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Original article

Comparison of efficacy and safety of ESWL in paediatric and adolescent versus adult urolithiasis: A single center 5-year experience from a tertiary care hospital

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KEYWORDS
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Abstract
Objective: To retrospectively compare the efficacy and safety of extra-corporeal shock wave lithotripsy (ESWL) for renal/upper ureteric calculi in pediatric/adolescents (group 1) vs adults(group 2).
Subjects and methods: Medical records of 948 patients who underwent ESWL for renal/upper ureteric calculi at a tertiary care center in North India from January 2012 to December 2017 (five years). The Dornier compact alpha-K1025163 (Dornier Med Tech) equipment was used for ESWL. We evaluated the stonefree rates, the number of ESWL sessions, use of ancillary procedures and complications between the two groups.
Results: A total of 110 patients were in group 1 and 838 patients were in group 2. The mean stone size in group 1 patients was $1.20 \pm 1.18\,cm^2$ while in group 2 it was $1.49 \pm 0.37\,cm^2$. The stone clearance rate was 85/110 (77%) for the group 1 and 545/838(65%) for group 2 patients. In group 1, a second session was required in 28/110 (25.4%) patients and the third session was required in 5/110 (4.5%) patients while in the adult group two sessions were required in 175 (20.8%) and three sessions were required in 24 (19.2%) patients. The overall complication rate in group 1 was 15/110 (13.63%) and in the group, II was 105/838 (12.5%). No statistical difference was found between post-ESWL complications and use of ancillary procedures (DJ stenting/PCNL) ($p = 0.067$).

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Conclusion: In renal/upper ureteric calculi ESWL has got better efficacy, comparable safety and requires equivalent ancillary procedures in children and adolescents compared to adults.

Introduction

Extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS) are accepted treatment modalities for renal/upper ureteric stones of size 1–2 cm in adults [1]. ESWL was described by Chaussey et al in 1980 for management of renal stones in adults and later on its first successful use in children was described in the year 1986 by Newmen et al. [2,3] ESWL works by fragmenting stones through shock waves that are produced by an external source (lithotripter) which propagate through the body and get focused on stone, it fragments stones and later on stone fragments are allowed to pass via the urinary tract. Although ESWL is widely accepted as first-line treatment modality there has been a decline in the use of this modality owing to the preferred use of endourological procedures like PCNL, ureteroscopy etc due to the high single stage treatment probability with these modalities. Few reports published in the past have shown that the efficacy of ESWL in children with stone-free rates is comparable with that of adults [4–6]. Recently one study also demonstrated the long-term safety of ESWL in children [7]. ESWL is widely available now and is an accepted minimally invasive tool for the management of renal stones in pediatric and adolescent patients [8]. However, despite previously available studies there is hesitancy in clinicians for use of ESWL in pediatric urolithiasis due to fears of potential dangers in growing children. To the best of our knowledge, there is only one study available which has compared the efficacy of ESWL in pediatric and adult urolithiasis [9]. In the present study we compared the efficacy and safety of ESWL in pediatric and adolescent age group (<18 years) and adults(>18 years).

