Comparative study of shockwave lithotripsy for the treatment of large pediatric renal stones with and without stenting

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Objective
Pediatric urolithiasis is an important renal disease encountered in clinical practice. So, this study was designed to assess the safety and efficacy of shockwave lithotripsy (SWL) in the treatment of large pediatric renal stones.

Patients and methods
Eighty-four children with large renal stones (2–3 cm) were enrolled with a range of age between 1 and 16 years. Patients underwent SWL and were divided into two groups according to the presence of JJ stent (J shaped stent); 44 underwent SWL sessions without prior stenting and 40 patients underwent SWL after JJ sent insertion. Regular follow-up was done at 2, 6, and 12 weeks after the SWL session by urinalysis and renal bladder ultrasound.

Results
It was noticed that all baseline characteristics had no significant differences between both groups with exception of stone bilaterally that was significantly higher in the case stented group (35 vs. 4.5%; $P < 0.001$). Patients with stent had higher frequency of lower urinary tract symptoms, longer duration of lower urinary tract symptoms, and hematuria.

Conclusion
SWL is a highly effective and safe modality for the treatment of children with large renal stones (2–3 cm) and could be used as an alternative to the more invasive stone therapy approaches.

Keywords:
JJ stent, pediatric stones, renal stone, shockwave lithotripsy

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Introduction

Despite being uncommon, infantile kidney stone has become a major health problem due to its morbidity and higher recurrence rate. The parents usually notice that their infants have recurrent fever and failure to thrive of unknown origin. Management of those patients comprises a big challenge especially in the era of minimally invasive surgeries [1].

There is evidence demonstrating that there is marked variation in the pattern of urolithiasis in children in developed and developing countries. Pediatric urolithiasis is still endemic in the developing countries, affecting children younger than 1 year to the age of adolescence (Rizvi *et al.* 2002).

During the last 30 years, the growing importance and revolutionary advances of minimally invasive treatment modalities has dramatically decreased the role of open surgery for stone treatment in children. Surgical treatments, although they remove the offending stone, do little to alter the course of the disease; stone recurrence after the initial episode is 30–40% at 5 years [2].

Most would prefer to do pretreatment prophylactic JJ stenting when they treat larger renal stones (>2 cm) with shockwave lithotripsy (SWL) due to fear of having complications. In our department, as a policy we do not follow prophylactic JJ stenting even for larger renal stones since the patients are closely followed during the whole treatment session [3]. This study was designed to assess the safety and efficacy of SWL in the treatment of large pediatric renal stones (2–3 cm) and compare the results between patients with and without JJ stenting.

Patients and methods

After obtaining the Institutional Research Ethics Board approval and parents' informed consent, this study was prospectively conducted between December 2014 and November 2015. Eighty-four children with large renal stones (2–3 cm) were enrolled with a range of age between 1 and 16 years. Any child with one or more of the following criteria was excluded: bleeding tendency, stone size less than 2 cm or more than 3 cm, stone in a solitary kidney, severe hydronephrosis, struvite stone, or mean Hounsfield (HU) attenuation more than 900.

Abdominal ultrasound, kidney, ureter and bladder films, and multislice computed tomography scan were done for the diagnosis of stones and assessment of their site, size, number, HU, and any associated congenital anomalies. Urine analysis, serum creatinine, coagulation profile, and complete blood count were done for all patients.

Patients underwent SWL and were divided into two groups according to the presence of JJ stent; 44 underwent SWL sessions without prior stenting and 40 patients underwent SWL after JJ sent insertion. Pre-SWL JJ stent insertion was according to the choice of patients' parents.

SWL sessions for both groups were an outpatient procedure under general anesthesia after confirmation of sterile urine and normal bleeding profile. All patients received a single dose of second-generation cephalosporin (50 mg/kg) intravenously before induction.

SWL was done using the Dornier-S lithotripter with a power of 14–16 kV at a rate of 70 shocks per minute. Each session consisted of 1500–2000 shocks (according to the stone disintegration status).

After SWL, all patients received a 15 mg/kg dose of paracetamol orally every 8 h for 5 days and were instructed to maintain a high oral fluid intake. Patients with lucent stones received potassium sodium hydrogen citrate at a dose of 1–2 mEq/kg/day in 2–3 divided doses till stone clearance.

