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Original Research Article

Study to Evaluate the Feasibility, Stone-Free Rate, and Complications of RIRS in Children <5 Years of Age

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Abstract

Aim: The aim of the present study was to evaluate the feasibility, stone-free rate, and complications of RIRS in children <5 years of age.

Methods: All children less <5 years of age with a stone size <2 cm (renal/proximal ureteric), who underwent RIRS for the period of three years were included in this retrospective study. A total of 100 children with 64 renal units met the inclusion criteria. From our hospital database, demographic data, complete history, clinical examination findings, laboratory reports of complete hemogram, serum biochemistry, urine analysis, and urine culture were retrieved.

Results: A total of 100 pediatric patients were evaluated, out of whom, 8 had bilateral renal stones (108 renal units). Out of these 100 renal units, 8 patients had multiple stones in the same renal unit. The youngest child was a 4-month-old boy who presented with anuria due to bilateral upper ureteric stones. The most common location of the stone was the pelvis and the lower pole. Stones were most commonly of the mixed composition (46%), followed by calcium oxalate dihydrate (22%). UAS 9.5/11.5 Fr could be successfully inserted only in 60 out of 100 renal units (60%) even after prior stenting.

Conclusion: Pediatric RIRS is a promising option in young children as it offers an acceptable stone free rates and a low incidence of high grade complications. However, it requires expertise and should be offered at tertiary care centres.

Keywords: Children; Renal stone; Retrograde intrarenal surgery; Ureteroscopy

Introduction

Previous epidemiological studies have shown that the kidney stone incidence rate has risen. Besides, we found that pediatric patients were at high risk for kidney stone disease. Meanwhile, the risk of kidney stones in younger children was related to diabetes mellitus and hypertension. Simultaneously, the little girls likely suffered from kidney stone disease. [1,2] RIRS (Retrograde Intrarenal Surgery, RIRS) is one of the primary measures to dispose of kidney stone disease in children. Compared with PCNL, RIRS has the advantage that it uses a natural orifice, which t requires no additional pathway for lithotripsies. For a child who suffers from kidney stones, RIRS can be a good option as the entrance of RIRS surgery is a natural pipeline of the human body which is smaller, the treatment is safer, and RIRS is more conducive to postoperative recovery. Nevertheless, during the operation of the RIRS for kids, the usage of sizeable medical instruments and the low-quality optics technology raise the possibility of the development of ureter ischemia, ureter injury, ureter stenosis, and reflux from the bladder and ureter. [3]

PCNL is a frequently-used therapeutic option for pediatric kidney calculi. There are various types of PCNL, including standard PCNL (24–30 Fr), mini-PCNL (16–18/20 Fr), ultra-mini PCNL (11–14 Fr), micro-PCNL (<10 Fr), etc. PCNL is suitable for more giant stones. If we select using the Mini-Micro PCNL, the instrument can enter the renal cortex under the condition of direct vision. Besides, the expansion can be avoided after entering the renal cortex. Consequently, the operative time can be shortened, the radiation exposure can be decreased, and the complications, including hemorrhage and perforation, which were connected with expanding of the urinary tract, can be averted. [4,5]

SWL has been the preferred method for the treatment of <2 cm stones in children. Noninvasive SWL has major setbacks such as the need for anesthesia, multiple sessions, and steinstrasse requiring additional intervention. The significantly lower stone-free rates (SFR) of SWL as compared to the PCNL and RIRS and the possibility of parenchymal damage to the growing kidney are the major limitations of SWL. [6,7] A recent meta-analysis by Chen et al. found pediatric PCNL to have significantly higher overall complications, high number of high-grade complications, and a greater need of blood transfusions as compared to the RIRS. [8]

The acceptability and utilisation of the mini, ultramini and the micro PCNLs is on the rise and the complication rate of these procedures is comparable with the RIRS and is significantly low. Nevertheless, the complications such as the risk of bleeding requiring transfusion, pleural and visceral injury, although low, have not been completely eliminated, even with the miniaturized PCNLs. [9-12]

The aim of the present study was to evaluate the feasibility, stone-free rate, and complications of RIRS in children <5 years of age.

