

## EFFICACY AND SAFETY OF PEDIATRIC URETEROSCOPY IN THE TREATMENT OF URETERIC CALCULI IN CHILDREN

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### ABSTRACT

**Background:** To evaluate the efficacy and safety of pediatric ureteroscopy and Holmium: YAG laser lithotripsy in the management of ureteric calculi in children.

**Patients and Methods:** A Prospective study of 49 children (age ranged 2-13 years) with ureteric calculi underwent ureteroscopy with a semi-rigid 6 Fr Karl Storz ureteroscope and Holmium:YAG laser lithotripsy. The stone size ranged from 4-14 mm depending on US, KUB, IVU and CT scan in some cases. All the procedures were done under general anaesthesia and on lithotomy position, and JJ stents inserted at the end of the procedure.

**Results:** Of 49 patients, 43 patients were stone free after first ureteroscopic lithotripsy and after a second ureteroscopy in five patients, one patient developed ureteric injury and treated with open ureterolithotomy. Post-operative complications encountered in 11 (22%) of cases, 7 cases with fever, 3 with gross hematuria and one with urinary extravasation due to ureteric perforation.

**Conclusions:** Ureteroscopy and Ho:YAG laser lithotripsy is an effective and relatively safe in the treatment of pediatric ureteric calculi.

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**Keywords:** Ureteroscopy, ureteric calculi, laser lithotripsy.

U symptomatology were described since the time of Hippocrates in the 4<sup>th</sup> century BC, and has presented into the modern times, and recent data suggest that it is becoming increasingly common. The prevalence of stone disease increased steadily throughout the end of 20<sup>th</sup> century for both men and women from 3.8% during 1976-1980 to 5.2% during 1988-1994<sup>1</sup>. Similarly, the incidence rate of urolithiasis in the pediatric population also increased 4% per year from 1984-2008<sup>2</sup>. While part of this increase may be due to improved detection of small calculi

with a higher quality imaging, the rapidly rising prevalence of obesity and diabetes mellitus may also play a role in the increased prevalence of stone disease<sup>3</sup>.

The first ureteroscopy was performed by Young in 1912 when he advanced a cystoscope in an extremely dilated ureter<sup>4</sup>. The first flexible ureteroscopy was performed fifty years later in 1964 when Marshall advanced a flexible scope through an open ureterostomy into renal pelvis<sup>5</sup>. In 1988 Ritchey et al pioneered the use of ureteroscopy for extracting lower ureteric calculi in children<sup>6</sup>. Since then

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other workers have advocated ureteroscopy as an acceptable method for treating ureteric calculi at various levels in children<sup>7</sup>. The management of children with ureteral stone is usually a challenge for the treating urologist. Ureteral calculi are less frequently seen in children than in adults accounting for 7% of calculi in all age group<sup>8</sup>.

More than 80% of ureteral stones pass spontaneously and do not require any intervention<sup>9</sup>. For stones that are unlikely to pass, treatment methods can be invasive or non invasive, depending on the presence of ureteral obstruction, intractable pain, urosepsis, persistent gross hematuria, the degree of stone impaction, patient expectation and surgeon experience<sup>10</sup>.

Ureteral stones in children have been traditionally managed by extracorporeal shock wave lithotripsy and has largely replaced open surgery during the last decades<sup>11</sup>. However, besides the need to eliminate stone fragments, re-treatments are eventually required, and unlike in adults, SWL in children may require general anesthesia<sup>12</sup>. Although the smaller dimensions of the pediatric genitourinary system that limit endourological procedures, advances in endoscopic equipment and widespread application of the Ho:YAG laser have made ureteroscopy a first-line treatment option for ureteral calculi in the pediatric population<sup>13</sup>. The principle of ureteroscopy is the retrograde introduction of a ureteroscope through the ureterovesical junction, which allows the surgeon to perform either a diagnostic or therapeutic procedure in the ureter and, in some cases in the pelvis of the kidney. In the presence of a calculus in the ureter, the question to be answered is whether the

stone will pass spontaneously or not. In general, the rate of spontaneous passage of a stone less than 4mm is related to its position in the ureter, 75% in the distal, 60% in the middle and 50% in the proximal ureter<sup>14</sup>. On the other hand, stones of 5mm-10mm have a spontaneous passage rate of 10 - 50% depending on the position at which they are located. Approximately 25- 50% of children with calculi in the ureter may need a surgical procedure, and ureteroscopy is a modality<sup>15</sup>.

