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Original article

Efficacy of shock wave lithotripsy in management of kidney stones in infants

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Abstract

Introduction and objectives: Despite being uncommon, infantile kidney stone remains a major health problem due to its higher recurrence rate and morbidity. The parents usually notice that their infants have recurrent fever and failure to thrive of unknown origin. Those patients comprise a big challenge for the urologist in management. Therefore, this study aimed to evaluate the outcome of shockwave lithotripsy (SWL) in management of renal stones in infants.

Subjects and methods: A retrospective analysis of prospectively collected data performed between January 2009 and December 2012 for infants underwent SWL for single radio-opaque renal stones ≤15 mm at a single stone center. SWL was performed with Dorneir S lithotripter with a maximum of 1500 shocks per session. A single session was indicated for each infant, but a second session was performed when satisfactory disintegration was not achieved. Follow-up based on urinalysis, urine culture and sensitivity, plain X-ray kidney ureter bladder (KUB) and abdominal ultrasonography (US) was carried out 2 weeks post SWL and monthly for 3 successive months. Multislice Computed tomography (MSCT) was performed 3-months post-SWL to confirm the stone-free status.

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Results: A total of 87 infants, less than 24 months of age were enrolled in this research. SWL success was defined as absence of any residual fragments on MSCT 3-months after the last session. Stone free rate was 93.1% after the first SWL session and reached 100% after the second session. Rate of retreatment with second session of SWL was 6.9%. Urinary tract infection (UTI) was detected in 10.3%, transient renal obstruction with low grade fever in 4.6% of infants and no major complication had been recorded.
Conclusion: The new generation of SWL technology with a precise focal area seems to be safe and effective in management of kidney calculi in infants.

Introduction

Treatment of renal calculi has dramatically changed by the development and advancement of shock wave lithotripsy (SWL). Therefore, SWL has become the first line for treatment of renal calculi less than 20 mm [1,2].

Safety and efficacy of SWL in treating renal calculi in adults have been reported, however, few studies have reported similar outcome in infants [3–6].

Despite being uncommon, infantile kidney stone 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 [7].

Management of those patients comprises a big challenge especially in the era of minimally invasive surgeries [8]. Therefore, the current study was designed to evaluate the efficacy of SWL in management of infants presented with single radio-opaque kidney stones less than 15 mm in their large diameters.

Subjects and methods

Institutional Research Ethics Board approval and parents' informed consent were obtained. In the period from January 2009 to December 2012, a total of 110 infants younger than 24 months of age, who were admitted to Assiut University Hospitals, Egypt, underwent SWL for single radio-opaque kidney stones less than 15 mm in their longest diameters. SWL was performed using Dornier S lithotripter, a 4th generation electromagnetic lithotripter.

Abdominal ultrasound (US), kidney, ureter and bladder (KUB) films, and multislice computerized tomography (MSCT) scan were done for diagnosis of stones and assessment of their site, size, number, Hounsfield (HF) units and any associated congenital anomalies. Urine analysis and culture, serum creatinine, coagulation profile and complete blood count (CBC) were done for all patients before SWL. Patients excluded from this cohort study included those with febrile urinary tract infection (e.g. infected hydronephrosis), uncorrectable coagulation disorders, solitary kidney, non secreting kidney, or those who have contraindication for anesthesia. Infants with infected urine were treated with antibiotics according to the results of culture and sensitivity for 5 days before SWL, while those with sterile urine received prophylactic antibiotic one hour before SWL session (50 mg/kg ceftriaxone) and maintained for two days post-SWL as a single daily dose.

The procedure

Under general anesthesia and in supine position, the children were secured to the gantry with tapes, leaving the skin over the treated kidney uncovered. Lung shielding and visceral protection were ensured by placement of polystyrene foam. Shock waves were fired at a very low energy level, then after 100–200 shocks the energy level was increased in stepwise manner up to 16–18 kilo voltage (kV). This depends upon the status of the stone fragmentation. The calculi were monitored fluoroscopically during treatment and the session was terminated when pulverization was satisfactory (the size of the fragments was smaller than 2 mm) or when 1500 shock waves were applied. Those who had unsatisfactory stone fragmentation were re-treated with a second SWL session after 2 weeks. The generator voltage ranged from 16 to 18 kV and pulse frequency rang was 60–80 shocks per min. No ureteral stents were inserted before SWL sessions in any infant.

All infants were discharged at the same day after recovery with Potassium Diclofenac 12.5 mg for post-SWL analgesia. KUB and abdominal ultrasound were routinely performed before discharge. Urine culture and sensitivity, KUB film and abdominal ultrasound were performed at 2 weeks and monthly for 3 successive months after the last SWL session. MSCT was done to confirm the stone-free status at the 3rd month post-SWL for all patients.