Materials and methods

All children less <5 years of age with a stone size <2 cm (renal/proximal ureteric), who underwent RIRS at Multiple Hospital for the period of three years were included in this retrospective study. A total of 100 children with 64 renal units met the inclusion criteria. From our hospital database, demographic data, complete history, clinical examination findings, laboratory reports of complete hemogram, serum biochemistry, urine analysis, and urine culture were retrieved.

Ultrasonography and X-ray findings of the kidney, ureter, and bladder were collected. Either intravenous pyelogram or computed tomography (CT) was performed in all cases. Diuretic renogram was obtained whenever thinned parenchyma with hydronephrosis was noted. Stone size was defined as the maximum diameter of a solitary stone or as the sum of the maximum diameters of all the stones in cases with multiple stones. All the patients submitted a preoperative urine culture. Children with positive results were treated according to the antibiogram and were taken up for RIRS after cultures turned sterile. Preoperative antibiotic cefotaxime 100 mg/kg was administered to all the cases 30 min before the procedure. All procedures were performed under general anesthesia. A 3.5 Fr, 16 cm double J (DJ) stent was placed in all the children 12 days before the surgery for passive dilatation of the ureter. If required, female urethra was dilated up to 12 Fr and the male external meatus was dilated up to 10 Fr with Hegar dilators. We performed cystoscopy, removed the DJ stent and then performed semirigid ureteroscopy with a 6.5 Fr (Richard Wolf, Germany) scope to assess the distensability of the ureter before the insertion of ureteral access sheath (UAS) and also to deal with the upper ureteric stones (to push it back in to the kidney). Upper ureteric stones which could be managed with semirigid ureteroscopy were not included in the study. Terumo Guidewire 0.038" (Glidewire®; Terumo, Somerset, NJ, US) was placed into the pelvis. UAS (9.5/11.5 Fr, 28 cm, Cook, USA) was placed only if it glided over the guidewire without any resistance. If any resistance was encountered, then the flexible ureterorenoscope (Flex X2, Storz or P6, Olympus) was back loaded over the guidewire, without the access sheath. When sheath less RIRS was performed, the bladder was drained by continuous suprapubic aspiration with an 18 G Intravenous cannula.

Holmium laser lithotripsy (30 W, Quanta) was performed with a 200 μ laser fiber (Quanta system Q1, Italy) using dusting and popcorn modes with appropriate LASER settings (frequency 5–12 HZ and energy 0.5–0.8 J). Lithotripsy was continued until the stone was completely powdered to a size small enough to pass spontaneously. Irrigation was done using a 50 ml syringe by a trained technician, depending on the visibility. Basket (N circle, nitinol stone extractor 2.2 F 115 cm basket; Cook Medical, Bloomington, IN, USA) was used primarily to relocate the stone to the most accessible calyx or to remove one of the last fragments for stone analysis. At the end of the procedure, retrograde pyelography and rigid or flexible ureteroscopy were performed in all the cases to detect any residual stones, intra/extravasation or ureteric injury. A 3.5 Fr, 16 cm DJ stent was placed in all the cases. All bilateral stones were taken up for RIRS in a staged manner, with the contralateral side operated a few weeks later, except in one child who presented with anuria which we have published. Postoperatively, the children were closely monitored with the help of the pediatrician and the intensive care pediatric anesthetist. If there were no complications, the patients were discharged on the 2nd postoperative day. Any child with fever was evaluated. Children with temperature more than 38°C, elevated total leukocyte counts, and elevated C-reactive protein levels were treated with higher antibiotics as per the hospital antibiogram. Postoperative complications were identified and graded according to the Clavien–Dindo system. [13]

Stents were removed under general anesthesia 2 weeks after the surgery. Children were followed at 2 months after surgery with an ultrasound KUB to detect residual stones which was repeated every 6 months to detect delayed complications or recurrence. Residual stones ≥2 mm at the end of 2 months were considered to be significant and were classified as a treatment failure when calculating the stone-free rate. Children with complete clearance of stones underwent metabolic evaluation. [14]

Statistical analysis was performed with the SPSS software version 24 (Statistics for Windows, IBM Corp, Armonk, NY, USA). Descriptive analysis was described as percentages and mean with standard deviation. Univariate and multivariate analyses were performed to predict the residual stones and complications using the variables. $P < 0.05$ was considered to be statistically significant.

