 2 and the other in group 3. These patients had been discovered during follow-up radiographs post-ESWL but remained to be asymptomatic. Advice regarding increasing fluid intake, to enhance stone passage, and medical treatment in the form of analgesics and selective α1a blocker (Tamsulosin), were prescribed for 1 week. The patient was followed up throughout the course of treatment using Computed Tomography Kidney Ureter Bladder (CT KUB) and ultrasound. Stone fragments were cleared spontaneously without the need for secondary intervention and the patient remained apyrexial pretreatment and posttreatment course, spontaneously without the need for secondary intervention and the patient was not feverish throughout the course.

One case (3%) in group 3 was further seen to develop acute obstructive pyelonephritis in the proximal ureter secondary to an impacted ureteral stone treated by in-situ ESWL. This case had been successfully treated with a JJ stent, antibiotics, and ureteroscopy. *P* value was calculated at 0.329 (Table 3).

As shown in the table, there appears to be no statistically significant difference seen between the three assessed groups regarding complications.

In terms of clearance time, it was found to be 21.44±5.7 days in group 1, 19.33±5.1 days in group 2, and 19.38 ±7.46 days in group 3.

The previous table shows that there was no statistically significant difference found between the three studied groups regarding clearance time (Table 4).

With regards the size, the mean size was 11.9±3.45 mm in group 1, 13.10±4.56 mm in group 2, and 14.4 ±4.55 mm in group 3. *P* value was calculated at 0.427 (Table 5).

Comparison between patients' sex and age did not appear to be statistically significant with *P* values of 0.861 and 0.858, respectively (Tables 6 and 7).

Discussion

Urolithiasis is a very common affliction affecting people since ancient times. Previously surgical intervention was the only way to deal with urolithiasis until the last quarter of the 20th century,

with the introduction of new methods that were being invented. These new methods consist of extracorporeal SWL and endourologic techniques such as percutaneous nephrolithotomy, retrograde intrarenal surgery, and ureteroscopy [10].

ESWL constitutes a new era, which started in 1980 when Professor Christian Chaussy carried out the first noninvasive disintegration and elimination of renal stones. This advance was probably particularly appreciated by most of the urologists worldwide. Nowadays, ESWL is considered the first line of treatment of the upper urinary tract stones [5].

A number of clinical studies performed over the last 15 years have attempted to define the optimal therapeutic approach for a given stone, although most of these studies have been retrospective in nature. Many variables must be considered when choosing a rational treatment approach to ureteral stones, including the number of stones, their size, composition, location, and presence of hydronephrosis, in addition to other anatomic factors such as morbid obesity, presence of a solitary kidney, strictures, and ureteral anomalies [6]. Finally, the wide variety and access to the current extracorporeal lithotriptors in use and the endourological equipment at various institutions has to be taken into consideration.

In addition to the physical properties of the stone (e.g., size and composition), some research has suggested the degree of obstruction to affect fragmentation success [7]. Urinary obstruction is a serious problem, as it can lead to developing kidney dysfunction or severe complications.

A preferred method of treatment is in-situ SWL as it is a noninvasive procedure that can be performed without anesthesia. It is an attractive line of treatment for obstructing ureteral stones. Nonetheless, the association between stone-induced urinary obstruction and SWL outcome in patients with ureteral calculi is still being contested.

Delakas *et al.* [7] demonstrated that the likelihood of SWL treatment failure rises in patients with more severe obstruction; in addition, it was found that factors like ureteral calculi and moderate to severe hydronephrosis were correlated with indigent SWL outcomes.

In comparison, Kirkali *et al.* [8] concluded that the success in terms of stone disintegration or passage with SWL is not affected by urinary obstruction. Moreover, Demirbas *et al.* [9] discovered that there was no significant effect on the clearance rates for ureteral stones treated with SWL and degree of obstruction.

We aimed from this study to assess whether the degree of hydronephrosis affects the outcome of ESWL in

Table 5 Comparison between the three studied groups regarding size

	Size		One-way ANOVA test	
	Mean±SD	Range	*F*	*P* value
Group 1	11.90±3.45	8–18		
Group 2	13.10±4.56	8–20	0.879	0.427
Group 3	14.40±4.55	8–20		

ANOVA, analysis of variance.

