Original Article

Pediatric retrograde intra-renal surgery for renal stones <2 cm in solitary kidney

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ABSTRACT

Introduction: Management of renal stones in children with a solitary kidney is a challenge. In the current study, the efficacy and safety of retrograde intrarenal surgery (RIRS) in these children were determined.

Patients and Methods: Records of children with renal stones who were treated at our institute between August 2011 and August 2014 were retrospectively assessed. Inclusion criteria were: Children with single renal stone <2 cm size, in a solitary kidney. A 7.5 Fr flexible ureteroscope (FURS) was introduced into the ureter over a hydrophilic guidewire under visual and fluoroscopic guidance - applying a back-loading technique. The stone was completely dusted using 200 μm laser fiber (0.2–0.8 joules power and10–30 Hz frequency). At the end of the maneuver, a 5 Fr JJ stent was inserted into the ureter. The children were discharged home 24 h postoperative - provided that no complications were detected.

Results: Fourteen children (3 girls and 11 boys) with median age 9.5 years (range 6–12) were included. The mean stone burden was 12.2 ± 1.5 mm (range 9–20). Stones were successfully accessed in all of the cases by the FURS except for 2 cases in whom a JJ stent was inserted into the ureter and left in place for 2 weeks to achieve passive dilatation. All of the stones were dusted completely. The immediate postoperative stone-free rate (SFR) was 79%, and the final SFR was 100% after 3 weeks. No intraoperative complications were observed.

Conclusions: RIRS for renal stone <2 cm in children with a solitary kidney is a single-session procedure with a high SFR, low complication rate, and is a minimally invasive, natural orifice technique.

Key words: Pediatric, solitary kidney, stone

INTRODUCTION

The management of renal stones in children with a solitary kidney is challenging to urologists. Complete clearance of the stones is mandatory to avoid urinary tract obstruction; however, this must be done with minimal manipulation to avoid any damage to nephrons in these vulnerable patients. Over the past few decades, percutaneous nephrolithotomy (PNL) and shock wave lithotripsy (SWL) have been used for the treatment of renal stones in patients with solitary kidney. PNL is associated with a high stone-free rate (SFR). However, it is an invasive and morbid procedure, and can be associated with serious complications including urosepsis, pelvicalyceal perforation, and severe blood loss.[1,2] The compensatory hypertrophy that occurs in patients with solitary kidney might increase the risk of bleeding during PNL.[3] SWL is another effective treatment modality for renal stones; however, it can be associated with steinstrasse,[4] and renal tissue injury that might result in impairment of renal function[5] with up to 22% reduction in glomerular filtration rate (GFR) on long-term follow-up.[6] However, some other reports suggested that SWL can be used safely in patients with chronic renal insufficiency.[7,8]

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Retrograde intrarenal ureteroscopy (RIRS) has been reported as an effective, and safe procedure in the management of renal stones <2 cm in adult patients with a solitary kidney.[9,10] In the current study, we evaluate the safety and the efficacy of RIRS in the management of renal stones <2 cm in children with a solitary kidney.

PATIENTS AND METHODS

Patients

Records of children with renal stones, who were admitted to our institute between August 2011 and August 2014, were retrospectively scrutinized. Inclusion criteria were: Children <18-year-old with solitary kidney, who had renal stones <2 cm in size.

All patients underwent serum creatinine assessment, urine analysis, urine culture and sensitivity (C/S), abdominal ultrasonography, plain X-ray kidney-ureter-bladder (KUB), and intravenous urography (IVU). Non-contrast computed tomography (NCCT) was performed in patients with radiolucent stone on X-ray KUB and uremia.

Twenty-four hours postoperatively, serum creatinine measurement, plain X-ray KUB, and abdominal ultrasonography were performed. The child was discharged home thereafter provided that there was no complication. The parents of the child were asked to collect the child's urine to look for stone fragments. The JJ stent was removed 3 weeks postoperatively using cystoscopy under anesthesia. Another follow-up serum creatinine, X-ray KUB, and abdominal ultrasonography were performed 6 weeks and 3 months postoperative.