Success of SWL was defined as stone-free status with no residual fragments, evidenced by MSCT 3 months after the last session. Failure of SWL was considered if no/or unsatisfactory stone fragmentation was achieved after the second session or presence of residual fragments at MSCT 3 months after the last session.

A retrospective descriptive analysis of prospectively collected data was done for those infants. Statistical analysis was performed with Statistical Package for Social Science (SPSS, Chicago, IL, USA). Categorical variables were expressed in numbers and percentages while continuous variables were defined in terms of means and standard deviation.

Results

Twenty-three infants who have missed follow-up were excluded from data analysis bringing the total number of included infants to 87. Infants' age ranged from 8 to 23 months with a mean of 14.6 ± 4.3 months.

Of those 87 patients, 55 (63.2%) were boys and 32 (36.8%) were girls. Mean stone size was 11.0 ± 3.0 mm (Table 1).

Table 1 Demographic data of infants included in the study.

Variable	Demographic data	No	%
Gender	Female	32	36.8
	Male	55	63.2
Age (months)	5–	10	11.5
	10–	35	40.2
	15–	28	32.2
	20–23	14	16.1
	Mean ± SD (range)	14.6 ± 4.3 (8–23)	
Stone laterality	Left	50	57.5
	Right	35	41.4
	Bilateral	1	1.1
Stone size (mm)	<10	29	33.3
	10–15	58	66.7
	Mean ± SD (range)	11.0 ± 3.0(6–15)	
Stone locations	Pelvis	64	73.6
	Upper calyx	12	13.8
	Mid calyx	6	6.9
	Lower calyx	5	5.7
Urine	Sterile	65	75.8
	Infected	21	24.2

Table 2 Characteristics of SWL session.

Variable		Mean	SD
Number of shock waves in first session		1166.6	281.3
Number of shock waves in second session		1315.0	145.6
Number of sessions	Single session	81 (93.1)	
	2 sessions	6 (6.9%)	

The mean number of shock waves delivered was 1166.6 ± 281.3 shocks in the first session and 1315 ± 145.6 shocks in the second session. The average number of SWL sessions was 1.07 per patient (Table 2).

Stone-free rates were 93.1% and 100% after the first and second sessions, respectively. Rate of retreatment with second session of SWL was 6.9% (6 infants).

No ureteral stents were inserted before SWL sessions in all patients. In the present cohort, no major complications were recorded where only some minor complications were detected. Nine patients (10.3%) had renal colic that was resolved with analgesia, transient renal obstruction with low grade fever in 4 (4.6%) of infants, 40 (46%) infants had transient hematuria, which were self-limited and resolved spontaneously with conservative management and fluid intake. No perirenal or subcapsular hematomas were noted on renal sonography. No anesthetic complications were reported in our group of patients.

Discussion

Recently, there is an increased concern about management for urolithiasis in infants in the era of minimally invasive techniques. Possibly, this might be due to increasing incidence of kidney stones in this age group with added risk of the higher recurrence rate and morbidity [7]. Although endourological procedures are a valid option for treating renal stones in infant, urethral instrumentation in boys is not favored as it may be hazardous [1] and associated with a high rate of complications [9].

SWL as a minimally invasive procedure offers many advantages over endourological or surgical interventions, including shorter hospital stay, rapid recovery, low complication rate and easy retreatment [10–15]. Therefore, SWL is typically considered as the first-line for treatment of renal calculi <20 mm in size because of its long- term safety, minimal complications and high success rates [3–5,10–15]. However, its outcome in infants is not documented as in adults. To date, few studies have described SWL application in infants due to its theoretical potential side effect for the developing organs, lower stone free rate, and the high incidence of retreatment rate with multiple sessions and anesthesia which put more stress on parents who prefer only one session for stone extraction [6].

In the present cohort, 87 infants with single radio-opaque renal stones less than 15 mm were managed by SWL in the last 3 years. To the best of our knowledge, this is the largest single center series reporting the efficacy of SWL in management of renal calculi in infants. Stone-free rates were 93.1% and 100% after the first and second sessions, respectively at 3 month of follow up. This is in agreement with other published data about stone-free of 88–100% at 3-month follow-up for renal calculi disintegrated by SWL in infants [1,5,16–20].

Lottmann et al. [1] reported that stone-free rate was 100% after 2 sessions of SWL in 19 infants whose age ranged from 5 to 24 months. Similarly, Shukla et al. [5] reported the same stone free rate after a single session in treating 8 infants of 9–15 months using Dornier HM3 lithotripter. Moreover, Ramakrishnan et al. [20] evaluated 74 infants younger than 2 years old and reported an 88% stone free rate after a single session of SWL.

