ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

FACTORS AFFECTING THE OUTCOME OF URETEROSCOPY IN THE MANAGEMENT OF URETERAL STONES IN CHILDREN: A SINGLE CENTER EXPERIENCE

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Abstract

Background:

The urinary stone disease occurs in children with less incidence than the adult. Small urinary anatomy requires fine instruments. The miniaturized devices, ureteroscopes and laser lithotripters are becoming popular in managing pediatric ureteric stones with minimum complication. However, some factors are still there for identifying the successful outcome of management.

Objective:

To identify the factors affecting endoscopic pediatric ureteric stone management outcomes.

Patient Methods:

This is a retrospective observational study during the period from June 2019 to March 2021. Including children at the age of 12 and below. We reviewed our experience with indicated Ureteroscopy(URS) stone surgery performed for 33children, including the history, physical examination, investigations, recorded data about the operative findings, complications, postoperative recovery, and stone clearance. In addition, types of Ureteroscopy and auxiliary instruments used were reviewed.

Results:

A-33 children, age range (2-12years) with an average of 6.1, had ureteroscopy surgery for ureteric stone,size of(5–15 mm), with a mean of 8.05 mm. After a single session, stone-free was detected in 32 (97%) of the children. Success rate was present in 32 cases (97%). Failure rate related to access failure occurred in 4 patients (12.2%), it reduced to one patient(3%) when 6Fr URS used andwas significantly associated with age below three years and small size ureters. Overall complication occurred in 25 cases (75.75%) . According to (ClaveinDendo grading system), postoperative complications were Grade I(75%) and Grade II(25%). there was no migration of stone or extravasations. The mucosal injury occurred in 21.2%. Complete stone fragmentation was achieved in all patients.

Conclusions:

Failure and complications rate in ureteroscopy and laser surgery was significantly affected by age below three years and small ureters, and there was no relation to stone radiolucency or degree of hydronephrosis.

Keyword:

Children. Ureteric Stones. Ureteroscopy. Holmium laser. Lithotripsy.

Background

Childhood stone disease continues to be a serious health concern, particularly in endemic areas [1]. The pediatric stone disease accounts for 1-5% in developed countries and 30% in developing countries, and pediatric stone disease increases by 3% each year [2, 3, 4].

In children, ureteral stones of < 3 mm passes spontaneously, and stones bigger than 4mm are more likely to require interventions such as shock wave lithotripsy (SWL) or uretero-renoscopy (URS)[5], particularly for the treatment of proximal ureteral stones. Because of the low success rate of SWL in the treatment of distal ureteral stones[6,7], URS with reduced instrument size has become an important treatment method. Although the use of URS in adult patients is common at almost all urology clinics, its use in pediatric patients has not yet been fully standardized because of the potential complications[8]. However, the recently developed 6 Fr semirigid uretero-renoscopy, thin diameter, can be used safely in children with minimum difficulties.

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Patients and Method:

A retrospective study of 33 children (14boy and 19girls) with ureteral calculi underwent semirigid ureteroscopy and Holmium: YAG laser lithotripsy, during the period between January 2019 and May 2021. The indication was children under the age of 12 with ureteric stone, failure of conservative management, symptomatic including (persistent pain, urosepsis, and fever) progressive hydronephrosis on serial Ultrasound or severe hydronephrosis on presentation, stone size: 5-15 mm. Lower or middle ureteric stone and previous ESWL or Operation. Exclusion criteria werestone associated with urinary tract anomaly or a non-functioning kidney, stone>15mm in size, or patient with severe orthopedic deformities.

All patients had a negative urine culture and sensitivity, serum creatinine, hemoglobin, abdominal ultrasonography (US), KUB, and IVU.

URS performed under general anesthesia, using 7.5 F and 6 F semirigid ureteroscope (Karl Storz Endoscopy, Tuttlingen, Germany) with laser lithotripsy a Holmium-Yttrium–Aluminium-Garnet (Ho: YAG) laser (CALLCULASE II SCB, Karl Storz, Germany) as a primary lithotripter. A safety guidewire was used before the introduction of URS.

A guidewire (Terumo, 0.035 inches) was used as a primary working guidewire. Following the guide wire technique performed for accessing the ureter in all patients. Stones were completely fragmented under direct vision with laser lithotripsy, and no basket was used. All patients underwent 3- 4 Fr, 16-22 cm, double J-stent insertion. The double JJ was removed after 3–4 weeks. All patients were evaluated with plain radiography at 24 h after operation and US at four weeks postoperatively. The stone-free status is defined as the absence of fragments of more than 1 mm in diameter in the ureter by ureteroscopy inspection. The method is considered successful if no stone was noticed in the ureter (no evidence of residual stone), the ureter was patent, a double J stent was inserted, and the patient's symptoms resolved. Efficacy is defined by the stone clearance rate and the need for additional procedures such as ureteric stenting. Process and recovery outcomes are measured by the length of hospital stay .

