Pneumatic ureterolithotripsy in paediatric and adolescent patients: a ten-year experience at the Hospital Universiti Sains Malaysia

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ABSTRACT

Introduction: Two to three percent of stone disease cases occur in the paediatric age group. It is common in some parts of the world, such as in Turkey, India and Thailand. More than 50 percent of stones in children are still managed through open surgery. Ureteroscopic intervention for children remains a challenging treatment option. However, in contemporary urology practice, this mode of intervention is becoming more common. In this retrospective study, we reviewed our experiences with ureteroscopy and pneumatic lithotripsy in the paediatric and adolescent age group.

Methods: A total of 13 patients at or below the age of 18 years underwent 17 retrograde semi-rigid ureteroscopy between 1998 and 2008. Their median age was 14 (range 3–18) years. The technique of ureterolithotripsy used for this age group was similar to that used among adults. The ureteric orifice and intramural part of the ureter were not dilated in all the patients. A double J stent was inserted into all the patients.

Results: The mean stone size was 7.9 (range 5–13) mm. The stone was in the distal ureter in eight patients, in the mid ureter in seven patients and at the ureterovesical junction in another two patients. The overall stone-free rate after one ureterolithotripsy procedure was 84.6%. We failed to clear the stones in two patients at the first sitting.

Conclusion: Semi-rigid ureteroscopy and pneumatic ureterolithotripsy are safe and effective procedures that and can be performed without ureteric dilation in experienced hands.

Keywords: paediatric lithotripsy, pneumatic lithotripsy, ureteroscopy, urolithiasis

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INTRODUCTION

About 2%–3% of all cases of stone disease occur in children, but it is uncommon among those under two years of age.[1] It is very common in some parts of the world, such as in Turkey, India and Thailand.[2] Infection is a major aetiological factor in children.[3] More than 50% of stones in this age group are still managed by open surgery.[3] Ureteroscopic intervention for ureteric stones in children is still a challenging option. However, with miniaturised ureteroscopes and ancillary instruments, this mode of intervention is becoming more common. This study is a retrospective review of our experience with using ureteroscopy and pneumatic ureterolithotripsy in this age group.

METHODS

The demographic data, radiological findings (stone size, site and side), indications for surgery, laboratory profiles, operative and postoperative findings of all patients aged ≤ 18 years who were admitted to our hospital between 1998 and 2008 were retrospectively reviewed and recorded. A total of nine boys and four girls underwent 17 ureterolithotripsy procedures. Their median age was 14 (range 3–18) years. Eight patients underwent right-sided ureteroscopy, four underwent left-sided ureteroscopy and one patient underwent bilateral ureteroscopy over the course of two sessions. Three patients required another ureteroscopic procedure in order to render them stone-free.

The indication for surgery was symptomatic ureteric calculi or calculi causing dilation of the upper urinary tract. Metabolic evaluation for stone diseases, routine biochemistry, urine culture, kidney, ureter and bladder (KUB) radiography, KUB ultrasonography (US) and intravenous urography (IVU) were conducted in all the patients, but stone analysis was not routinely requested. The technique of ureteroscopy utilised in this age group

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Table I. Clinical characteristics and outcomes of our patients.

Age (yrs)	Side	Site	Stone size (mm)	Duration (min)	Outcome procedures	Auxiliary procedure	Other	Complications
3	RT	Mid	5	60	Clear	Postop DJ	-	-
6	LT	Distal	10	30/80	Postponed	Postop DJ	Re-URS	False passage
9	BIL	Distal	9/7	75/60	Clear	Postop DJ	2 URS	-
11	RT	Mid	7	60	Clear	Postop DJ	-	-
13	LT	UVJ	9	80	Clear	Postop DJ	-	-
15	RT	Mid	8	60	Clear	Postop DJ	-	-
14	RT	Mid	9	75	Clear	Postop DJ	-	-
17	RT	Mid	11	90	Clear	Postop DJ	-	-
18	LT	UVJ	12	75	Clear	Postop DJ	-	-
14	RT	Distal	8	75	Clear	Postop DJ	-	-
17	RT	Mid	12	30/90	Postponed		Re-URS	Perforation
18	LT	Distal	10	75	Clear	Postop DJ	-	-
18	RT	Distal	13	90	Clear	Postop DJ	-	-

LT: left; RT: right; BIL: bilateral; UVJ: ureterovesical junction; Postop: postoperative; DJ: double J stent; URS: ureteroscopy

was similar to that used in adults. All the procedures were performed under general anaesthesia in the dorsal lithotomy position, and the patients were well padded to avoid compartment syndrome or excessive limb abduction. The median working time was 75 (range 60–90) minutes, and a prophylactic antibiotic was used in all patients according to their body weight and the results of their urine culture.

