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Original Article

Ureteroscopy for ureteral stones in children: what has changed with the increase in experience?

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ABSTRACT

Objective: With advancements in endourological equipment and the routine use of the Holmium:YAG laser, endoscopic treatment has become the first-line approach for managing ureteral stones in children. Although ureteroscopy is widely performed, the literature reports varying outcomes regarding its efficacy in pediatric cases. This study aimed to evaluate the impact of increasing endourological experience on stone-free rates and procedure-related complications in children undergoing ureteroscopy with Holmium: YAG laser for ureteral stones

Material and Methods: A comparative analysis was conducted on 32 cases treated with URS for ureteral stones between 2009-2011, the initial three years of our endourological interventions in children, and 78 cases treated with URS for ureteral stones between 2020-2022, the final three years of our 15-year endourological experience, utilising hospital records as the primary data source. Demographic data, stone-free rates, and recorded complications were evaluated in both groups.

Results: In our initial cohort of 32 cases, the stone-free rate at first attempt was 57%, with a complication rate of 15.6% and a conversion rate to open surgery of 18.75%. In contrast, during the last three years, 73 patients (93.5%) achieved stone-free status with a single URS session. Only one case (1.3%) required conversion to open surgery. Complications were observed in 10.2% of cases. Notably, the use of passive dilation with preoperative JJ stent placement became more prevalent during the latter period.

Conclusion: Increasing surgical experience is associated with higher stone-free rates following a single intervention. There were no significant differences in the overall or major complication rates between the two periods. Postoperative fever remains a common complication, underscoring the importance of careful management of JJ stent placement. The most notable parameter that showed a significant improvement with increased experience was the reduced rate of conversion to open surgery.

Keywords: Children, Complication, Ureteroscopy, Ureterolithiasis

INTRODUCTION

Due to changing dietary habits and increasingly sedentary lifestyles, urolithiasis is being encountered more frequently in the pediatric population (1–3). Ureteral stones in children are now commonly managed with endourological interventions, facilitated by the development of smaller-caliber ureteroscopes (4–10). Despite advances in endoscopic technology and the narrower ureteral diameter in children compared to adults, concerns remain regarding key outcomes such as the stone-free rate (SFR) and the complication profile of ureteroscopy (URS) (4,5,9).

We previously published findings based on our initial 32 cases, where we began using routine endourological methods for treating ureteral stones in pediatric patients between 2009 and 2011. During this period, we achieved a stone-free rate of 57% in one session, a complication rate of 15.6%, and a conversion rate of 18.75% to open surgery (4). However, the literature presents varying results concerning stone-free rates and complications following ureteroscopy treatment for ureteral stones in children (4-10).

As our experience with endourological procedures in children has gradually increased over the years, we aimed to evaluate how this enhanced expertise has impacted the outcomes of endoscopic treatment for pediatric ureteral stones. To achieve this, we analyzed cases of ureteroscopy (URS) performed for ureteral stones over the past three years. Our primary objective was to assess the stone-free rate, procedure-related complications, and the conversion rate to open surgery. We sought to compare these results with those from a period when

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our experience was more limited, by presenting data from patients treated with ureteroscopy and Holmium: YAG laser over the past three years, following 15 years of endourological practice.

MATERIALS and METHODS

The cases between 2009-2011, when we initiated routine ureteroscopy for treating ureteral stones in children at our clinic, and the pediatric cases treated with ureteroscopy for ureteral stones between 2020-2022, during which our endourological experience increased, were retrospectively evaluated from hospital records.

Patient age, sex, stone size, stone number, stone location, dilation method, use of a postoperative stent, intraoperative complications, stone-free status, postoperative complications, and conversion to open procedure were recorded. Preoperative ultrasonographic examination was routinely performed in all patients to determine stone size and location. Where ureteral stones could not be detected by ultrasonography, the location and size of the stones were evaluated by computed tomography. We routinely prefer observation as the initial management strategy for pediatric patients with newly diagnosed ureteral stones. Ureteroscopy procedures were performed under direct videoscopic guidance. The semirigid URS (4.5F, R. Wolf, Knittingen, Germany; 7.5F, Karl Storz, Tuttingen, Germany) was advanced into the ureter over a guidewire. Antibiotic prophylaxis, which was started in the perioperative period, was continued as long as the JJ catheter was present.

A manual irrigation pump system was used for ureteral hydrodilation during URS. If hydrodilation was insufficient, a double-J catheter was placed for passive dilation. Active coaxial dilation is not routinely performed in our clinic. An ureteral access sheath and flexible ureterorenocope were not used.

To prevent hypothermia and hyponatremia, isotonic fluid heated to 32 degrees Celsius was used during the procedure. Stones were fragmented using the Holmium: YAG laser (Litho Quanta System, Solbiate Olona Italy) and grasped using a stone basket if applicable. At the end of lithotripsy, stone-free status was confirmed visually and re-evaluated by ultrasonography within a month. Postoperative ureteral stent placement was decided based on visible mucosal or ureteral trauma.

