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Original Article

Ureteroscopy for Treatment of Ureteral Calculi in Children

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ABSTRACT

Objective: To evaluate the efficacy and safety of rigid ureteroscopy and Holmium:YAG laser lithotripsy for the treatment of ureteral calculi in children.
Patients and Methods: Between January 2003 and January 2008, 24 boys and 16 girls with an average age of 8 (range 3-12) years were treated for ureteral calculi. In total, 42 calculi sized 5 to 12 mm (mean 7 mm) were managed using rigid ureteroscopy (7F) and Holmium:YAG laser lithotripsy. The stones were located in the upper ureter in 4, in the mid-ureter in 10, and in the lower ureter in 26 cases. Dilatation of the ureteric orifice and intramural ureter was required in 16 patients (40%). Internal ureteral stents were inserted in 24 patients (60%).
Results: In total, 40 ureteroscopic procedures were performed to treat 42 stones in 40 patients and 37/40 patients (93%) were rendered stone-free after a single procedure. In 2 cases stone fragmentation was incomplete; the residual stones which had migrated into the kidney were treated with insertion of a JJ stent and ESWL. Ureterolithotomy was done in one patient. Early post-operative complications were reported in 4 patients (10%), two cases with hematuria and another two with fever; all were managed conservatively. Follow-up in 32/40 patients was 3 to 36 months. The patients were not specifically evaluated for vesicoureteral reflux.
Conclusion: Ureteroscopic Holmium:YAG laser lithotripsy is an efficient and safe treatment modality for ureteric calculi in children. Routine ureteral dilatation and stent placement post-operatively is not always necessary.

Keywords : Ureteroscopy, ureter, calculi, children

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INTRODUCTION

The management of children with ureteral calculi 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 groups[1]. More than 80% of ureteral stones pass spontaneously and do not require any intervention[2]. 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 the surgeon's experience[3].

Ureteral stones in children have been traditionally managed by extracorporeal shock wave lithotripsy (ESWL) and open surgery. Achieving high stone-free rates, ESWL has largely replaced open surgery during the past decades[4]. However, besides the need to eliminate stone fragments, re-treatment is eventually required, and unlike in adults, ESWL in children may require general anesthesia[5].

Although the smaller dimensions of the pediatric genitourinary system limit endourological procedures, advances in

Table 1: The efficacy of ureteroscopic Holmium:YAG lasertripsy at various levels in the ureter

	Upper ureter	Mid-ureter	Lower ureter	Total
Number of patients	4	10	26	40
Number of impacted stones	1	1	2	4
Success rate n (%)	3	9	25	37 (92.5%)
Failure rate n (%)	1	1	1	3 (7.5%)
Auxiliary measures:				
1- ESWL	1	1	0	2
2- Ureterolithotomy	0	0	1	1

endoscopic equipment and the widespread application of the Holmium:YAG laser have made ureteroscopy a first-line treatment option for ureteral and renal calculi in the pediatric population[6]. In this study, we evaluated the efficacy and safety of rigid ureteroscopy and Holmium:YAG laser lithotripsy as a treatment modality for ureteral calculi in children.

PATIENTS AND METHODS

Forty children (24 boys and 16 girls) with ureteral calculi underwent ureteroscopy and Holmium:YAG laser lithotripsy at the Urology Department, Assiut University Hospital, Assiut, Egypt, between January 2003 and January 2008. The patients' mean age was 8 (range 3-12) years. The presenting symptoms were flank pain in 28 (70%), urinary tract infection in 8 (20%) and hematuria in 4 (10%) patients. In total, we treated 42 unilateral calculi in 40 ureters; two patients each had two calculi in the ureter. The calculi were located in the upper ureter in 4 (10%), in the mid-ureter in 10 (25%) and in the lower ureter in 26 patients (65%); the stones were found on the right side in 22 and on the left side in 18 cases. The mean stone size (defined as the longest diameter, as measured on plain abdominal radiography) was 7 (range 5-12) mm. Impacted stones were encountered in 4 patients (10%) (Fig. 1). One child had a stone in the lower ureter of the only functioning kidney. All stones were radio-opaque. Children with bilateral ureteric stones, those with concomitant ureteral and renal calculi in the same renoureteral unit and those with impaired renal function were excluded from the study.