The primary outcomes of this study were stone free rate (SFR) and renal function.

Operative technique

All patients received a single shot of preoperative IV ceftriaxone 100 mg/kg. Under general anesthesia, the child was placed in lithotomy position. A diagnostic urethrocystoscopy was performed using a pediatric 7 Fr cystoscope. A 0.025 Fr guidewire was inserted into the ureter. Ureteral dilatation was performed using 6 and 8 Fr teflon dilators and the guide wire was replaced by 0.035 Fr. hydrophilic BiWire. No access sheath was used in any of the patients. A 7.5 Fr flexible ureteroscope (FURS) (Storz FLEX X2, Karl Storz, Tuttlingen, Germany) was introduced into the ureter applying a back-loading technique over the BiWire under visual and fluoroscopic guidance. In the case of any resistance on inserting the ureteroscope, a 5 Fr JJ stent was inserted into the ureter and left in place for 2 weeks to achieve passive ureteral dilatation. After 2 weeks, a second attempt of FURS was performed. On introducing the ureteroscope, the ureter, and the entire pelvicalyceal system were assessed. Once the stone location was identified, a 200 μm holmium laser fiber was inserted. Stone dusting was done applying 0.2–0.8 joules power at 10–30 Hz frequency. This was mandatory to ascertain complete stone dusting and not fragmentation. At the end of the maneuver, the entire pelvicalyceal system was visually assessed for any residual stone fragments. On removal of the FURS, the entire lumen of the ureter was assessed to detect any potential trauma to the ureter. At the end of the procedure, a 5 Fr JJ stent was inserted into the ureter and left in place for 3 weeks.

Values are presented in the manuscript as mean ± standard deviation, median (range), or percentage (%).

RESULTS

Fourteen children (3 girls and 11 boys) with renal stones in a solitary kidney were included in the study. The median age of the study group was 9.5 years (range 6–12). Some of the children presented with more than one symptom. Three of the 14 patients presented with obstructive anuria that were managed by inserting a JJ stent into the ureter at the emergency unit. Seven children presented with visible, painful hematuria. Eight children presented with flank pain. Three children presented with urosepsis and were started immediately on antibiotics on empirical basis. The stone was single in all cases. It was located in the right kidney in 9 cases, and in the left kidney in 5 cases. The stone was located in the renal pelvis in 11 cases, upper calyx in 2, and lower calyx in one case. The mean stone burden was 12.2 ± 1.5 mm (range 9–20 mm). Five cases had previous intervention: 2 cases underwent previous open renal surgery for stone disease, and 3 cases underwent stent placement for the obstructive anuria (2 of them underwent failed SWL session). Urine C/S was positive in 5 cases for whom the proper antibiotics were administered preoperatively, but no follow-up C/S tests were done for these patients.

All stones were successfully accessed by the FURS apart from 2 patients in whom a JJ stent was inserted into the ureter and left in place for 2 weeks to achieve passive dilatation of the ureter to facilitate the introduction of the FURS later during the second attempt. All of the stones were dusted completely including the lower calyceal stones which were also successfully dusted *in-situ* without any need for relocation. At the end of the procedures, no significant stone fragments were detected in the entire pelvicalyceal system, apart from some negligible stone fragments. The mean operative time was 45.2 ± 18.5 min. Abdominal ultrasonography and plain X-ray KUB were done 24 h postoperative and revealed some fragments in 3 of the 14 cases (79%). However, 3 weeks later, the 3 cases became completely free of fragments. Thus, the initial SFR was 79% (postoperative day 1) and then it reached 100% after 3 weeks. No intraoperative complications were observed in any of the 14 children. All children were discharged home

24 h postoperative. One child developed urosepsis with a fever that was completely cured after receiving an IV antibiotic for 72 h. All of the cases had normal preoperative serum creatinine (normal range 20–70 μmol/L). In two of the 14 cases, a slight rise in postoperative serum creatinine was observed (0.1 and 0.2 mg, respectively). Serum creatinine returned to its normal value 1 week postoperative. All JJ stents were removed 3 weeks postoperative. Noureteric obstruction (significant fragments or ureteral stricture), anuria, or fever was observed in any of the children during the first 3 months postoperative. The stone fragments analysis revealed uric acid composition in 3 cases, calcium phosphate in 2, and calcium oxalate in 9 cases.