Intraoperative postoperative patients and operative findings are collected for statistical analysis using the IBM SPSS-21 Statistics program used to analyze the data. The Chi-square or Fisher's exact test were used to calculate the p-value. A P-value < 0.05 is considered statistically significant

Result

A -33- patients were treated for ureteric stones with a mean age of 6.1 years (2-12 years). Preoperative data are present in (Table 1,2). The site, size and number of stones were recorded see (Tables 3)

Table1:Patients preoperative &postoperative data

Preoperative data	
Gender	
Male	14 (42.4%)
Female	19 (57.6%)
Symptoms	
Loin pain	13 (39.4%)
Vomiting	12 (12.1%)
Nausea	3 (9.1%)
Fever	1 (3.0%)
Hematuria	1 (3.0%)
Mean size of stones (mm)	
10 mm	48.6%
10-15 mm	49.1%
Number of stones	
One	30 (90.9%)
Two	3 (9.1%)
Site of the stone	
Left lower ureter	20 (60.06%)

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Right lower ureter	12 (36.3%)
Right mid ureter	1 (3.0%)
KUB	
Radio-lucent	7 (21.2%)
Radio-opaque	26 (78.8%)
US (hydronephrosis)	
Grade 1	19 (57.5%)
Grade 2	14 (42.5%)
Mean S.creatinine (mg/dl)	
Preoperative	0.71
Postoperative	0.68
Mean S. HB (g/dl)	
Preoperative	12.8
Postoperative	12.8
Preoperative IVU	
G1 (HN, HU)	19 (57.6%)
G2 (HN, HU)	14 (42.4%)

Table2: Intraoperative & Postoperative data

Success rate	32 (97%)
No residual	32 (97%)
Radio opaque	1 (3.0%)
Access failure	5 (15.1%)
URS 7.5 Fr	4 (12.2%)
URS 6 Fr	1 (3.0%)
Complication rate	25 (75.75%)
Mucosal injury	7 (21.2%)
Hematuria	15 (53.6%)
Fever	3 (9.0%)
SFR	
radio opaque	1 (3.0%)
No residual	32 (97.0%)
Semi-rigid URS	
6 Fr	4 (12.2%)
7.5 Fr	33 (100%)
Post-operative KUB	
No residual	32 (97.0%)
Radio-opaque	1 (3.0%)
Post-operative US	
G1	14 (42.45)
G1-G2	2 (6.15)
No	17 (51.5%)
Operative time	
≤ 30 min	17 (51.5%)
> 30 min	16 (48.5%)

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Table3: Analysis of preoperative data

		History of .op previous operation)	S.creatinine (0.7-1.2 mg/dl)	KUB (Radio-opaque)	Number of stones (one stone)	Hydronephrosis (Grade 1)
Age (Years)	**2**	**6 (21.4%)**	**1 (5.9%)**	6 (23.1%)	**5 (16.7%)**	**2 (10.5%)**
	> **2-4**	**7 (25.0%)**	**5 (29.4%)**	5 (19.2%)	**7 (23.3%)**	**6 (31.6%)**
	> **4-12**	**15 (53.6%)**	**11 (64.7%)**	15 (57.7%)	**18 (60.0%)**	**11 (57.9%)**
Stone size (mm)	**5.1-10**	**25 (89.3%)**	**15 (88.2%)**	23 (88.5%)	**27 (90.0%)**	**18 (94.75)**
	10.1-15	**3 (10.7%)**	**2 (11.8%)**	3 (11.5%)	**3 (10.0%)**	**1 (5.3%)**
Stone site	**Lower**	**27 (96.4%)**	**16 (94.1%)**	26 (100%)	**29 (96.75)**	**18 (94.7%)**
	Middle	**1 (3.6%)**	**1 (5.9%)**	0 (0.0%)	**1 (3.3%)**	**1 (5.3%)**

*Statistically significant
Note: In some tests Fishers exact test applied

The mean laser energy used for fragmentation of stones was 0.8 J, and the frequency was 0.6 Hz. Double J stent was inserted in all patients 33(100%): JJ 3 Fr in 21 patients (63.63),and Fr 4 in 12patients (36.36%) for 4 week (Table 3,4), there was statistically significant association between age category of (>4-≤12) &the use of 4Fr JJ stent during operation, see (Table 5).

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Table 4: Analysis of factors affecting the outcomes of ureteroscopy.