Despite children having small ureteral diameters, they have a higher clearance rate of stones fragments than adults [21,22] due to the shorter and more distensible ureters they have [23]. In addition, the infundibulo-pelvic angle in children may be more favorable for clearance of stone fragments of the lower calyceal stones [24].

No ureteral stents had been inserted prior to SWL in all infants in the current cohort as stenting is not recommended before SWL, especially in children [25]. Moreover, ureteral stents may decrease ureteral peristalsis and increase the time for stones fragments to pass [26].

Although, multiple sessions of SWL confer increase stone clearance, they request repeated anesthesia, which is considered a stress on the patients' families [27]. Therefore, maximally two sessions of SWL were considered in this study.

In the present study, SWL was considered to be successful if the child became stone-free with no residual fragments at the follow-up MSCT 3-months post-SWL. Some studies defined success as the presence of residual stone fragments less than 4 mm, considering them as clinically insignificant residual fragments (CIRFs) that are expected to pass spontaneously without further treatment [3,19]. However, what is allowed for adults is not necessary to be accepted for infants due to different anatomy. Moreover, it was reported that 69% of clinically insignificant residual fragments resulted in adverse effects of clinical significance [28]. Therefore, persistence of those fragments urges secondary interventions either with SWL or endoscopic procedures [29].

During the follow up period, KUB film and abdominal ultrasound were performed several times, while MSCT was done to confirm the stone-free status 3-months after the last SWL session for all patients. Of these imaging modalities, MSCT has been demonstrated to be the most sensitive, accurate and specific to determine the stone-free status post-SWL, detecting fragments as small as 1 mm [30].

The frequency of complications related to SWL is relatively low [16,31]. The most frequently reported complications are hematuria, renal hematomas, upper urinary tract obstruction, renal colic and urinary tract infection. Hematuria is always transient and resolved spontaneously without further management. Similarly, complications of general anesthesia as laryngospasm and hemoptysis have been reported [32,33]. The complications reported in the current cohort were minor, which responded readily to conservative treatment or resolved spontaneously. A higher rate of complications (20%) and SWL failures (19%) was reported by Ather et al. [17] who managed larger stones 20 mm in diameters or larger. This may indicate that SWL is not as efficient for large stones as for small stones. Moreover, the precise focusing area used by the new SWL generation technology provides less damage to surrounding tissues with less complications [29].

Conclusion

The new generation of SWL technology with a precise focal area seems to be safe and effective treatment for kidney stone less than 15 mm in size in infants.

Conflict of interest

No conflict of interest.

References

[1] Lottmann HB, Archambaud F, Traxer O, Mercier-Pageyral B, Helal B. The efficacy and parenchymal consequences of extracorporeal shock wave lithotripsy in infants. BJU Int 2000;85(3):311–5.

[2] D'Addessi A, Bongiovanni L, Sasso F, Gulino G, Falabella R, Bassi P. Reviews in endourology: extracorporeal shockwave lithotripsy in pediatrics. J Endourol 2008;22:1–11.

[3] Muslumanoglu AY, Tefekli A, Sarilar O, Binbay M, Altunrende F, Ozkuvanci U. Extracorporeal shock wave lithotripsy as first line treatment alternative for urinary tract stones in children: a large scale retrospective analysis. J Urol 2003;170:2405–8.

[4] Rodrigues Netto N, Longo JA, Ikonomidis JA, Rodrigues Netto M. Extracorporeal shock wave lithotripsy in children. J Urol 2002;167:2164–6.

[5] Shukla AR, Hoover DL, Homsy YL, Perlman S, Schurman S, Reisman EM. Urolithiasis in the low birth weight infant: the role and efficacy of extracorporeal shock wave lithotripsy. J Urol 2001;165:2320–3.

[6] Lifshitz DA, Lingeman JE, Zafar FS, Hollensbe DW, Nyhuis AW, Evan AP. Alterations in predicted growth rates of pediatric kidneys treated with extracorporeal shockwave lithotripsy. J Endourol 1998;12:469–74.

[7] Bartosh SM. Medical management of pediatric stone disease. Urol Clin North Am 2004;31:575–85.

[8] Van Dervoort K, Wiesen J, Frank R, Vento S, Crosby V, Chandra M, et al. Urolithiasis in pediatric patients: a single center study of incidence, clinical presentation and outcome. J Urol 2007;177:2300–5.

[9] Pirincci N, Gecit I, Bilici S, Taken K, Tanik S, Ceylan K. The effectiveness of extracorporeal shock wave lithotripsy in the treatment of ureteral stones in children. Eur Rev Med Pharmacol Sci 2012;16:1404–14.

[10] Newman DM, Coury T, Lingeman JE. Extracorporeal shock wave lithotripsy in children. J Urol 1986;136(1 Pt 2):238–42.