Intraoperative complications recorded included mucosal injury, ureteral perforation, contrast material extravasation, ureterovesical junction injury, and avulsion. Postoperative complications comprised fever (>38^{0}C), ureteral stricture or obstruction, and vesicoureteral reflux. Stone specimens were sent for analysis, and medical therapy and dietary planning were provided postoperatively based on the stone composition. Ultrasonography was performed at first and third months post-procedure to assess for stone recurrence and hydronephrosis. In cases where hydronephrosis was detected in the follow-up USG examination, VUR and ureteral stenosis were tried to be ruled out by performing VCUG and, when deemed necessary, retrograde ureterography.

Statistical analysis was performed using Student's t-tests and Chi-Square tests in SPSS 17.0 Statistical Package Program for Windows, with p <0.050 0considered statistically significant.

RESULTS

In the first period (2009–2011), a total of 32 pediatric patients underwent ureteroscopy (URS) for ureteral stones. In the second period (2020–2022), URS was performed in 78 children for the same indication. The demographic data of both groups are presented in Table I. The follow-up period ranged from 10 to 32 months, with a mean of 21 months. The number of cases significantly increased during the second period, indicating a growing trend in the use of URS for pediatric ureteral stones. While there was no difference in gender distribution between the groups, the mean age of patients in the first period was significantly lower than in the second period (p = 0.001). Renal colic remained the most common presenting symptom in both groups.

The operative data of the patients are summarized in Table II. The rate of multiple stones was significantly higher in the first period, whereas only a few cases with multiple stones were observed in the second period. Although the average stone size was greater in the first period compared to the second, the difference was not statistically significant (p = 0.785). The conversion rate to open surgery was 18.75% in the first period. In the second period, open surgery was required in only one patient due to a severe postural deformity that precluded endoscopic intervention.

While in the first period, in four, URS could not be conducted because of ureterovesical obstruction and edema, and ureterotomy was performed to remove the ureteral stone. Two patients underwent an open procedure because of impacted stones, and ureteroneocystostomy was performed in both. In

Table I: Demographic data of patients

	2009-2011*	2020-2022*
Sex		
Male	16 (50)	40 (51)
Female	16 (50)	38 (49)
Age (years)	5.91±4.98 (0.57-7)	9.64±4.91 (0.74-17)
Patients aged <5 years*	18 (56.2)	29 (37.2)
Symptoms*		
Flank pain	23 (71.8)	5 (65.1)
Urinary tract infection	6 (18.7)	12 (15.4)
Hematuria	2 (6.3)	13 (16.7)
Obstruction	1 (3.2)	2 (2.6)

**: n(%), †: mean±SD (Range)*

Table II: Operative data of patients

	2009-2011	2020-2022
Laterality*		
Right	12 (37.5)	45 (57.7)
Left	11 (34.37)	30 (38.5)
Bilateral	9 (28.13)	3 (3.8)
Stone location*		
Distal	23 (56.1)	51 (65.3)
Mid	4 (9.8)	14 (17.9)
Proximal	8 (19.5)	11 (14.1)
Distal and mid	6 (14.6)	2 (2.7)
Stone number*		
Single	14 (41.5)	73 (93,6)
Multiple	24 (58.5)	5 (6.4)
Stone burden (mm)	8.76±3.08 (4-18)	6.58±2.94 (3.5-20)
Orifice dilation*		
Passive dilation	8 (19.5)	53 (67.9)
No dilation	33 (80.5)	25 (32.1)
Postoperative JJ stent (ureter)*	27 (70.7)	41 (50.6)
Conversion to open surgery*	6 (18.75)	1 (1.28)
Stone free rate in first sesion	57%	93.5%
Over all	92.7%	100%

**: n(%),†: mean±SD (Range)*

Table III: Postoperative complications

	2009-2011	2019-2022
Ureter perforation or extravasation	3	1
Ureterovesical stricture	-	2
Fever	1	5
UV Junction injury (UNC)	1	-
Total	5 (15.6%)	8 (10.2%)

the first period, a Holmium: YAG laser was used to fragment the stones in 9 patients (34.6%), pneumatic lithotripsy in 2 (7.7%), a basket catheter to extract ureteral stones in 4 patients (15.4%), and a combination of Holmium: YAG laser plus pneumatic lithotripsy in 11 patients (42.3%) (2). In the second period, only Holmium: YAG laser was used for fragmentation.

A stone-free rate of 57% was achieved with a single intervention in patients during the first period, whereas this rate increased to 93.5% in the second period (p = 0.001). The overall stone-free rate reached 92.7% in the first period, while all patients in the second period ultimately achieved stone-free status.

Passive dilation by applying a JJ stent before the procedure was performed in 19.5 % of the cases in the first-period patients, increasing to 67.9% in the second-period patients. After the procedure, the JJ stent placement rate was 70.7% in the first group and 50.6% in the second group.