Pre-operative evaluation included a detailed history, clinical examination, urine analysis, urine culture and sensitivity test, blood urea and serum creatinine. Abdominal ultrasonography, plain urinary tract (PUT) film and intravenous urography (IVU) were obtained for all children. They received pre-operative prophylactic antibiotics (third-generation cephalosporin).

All ureteroscopic procedures were performed under general anesthesia, without prior ureteral dilatation (none of the patients had a stent prior to ureteroscopy). An initial cystoscopy was done with a 10F Storz cystoscope. A 0.025-inch working guide wire was passed up into the renal pelvis under fluoroscopic guidance in 36 cases. In the remaining 4 patients the stones were impacted and the guide wire could not be passed beyond the level of the stone. The ureteric orifice and intramural ureter were dilated up to 9F using Teflon dilators in 16 patients (40%); in the remaining 24 patients ureteric dilatation was not required. A 7F semirigid ureteroscope was passed alongside the guide wire and advanced up to the level of the stone. Flexible ureteroscopy was not available for the treatment of upper ureteric calculi.

Lithotripsy was performed using the Holmium:YAG laser generator through a 365 μm flexible quartz fiber. A red helium-ion aiming beam facilitated accurate visualization and placement of the fiber tip on the stone surface. Treatment was started at an initial laser energy setting of 0.6 J and a pulse frequency of 6 Hz. Both the pulse frequency

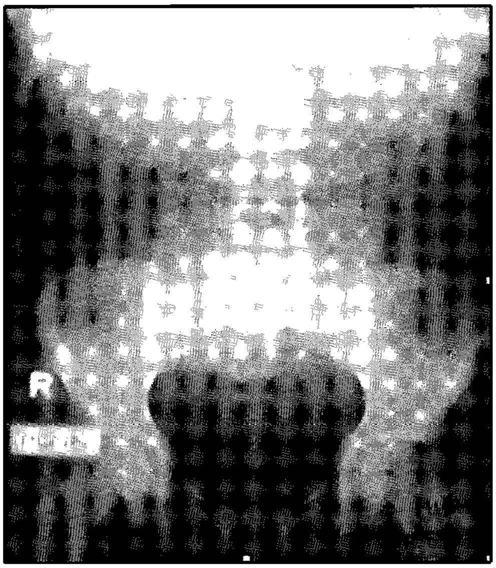

Fig. 1A: Plain abdominal X-ray of a female 11-year-old child showing a stone in the middle third of the right ureter.

Fig. 1B: IVU of the patient showing persistent nephrogram due to stone impaction.

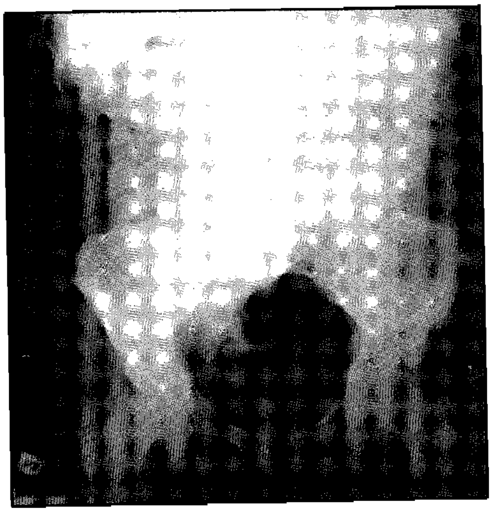

Fig. 1C: Post-operative PUT of the patient showing right double-J stent and complete clearance of the stone.

and energy were continuously increased until adequate fragmentation was achieved. Lithotripsy was continued until the stone was fragmented into tiny «sand» particles which were left in situ for spontaneous passage.

Indwelling JJ stents were inserted selectively at the end of the procedure in those children who had impacted stones, prolonged manipulations, dilatation of the ureteric orifice and a solitary kidney. The smallest stent possible for any particular patient was used. The stents were later on removed under general anesthesia.