Results

Table 1: Demographic and stone details

Variables	N%	Mean±SD
Age (months)		
0-12	5 (5)	43.17±13.7
13-24	5 (5)	
25-36	21 (21)	
37-48	31 (31)	
49-60	38 (38)	
Gender		
Male	75 (75)	
Female	25 (25)	
Side (n=108)		
Right	40 (37.05)	
Left	60 (55.55)	
Bilateral	8 (7.40)	
Weight (kg)	Range (6-16.3 kg)	13.31±1.9
Number of renal units with		
Single stone	100	
Multiple stone	8	
Stone location (n=120)		
Pelvis 56 (37.8)	48 (60)	
Upper ureter 24 (16.2)	20 (16.66)	
Upper calyx 14 (9.4)	12 (10)	
Middle calyx 20 (13.5)	18 (15)	
Lower calyx 34 (22.9)	22 (18.34)	
Stone size (mm)	Range (7.3-18.2)	11.9±2.7
HU		920.4±420.1

A total of 100 pediatric patients were evaluated, out of whom, 8 had bilateral renal stones (108 renal units). Out of these 100 renal units, 8 patients had multiple stones in the same renal unit.

Table 2: Operative and postoperative details

Variables	Range	Number of cases (%)	Mean±SD
Operative time (min)	37.3-80.8		56.4±11.6
Lasering time (min)			43.6±16.4
Access sheath used in (n=100)		60 (60)	
Hospital stay (h)	40.4-83.2		62.2±12.4
Successful retrograde ureteral access failure (n=108)		6 (5.55)	
Residual stone ≥2 mm (n=59)		18 (15.3)	
Stone free rate (n=59)		90 (76.3)	
Stone composition			
Calcium oxalate monohydrate		14 (14)	
Calcium oxalate dehydrate		22 (22)	
Uric acid		18 (18)	
Mixed type		46 (46)	
Metabolic abnormalities			
Hypocitratuira		10	

Hypercalciuria		6	
Intraoperative complications where RIRS was done (n=100)			
Ureteric damage			
Grade 1		2 (2)	
Grade 2		2 (2)	
Postoperative complications (n=100)			
G1		28 (28)	
G2		4 (4)	
G3a		0	
G3b		6 (6)	

The youngest child was a 4-month-old boy who presented with anuria due to bilateral upper ureteric stones. The most common location of the stone was the pelvis and the lower pole. Stones were most commonly of the mixed composition (46%), followed by calcium oxalate dihydrate (22%).

Table 3: Access sheath placement according to age distribution

Age months	Number of cases	Access sheath used in (%)
0-12	4	0
13-24	8	2
25-36	24	10
37-48	40	16
49-50	44	32
Renal units	100	60

UAS 9.5/11.5 Fr could be successfully inserted only in 60 out of 100 renal units (60%) even after prior stenting.

Discussion

Stone disease is an important reason of morbidity worldwide. Its prevalence has increased in recent years both in adults and children. [15,16] Thanks to the technological developments, popularity of retrograde intrarenal surgery (RIRS) in treatment of stone disease has increased gradually. Nowadays, RIRS has become nearly the standard treatment option in the surgical treatment of kidney stones in adults. [17,18] Similarly, the improvements in available instruments have created an increasing trend of RIRS in children. However, the instrument size may limit the success rate of RIRS in children due to the anatomical variations between adults and children. [19] In the last decade, technological advancement and miniaturization of instruments have changed the management of urinary stone disease. Since the initial report, percutaneous nephrolithotomy (PCNL) has become accepted as a well-established, minimally invasive procedure in children and adults. However, PCNL may present problems in infants and preschool-age children because of the small size and mobility of the pediatric kidney, friable renal parenchyma, and the small size of the collecting system. Small-volume, nonstaghorn stones can be effectively managed with the retrograde intrarenal surgery (RIRS) with good outcomes without the need for open surgery or PCNL. With increasing experience of RIRS in adults, recently, a few reports of successful ureterorenoscopic management of renal stones in children have been published. [20-22]