		Methods (Laser Lithotripsy)	**SFR (No residual)**	**JJ stent (Fr.4)**	**Ureteral injury (Mucosal injury)**	**Laser type (HO: YAG)**	**Clavie ndindo (Grade 1)**	**S.creatinine(postoperatie (0.7-1.2 mg/dl)**	**Operation Time (>30 min.)**	**Post-operative KUB (No residual)**	**Post-operative US (No HN or HU)**
Age(years)	≤2	**5(16.1%)**	**2(7.1%)*1**	**0(0.0%)*2**	**3(42.9%)**	**5(15.6%)**	**3(12.0%)**	**1(5.8%)**	**3(18.8%)**	**5(15.6%)**	**2(11.8%)**
	>2-≤4	**7(22.6%)**	**6(21.4%)**	**0(0.0%)**	**1(14.3%)**	**7(21.9%)**	**5(20.0%)**	**5(35.7%)**	**2(12.5%)**	**7(21.9%)**	**5(29.4%)*4**
	>4-≤12	**19(61.3%)**	**20(71.4%)**	**12(100%)**	**3(42.9%)**	**20(62.5%)**	**17(68.0%)**	**8(57.1%)**	**11(68.8%)**	**20(62.5%)**	**10(58.8%)**
Stone Size (mm)	**5.1-10**	**30(93.8%)**	**26(92%)*3**	**21(100%)**	**6(85.7%)**	**30(93.8%)**	**23(92.0%)**	**12(85.7%)**	**16(94.1%)**	**30(93.8%)**	**16(94.1%)**
	10.1-15	**2(6.2%)**	**2(7.1%)**	**0(0.0%)**	**1(14.3%)**	**2(6.3%)**	**2(8.0%)**	**2(14.3%)**	**1(5.9%)**	**2(6.2%)**	**1(5.9%)**
Stone Site	**Lower**	**31(96.9%)**	**27(96.4%)**	**21(100%)**	**7(100%)**	**31(96.9%)**	**24(96.0%)**	**13(92.9%)**	**16(100%)**	**31(96.9%)**	**16(94.1%)**
	Middle	**1(2.1%)**	**1(3.6%)**	**0(0.0%)**	**0(0.0%)**	**1(3.1%)**	**1(4.0%)**	**1(7.1%)**	**0(0.0%)**	**1(3.1%)**	**1(5.9%)**

*Statistically significant

Note: In some tests Fishers exact test applied

*1 There is statistically significant association between age category of (>4-≪12)&stone free rate , p value < 0.05

*2 There is statistically significant association between age category of (>4-12) & usage of JJ stent Fr 4 during the operation, P value < 0.05

*3 There is statistically significant association between stone size category of (5-10 mm) &stone free rate , P value < 0.05

Table 5: Data of significant factors in the back ward stepwise logistic regression analysis

Type of stepwise logistic regression Analysis	significant reading factor	P-value	Or	95% Cl for Or	
JJ stent Fr	Age/Year	≪0.001	3.4	1.63	7.10
SFR	Age/Year	≪0.001	0.69	0.49	0.96
Stone size	SFR	≪0.001	0.31	0.02	4.23

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

The mean operative time was 30.57 min. There was no statistically significant difference in the mean operative time in relation to stone site, stone radiolucency, age, size of the ureteroscope.Postoperative hydronephosis at 4 weeks persist in 16 patients (48.4%): G1in 14 patients (42.4%), G1-G2 in 2 patients (6.1%), no HN in 17 patients (51.5%) ,see (Table 2) .

Overall complication was present in 25 cases(75.75%), Intraoperative complication include mucosal injury in 7 cases (21.2%), post operative hematuria for 2 days present in 15 cases (53.6%), postoperative fever for one day in 8 cases (24.24%),see (Table 2) . There was no ureteral avulsion, persistent hematuria or bleeding requiring blood transfusion or septic complications.

We evaluated the impact of different factors on outcomes of ureteroscopy and laser lithotripsy,see (Table4). Access failure for URS 7.5 Fr occurred in 4 patients (12.2%) ,and reduced toone patient (3%) when using 6 Fr. There is statistically significant association between age category (> 4- 12) & no residual stone, also there is statistically significant association between stone size category of (5.1-10 mm) & no residual stone,see (Table 4). The prevalence of different complication showed no statistically significant in relation to side, gender, stone radiolucency ($p > 0.05$), While there was statistically significant association between age category of ($> 2-\leq 4$) & persistent postoperative hydronephrosis, see (Table 4). Factor that remained significant are age of the patients and size of ureteroscopy which remained significant predictor for access failure .

Laser lithotripsy was successful in fragmentation of 32patients stones (97%). Causes of failure rate were access failure in one case (3%). The failure rate was significantly affected by the age and ureteroscopy size, but there was no statistically significant difference in relation to side, gender, radiolucency or degree of hydronephrosis ($P > 0.05$).