Regular follow-up was done at 2, 6, and 12 weeks after the SWL session by urinalysis and renal bladder ultrasound. Kidney, ureter and bladder was done only for radiopaque stones.

Stone clearance was defined as no renal stone or fragment greater than 4 mm. For those with residual renal stone or fragment (s) greater than 4 mm, the patient underwent a second session of SWL. Residual renal stone or fragment (s) greater than 4 mm after three SWL sessions was considered as failure of treatment.

Statistical analysis

Statistical analysis was performed with the statistical package for the social sciences (SPSS Inc., Chicago, Illinois, USA). Categorical variables were expressed in numbers and percentages and compared with the χ^2-test, while continuous variables were expressed in the form of median and range and compared by Mann–Whitney *U*-test. The level of confidence was kept at 95% and the *P* value was significant if less than 0.05.

Results

A total of 84 children were enrolled, 44 of them underwent SWL sessions without stenting and 40 with JJ stents. It was noticed that all baseline characteristics had no significant differences between both groups with exception of stone bilaterally that was significantly higher in the case stented group (35 vs. 4.5%; $P < 0.001$) (Tables 1 and 2). Also, both groups had no significant differences as regards the number of sessions and time spacing between sessions.

Regarding SWL procedure, 13 (15.48%) children needed only one session to become stone free. After two SWL sessions, 53 (63.10%) patients became clear. The final successful outcome after three sessions was 72 (85.71%) patients. Of these, there were 72 successfully treated patients, 31 (36.90%) patients showed complete clearance (CC), and 41 (48.81%) patients had clinically insignificant residual fragments (CIRFs) of less than 4 mm. At last follow-up; 12 (14.29%) patients had residual stones or fragments of more than 4 mm.

During SWL sessions, 55 (65.48%) patients had no adjuvant treatment. Twenty-six (30.95%) patients with radiolucent stones received potassium sodium hydrogen citrate (of them four patients were noncompliant to therapy). One (1.19%) patient with neglected encrusted JJ stent for 6 months underwent percutaneous nephrolithotomy (PNL), ureteroscopy (URS) removal of the stent, and cystolithotripsy of bladder stones. Two (2.38%) patients underwent URS stone treatment of persistent steinstrasse after 6 weeks of conservative treatment.

In the nonstented group, 10 (22.73%) patients needed only one session to become stone free while in the stented group, three (7.50%) patients needed only one session to become stone free. After the second session, 32 (72.73%) patients of the nonstented group became

clear, while 21 (53.85%) patients of the stented group became clear ($P > 0.05$).

The final outcome after three sessions, 41 (93.18%) patients of the nonstented group became clear (18 patients showed CC and 23 patients had CIRF) while 31 (77.50%) patients of the stented group became clear (13 patients showed CC and 18 patients had CIRF) with $P = 0.04$ (Fig. 1).

Table 1 Baseline characteristics of the studied groups

	No JJ stent	JJ stent	*P*
Age [median (range)] (years)	7 (3-9.5)	9 (3.5-12)	0.18
Male (%)	63.64	60	0.73
Right-sided stone (s) (%)	54.55	55.00	0.96
Normal targeted kidney (%)	100.00	95.00	0.22
Degree of hydronephrosis (%)			0.40
No	59.09	72.50	
Mild	22.73	12.50	
Moderate	18.18	15.00	
Number of stones [median (range)]	2 (2-3)	2 (2-3)	0.25
Stone length [median (range)] (cm)	2.30 (2.1-2.55)	2.35 (2.1-2.7)	0.72
Hounsfield attenuation [median (range)]	620 (475-730)	589.5 (471.5-689)	0.25
Bilateral stone (s) (%)	4.55	35.00	**<0.001**
Multiple stones (%)	84.09	90.00	0.52
Stone site (%)			
Calyceal	15.91	25.00	0.33
Pelvis	20.45	10.00	
Staging	63.64	65.00	
Stone character (%)			
Faint radiopaque	27.27	42.5	0.32
Lucent	40.91	30.00	
Radiopaque	31.82	27.50	
Previous stone therapy (%)			
No	72.73	60.00	0.21
Surgery	25.00	37.50	
URS	0.00	2.50	
PNL	2.27	0.00	

Bold: Values less than 0.05 which is significant. Data were expressed in the form of median (range) or percentage.PNL, percutaneous nephrolithotomy; URS, ureteroscopy.*P*<0.05, significant.