Complications of ureteroscopy are variable in severity and graded according to the modified ClavienDendo grading system for surgical complications.

Resent study is for evaluating the efficacy and safety of ureteroscopy using Holmium: YAG laser lithotripsy as a modality for ureteral stone treatment in children.

## **PATIENTS AND METHODS**

A prospective study of a 49 children (27 boy and 22 girls) with ureteral calculi underwent ureteroscopy and Holmium:YAG laser lithotripsy at the urology department in AL-Jumhori teaching hospital, Mosul, during the period between January 2013 and May 2014. All patients aged between 2 and 18 years were included in the study. Patients younger than two years, patients with bilateral obstructed kidneys and those who had ureteral reconstructive surgery were excluded from this study.

Pre-operative evaluation included a detailed history, clinical examination, urine analysis, renal function tests, abdominal ultrasonography, plain abdominal radiography (KUB) and

intravenous urography (IVU) were done for all patients. Abdominal CT scan was done when indicated. Pre-operative prophylactic antibiotics (third generation cephalosporin 50mg/kg or gentamicin 3mg/kg) was given to all patients. All ureteroscopic procedures were performed under general anaesthesia without prior ureteral dilatation (none of the patient had a stent prior to ureteroscopy).

A 6F semi-rigid ureteroscopy (KARL STORZ) is passed through the urethra to the bladder, the ureteric orifice is visualized and the ureteroscope is advanced to the ureter after a 0.025-inch guide wire passed up into the renal pelvis, in some cases when the guide wire does not pass due to impacted stone, the guide wire is inserted after partial lithotripsy of the stone.

Lithotripsy is performed using the Ho:YAG laser generator through a 365um flexible quartz fiber. A green Holmium-ion aiming beam facilitated accurate visualization and placement of the fiber tip on the stone surface. Treatment is usually started at an initial laser energy setting of 0.6 J and a pulse frequency of 8 Hz. both the pulse frequency and energy were continuously increased until adequate stone fragmentation is achieved. Continuous fluid irrigation is used with warm distilled water using closed system fluid pump which aids for clear visualization of stone during lithotripsy.

Lithotripsy is continued until the stone is fragmented into tiny particles which were left in situ for spontaneous passage. A stone forceps and Dormia basket were used in some cases for extraction of small stones after lithotripsy.

The JJ stents were inserted at the end of the procedure unless the procedure was uncomplicated with minimal manipulation (4F 10-15cm for those less than 6 years and 4.7F 16-28cm JJ stents for those more than 6 years). The stents were removed 3 to 4 weeks later under general anesthesia. All children were evaluated by KUB on the first post-operative day to assess the stone fragmentation and JJ stent position.

Follow - up KUB, US of the patients were done at one and 3 months after lithotripsy.

## RESULTS

A total of 54 ureteroscopic procedures were performed to treat ureteric calculi in 49 patients. A 6F semi-rigid ureteroscope is usually passed without difficulty. The demographic characteristics of the patients are shown in **Table 1**, the patient's mean age was  $6.3 \pm 1.5$  (2-13) years. The mean stone size (defined as the longest diameter as measured on plain abdominal radiography) was  $8.2 \pm 1.3$  (4-14mm).