DISCUSSION

PNL and SWL are currently the standard approaches for the treatment of renal stones >2 cm in size. Both procedures are associated with adverse events. PNL can lead to intraoperative massive bleeding.[1,2] The risk of bleeding and need for blood transfusion is even higher in patients with solitary kidney due to a compensatory increase in renal parenchymal thickness.[3] Moreover, excessive bleeding may result in the formation of blood clots that may result in obstruction of the urinary passage while passing down the ureter, which poses a major risk in children with solitary kidney.[9] SWL is less invasive; however, it has a lower SFR especially in hard stones.[11] Consequently, children might undergo two or more SWL sessions, under anesthesia, to clear their renal stones which is an unfavorable issue in the pediatric population.[12] Moreover, although SWL is a noninvasive procedure, some complications have been reported such as the formation of steinstrasse,[4] renal scars formation,[13] and potential reduction in GFR on long-term follow-up.[6] Therefore, endo-urologists have been investigating the application of a third approach that combines the criteria of minimal invasiveness and high SFR. RIRS has been reported to be effective and safe procedure in the management of renal stones <2 cm in adult patients with a solitary kidney.[9,10]

To our knowledge, this is the first study that investigates the efficacy and safety of RIRS in children with solitary kidney. Our study aimed to achieve the highest SFR with minimal manipulation in 14 children with renal stones in a solitary kidney. The ureteroscope was passed easily in 12 of 14 cases (85%). In 3 of 12 patients in whom the ureteroscope was successfully introduced in the first attempt, a JJ stent was in-place due to preoperative obstructive anuria.

We used holmium laser lithotripsy to perform stone dusting and not stone fragmentation. Consequently, there was no need to manipulate any stone fragments in any of our patients. We believe that this was a success key in our series. It has been reported that the use of access sheath in adults was associated with a severe ureteric smooth muscle injury in up to 13% of cases.[14] To reduce the risk of complications related to the use of access sheath, we started 11 of the 14 procedures with active dilatation of the ureters using 6 Fr. and 8 Fr. teflon dilators. In the other three patients, active dilatation was not necessary because they already had JJ stents due to previous obstructive anuria. Moreover, A 7.5 ureteroscope was used in our study. Therefore, there was no need to use access sheath in any of the 14 procedures.

In our series, initial SFR 79% was achieved. This is comparable to results obtained from other studies in which RIRS was used for the management of renal stones in children with two kidneys. In these studies, the initial SFR ranged from 83% to 88.5%.[15,16] Using FURS in treatment of renal stones in children, Erkurt *et al.*[15] reported 27% complication rate (ureteral perforation, UTI, and hematuria), while Unsal and Resorlu[17] reported 31% complication rate (ureteral perforation, voiding disturbances, and abdominal pain) in their series [Table 1]. Only 1 of our 14 patient (7%) developed UTI that improved after administration of the proper antibiotic. The average operative time in our series was 45 min this was comparable to the average operative time reported in other studies in children with two kidneys (46–52 min).[15,16] We can explain the absence of any major complication in our series by careful patient selection, using active dilatation before introducing the small sized FURS, complete dusting of the stones. Above all, insertion of a JJ stent for 3 weeks postoperative helped avoid the occurrence of postoperative anuria as a result of ureteric instrumentation.

PNL and SWL are efficient modalities for treatment of renal stones. However, we believe that RIRS would be the ideal modality for renal stones in children with solitary kidney. Conservative treatment modality could be associated with risk of developing obstructive anuria at any stage during follow-up while SWL might be associated with risk of developing steinestrasse.