Subjects and methods

The study was conducted at a tertiary care referral center in North India. The patient's records were retrospectively reviewed from January 2012 to December 2017.ESWL was performed on children aged ≤ 18 years (group 1) and adults aged >18 years (group 2) for urolithiasis. All patients underwent baseline evaluation including medical history, relevant physical examination, complete blood counts, kidney function tests, tests for coagulation, urine analysis and urine culture before the procedure. Assessment of stone size and location pre-operatively was done using plain X-ray KUB, intravenous urography (IVU), renal ultrasonography (USG), and/or contrast computed tomography scan (NCCT). Patients having longest stone diameter ≥2 cm on imaging, bleeding diathesis, active urinary tract infection with fever, pregnancy and nonfunctioning kidneys were excluded from the study. The Dornier compact alpha-K1025163 (Dornier Med Tech) equipment was used for ESWL. In case of adult kidney stones energy used varied between 5 and 7 kV, and for upper ureteric stones, it was between 5 and 9 kV. The energy level was kept lower in group 1 patients;for kidney stones it ranged from 2 to 4 kV while it was 3–5 kV kilovolts for ureteric stones. The energy level was gradually increased in pediatric age group. The approximate time for a single session of ESWL was approximately 45–55 minutes in adults, and around 45 minutes in children. ESWL was performed under mild sedation for all patients in group-II while general anesthesia (GA)/sedation was required for patients in group 1. Also, fentanyl 2–2.5 μg/kg was given for pain control. Fluoroscopy was used for stone localization. Most patients who were done under mild sedation were discharged on the same day of the procedure while patients done under GA were discharged on next day. Patients were asked to follow up after 2 weeks and were assessed with either X-ray KUB/USG to assess stone fragmentation and the requirement for any additional sessions/ancillary procedures. The additional sessions if required were given on a weekly basis. We evaluated the stone-free rates, the number of ESWL sessions, number of shockwaves used and use of ancillary procedures. The patients were also monitored for complications-hematuria, fever, sepsis, and steinesstrase. Success after ESWL was defined as either stone-free status (no evidence of residual stones in the imaging studies) or the presence of clinically insignificant residual fragments < than 3 mm at 3 months of follow-up. Failure of ESWL was defined as either non-reduction of stone size after three sessions of ESWL or presence of clinically significant residual fragments (>3 mm) after 3 months of follow-up [10,11].

Table 1 Patient demographics and clinical data.

Variable	Group-1	Group-2
No of patients	110	838
Male	88	570
Female	22	268
Age(Mean + SD)	14.81 ± 2.56	35.50 ± 13.27
Stone size(Mean ± SD)	1.20 + .18	1.49 ± 0.37
Stone location		
renal pelvis	52	435
calyceal	28	251
upper ureteric	30	152

Results

The baseline clinical and demographic characteristics of patients are depicted in Table 1. A total of 948 patients underwent ESWL out of which 110 patients were in group 1 and rest of the 838 patients were in group 2. The mean stone size in group 1 patients was $1.20 \pm 1.18\ cm^2$ while in group 2 it was $1.49 \pm 0.37\ cm^2$. The stone clearance rate was 85/110 (77%) for the group 1 and 545/838(65%) for group 2 patients (Table 2**).** In group 1, a second session was required in 28/110 (25.4%) patients and the third session was

Table 2 Assessment of outcomes.

Variable	Group-1	Group-2	p Value
Stone free rates	85/110(77%)	545/838(65%)	0.035
No of sessions(1/2/3)	77/28/5	502/175/161	
No of shockwaves(Mean + SD)	2877.89 ± 670.59	3525.33 ± 491.83	0.042
Ancillary procedures	14/110(13%)	91/838(10.8%)	0.067
a)PCNL	1	4	
b)DJ stenting	13	87	

Table 3 Post ESWL complications.

Variable	Group-1	Group-2	p Value
Mild Hematuria	6	45	0.02
Mild Fever	5	27	0017
Steinesstrase	2	15	0.001
Sepsis	2	18	0.001
Overall complications	15	105	0.067

required in 5/110 (4.5%) patients while in the adult group two sessions were required in 175 (20.8%) and three sessions were required in 24 (19.2%) patients. Post ESWL complications are depicted in Table 3. In group 1, the complications included steinstrasse in two patients (1.8%), fever in 5 (4.5%), hematuria in 6 (5.4%) and sepsis in two (1.8%) patients. In group 2 steinstrasse was found in 45 patients (5.3%), mild fever was diagnosed in 27 patients (3.1%), mild hematuria in 45 patients (5.3%) and sepsis was seen in 18 (2.1%) patients (Table 3) (Fig. 2). The overall complication rate in group 1 was 15/110 (13.63%) and in group II was 105/838 (12.5%). No statistical difference was found between post-ESWL complications between children and adults ($P > 0.05$). Ancillary procedures such as DJ stenting was done in 13 patients (11.8%) and PCNL was done after failure in one patient in group 1 while 87 patients (10.3%) underwent DJ stenting in group 2 and PCNL was performed for failure in four patients.