**Table:1 Patient's Demography and Stone's Parameters.**

Number of patients	49
Gender (male: female)	27 : 22
Mean age (years)	$6.3 \pm 1.5$ (2-13)
Clinical presentation	(%)n
-Abdominal pain	25 (51%)
-Urinary tract infection	13 (27%)
-Hematuria	8 (16.3%)
-Incidental	3 (6%)
Stone side:	(%)n
-Right	28 (57%)
-Left	21 (43%)
Stone size (mm)	$8.2 \pm 1.3$ (4-14)
Stone location:	(%)n
-upper	8 (16.3%)
-middle	15 (30.6%)
-lower	26 (53%)

The presenting symptoms were: flank pain in 25(51%), urinary tract infection in 13(27%), hematuria in 8(16%) and incidental finding for extra urinary symptoms in 3(6%) patients. The stones were found on the right side in 28 patients and in the left side in 21. The calculi were located in the upper ureter in 8 (16%), mid-ureter in 15 (31%), and in the lower ureter in 26 (53%) patients. The mean pulse energy 0.8 j (range 0.6-1.2), mean frequency used 8 Hz (range 6-10), and mean total energy required for fragmentation was 2 (range 0.08-5) KJ. The mean duration of the procedures was 25 minutes (range 15-60). Ureteric JJ stent were inserted at the end of the procedure in 45 patients (91%).

The JJ stents were left in situ for 3-4 weeks. Mean hospitalization was 2.5 (range 2-5) days.

Forty-three patients were stone-free after first ureteroscopic procedure, accounting for a success rate of about 88%. Five cases had incomplete stone fragmentation with migration of residual stone up into the pelvis and were treated with SWL and or by a second ureteroscopy.

Failure of ureteroscopy faced in one case with lower ureteric stone and ureteric stricture, the stone removed eventually with open surgery with JJ stent insertion at the same time due to extravasation.

Six out of 8 patients with upper ureteric stone, 13 out of 15 patients with mid-ureteric stone and 24 out of 26 patients with lower ureteric stones were stone free after first ureteroscopy with a success rate of 75%, 86.6%, and 92.3% respectively. The overall success rate after first ureteroscopy was 87.9%, and achieving about 93.9% after second ureteroscopy (46

cases of 49 rendered stone free) as shown in **Table 2**.

Early post-operative complications were encountered in 11(22%) patients (fever in 7, frank hematuria in 3 and one case with false passage and extravasation that necessitates open ureterolithotomy).

**Table 2: The Stone's Fate After Ureteroscopic Lithotripsy at Various Levels in the Ureter.**

	Upper	Middle	Lower	Total
Number of patients	8	15	26	49
Stone free after first URS	6 (75%)	13 (86.7%)	24 (92.3%)	43 (87.8%)
Stone free after second URS	7 (87.5%)	14 (93.4%)	25 (96%)	46 (93.9%)
Auxiliary measures				
-SWL	1	1	0	
-open ureterolithotomy			1	

## DISCUSSION

Ureteroscopy has become a widely accepted modality in the management of ureteric calculi. Endoscopic lithotripsy has gradually become the main technique for treatment of ureteric calculi. This progression has been on the bases of the development of appropriate endoscopes and effective working instruments. Currently, stones throughout the entire upper urinary tract can be treated endoscopically in children using semi-rigid or flexible ureteroscopes with proven effectiveness and safety<sup>15</sup>. The stone free rate was defined as the complete absence of stone fragments of any size on radiography at three months follow-up. The stone free rate following ureteroscopic lithotripsy for ureteral stone has been reported to be as high as 98-100%<sup>16</sup>. The

**Table 3**, shows the comparison of our study with other four studies regarding the stone free rates.

In our study, the overall stone free rate after one session was 87.9%. This result is similar with Bassiri et al<sup>17</sup>. European Association of urology indicated the success rates of ureteroscopic lithotripsy in management of upper, middle and lower ureteral stone to be 74.2%, 96% and 92.4% respectively<sup>18</sup>. In our study, stone-free rates that we achieved were 75%, 86.7% and 92.3% for upper, middle and lower ureteral stone respectively. The success rates in the treatment of ureteric calculi are variable, as they are related to the patient characteristics, stone size, site and impaction, surgeon experience and quality of the technology used. The practice of routine dilatation of ureteral orifice and intramural ureter prior to performing ureteroscopic procedure remains controversial in children. There is a belief that a controlled dilatation using the balloon dilator or gradually dilating catheter may be less traumatizing to the ureter than dilatation with the ureteroscope itself. In our study, we didn't use active ureteral dilatation which was similar to findings of Al-bussaidy, Herndon et al, and Scarpa et al<sup>13, 19,20</sup>.