All children had a PUT film on the second post-operative day to assess the stone fragmentation and to check the position of the JJ stent. Follow-up ranged from 3 to 36 months with an average of 16 months. PUT, abdominal ultrasonography, urine analysis and urine culture were performed 3 and 12 months post-operatively in 32 children. The patients were not evaluated for post-operative vesicoureteral reflux. The stone-free rate was defined as the complete absence of stone fragments of any size on radiography at three months follow-up.

RESULTS

In total, 40 ureteroscopic procedures were performed to manage 42 stones in 40 children. There was no difference in the mean age of the 16 patients who required dilatation and those who did not (8.4 and 9.1 years, respectively). A 7F rigid ureteroscope could be passed without difficulty into the urethra of the male patients. The procedure could also be done safely in younger male patients with no added risk for urethral stricture formation.

The mean duration of the procedure was 30 (range 20-50) minutes. The mean pulse energy, frequency and total energy required for fragmentation were 0.7 (range 0.6-1.2) J, 7 (range 6-10) Hz and 2 (range 0.06-5) KJ, respectively. Ureteric stents were inserted at the end of the procedure in 24 patients (60%). In children less than 5 years we inserted 4F, 8-10 cm JJ stents, while 4F,12-16 cm JJ stents were used for older children. The stents were left in situ for a mean of 25 (range 20-45) days. Mean hospitalization was 2.7 (range 2-8) days.

Thirty-seven children were rendered stone-free after a single ureteroscopic procedure accounting for a success rate of 93%. Two cases had incomplete stone fragmentation with migration of the residual stone into the kidney and were treated with insertion of a JJ stent and ESWL. The remaining case was an impacted lower ureteral stone; failure was due to significant ureteral narrowing that rendered endoscopic access impossible. The stone was eventually removed by open surgery under the same anesthesia (Table 1). There was no limitation to the procedure concerning the site of the stone even in the proximal ureter.

Early post-operative complications were encountered in 4 cases (10%): 2 cases of fever and another 2 with gross hematuria which were treated conservatively. No complications, such as obstruction or sepsis were encountered in non-stented children.

At a mean follow up of 16 (range 3-36) months, the upper tracts were sonographically normal, and the urine cultures were negative. Voiding cystourethrography was not done.

DISCUSSION

Ureteroscopy has become a widely accepted modality in the management of ureteric calculi. However, its use in children has been limited, the main concern being trauma to the ureterovesical junction and lower ureter during introduction. Advances in the design of ureteroscopes and ancillary instruments during the last 15 years have resulted in miniaturization and increased durability of the smaller scopes required for the pediatric patients[7]. In this study the children's age did not present a limitation to the use of ureteroscopy without prior dilatation of the intramural ureter. Passage of the ureteroscope (7F) through the urethra made no difference in either sex. This miniscope that can be passed up to the proximal ureter is expected to be passed easily through the urethra without undue trauma. Holmium:YAG laser represents a further advance in endoscopic stone surgery. The laser energy is absorbed by the water content of the stone leading to thermal disintegration rather than fragmentation of the stone[8].

In experienced hands, the endoscopic approach to ureteral stones in children is successful in 86% to 94% of patients in one procedure, and the success rate increases to 100% with the use of secondary minimally invasive procedures, such as ESWL and secondary ureteroscopy[3,9-13]. In the current study, 37/40 patients (93%) were rendered stone-free after a single procedure and when including the secondary auxiliary procedures used (ESWL) we even had a success rate of 98%. Ureterolithotomy was done in one patient (3%). Although the stone location may affect treatment efficacy and success, it did not affect our results, which may be attributed to the small number of patients with stones in the upper ureter. Moreover, the proximal location of the ureteral stones was not a limiting factor of the procedure.