All of our cases were managed in a single session procedure. Resorlu *et al.*[18] reported a need for an auxiliary procedure including SWL in 4 cases and a repeated RIRS in another 4 cases in their series. This might be explained by the relatively large stone size (up to 3 cm) in their series. Table 1 presents a comparison of patients' demographics, stone criteria, and techniques between our series and other studies where RIRS was used for the management of renal stones in children with two kidneys.

Our approach has many advantages: RIRS for renal stones in children with a solitary kidney is an effective treatment modality and has a low complication rate. In addition, the visibility throughout the procedures was excellent. Above all, RIRS resulted in a high SFR. The drawbacks of our study are the small number of patients, limiting of the stone size to 2 cm, and the short follow-up period that

Table 1: Surgical outcomes of previous studies applying retrograde intra-renal surgery in treatment of renal stones, including the current series

Parameter	Current series	Erkurt *et al.*[15]	Abu Ghazaleh *et al.*[16]	Unsal and Resorlu[17]
Type of study	Retrospective	Retrospective	Retrospective	Retrospective
Duration (years)	3	8	2.5	5
Number of patients	14	65	56	16
Gender				
Male	11	31	38	9
Female	3	34	18	7
Age (year) mean±SD (range)	9±1.5	4.3±2 (0-7)	8.2 (6-14)	4.9 (1-7)
Solitary kidney	All	0	0	0
Stone size (cm) mean±SD (range)	1.2±0.15 (9-20)	1.4±0.6 (0.7-3)	1.2 (0.9-1.5)	1.1 (0.8-1.7)
Side, *n* (%)				
Right	9 (64)	29 (44)	?	6 (37.5)
Left	5 (36)	36 (55)	?	9 (56)
Bilateral	None		12 (21)	1 (6.3)
History of failed SWL, *n* (%)	2 (14)	17 (26)		16 (100)
Location of stone, *n* (%)				
Upper calyx	2 (14)	10 (13.9)	6 (10.7)	3 (17.7)
Middle calyx	No	12 (16.7)	4 (7.2)	4 (23.5)
Lower calyx	1 (7)	28 (38.9)		5 (29.4)
Pelvis	11	22 (30.5)	34 (60.7)	5 (29.4)
Mixed			12 (21.4)	
Unspecified				
Dilation, *n* (%)				
Active	9 (64)	0	0	5 (29.4)
Passive	5 (36)	17	100	37
UAC attempted, *n* (%)	None	65 (100)	"-"	3
UAC successful, *n* (%)	None	40 (61.5)	"-"	3 (17.6)
Operative time (min) mean±SD (range)	45.2±18.5	46.7±18.3	"-"	52 (30-85)
Hospital stay (days) mean±SD (range)	All cases discharged after 24 h except one case that get feverish stayed 72 h	1.5±1.4 (1-8)		2.1 (1-4)
Initial success (%)	79	83	88.5	88
Complications, *n* (%)	1 (7)	18 (27)	4 (5.6)	5 (31)
Complication type				
Ureteral perforation	No	2 (3) Calvien Grade III Calvien Grade III		1 (6)
UTI	1 (7)	10 (15.4) II	3 (3.9)	
Hematuria	No	6 (9.2) CGI	1 (1.7)	
Abdominal pain	No			2 (12.5)
Voiding disturbances	No			2 (12.5)
Nausea and vomiting	No			

SD=Standard deviation, SWL=Shock wave lithotripsy, UTI=Urinary tract infection, UAC=Umbilical artery catheter, CG=Calvien Grade

does not give a clue to the potential long-term complication including ureteric stricture and renal scarring. Therefore, randomized controlled studies on larger population with higher stone burden are needed to determine the impact of the above-mentioned limitations on the surgical outcomes, in that particular group.

CONCLUSIONS

RIRS for renal stone <2 cm in children with a solitary kidney is a single session procedure with a high SFR, low complication rate, and is a minimally invasive natural orifice technique.

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Conflicts of interest
There are no conflicts of interest.

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