Among the currently available lithotripsy devices, laser lithotripsy has gained the most popularity. The safety and efficacy of Holmium:YAG laser lithotripsy makes itself to be the intracorporeal lithotripter of choice. The energy necessary to fragment the stones is delivered via small flexible fibers. Laser fragmentation is precise, producing easily passable stone fragments<sup>15</sup>. The excellent results achieved with the Ho:YAG laser are attributed to its ability

to fragment all stones regardless of their composition. Also, it is known to produce small stone fragments making retrieving of fragments with Dormia baskets or forceps to be easy or even unnecessary due to spontaneous passage. Furthermore, the Ho:YAG laser is known to generate weak shock waves, this result in less retrograde propulsion of the stone or it's fragments up to the kidney.

In our study no more attempts were made to extract the stone fragments, they were left in situ for spontaneous passage, with the aids of JJ stents. As the Ho:YAG laser acts by a photo thermal mechanism, a point of concern is the risk of thermal damage to the ureteral epithelium. However some technical considerations need to be emphasized, while this laser is being used. The laser fiber should be kept at least 1 mm from the ureteral wall mucosa to avoid thermal injury, and at least 2 mm from the tip of the ureteroscope to prevent damage to its lens, and the energy should be applied only when the laser fiber is seen to be in contact with stone surface<sup>16, 21</sup>. Furthermore, judicious irrigation is essential during laser lithotripsy to dissipate heat and facilitate visualization<sup>22</sup>.

Intra-operative and post-operative complications following ureteroscopy reported in literature include failure of negotiation, stone expulsion, ureteral perforation, hematuria, infection, ureteric stricture, and vesico-ureteral reflux<sup>12</sup>. In our study post-operative complications were reported in 11 cases (22%), although higher than other studies but most of the complications in all studies are minor ones and depends mainly on the ureteroscopic

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experience (7cases of fever, 3 cases of gross hematuria which were managed conservatively. One case with ureteric injury due to impacted stone, which was extracted by open surgery at the same

time). Accordingly, semi-rigid ureteroscopy and Ho; YAG laser lithotripsy is an effective and relatively safe in the management of ureteral calculi in children.

**Table 3:Comparisons of the Results and Complications of Our Study with the Others.**

Study	No. of operations/ No. of patients	Average age (years)	Mean stone size (mm)	Active ureteral dilatation	Stone free rate (%)	Complications rate (%)
AL-Bussaidy et al.(13)	47/43	6.2	12.6	0	93	8%
AL-Bassiri et al.(17)	66/66	9	8	37.9	88	23%
Raza et al.(23)	52/35	5.9	9.4	39	79	27%
Amjadi et al.(24)	40/38	3.5	9.3	0	89.35	12.5%
Our study	54/49	6.3-1.5	8.2-1.3	0	93.9	22%

## REFERENCES

- Curhan GC. Epidemiology of Stone Disease. *UrolClin North Am.* 2007; Aug ; 34(3): 287-293.
- Dwyer ME, Krambeck AE, Bergstralh EJ, Milliner DS, Lieske JC, Rule AD. Temporal Trends in Incidence of Kidney Stones Among Children: 25-year Population Based Study. *J Urol.* 2012; Jul;188(1):247-252.
- Cupisti A. Update on Nephrolithiasis: Beyond Symptomatic Urinary Tract Obstruction. *J Nephrol.* 2011; May-Jun: 24 suppl 18:S25-9.
- Young HH, Mckay RW. Congenital Valvular Obstruction of Prostatic Urethra.*EurGyne Obstet.* 1992; (48):509.
- Marshall VF. Fiber Optics in Urology. *J Urol.* 1994; Jan: 91:110-114.
- Ritchy M, Patterson DE, Kelalis PP, Segura JW. A Case of PaediatricUreteroscopicLasertripsy. *J urol.* 1988;139:1272-74.
- Lim DJ, Walker RD, Ellsworth PI, Newman RC, Cohen MS, Barraza MA, Stevens PS. Treatment of PaediatricUrolithiasis Between 1984 and 1994. *J Urol.* 1996;156(2):702-5.
- Rubenstien RA, Zhao LC, Loeb S, Shore DM, Nadler RB. Pre Stenting Improves Ureteroscopic Stone - Free Rates. *J Endo Urol.* 2007;21(11):1277-80.
- Satar N, Zeren S, Bayazit Y, Aridogan LA, Soyupak B, Tansug Z. Rigid Ureteroscopy for the Treatment of Ureteral Calculi in Children, *J Urol.* 2004; Jul 172(1): 298-300.
- Landan FH, Gofrit ON, Shapiro A, Meretyk S, Katz G, Shenfeld OZ, et al. Extracorporeal Shock Wave Lithotripsy is Highly Effective for Ureteral Calculi in Children. *J Urol.* 2001; Jun165 (6p2):2316-19.
- Thomas JC, Demarco RT, Donohoe JM, Adams MC, Brock JW 3<sup>rd</sup>, Pope Jc 4<sup>th</sup>. PaediatricUreteroscopic Stone



