Factors that affect outcome of pediatric shock waves lithotripsy with sedoanalgesia

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Abstract

Introduction: Performing shock wave lithotripsy (SWL) under intravenous sedoanalgesia and the ability to predict the effectiveness of SWL is essential in determining the most appropriate treatment for patients.

Patients and Methods: This study consisted of 56 children aged between 1 and 16 years mean age 6.7 ± 4.3 years with renal and ureteric stones who underwent SWL. Incomplete child data were excluded from the study, leaving 47 patients. The procedure was performed under sedoanalgesia with diazepam and ketamine was given intravenously during SWL session. We study the effect of the following factors (age, site, size, opacity of stone, degree of pelvicalyceal dilation, previous urological surgery, number of shock waves, and number of sessions) on stone clearance after SWL.

Results: Forty-seven children range from 1 to 16 years, mean age 6.7 ± 4.3 years. There were 39 (83%) with renal stone and 8 (17%) with ureteric stone. The mean size of stone was 12.2 ± 4.4 mm ranging 6–25 mm. Of 47 children, 36 (76.6%) were stone-free. Age below 6 years, pelvic stones, children without surgery, number of shock waves, and number of sessions were significant factors that affect the stone-free rate after SWL, while the stone size, opacity, and calyceal system dilatation were not statistically significant factors.

Conclusions: The present analysis shows that stone-free status for children with urolithiasis depends on the age of presentation, previous history of ipsilateral stone treatment, stone location, and number of sessions. Pediatric lithotripsy under intravenous sedoanalgesia is feasible, general anesthesia is not mandatory, and any anesthetic complications were not encountered.

Keywords: Pediatric urolithiasis, sedoanalgesia, shock wave lithotripsy

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INTRODUCTION

The incidence of nephrolithiasis in children has increased rapidly in the past 25 years, producing a new population of pediatric patients at risk of kidney stone recurrence.[1,2] In spite of the popular use of shock wave lithotripsy (SWL), it is necessary to define which children with the stone disease would benefit from SWL treatment and the number of sessions required to achieve stone-free status.

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PATIENTS AND METHODS

This study consisted of 56 children aged between 1 and 16 years mean age 6.7 ± 4.3 years with renal and ureteric stones who underwent SWL. Nine children with incomplete data were excluded from the study, leaving 47 patients for evaluation. Demographic data of child with a urinary stone are shown in Table 1.

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Thirty-nine children (83%) with renal stone size range (6–25 mm) and 8 children (17%) with ureteric stone size range (6–15 mm).

Stone size was determined by measuring the longest diameter on plain abdominal radiograph and/or computed tomography (CT) for opaque and lucent stone, respectively. Before SWL evaluation of the patients included renal function tests, urinalysis and imaging evaluation included plain X-ray of kidney, ureter, and bladder (KUB) and abdominal ultrasonography for all children, intravenous urography and/or CT for selected cases. The exclusion criteria were stones >25 mm, coagulation disorders, pyelonephritis, and nonfunctioning kidney.

SWL was performed using (Siemens lithoskope) focal size is 12 mm, and focal depth is 160 mm. For all children, its localization system includes (isocentric fluoroscope for opaque stone and inline ultrasound for lucent stone).

Children were treated in the supine position for the renal and ureteral stones with the availability of over-table modality for ureteric stone [Figure 1].

SWL was done under sedoanalgesia was initiated with diazepam (0.2 mg/kg) given by intravenous route with ketamine (0.5–1 mg/kg) given intravenously. Plus intravenous fluid was given to enhance diuresis.

The level of sedation was assessed according to the modified Ramsay scale [Table 2].[3] When the score was 5 or 6, which was considered as satisfactory sedation, the procedure was initiated. Children were observed for ½ h after the end of SWL procedure for any adverse events.

Figure 1: A 9-year-old child with overtable shock head in prone position, under sedoanalgesia

SWL success was defined as stone-free status or the presence of clinically insignificant residual fragments smaller than 4 mm.[4,5]

Patients were evaluated 2 weeks after each session using US and/or KUB to assess fragmentation and obstruction, second SWL session was performed at least 2 weeks after the previous one. Patients were finally evaluated 3 months after the last lithotripsy session repeated sessions were done if significant residual fragments were observed. Only two patients had JJ stent pre-SWL.

In this study, we divided outcome of pediatric lithotripsy into

1. Stone-free group (no residual stone)
2. Residual group when there is residual fragments <4 mm
3. Nonresponding group c after three sessions.

Analysis of data was carried out, using Statistical Packages for Social Sciences- 22 version (IBM Corporation). The significance of difference of different percentages was tested using Pearson Chi-square test with application of Yate's correction or Fisher's exact test whenever applicable.