The excellent results achieved with the Holmium:YAG laser are attributed to its ability to fragment all urinary stones regardless of composition. Also, it is known to produce small stone fragments and thus retrieving fragments with baskets and forceps is unnecessary. Furthermore, the Holmium:YAG laser is known to generate weak shock waves; this results in less retrograde propulsion of the stone or its fragments compared to other methods, e.g. the electrohydraulic lithotripter[14]. In the present study no attempts were made to extract the stone fragments, they were left in situ for spontaneous passage. Proximal migration of stone fragments was reported in two cases; however this is probably attributable to the force of irrigant fluid rather than to the laser itself.

As the Holmium: YAG laser acts by a photothermal mechanism, a point of concern is the risk of thermal damage to the urothelium, especially within the narrow confines of the pediatric ureter. However, various reports suggest that ureteric injury after Holmium:YAG laser lithotripsy is uncommon in children[9,10,14-18]. Despite the high safety profile of the Holmium:YAG laser 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 mucosa to avoid perforation, and at least 2 mm from the tip of the endoscope to prevent damage to the lens system[19]. Also, the energy should be applied only when the laser fiber is seen to be in contact with the stone surface[16]. Furthermore, judicious irrigation is warranted during lasertripsy to dissipate heat and facilitate visualization. Without irrigation the scattering of stone fragments creates a snowstorm appearance, which obscures vision and makes it difficult to monitor the fiber tip[20].

Intra-operative and post-operative complications following ureteroscopy reported in the literature include ureteral perforation, hematuria, infection, ureteric stricture and vesicoureteral reflux[11-13]. In the current study post-operative complications were reported in four patients (10%): two cases of hematuria and two cases of fever which were managed conservatively. However, ultrasonography is recommended for all patients to detect or rule out upper urinary tract dilatation that may indicate the presence of ureteric stricture.

The practice of routine dilatation of the ureteric orifice and intramural ureter prior to performing ureteroscopic procedures in children remains controversial[21]. Dilatation is not necessary in the majority of cases and when it is required, it should be done only to the smallest size that will allow the introduction of the ureteroscope[11,22]. The true incidence of vesicoureteral reflux in children after ureteroscopy with or without ureteral dilatation is unkown. Most reported cases of vesicoureteral reflux were of low grade and resolved spontaneously[7]. In the current study, teflon ureteral dilatation up to 9F was done in 16 patients (40%). Evaluation for reflux was not done as ultrasonography and urine cultures were normal in all patients, suggesting that reflux is clinically insignificant if present. Voiding cystography should be reserved for children in whom post-operative upper tract dilatation or urinary tract infection is evident[21].

Routine ureteric stenting after ureteroscopy remains controversial. The rationale for stent placement has traditionally been the avoidance of stricture formation, post-operative pain and acute pyelonephritis. However, ureteral stents themselves are known to cause significant pain and bladder spasm. Most pediatric urologists prefer to stent the ureter after ureteroscopic manipulations. However, some authors have questioned the need for routine stenting and consider stent placement indicated only in cases of gross hydronephrosis, increased stone burden, edema of the ureteric orifice, impacted ureteral calculi and trauma to the ureter[9,15,17,19,21]. Indwelling JJ ureteral stents were inserted at the end of the procedure in 24 (60%) of our patients. No complications, such as obstruction or sepsis were encountered in non-stented children.

Much debate has focused on the issue of using in situ ESWL versus ureteroscopy for managing ureteral calculi in children. Despite the minimally invasive nature of in situ ESWL, stone-free rates vary and multiple treatments are required. Furthermore, in situ ESWL is known to be less effective for stones >10 mm, impacted stones, radiolucent stones, and for cystine and calcium oxalate monohydrate stones[23]. In situ ESWL, being less invasive, may be offered as the treatment of choice for children with small (<10 mm), not impacted, radio-opaque upper ureteric stones. In all other cases ureteroscopy and Holmium:YAG laser lithotripsy are preferable[13].

In conclusion, in experienced hands, rigid ureteroscopy and Holmium:YAG laser lithotripsy for the treatment of ureteral calculi in children have a high success rate with minimal morbidity. Routine ureteral dilatation and stent placement post-operatively are not always necessary. Uncomplicated ureteroscopy with or without ureteral dilatation can be safely performed without placement of a ureteral stent.

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