- Management. *J Urol.* 2005;Sept.174(3):1072-4.
12. El Asmy A, Hafez AT, Eraky I, Elnahas AR, El keppaney HA. Safety and Outcome of Rigid Ureteroscopy for Management of Ureteral Calculi in Children, *J Endourol.* 2006; Apr 20(4):252-5.
13. Al Busaidy SS, Prem AR, Medhat M, Al Bulushi YH. Ureteric Calculi in Children. Preliminary Experience with Holmium:YAG Laser Lithotripsy. *BJU Int.* 2004; Jun 93(9):1318-23.
14. Minevich E, Management of Ureteric Stone in Paediatric Patients. *Indian J urol.* 2010;26(4):564-67.
15. Minevich E, Defoor W, Reddy P, Nishinaka K, Wacksman J, Sheldon C, et al. Ureteroscopy is Safe and Effective in Prepubertal Children. *J Urol.* 2005;174(1):276-9.
16. Lingeman JE, Lifshitz DA, Evan AP. Surgical Management of Urinary Lithiasis. in Walsh PC, Retz AB, Vanghan ED, Wein AG, Kavoussi LR, Novik AC, et al, Campbell-Walsh Urology 10<sup>th</sup> edition. Philadelphia: Saunders: 2012 : 3361- 451.
17. Bassiri A, Ahmadnia H, Darabi MR, Yonessi M. Transureteral Lithotripsy in Paediatric Practice. *J Endourol.* 2002; 16(4):257-60.
18. Turk C, Knoll T, Petrik A, Sarica K, Skolarkos A, Straup M, Seirz C, EAU Guidelines on Urolithiasis. *Euro Ass of uro.* 2013;29-35.
19. Herndon CD, Viamonte L, Joseph DB. Ureteroscopy in Children: Is there Need for Ureteral Dilation and Post Operative Stenting? *J Ped Urol.* 2006; 2(4):290-3.
20. Scarpa RM, De Lisa A, Porru D, Canetto A, Usai E. Ureterolithotomy in Children. *Urology.* 1995;46:859-62.
21. Wollin TA, Techman JMH, Rogens VJ, Razvi HA, Denstedt JD, Grasso M. Holmium:YAG Laser Lithotripsy in Children. *J Urol;* 1999;162(5): 1717-20.
22. Scarpa RM, De lisa A, Orru D, Usai E. Holmium:YAG Laser Ureterolithotripsy. *EUR. Urol.* 1999; 35(3): 233-8.
23. Raza A, Smith G, Moussa T, Tolley D. Ureteroscopy in Management of Paediatric Urinary Tract Calculi. *J Endourol.* 2005;19(2):151-8.
24. Amjadi M, KazemiRashed F, Sari Motlagh R, Sheikh Monazzah F. Transureteral Lithotripsy of Ureteric Calculi in Children with Holmium:yttriumAlumnium Garnet (Ho:YAG) laser: *J Laser Med Sci* 2011;2(4): 148-51

## نوخته

### کاریگری و دلتیایی بوونا دوبرینا میزمجوویا زاروکان بو چارهمریا بهرکین میزمجووی لدهف زاروویان

**نامانج:** بو هلمسنگاندنا کاریگری و دلتیاییبوونا دوبرینا میزمجوویا زاروکان و بهردشکاندنا هالمیموم:یاگ لیزمرژبوو چارهمریا بهردین میزمجووی لدهف زاروویان.