RESULTS

Mean age of –47 children was 6.7 ± 4.3 years, ranging 1–16 years; there were 39 (83%) with renal stone and 8 (17%) with ureteric stone all were treated with

Table 1: Demographic data of child with urinary stone

Parameter	*n* (%)
Age (years)	
<6	23 (48.9)
≥6	24 (51.1)
Mean±SD (range)	6.7±4.3 (1-16)
Gender	
Male	33 (70.2)
Female	14 (29.8)
Side	
Right	24 (51.1)
Left	23 (48.9)
Previous history of ipsilateral surgery	17 (36.2)
Open surgery	13 (76.4)
PCNL	3 (17.6)
URS	1 (6)

SD: Standard deviation, PCNL: Percutaneous nephrolithotomy, URS: Ureterorenoscopy

Table 2: Sedation Score (modified Ramsy score)

Sedation level	Description of clinical status
1	Fully awake, anxious
2	Calm, adequate cooperation
3	Arousable to verbal commands
4	Arousable to mild stimulation/vigorous reaction to painful stimuli
5	Slow/incomplete reaction to painful physical stimuli
6	No reaction to painful stimulus

extracorporeal shock wave lithotripsy (ESWL) under sedoanalgesia. The mean size of stone was 12.2 ± 4.4 mm ranging 6–25 mm.

Of 47 stones, 36 (76.6%) were stone-free. The mean number of sessions 1.6 ± 0.8. The mean number of shock waves per case delivered in several sessions was 3348. Complete stone fragmentation was achieved after one session in 22 children (84.6%), two sessions in 12 children (100%), three and more sessions in 2 children (22.2%) failure to break the stones after three sessions was recorded in 4 cases (8.5%).

We study the effect of the following factors (age, gender, site, size, opacity of stone, degree of pelvicalyceal dilation, previous urological surgery, number of shock waves, and number of sessions) on stone clearance after SWL on 47 children as outlined in Table 3.

Table 3: Factors affecting stone clearance after shock wave lithotripsy

Variables	Successful, *n* (%)	Residual stone, *n* (%)	Nonresponding, *n* (%)	*P*
Age (years)				
<6	21 (91.4)	1 (4.3)	1 (4.3)	0.019*
≥6	15 (62.5)	6 (25.0)	3 (12.5)	
Gender				
Male	23 (69.7)	6 (18.2)	4 (12.1)	0.086
Female	13 (92.9)	1 (7.1)	-	
Site				
Pelvic	23 (88.5)	1 (3.8)	2 (7.7)	0.010*
Calyx	6 (46.2)	6 (46.2)	1 (7.7)	
Ureteric	7 (87.5)	-	1 (12.5)	
Calyx				
Upper	3 (100)	-	-	-
Middle	1 (25.0)	3 (75.0)	-	
Lower	2 (40.0)	3 (60.0)	1 (20.0)	
Ureteric				
Upper	1 (100)	-	-	-
Lower	6 (85.7)	-	1 (14.3)	
Size (mm)				
≤10	21 (77.8)	4 (14.8)	2 (7.4)	0.826
11-15	11 (78.7)	2 (14.2)	1 (7.1)	
15-25	4 (66.6)	1 (16.7)	1 (16.7)	
Opacity				
Opaque	28 (75.7)	6 (16.2)	3 (8.1)	0.774
Lucent	8 (80.0)	1 (10.0)	1 (10.0)	
System				
No dilatation	12 (85.7)	2 (14.3)	-	0.383
Dilated	24 (72.7)	5 (15.2)	4 (12.1)	
Previous surgery				
With surgery	10 (58.7)	4 (23.5)	3 (17.7)	0.030*
Without surgery	26 (86.7)	3 (10.0)	1 (3.3)	
Number of shock waves				
≤3000	22 (84.6)	4 (15.7)	-	0.009*
>3000	14 (66.6)	3 (14.3)	4 (19.1)	
Number of sessions				
One	22 (84.6)	4 (15.4)	-	0.0001*
Two	12 (100)	-	-	
Three and more	2 (22.2)	3 (33.4)	4 (44.4)	

*Significant difference in proportions using Pearson Chi-square test at 0.05 level

Forty-seven children were included there were 23 (48.9%) below 6 years, and 24 above 6 years (51.1%). Stone free rate 91.4 % in children below six years old versus 62.5 % in those above 6 year old.

Age below 6 years, pelvic stones, children without surgery, number of shock waves, and number of sessions were significant factors that affect the stone-free rate after SWL.

While gender, stone size, opacity, and pelvicalyceal system dilatation were not statistically significant factors. All stones were treated without the presence of JJ stent apart from two patients who had stented pre-SWL.

We had 17 patients with previous urological surgery, 11 patients with pyelolithotomy, 3 patients had ureteric surgery including (ureterolithotomy, ureteric reimplantation, and ureteroscopy), and 3 patients had PCNL. All of them had ESWL on the ipsilateral side.

We had 4 children with 4 nonresponding stones (three renal stone and one lower ureteric stone) were treated by another modality (percutaneous nephrolithotomy or ureterosope).