Table 7 Descriptive statistics for all the studied patients

	n (%)
Sex	
Females	10 (33.3)
Males	20 (66.7)
Number of sessions	
One	9 (30.0)
Two	12 (40.0)
Three	9 (30.0)
Outcome	
Failed	4 (13.3)
Success	26 (86.7)
Complications	
Noncomplicated	27 (90.0)
Complicated	3 (10.0)

Table 6 Comparison between the three studied groups regarding age and sex

	Group 1 [*n* (%)]	Group 2 [*n* (%)]	Group 3 [*n* (%)]	χ^2 test	
				χ^2	*P* value
Sex					
Females	3 (30)	3 (30)	4 (40)	0.300	0.861
Males	7 (70)	7 (70)	6 (60)		
Age					
Mean±SD	50.40±13.21	52.70±11.95	53.40±12.72	0.154	0.858[a]
Range	30–70	30–66	30–70		

[a]One-way analysis of variance test.

upper ureteric stones with variable degrees of hydronephrosis.

The study included patients of BMI of less than 30 kg/m^2; obese patients who had a BMI more than 30 kg/m^2 were excluded as the obesity may interfere with visualization of the stone by ultrasonography. Obesity may also reduce the efficacy of shock-wave by increasing the skin to stone distance as Pareek *et al*. [11] reported.

Patients with any contraindications to ESWL were excluded such as the presence of distal urinary tract obstruction, renal stones in a closed calyces and uncorrectable bleeding disorders [6].

Pregnant women with renal stones were excluded as the pregnancy remains an absolute contraindication for ESWL as EUA 2014 guidelines for urolithiasis sets. Patients who fulfilled the inclusion and exclusion criteria underwent full history taking, with special attention to history of renal surgery, pervious history of stone formation, or receiving ESWL sessions.

Then, the following laboratory investigations were collected from patients: urine analysis to check the presence of urinary tract infection, if urinary track infection was present, urine culture and sensitivity were done and suitable antibiotics given. Lingeman *et al*. [6] observed in that the risk of sepsis after ESWL escalated if the urine culture exhibits bacterial growth before ESWL, or if there is presence of obstruction and so, for this reason ESWL should only be completed if the urine is sterile at the time of treatment.

Streem and Chow [12] observed that it is obligatory to obtain coagulation profile and complete blood count to insure that the patients have no coagulopathy and to know the platelets count to avoid the risk of bleeding and perinephric hematoma formation.

Also, it is important to know the baseline hemoglobin level to follow up patients in case of developing post-ESWL hematoma.

As renal insufficiency may influence the results of ESWL as Lingeman and colleagues have stated, we assessed renal function by measuring the serum level of creatinine and blood urea nitrogen.

We defined success as stone clearance after a maximum of three SWL sessions within 3 months. This was confirmed with CT KUB. In patients where no residual fragments or stones less than 4 mm were found, ESWL was considered successful. This was achieved in 86.6% of total patients.

Whether hydronephrosis in patients with proximal ureteral stones affects the outcome in SWL treatment still remains controversial. In our series, all patients were presented with hydronephrosis prior to SWL treatment. In these patients, we were able to achieve stone clearance in 86.6% after a 3-month follow-up. These results are in accordance with findings from Singh *et al*., [13] where neither the presence, nor the degree of hydronephrosis had a significant impact on time to stone clearance or success rates.

No statistically significant differences were recorded between hydronephrotic groups in terms of stone size, impulses applied, and success and failure rates. Complications were observed in a total of three patients. Steinstrasse was observed in two (6%) patients, which was discovered during follow-up radiographs post-ESWL. This was treated with advice regarding increasing fluid intake and medical treatment in the form of analgesics and selective α1a blocker (Tamsulosin) prescribed for 1 week. The patients were followed up throughout the course of treatment using KUB and ultrasound. Stone fragments were cleared spontaneously without the need for secondary intervention and the patient remained apyrexial throughout their treatment course.

One further case (3%) developed acute obstructive pyelonephritis proximal to an impacted ureteral stone treated by in-situ ESWL. This case has been successfully treated with a JJ stent, antibiotics, and ureteroscope.

Conclusion

The degree of hydronephrosis secondary to proximal ureteral stones of between 6 and 20 mm has shown not to affect the duration till stone clearance or overall treatment success following SWL treatment.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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