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Retrograde intrarenal surgery for the treatment of renal stones in children: Factors influencing stone clearance and complications

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ABSTRACT

Background: Retrograde intrarenal surgery (RIRS) is a known option for the treatment of upper tract calculi with an excellent success. However, the reports of RIRS in prepubertal children are limited. In this study, we evaluated the factors which affected the success rate and the complications of RIRS at renal stone treatment in childhood.

Methods: We retrospectively reviewed the records of children under 14 years old who underwent RIRS for renal stone disease between January 2009 and December 2012. Patients' age, gender, body mass index (BMI), stone size, stone location, stone number, intraoperative complications, stone free status, postoperative complications were recorded.

Results: There were 80 ureterorenoscopic procedures performed in 58 renal units of 47 children (23 males and 24 females). The patients' ages ranged from 8 months to 14 years (mean age 4.7 ± 3.4 years). There was a difference in the distribution of symptoms in age groups. UTI was higher in the 1–4 years age group, abdominal pain was seen mostly in children aged 5–14 years. Multiple stones (included staghorn stone) were noted in 60.4% of patients. In 27.6% of patients, ureteral stones were accompanied by renal stones in our series. In the infancy group, cystine and staghorn stones were more frequently seen, mostly bilateral. After a single ureteroscopic procedure for intrarenal stones in children, we achieved stone free status in 50.9% of the ureters ($n = 26$). After the repeated sessions, the stone clearance rate reached to 85.1%.

Conclusion: Retrograde intrarenal surgery can be used as a first line therapy to treat renal stones in children. This is especially important if an associated ureteral stone is present that requires treatment; or in patients with cystinuria, which is not favorably treated with ESWL. Complications were seen more frequently in patients with cystine stones. Extravasation was noted more frequently in patients admitted with UTIs. There was a significant relationship between the conversion to open procedures and the age groups, with most procedures occurring in infancy. The parents should be informed about the probability of multiple procedures to achieve stone free status.

1. Background

The surgical management of renal stones in children has undergone a dramatic shift in the last 40 years. While therapy historically consisted of open surgical procedures, this approach has largely been replaced by minimally invasive techniques, including shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PNL), and ureteroscopic (URS) methods [1,2]. These treatment options have become a standard of care in adults; yet, despite an increasing prevalence of stone disease in children, they are not being used in the pediatric population. Recent pediatric stone free rates for intrarenal calculi less than 2 cm in diameter after a single extracorporeal shock wave lithotripsy (ESWL) procedure range from 36% to 68% [3]. Multiple ESWL sessions are required for stone free status in 75% of children with kidney stones [1,2,4]. Additional general anesthesia sessions and further radiation exposure are required for multiple ESWL sessions in children. Moreover, residual fragments after ESWL can become clinically symptomatic and act as a nidus for a new stone growth. On the other hand, PNL is relatively invasive and can be restrictive in infants and younger children [5]. Although stone free rates are more than 85% after a single PNL procedure in children, complications including urosepsis, bleeding requiring transfusion, renal pelvis perforation, and injury of adjacent organs are not uncommon [6,7]. Therefore, PNL should be reserved for a larger stone burden and when ESWL and/or retrograde endoscopy is not successful. Retrograde intrarenal surgery (RIRS) is an option for the treatment of upper tract calculi, with excellent success for adult kidney stone disease [8,9]. Advances in endoscopic equipment and the widespread application of the holmium YAG laser have rendered RIRS an attractive option for pediatric patients [10,11]. In the last three years, we have increasingly used ureterorenoscopy to treat intrarenal

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calculi in children. However, reports of RIRS in prepubertal children are limited. In this study, we evaluated the factors which affected the success rate and complications of RIRS for renal stone treatment in children.

2. Methods

We retrospectively reviewed the records of children under 14 years who underwent RIRS for renal stone disease between January 2009 and December 2012. The patient's age, gender, body mass index (BMI), stone size, stone location, stone number, intraoperative complications, stone free status, and postoperative complications were recorded. Preoperative imaging was also reviewed to determine the stone size and location. Stone burden was measured in millimeters.

Stones were classified as pelvic calculi with non-lower pole extension that were located in the pelvis or impacted at the ureteropelvic junction (UPJ), as calculi with lower polar extension, and as staghorn calculi. The management of renal calculi was determined by stone location, caliceal extension, stone size, and stone composition. Our preferred initial treatment option was observation for patients who had newly diagnosed renal stones sized less than 7 mm when symptoms could be controlled. Patients were followed with periodic imaging studies to monitor stone position and size and to assess hydronephrosis. Surgical treatment was indicated when there was an obstruction, infection, failure of spontaneous stone passage, or stones bigger than 7 mm, and in the presence of increasing or unremitting colic. In this series, RIRS was primarily performed for intrarenal stones less than 2 cm or after the failure of PNL and ESWL.