Discussion

In the present study, we included pediatric, adolescent and adult patients with renal, as well as upper ureteric calculus and these patients, underwent stone fragmentation with ESWL. The decision to undergo ESWL in these patients was based on urologist's discretion and after obtaining well informed bilingual consent from the patient/relatives after explaining them the results and complications of ESWL and other modalities available for stone fragmentation in their case. After the first use of ESWL was done in 1986 in children various published case series have shown promising results in children as well as an adult population with stone-free rates >80% percent in the pediatric population [3–6]. The success rates of other modalities such as ureteroscopy vary between 80 and 100% while for PNL the reported success rates in children have been reported to be 79–88% [12–16]. There are concerns with other modalities such as risks of postoperative bleeding, blood transfusion requirements with PNL and risks of urethral and ureteric injury, developing future vesicoureteric reflux (VUR) associated with ureteroscopic removal of stone due to ureteric orifice dilatation which is mostly required in all paediatric cases due to small diameter of urethra and ureter in children. Despite the suspected risks and anticipated complications associated with other modalities and various case series depicting good stone-free rates with ESWL, it has not become popular in the pediatric population. The results of the present study depict that children and adolescents have a better stone-free rate (77%) than adults (65%) population which were statistically significant($p < 0.05$). The results of this study are similar to the study done by Iqbal et al in which the authors have shown that children can achieve high stone-free rates after ESWL with a lower need for repeat ancillary procedures as compared to adults [9]. The authors reported statistically significant stone-free rates(79% in children vs 68% in adults; $p = 0035$) with 12.5% children requiring ancillary procedures like DJ stenting compared to 29% in adults. The definition used for stone-free status used in this study is stone size on imaging <4 mm [9]. The criteria used in our study for demonstrating stone-free rates was documenting stone fragment size <3 mm on X-ray KUB and USG with no infection at 3 months follow up. However, there is no concrete definition of stone-free status after ESWL in children. Thus ancillary endourological procedures should be reserved for patients who fail treatment with ESWL or have contraindications to ESWL owing to higher safety profile and comparable success rates. Residual stones after surgery have been found to be a nidus for the further stone formation and they have been found to mature serially [14,15]. The results of the present study showed that children and adolescents have lesser re-sessions of ESWL (29.8%) compared to adults (40%). Children tend to have shorter skin to stone distance, small body surface area and softer stones as compared to adults which might result in increased stone clearance in this subset of patients. However, there was a difference between in numbers of shock waves used in both group patients as more amount of shockwaves were required for adequate stone clearance in group 2 patients(adult group) in the present study. The overall complications were comparable in both the groups (13.2% in group 1 vs 11.2% in group 2). The results of the present study indicated that ESWL in children has few complications similar to that of study by Defoor et al. and Rhee et al. [17,18]. On study suggested that the harmful effects of ESWl on paediatric kidney can be decreased by reducing the energy and number of shockwaves given to the kidney [19]. The present study was a retrospective analysis done by a single center only which limits the applicability of this study to a wider population in a different geographical region. We did not include any patients less than 10 years of age and also no age-specific comparisons were done. We could not perform metabolic stone workup and stone analysis in all the patients as this could have thrown further insight on the efficacy of ESWL in different stone composition subtypes. However, the results from this study cannot be ignored.

Conclusion

In renal/upper ureteric calcului ESWL has got better efficacy, comparable safety and requires equivalent ancillary procedures in children and adolescents compared to adults.

Conflict of interests

No conflict of interest was declared by the authors.

Authors contribution

1. Dr. G Garg — Concept, design, supervision, processing, writing manuscript and critical analysis.
2. Dr. A Aggarwal — Concept, design, supervision, processing, writing manuscript and critical analysis.
3. Dr. M Singh — Supervision, processing, writing manuscript and critical analysis.
4. Dr. S N Sankhwar — Concept, supervision, writing manuscript and critical analysis.
5. Dr. S Pandey — Concept, supervision, writing manuscript and critical analysis.
6. Dr. D Sharma — Concept, supervision, writing manuscript and critical analysis.

Ethical Committee Approval

Ethical clearance was taken from local institutional ethics committee.

Consent from the patient

A written informed consent was obtained from the all the patient's/relatives.

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