Table 2 Complications of shockwave lithotripsy of the studied groups

	No JJ stent	JJ stent	*P*
Steinstrasse	4.55	10	0.41
Hematuria	27.27	27.50	0.98
Duration of hematuria [median (range)] (days)	5 (4-7)	15 (12-20)	**<0.001**
Percentage of LUTS	27.27	57.50	**<0.001**
Duration of LUTS [median (range)] (days)	9 (7-11)	15 (10-15)	**<0.001**

Bold: Values less than 0.05 which is significant. Data were expressed in the form of median (range) or percentage.LUTS, lower urinary tract symptoms.*P*<0.05, significant.

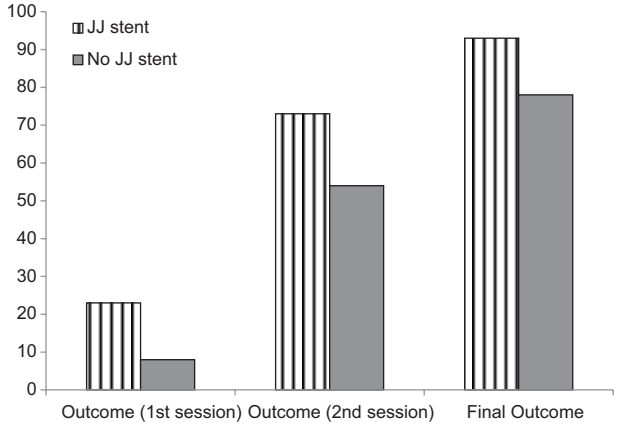
Thirty patients with radiolucent stones (12 of them had JJ stents) received medical dissolution therapy as combination with SWL but four of them were noncomplaint. The successful rate for those patients after SWL sessions and medical dissolution therapy was 84.61% with a mean number of 2.4 sessions; 61.53% showed CC; and 23.07% had CIRF. There was no significant difference between stented and stentless patients ($P = 0.32$).

As regards the complications of SWL, mild hematuria occurred in 12 (27.27%) patients of the nonstented group and 11 (27.50%) patients of the stent group. Renal colic and steinstrasse without fever occurred in two (4.55%) patients of the nonstented group where stone fragments passed spontaneously within 2 weeks.

In the stented group, renal colic and steinstrasse occurred in four (10%) patients. Spontaneous relief occurred in one. Two patients underwent URS treatment after 6 weeks of medical treatment and one patient needed PNL, URS removal of JJ stent, and cystolithotripsy of the bladder stone over neglected JJ stent. For both groups, renal colic was managed initially by oral paracetamol 15 mg/kg three times daily for 1 week and then on demand.

Lower urinary tract symptoms (LUTS) in the form of burning micturition, urgency, and frequency were found in 12 (27.27%) patients of the nonstented group lasting for 6–15 days (median 9 days), while in the stented group LUTS were found in 23 (57.50%) patients lasting for 5–20 days (median 15 days) and both groups were treated by oral paracetamol 15 mg/kg three times daily for 10 days and then on demand.

Figure 1



Outcome of three sessions in the studied groups.

Discussion

In the past 15 years, a number of reports have proved the efficacy of SWL in children. Reports from the first decade (1986 to 1995) were mainly of first-generation lithotripters (Dornier HM3), and the stone clearance rate ranged from 41 to 96%.

The slower acceptance of SWL for children was predominantly from the fear of causing renal damage with renal growth retardation and the development of hypertension. However, many studies published since have consistently shown that neither fears about renal growth retardation nor concern about the development of hypertension are well founded [4].

Treatment of pediatric renal stones by SWL requires some modifications of the standard adult protocol, which depend on the type of lithotripter used and the age and size of the child. Dornier MPL 9000 lithotripter offers numerous advantages for the treatment of pediatric stones. It uses a spark gap generator with wide energy range [5].