While complications were detected in 15.6% of the first-period patients, a major complication requiring serious surgical intervention was encountered in one patient. No major complications were encountered in the second period, with the total complication rate at 10.2% (Table III). There was no significant difference in complication rates or major complications (p =0.082 and p =0.393, respectively).

DISCUSSION

Ureteroscopy for pediatric ureteric stones stands a safe and effective first-line treatment, particularly when conservative therapy proves ineffective (11,12). Since 2009, our clinic has routinely performed ureteroscopy with Holmium: YAG laser lithotripsy for pediatric patients with ureteral stones. In this study, we evaluated the treatment of ureteral stones using this approach, comparing two periods: one with limited experience (2009-2011) and another with increased proficiency (2020-2022).

The significant increase in cases during the second period (2020–2022) reflects a rising trend in the utilization of URS for pediatric ureteral stones. The higher mean age of patients observed in this period may be attributed to the redirection of cases to our clinic due to COVID-19–related restrictions in other healthcare facilities.

The second period showed a decrease in the incidence of multiple stones and a reduction in the mean stone size, which may reflect improvements in early detection and intervention, thereby preventing stone progression.

Notably, the stone-free rate after a single session significantly improved, rising from 57% in the first period to 93.5% in the second period, highlighting enhanced proficiency in stone fragmentation. The increased use of pre-intervention JJ stent placement during the second period likely contributed to the higher stone-free rate in a single attempt. Furthermore, passive dilation with preoperative JJ stent placement became more prevalent in the second period, potentially influencing the improved outcomes. Additionally, preoperative JJ stent insertion reduced the need for postoperative stent placement.

The substantial decrease in conversion to open surgery from 18.75% in the first period to 1.28% in the second period demonstrates advancement in surgical techniques and decision-making.

Although ureteroscopy is a minimally invasive, it may lead to intra and/or postoperative complications. Those complications included stone migration, ureteral perforation, mucosal laceration, hematuria, pain, and urinary tract infection. Notably, our study did not encounter stone migration, likely due to careful procedural techniques, including low fluid pressure, laser power, and catheter placement. The overall complication rate decreased from 15.6% to 10.2% between the two periods, with no major complications in the latter. There was no statistically significant difference in the complication rate or major complications between the two periods. According to our data, increasing experience had no effect on the complication

rate. Although it is not possible to avoid some complications due to the nature of the procedure, meticulous work from the beginning under the supervision of a single senior surgeon has ensured that our complication rates are within acceptable limits, according to the literature.

Postoperative fever emerged as the most common complication in the second period, despite clean urine tests and cultures preoperatively. This underscores the need for judicious JJ stent use to minimize postoperative UTI rates (14). Postoperative UTI rates increased with prolonged indwelling time. This was attributed to JJ stent placement and colonization, highlighting the need for careful consideration of stent use (15).

Campbell et al. (16) advocate for primary URS whenever possible due to the excellent SFR and potential for single anesthetic treatment (17). However, some authors suggest preoperative JJ stent replacement when ureterorenoscopy is planned (18). While JJ stent is preferred in adults to reduce postoperative complications, in our pediatric series, JJ stents were primarily used for passive ureteral dilation, enhancing safety (19,20).

Limitations of our study include its retrospective nature and the involvement of various fellows in procedures, which could introduce variability. Additionally, pneumatic lithotripsy was utilized for stone fragmentation in patients in the early period. Future studies with a prospective design and a standardized approach may offer further insight.

Nonetheless, our study underscores the importance of continuous learning and experience in improving outcomes. Ongoing education and mentoring programs are crucial for advancing urologists' skills.

CONCLUSION

Ureteroscopy with laser lithotripsy stands as an excellent first-line treatment for pediatric ureteral stones, especially following failed conservative therapy. We advocate for preoperative JJ stent placement to enhance stone-free rates in a single session and reduce conversion to open surgery, although experience did not significantly affect complication rates. Double-J stent application may increase postoperative fever incidence. We also observed that preoperative JJ stent insertion reduced the need for postoperative stent placement.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. This study was approved by the Bilkent City Hospital Ethics Committee (Approval no. E-2-23-5304; Clinical Research ID NCT06147817).

Contribution of the authors

Demirtaş G: Taking responsibility in the writing of the whole or important parts of the study. ***Tagcı S:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. Taking responsibility in logical interpretation and conclusion of the results. ***Ekberli G:*** Taking responsibility in necessary literature review for the study. ***Karabulut B:*** Planning methodology to reach the Conclusions. Reviewing the article before submission scientifically besides spelling and grammar. ***Tiryaki HT:*** Constructing the hypothesis or idea of research and/or article. Organizing, supervising the course of progress and taking the responsibility of the research/study.

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Conflict of interest

The authors declare that there is no conflict of interest.

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