All RIRS procedures were performed by two surgeons at one institute under general anesthesia with direct videoscopic and fluoroscopic guidance. Semi-rigid ureteroscopy (4.5 Fr R. Wolf, Knittlingen, Germany) or flexible ureteroscopy (Karl Storz FLEX-X, Tuttlingen, Germany) was performed to place an access sheath. The decision to use a flexible or semi-rigid ureteroscope depended on the location of stones. A flexible ureteroscope was used for lower pole stones; while, a semi-rigid ureteroscope was preferred for renal pelvic or upper pole stones.

In our practice, all children undergoing RIRS procedures for stone disease received ampicillin/sulbactam. Perioperative antibiotic treatment was continued for a week following surgery. If a double J (JJ) stent was inserted, antibiotic prophylaxis was continued and then ceased after removal of the JJ stent. A manual irrigation pump system was used for hydrodilation of the ureter during ureterorenoscopy. If this was not enough to pass the ureteroscope, we then placed a JJ catheter for passive dilation. Ureteral active coaxial dilation was not performed. We used isotonic fluid at body temperature to avoid hypothermia and hyponatremia during the procedures. The urinary bladder was maintained at low pressure with a 14 F suprapubic angiocatheter in all patients.

Stones were fragmented using the holmium-YAG laser (Litho Quanta System, Italy) or pneumatic lithotripsy (Vibrolith Plus, Elmed, Turkey) and grasped by a stone basket when applicable. Contrast injection was performed at the end of the procedures to confirm the absence of extravasation and the stone free status. The decision to place a postoperative ureteral stent was determined according to visible mucosal ureteral trauma or edema at the end of the procedures. Extracted stone specimens were submitted for stone analysis. All patients were discharged the next day after the procedures. Medical therapy and dietary planning were provided postoperatively based on the composition of the stones. Ultrasonography (USG) was performed one and six months after the procedures to evaluate stone recurrence and hydronephrosis. We did not perform routine voiding cystourethrogram (VCUG) following the ureteroscopy when there was no hydronephrosis. Patient follow-up ranged from 1 to 18 months (mean 7 months). We analyzed the factors that contributed to complete removal of the stones, complications, and the conversion to open procedure. Statistical analysis was performed using the Mann Whitney U test and $p < 0.05$ was considered statistically significant.

3. Results

There were 80 ureterorenoscopic procedures performed in 58 renal units of 47 children (23 males and 24 females). The patients' ages ranged from 8 months to 14 years (mean age 4.7 ± 3.4 years) (Table 1). Patients were divided into three age categories: infants (0–1 year), young children (1–4 years), and school-age children (5–14 years).

The most common presenting symptom was flank pain in 19 (40.5%) patients. The other common symptoms were urinary tract infection (UTI) in 16 patients and hematuria in nine patients. Obstruction was noted in three patients. The incidence of UTI was higher in the group of children aged 1–4 years; while, abdominal pain was the most common symptom in children aged 5–14 years. The BMIs ranged from 20.45 to 34.28 kg/m^2 (mean 23.8 ± 3.2). Seven patients were overweight (BMI: 25 to 29.9 kg/m^2), three were obese (BMI: 30 kg/m^2 or greater), and 37 patients had normal BMIs.

Stones were in the right kidney in 19 patients (40.5%), in the left kidney in 17 patients (36.1%), and bilateral in 11 patients (23.4%). Patients with bilateral renal stones were managed in two separate sessions. Stones were located at the renal pelvis/ureteropelvic junction/non-lower pole in 29 renal units (50%), at lower pole calices in 23 renal units (39.6%), and staghorn stones were present in 6 (10.4%) renal units. Multiple stone locations were noted in 29 renal units (50%) and a single stone was noted in 23 renal units (39.6%). In 16 renal units (27.6%), there were ureteral and renal stones. Stone sizes ranged from 5 to 20 mm (mean 11.4 ± 3.7 mm). The location of stones did differ between age groups.

Staghorn and bilateral stones were more frequent in the infant group; while, renal stones accompanying ureteral stones were found less in this group. Pelvis stones were more frequent in the group aged 5–14 years compared with the other age groups; while, lower pole stones were more common in the group aged 1–4 years.

Retrograde endoscopic management was the initial surgical approach in 41 renal units (70.7%) in our series; while, seven renal units were managed by ESWL and PNL was performed in ten renal units before RIRS. RIRS was performed as an initial approach more often in younger aged patients; while, ESWL or PNL was more common in older age groups.

The distribution of the ureters according to age was: 8 ureters in the group of children aged under 1 year old, 26 in the group aged 1–4 years, and 24 in the group aged 5–14 years. We placed ureteral stents in 27 (46.5%) of the 58 ureters for passive dilation before ureteroscopy. The age range for this group was 0.8 to 10 years (10 boys and 11 girls). In the group receiving JJ stents, there were six

Table 1
Patients' demographic data.

Age groups			
	0–1 year	1–4 years	5–14 years
Number of patients	4	22	21
Gender, n			
Male	4	12	7
Female	0	10	14
Stone size (mean), mm	10.36	11.5	12.38
Side			
Right	0	9	10
Left	0	9	8
Bilateral	4	4	3