All patients were monitored and treated for eventual complications during the first 3 months after SWL. SWL-related complications might be variable from skin petechiae noticed in five children, treated conservatively. Seven children with hematuria were treated by bed rest and hydration. We had three patients with urinary tract infection (UTI) treated conservatively with antibiotics did not need surgical intervention.

DISCUSSIONS

Extracorporeal SWL was introduced as a minimally invasive treatment for nephrolithiasis in the 1980s, with the first successful use in the pediatric population by Newman in 1986.[6]

In spite of the popular use of SWL, it is necessary to define which children with the stone disease would benefit from SWL treatment and the number of sessions required to achieve stone-free status. The ability to predict the effectiveness of ESWL is essential in determining the most appropriate treatment for patients.[7]

We study 56 children their age range from 1 to 16 years and mean age ± standard deviation (SD) 6.7 ± 4.3 nine children were excluded from the study due to incomplete data, the remaining number 47 children (33 boys and 14 girls) 23 children their age below 6 years, and 24 children above 6 years.

Efficacy of SWL is best measured by the stone-free rate, typically within 3 months of SWL therapy to allow time for passage of stone fragments. In a review of 22 pediatric SWL series, D'Addessi found that the stone-free rates mostly exceed 70% at 3 months.[8]

In this study, thirty-six (76.5%) of 47 children were the stone-free rate. We observed that age at presentation was a significant variable in predicting stone-free status after SWL. Age could be classified into two groups (below 6 years and above 6 years), with the highest probability of stone-free status for the younger age group (n = 21) 91.4% and the lowest probability for the older age group (n = 15) 62.5%.

The shock wave effect is stronger in younger children than older may be shorter length of ureter and greater distend ability and elasticity of it, in addition to the small size of the body, so shock waves reach with less energy loss, and they also quickly recover from SWL.[9]

Our finding consistent with Aksoy *et al*. found that children aged 0–5 years had the greatest stone-free rate and that children aged 11–14 years had the poorest outcomes.[10,11] While other study found stone-free rate also was higher in children with age group range from 1 to 6 than age group (7–15 years).[12]

We observed that stone-free rate was higher in pelvic stones 88.5% while lower stone-free rate in calyceal stone 46.2% that is consistent with a study by El-Nahas *et al*.[13]

We found that stone-free rate for ureteric stone (n: 8) was 87.5%. Pirincci *et al*. found that 3-months of stone-free rates in the upper, middle, and lower ureteral stones were respectively 93.5, 90, and 95.2% and that there was no difference between the stone-free rates of the three group.[14]

Regarding number of shock wave sessions were range from 1 to 4 with Mean ± SD 1.6 ± 0.8. Twenty-six children had one session, 12 had two sessions, and 9 had more than three sessions successful fragmentation were 84.6%, 100%, and 22.2% respectively. We found the highest fragmentation was achieved in the second session.

In our study, seven children had residual stones which were clinically insignificant, for follow-up only. We have four patients nonresponding to SWL after three sessions were treated by other modality.

The methods to enhance expelling of residual fragments in lower calyx by increase fluid intake and percussion on site of the kidney, in addition to reverse position.[15] Those children with a previous ipsilateral pyelolithotomy negatively impact on stone-free status that may be due to the effect of scarring might prevent good propulsive peristalsis and adequate contractions, resulting in subtle delays in urinary drainage which then can impede on the subsequent passage of the stone fragments after SWL.[8]

Stone-free rate was higher in lucent stones (80%) than opaque stone (75.7%), in addition, better fragmentation was found in children without pelvicalyceal system dilatation (85.7%) than dilated system (72.7%). These two factors were statistically insignificant. Our finding is consistent with da Cunha Lima *et al*.[10]

Numerous anesthetic methods have been utilized in children undergoing ESWL, but there is no conformity on the best anesthetic method to use during ESWL in pediatric patients.[16] In many studies, it has been shown that sedation and analgesia during painful procedures were given with equally good results by treating doctors.[17-19] In the present study, SWL done under sedoanalgesia (ketamine and diazepam).

Ketamine is a widespread used anesthetic agent in neonates and children due to its fast onset of action, short duration of action, and secure respiratory and hemodynamic profile.[20,21]

According to the American Society of Anesthesiologists theses medication can be administered by nonanesthetist.[17]

SWL-related complications might be variable from skin petechiae noticed in five children treated conservatively to hematuria in seven children treated by bed rest and hydration. We had three patients with UTI treated conservatively with antibiotics only not need surgical intervention.

Limitation in the present study was the absence of stone analysis. Depending on the patient's age, the chemical composition of the stone might be changed, which could affect the stone disintegration; however, such data were not integrated in this work.

CONCLUSIONS

The present analysis shows that stone-free status for children with urolithiasis depends on the age of presentation, previous history of ipsilateral stone treatment, stone location, and number of sessions.

Pediatric lithotripsy under intravenous sedoanalgesia is feasible, general anesthesia is not mandatory, and any anesthetic complications were not encountered.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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