**نمخوش و شتواز:** فمکولینهکا چاومروانگریه ۴۹ زاروویان بخوفه دگریت دژیی ۲-۱۳ سالی کو دوبرینا میزمجووی بو هاتیه نمنجام دان ژ جورئ کارل ستورز ۶ فرنج یا نیف توند و بهردشکاندهری هالمیموم یاگ لیزمر. قهبارئ بهرکان دهست پی دکهت ژ ۴-۱۴ ملیمتر بوون پالپشت ب تیشکا سونارئ و تیشکا سینی یا زکی و تیشکا رننگریا جوبارین میزئ و تیشکا میفراسئ ژ بو هندهک نمخوشان.هممی کریار بیت هاتینه کرن لبن بیهوشکرنا گشتی و شتوی بهرد دهرهینانی و رایه لا جهی جهی بو هاتیه دانان لادویا کریاری.

**دهرنمنجام:** ژ سرجهمی ۴۹ نمخوشان ۴۳ هاتینه نازادکرن ژ بهرکان پستی دوبرین و شکاندنا ئیکئ و پینچین دیتر پستی دوبرینا دووی و ئیک نمخوش یی هاتیه چارهمرکرن ب نیشترگریا لابرنه بهری میزمجووی ب کهلاشتنی پستی میزمجو بریندار بووی ب دوبرینی. سربارکین پستی چارهمری هاتنه دیتن لنک ۱۱ نمخوشان(۲۲٪) ، ۷ ژ وان نمخوشیا تایئ و ۳ ژوان خوینبوونا میزئ یا دیار و ئیک ژ وان دهرچوون میزئ ژ میزمجووی ژ بهرکونبوونا میزمجووی.

**دهرکفتن:** دوبرینا میزمجووی و بهردشکاندنا هالمیموم یاگ لیزمر چارهمریکا کاریگر و دلتیایه تا رادهکئ ژ بو چارهمریا بهرین میزمجووی لدهف زاروویان.



## الخلاصة

### كفاءة وسلامة ناظور الحالب في معالجة حصى الحالب لدى الأطفال

**الخلفية والأهداف:** تقييم كفاءة وسلامة ناظور الحالب في معالجة حصى الحالب لدى الأطفال.

**المرضى و طرق البحث:** أدراسة مستقبلية أجريت لـ 49 طفل ( 27 ذكر و 22 أنثى ) أجري لهم ناظور الحالب مع تفتيت الحصى بالليزر، للفترة مابين كانون الثاني 2013- أيار 2014. معدل عمر المرضى  $6.3 \pm 1.5$  سنة . تم إجراء فحص التصوير بالأمواج فوق الصوتية و أشعة الحوض والبطن، وأشعة الكلية الظلية لكل المرضى، وفي بعض الحالات مفراس البطن. كل العمليات أجريت تحت التخدير العام، بعد إكمال عملية التفتيت تم وضع قسطرة الحالب لـ 45 من المرضى.

**النتائج:** من مجموع 49 مريض اعتبر 43 من المرضى خاليين من حصى الحالب بعد أول ناظور للحالب. 5 من المتبقين أجري لهم ناظور الحالب للمرة الثانية، بينما تعذر التفتيت في واحدة من الحالات نتيجة تضيق الحالب وإحتباس الحصى في أسفل الحالب. مضاعفات ما بعد العملية حدثت 11 مريضاً 7 منهم إرتفاع درجة الحرارة، 3 تبول دموي، وفي أحد المرضى فشل التنظير مع جرح الحالب حيث أخرجت الحصى بعملية جراحية.

**الاستنتاجات:** ناظور الحالب مع التفتيت بالليزر أثبت كفاءته وسلامته في معالجة حصى الحالب لدى الأطفال.