[11] Choong S, Whitfield H, Duffy P, Kellett M, Cuckow P, Van't Hoff W, et al. The management of paediatric urolithiasis. BJU Int 2000;86(7):857–63.

[12] Lottmann HB, Traxer O, Archambaud F, Mercier-Pageyral B. Monotherapy extracorporeal shock wave lithotripsy for the treatment of staghorn calculi in children. J Urol 2001;165(6 Pt 2):2324–7.

[13] Traxer O, Lottmann H, Archambaud F, Helal B, Mercier-Pageyral B. Extracorporeal lithotripsy in children: study of its efficacy and evaluation of renal parenchymal damage by DMSA-Tc 99m scintigraphy: a series of 39 children. Arch Pediatr 1999;6:251–8.

[14] Vlajkovic M, Slavkovic A, Radovanovic M, Siric Z, Stefanovic V, Perovic S. Long-term functional outcome of kidneys in children with urolithiasis after SWL treatment. Eur J Pediatr Surg 2002;12:118–23.

[15] Reisiger K, Vardi I, Yan Y, Don S, Coplen D, Austin P, et al. Pediatric nephrolithiasis: does treatment affect renal growth. Urology 2007;69:1190–4.

[16] Orsola A, Diaz I, Caffaratti J, Izquierdo F, Alberola J, Garat JM. Staghorn calculi in children: treatment with monotherapy extracorporeal shockwave lithotripsy. J Urol 1999;162(3 Pt 2):1229–33.

[17] 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 2003;61(1):212–5.

[18] Onal B, Demirkesen O, Tansu N, Oner A. The impact of caliceal pelvic anatomy on stone clearance after shock wave lithotripsy for pediatric lower pole stones. J Urol 2004;172(3):1082–6.

[19] Demirkesen O, Onal B, Tansu N, Altintaş R, Yalçin V, Oner A. Efficacy of extracorporeal shock wave lithotripsy for isolated lower caliceal stones in children compared with stones in other renal locations. Urology 2006;67(1):174–5.

[20] Ramakrishnan PA, Medhat M, Al-Bulushi YH, Priti N, Al-Kindy A. Extracorporeal shockwave lithotripsy in infants. Can J Urol 2007;14:3684–94.

[21] Longo JA, Netto Junior NR. Extracorporeal shock-wave lithotripsy in children. Urology 1995;46(4):550–2.

[22] Marberger M, Türk C, Steinkogler I. Piezoelectric extracorporeal shock wave lithotripsy in children. J Urol 1989;142(2 Pt 1):349–52.

[23] Andreesen R, Fedel M, Sudhoff F, Friedrichs R, Loening SA. Quality of semen after extracorporeal shockwave lithotripsy for lower urethral stones. J Urol 1996;155:1281–4.

[24] Gurocak S, Kupeli B, Acar C, Tan MO, Karaoglan U, Bozkirli I. The impact of pelvicaliceal features on problematic lower pole stone clearance in different age groups. Int Urol Nephrol 2008;40:31–7.

[25] Sigman M, Laudone VP, Jenkins AD. Initial experience with extracorporeal shock wave lithotripsy in children. J Urol 1987;138(4):839–41.

[26] Ryan PC, Lennon GM, McLean PA, Fitzpatrick JM. The effects of acute and chronic JJ stent placement on upper urinary tract motility and calculus transit. Br J Urol 1994;74(4):434–9.

[27] Hammad FT, Kaya M, Kazin E. Pediatric extracorporeal shockwave lithotripsy: its efficiency at various locations in the upper tract. J Endourol 2009;23:229–35.

[28] Afshar K, McLorie G, Papanikolaou F, Malek R, Harvey E, Pippi-Salle JL, et al. Outcome of small residual stone fragments following shock wave lithotripsy in children. J Urol 2004;172:1600–3.

[29] Ozgür Tan M, Karaoglan U, Sen I, Deniz N, Bozkirli I. The impact of radiological anatomy in clearance of lower calyceal stones after shock wave lithotripsy in paediatric patients. Eur Urol 2003;43:188–95.

[30] Diamond DA, Menon M, Lee PH. Etiological factors in pediatric stone recurrence. J Urol 1989;142:606–13.

[31] Jayanthi VR, Arnold PM, Koff SA. Strategies for managing upper tract calculi in young children. J Urol 1999;162(3 Pt 2):1234–7.

[32] Goel MC, Baserge NS, Babu RV, Sinha S, Kapoor R. Pediatric kidney: functional outcome after extracorporeal shock wave lithotripsy. J Urol 1996;155(6):2044–6.

[33] Aksoy Y, Ozbey I, Atmaca AF. Extracorporeal shock wave lithotripsy in children: experience using a mpl-9000 lithotriptor. World J Urol 2004;22(2):115–9.