Several investigators have shown that treatment of urolithiasis in children using SWL has a morbidity rate and results comparable to those in adults. Also they agreed that the selection criteria for children and adults are equivalent [6].

Stone-free rates are significantly affected by multiple factors. Regardless of the site, as the stone burden increases, the stone-free rates decrease. The stone-free rates for less than 1, 1–2, and more than 2 cm were reported as nearly as 90, 80, and 60%, respectively. As the stone size increases, the need for additional sessions increases (EAU 2015) [7].

In this study, the success rate is 93.18% for the nonstented group and 77.5% for the stented group after three sessions. We were encouraged to treat large renal stones using SWL monotherapy. The effect of stone size on the stone clearance was determined. Our policy was to use shock waves of low energy by decreasing the loading Kilo Voltage at 14:16 kilo voltage. The number of shock waves per session was not allowed to be more than 2000 shock waves per session.

Stone attenuation value (SAV) in HU in this study was a maximum of 900 U from NCCT. Massoud *et al.*[8] treated 305 patients with renal calculi of 30 mm length. The patients were grouped according to SAV as group one (≤500 HU), group 2 (501–1000 HU), and group 3 (>1000 HU). Stone clearance was 100% in group 1, 95.7% in group 2, and 44.6 in group 3 after three SWL sessions. They concluded that SAV is an independent predictor of the success of SWL [9].

The mean stone burden in our patients was 2.39 cm for nonstented patients and 2.46 cm for stented patients. The stone size has clear impact on the treatment outcome. Lingman *et al.* (1986) stated that SWL should be the preferred method of treatment for renal calculi of less than 2 cm. Others have reported a success rate of 83.3% with SWL as monotherapy for staghorn calculi with a mean number of 2.2 SWL sessions [10].

Muslumanoglu *et al.* (2003) treated 344 children who had renal stones of 2 cm or less in length (mean age 8.7 years, range 6 months to 14 years) managed with SWL. Overall, a stone-free rate was seen 79.9% and CIRF in 13.2%. The mean number of sessions was 1.9 sessions.

Ather and Noor[11] reported a stone-free rate of 95% in children with renal stones 20–30 mm in size. The mean number of treatment sessions needed for complete treatment was 1.65 session. In the same study, they treated 35 children with renal stones 10 mm or less in length. Stone-free rate was reported in 34 (97%) of them. In this study, we reported a stone-free rate of 93.18% in the nonstented group and a rate of 77.50% in the stented group.

Miniberg *et al.* (1988) reported that there was less success with calyceal stones than with renal pelvic stones. Our series showed that calyceal stones needed more treatment sessions, more shock waves, and longer treatment time to achieve nearly the same stone-free rate for renal pelvic stones. The mean number of sessions in pelvic stones was 1.69 session, in calyceal stones was three sessions. The rate of complications in calyceal stones was nearly similar to those in renal pelvic stones.

Osman *et al.* [12] evaluated 173 patients with renal stones who have been treated by SWL and released with CIRF. The mean follow-up time was 4.9 years. CIRF cleared spontaneously in 78.6% of patients within few weeks and did not recur within 5 years. In 21.4% of patients, CIRF led to stone recurrence and retreatment.

Al-Busaidy *et al.* [13] treated staghorn calculi in 42 children of 9 months to 12 years old with SWL. They found that major complications developed in 21% of the nonstented group, while no complications were observed in patients who were stented. Seven (five URS and two PNL) post-SWL auxiliary procedures were required in the nonstented group to manage complications. Hospital stay was significantly longer in the unstented group compared with the stented group.

Our stone-free rate is comparable to that of other series with smaller stone sizes. Treatment failure was reported in 6.82% of nonstented patients and in

22.50% of stented patients; however, the retreatment rate and number of children with CIRF were closer to that reported in other series [13]. These findings are also supported by those from Rodrigues Netto *et al.* (2002) who had a 97.6% stone-free rate. All children showed great ability to pass the stone fragments spontaneously.