A total of 100 pediatric patients were evaluated, out of whom, 8 had bilateral renal stones (108 renal units). Out of these 100 renal units, 8 patients had multiple stones in the same renal unit. The youngest child was a 4-month-old boy who presented with anuria due to bilateral upper ureteric stones. The most common location of the stone was the pelvis and the lower pole. UAS 9.5/11.5 Fr could be successfully inserted only in 60 out of 100 renal units (60%) even after prior stenting. There are many recent studies in the literature describing the feasibility and safety of RIRS in children. [20,23,24] However, only a few studies describe the outcomes of RIRS in a cohort like ours. Smaldone et al. [23] and Kim et al. [24] have published their results in 100 cases. Both these groups combined semirigid ureteroscopy and flexible ureteroscopy, so they included a smaller cohort of RIRS as compared to our study. Also, they included children above 10 years of age, in whom the technical aspects of RIRS are similar to that of the adults. We have restricted our study to children <5 years (anatomically smallrt ureters and urethrae) to assess the feasibility and outcomes of RIRS in this population.

Erkurt et al. [25] have described RIRS in 65 children who were not routinely pre-stented. They placed an access sheath in 61.5% of the cases and noted two ureteric wall injuries due to the sheath placement. Berrettini et al. [26] had placed an access sheath in 15 out of 16 children weighing <20 kg and have reported ureteral perforation in 1 case. We were able to pass the access sheath in 60% (40 out of 50 cases) and noted two ureteric injuries Grade 1 and Grade 2 according to classification described by Traxer and Thomas. [27] Both these cases were managed with prolonged DJ stenting for 4 weeks. At follow-up for a mean period of 32 months, these two cases did not reveal any ureteric stricture, which we attribute to the prior stenting. We had a stone-free rate of 76.3% (45 out of 59 cases). Lower stone-free rates were reported in the systematic review by Ishii et al. [28] where the mean (range) stone burden was 9.8 (1–30) mm and the mean (range) SFR was 87.5 (58%–100%) after the initial therapeutic URS. A similar systemic review by the same authors Ishii et al. [29] which had a mean age of 7.3 years reported the mean stone-free rate across the three studies of 85.5% (range 58.0%–93.0%) after the initial ureteroscopy. We aimed for complete powdering of the stone, small enough to pass spontaneously. Repeated basketing of the stone fragments is cumbersome more so if the access sheath is not used. We used basket only for stone relocation or stone removal for the analysis at the end of the procedure. Children with residual stones, more than 6 mm (n = 4) underwent relook RIRS, but we did not include them in the analysis of the present study to assess the outcomes of primary RIRS.

Postoperative complications seen in our study were comparable to most of the pediatric case series. Erkurt et al. [25] had reported an overall complication rate of 27.7% but they did not use the Clavien system, and long-term follow-up was not available. Berrettini et al. [26] had studied the use of access sheath in RIRS for children <20 kg. The complication rate was 37.7%, out of which, only 18.8% were of Clavien grade I. We too had an overall complication rate of 38% and a higher proportion (28.5%) of Grade I complications. In the systematic review by Ishii et al. [28], a higher complication rate (24.0 vs. 7.1%) was observed in children whose mean age was <6 years. Stones were most commonly of the mixed composition (46%), followed by calcium oxalate dihydrate (22%).

Conclusion

Pediatric RIRS is a promising option in young children as it offers an acceptable stone free rates and a low incidence of high grade complications. However, it requires expertise and should be offered at tertiary care centres.

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