Discussion

Urinary stone disease becomes a more important health problem with increasing incidence of urolithiasis [9]. The use of ureterscopy in children has been limited due to concerns about the risk of ureteral ischemia, perforation, stricture formation and development of vesicoureteral reflux [10]. With the downsizing of ureterscopes and miniaturization of working instruments and intracorporeal lithotripsy devices, ureteroscopy has become a more attractive option for pediatric ureteral stones [11].

The Ho: YAG has shown excellent results in the Ureteroscopic treatment of ureteral stones[12]. Thomas et al. reported an 88% success rate for stone 7-14 mm in size using laser lithotripsy in 29 children (mean age , 7.8 years)[13]. Total success rate was 84.8% in a study done on 105 URS using Ho: YAG lithotripsy [14]. Using Ho:YAG lithotripsy with semirigid URS, the stone-free rate was 81.3% (89.4, 87.4 and 74.2 % for lower , middle and upper ureter, respectively) in a study on 412 patients[15], 79.4 % for proximal and 96.8 % for distal stones in a study done on 543 patients[16], while it was 92.7 % in a series of 188 patients[17]. Success rate in multiple studies on pediatric ureteric stones using semirigid URS were 83-92.8 %. The mean age of patients in these studies was 5-9.5 years with a mean stone size ranging from 5.6 to 8.9mm [18-23].

Although we had younger children and larger stones, we had comparable results with 97% success rate. This is also comparable to data obtained from 24 articles reviewed by Basiri et al. on pediatric ureteral calculi. They reported overall success rate of 93.2 and 74.4 % for Ureteroscopic management of lower and upper ureteral calculi, respectively [24].

Cause of failure in our study was access failure occurred in one patients (3.0%), mucosal injury was 21.2%, Calvin Dendo grading: grade I was 75 %, grade II was 25%. Galal et al. reported 5.5% access failure [25]. Earturhan et al. reported 7% bleeding and mucosal injury, 5% access failure and 5% stone migration [18]. Geavlete et al. reports 3.7% access failure in 2,735 procedures [26]. Tiryaki et al. have reported 7.3% extravasations [27]. There was no incidence of extravasations but a relatively lower incidence of access failure which may be due to younger age in our study. There was no proximal calculus migration in our series , which is a significant problem, and it occurred in 3-16% of patients in different studies [17, 18, 26-28]. In a study of 188 patients had semirigid URS and Ho: YAG laser, the recorded failures was secondary to retropulsion of the stones (3.3%)[17].

Despite the high success rates, URS can result in various complications, with an overall rate of 9-25% in different studies [12]. Overall complication rate was 14.8% in a study done on 54 children (mean age; 7.6 years) with a mean stone size of 6.6 mm [21], while it was 8.4% out of 670 URS in children (mean age; 7.5 years) with a mean stone size of 8.9mm [23]. We had complication rate include mucosal injury 21.2%, Calvin Dendo grading : grade I was 75 %, grade II was 25% .This relatively higher complication rate is due to inclusion of younger patients with larger mean stone size in our study.

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We have evaluated the impact of different factors on the success and complications during URS surgery, one of the factors was the age of patients which remained significant for failure rate (Access failure) after multivariate analysis.. Complication and success rates were not significantly affected by age in some studies done on pediatric URS surgery [14, 15,29]. In a study done on 670 ureteral units in children using semirigid URS, age was significantly affecting the complication rate on univariate analysis, and multivariate analysis [23].
Tiryaki et al. reported a significant relationship between the occurrence of a complication and patient age and higher failure rate was related to lower patient age .The mean age of patient with residual stone was 1.33 years [27].
Other factorsin our study were the degree of hydronephrosis and stone radiolucency which did not affect significantly type of complications or success rate. This is similar to other studies [16, 22, 25].

In some studies, more complications were recorded in the proximal than in the distal ureter [16, 25, 29], while stone localization did not affect the complication rate in other studies [14, 27,29]. In our study, failure rate was significantly higher in younger ages, on multivariate analysis. Previous studies showed that stone size did not affect stone clearance rate [14, 16, 27]. On the other hand, a significant negative correlation between stone size and success rate was found in other studies [15, 22]. In our study, stone size did not affect success rate significantly. Ureteral perforation and other complications were not significantly correlated with stone size in different studies [14, 27, 29]. In a multicenter study on 670 children, stone burden was significantly affecting the complication rate on univariate analysis, but it was significant on multivariate analysis [23]. Stone burden was also a significant parameter affecting the occurrence of complications in a study done on 1,926 patients [30]. In our study, prolongation of time not related to size of stone.

Conclusion:

Ureteroscopyand Ho: YAG laser lithotripsy are safe and successful treatment option for ureteral stones in children. Complication and failure rateswere significantly affected by younger age. Complicationsare low, transient, andrelated to the small ureter caliber, and not related to the :side, gender, stone radiolucency, or degree of hydronephrosis. The age of patients and size of ureter was the only significant predicting factor for the failure.

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