Transient macroscopic hematuria is reported in most of the patients in this study. However, clinically significant bleeding with the development of perirenal hematoma did not occur. Abara *et al.* (2004) reported that short-lasting hematuria (<24 h) happened in all of 20 patients who underwent SWL sessions. Prolonged duration of hematuria in this study is attributed to the large stone length and presence of JJ stents.

In this study, steinstrasse occurred in two (4.55%) patients of the nonstented group, but none of them required hospitalization or URS management. The stone fragments passed spontaneously, while in the stented group, steinstrasse occurred in four (10.00%) patients. Spontaneous relief occurred in one of them, two patients underwent URS treatment, and one patient needed PNL, URS JJ stent removal, and cystolithotripsy.

Marberger *et al.* [14] reported that the stone fragments passed faster and with fewer complications in children than in adults. He attributed this to the easy dilatation of the pediatric ureter. Patients with stents seem to have significantly more bladder and lower urinary tract symptoms than those in whom stents are not placed.

In this study, LUTS in the form of burning micturition, urgency, and frequency were found in 12 patients of the nonstented group lasting for 6–15 days (median 9 days), while in the stented group LUTS were found in 23 patients ($P = 0.005$) lasting for 5–20 days (median 15 days) ($P = 0.003$).

This results seem encouraging despite the study limitations. This study lacks a long-term follow-up for growing kidneys, including data on the possibility of developing renovascular hypertension and stone regrowth in patients with CIRF.

Conclusion

SWL is a highly effective and safe modality for the treatment of children with large renal stones (2–3 cm) and could be used as an alternative to the more invasive stone therapy approaches where stentless SWL for such patients are more effective and showed fewer complications.

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Conflicts of interest

There are no conflicts of interest.

References

1 Bartosh SM. Medical management of pediatric stone disease. Urol Clin North Am 2004; 31:575–585.

2 Kartha G, Calle JC, Marchini GS, Monga M. Impact of stone disease: chronic kidney disease and quality of life. Urol Clin North Am 2013; 40:135–147.

3 Lingeman JE, Coury TA, Newman DM, Kahnoski RJ, Mertz JH, Mosbaugh PG, *et al.* Comparison of results and morbidity of percutaneous nephrostolithotomy and extracorporeal shock wave lithotripsy. J Urol 1987; 138:485–490.

4 Brinkman OA, Griehl A, Kuwetrz-Broking E. Extracorporeal shock wave lithotripsy in children. Eur Urol 2001; 39:591–597.

5 Myers DA, Mobley TB, Jenkins J. Pediatric low energy lithotripsy with Lithostar. J Urol 1995; 153:453–457.

6 Raza A. Pediatric urolithiasis: 15 years of local experience with minimally invasive endourological management of pediatric calculi. J Urol 2005; 174:682–685.

7 El-Assmy A. Kidney stone size and hounsfield units predict successful shockwave lithotripsy in children. Urology 2013; 81:880–884.

8 Massoud M, Abdel Bary AM, Mahmmoud O. The success of extra corporeal shock- wave lithotripsy based on the stone attenuation value from noncontrast computed tomography. Arab J Urol 2014; 12:155–165.

9 McAdams S. Preoperative stone attenuation value predicts success after shock wave lithotripsy in children. J Urol 2010; 184(Suppl):1804–1809.

10 Shouman M, Ziada AM, Ghoneim IA, Morsi HA. Extracorporeal shock wave lithotripsy monotherapy for renal stones>25 mm in children. Urology 2009; 74:109–111.

11 Ather MH, Noor MA. Does size and site matter for renal stones up to 30-mm in size in children treated by extracorporeal lithotripsy? Urology 2008; 61:212–215.

12 Osman M, Yvonne A, Stefan K, Thomas K. 5-year follow-up of patients with clinically insignificant residual fragments after extracorporeal shockwave lithotripsy. Eur Urol 2005; 47:860–864.

13 Al-Busaidy SS, Prem AR, Medhat M. Pediatric staghorn calculi, the role of extracorporeal shock wave lithotripsy monotherapy with special reference to Ureteral stenting. J Urol 2003; 169:629–633.

14 Marberger M, Turk C, Steinkogler I. Piezoelectric extracorporeal shock wave lithotripsy in children. J Urol 1989; 142:349–352.