An appropriate cystoscope was used to inspect the urethra and bladder, and to place a 4 FR open-ended ureteric catheter at the level of the intramural ureter. A low-pressure retrograde ureteropyelogram was conducted. Under fluoroscopic guidance, through an open-ended ureteric catheter, a 0.035-inch Bentson guidewire (Cook Medical Inc, Bloomington, IN, USA) was positioned in an upper collecting system. The ureteric orifice and intramural part of the ureter was not dilated in all the patients. A 6/7.5 FR tapered semi-rigid ureteroscopy and a 0.8 FR Swiss lithoclast (Richard Wolf GmbH, Knittlingen, Germany) semi-flexible probe were used in all the patients. We gained access to the ureter alongside the guidewire and under visual guidance. Any difficulties in negotiating the ureteric orifice were overcome either by inserting a second guidewire through the working channel of the ureteroscope and advancing the ureteroscope between the two guidewires under visual guidance, or by rotating the instrument gently by 180° during insertion.

Normal saline at room temperature was used as the irrigation fluid, with minimal use of fluoroscopy during the procedure. Once the stone was visible through the ureteroscope, the size of the stone in relation to the diameter of the ureter was estimated so as to ensure a better chance of removing the stone in one piece through a basket or by grasper manipulation, provided the diameter of the distal ureter was adequate to allow for atraumatic retrieval. To remove a large or impacted stone in one piece, the flow of irrigation fluid was kept to a minimum and the patient was placed in an upright position (45° angle) to avoid significant deflection of the probe. With direct contact between the probe and the calculus, the stone was blasted using either a single- or multiple-shot operating mode (pneumatic lithoclast) until the stone was reduced into smaller fragments that could be passed out spontaneously or extracted by forceps under direct vision with or without basket extraction. For an impacted stone, attempts were made to dislodge the stone into the proximally dilated ureter, which allowed for more room for ureterolithotripsy. At the end of the procedure, the proximal ureter was inspected to ensure that no migration of the stone had occurred. A double J (DJ) stent was inserted over the guidewire for two to four weeks in 11 patients and for four to six weeks in another two patients in whom ureteral mucosal injury was suspected. Before discharge, all the patients underwent KUB radiography to confirm the position of the DJ stent and to exclude significant residual stones (> 4 mm). Perioperative prophylactic antibiotics were prescribed to all the patients.

RESULTS

A total of 17 retrograde semi-rigid ureteroscopies were conducted in 13 patients in an attempt to clear eight distal (Fig. 1), seven mid-ureteric and two ureterovesical junction stones (Fig. 2). All the ureteric stones in this study were radiopaque, with an average size of 7.9 (range 5–13) mm. The average length of hospital stay was two to three days. In six of the 13 patients, no risk factor for urinary stone

Fig. 1 Kidney, ureter and bladder radiograph of a five-year-old girl shows a stone in her right ureterovesical junction.

Fig. 2 Kidney, ureter and bladder radiograph of a six-year-old girl shows a bilateral distal ureteric stone.

disease was found. Three patients had metabolic causes, while urine culture and sensitivity showed mixed growth in the remaining patients. There were no anatomical abnormalities in any of the patients, as documented by the preoperative KUB US, IVU and intraoperative retrograde pyelography (RPG). Out of the 13 patients, 11 (84.6%) were stone-free at the end of one ureteroscopic session, while the procedure was unsuccessful in two patients. These failures were encountered in conjunction with intraoperative complications. A six-year-old girl with an impacted distal left ureter had a mucosal injury caused by the false passage of a guidewire demonstrated intraoperatively. Ureteric perforation created by a guidewire was seen in a 17-year-old boy with an impacted right mid-ureteric stone, whose RPG showed a large amount of extravasation. The procedure was terminated in both patients despite the stone not having been fragmented. This prompted the use of a DJ stent in the first patient for four weeks and the insertion of a US-guided percutaneous nephrostomy in the second patient for two weeks, which was then replaced with a DJ stent for another four weeks. The stones were successfully removed in these two patients after six weeks (the re-treatment rate was 15.4%). No other complications were observed to have occurred from the ureterolithotripsy and the postoperative stenting of the ureter. The average follow-up time was 8.5 (range 3–24) months. All the patients were followed up with urinalysis with or without urine culture and sensitivity as well as KUB US to ensure that dilation of the upper urinary tract and other complications did not occur.

DISCUSSION

Paediatric and adolescent urolithiasis can be associated with significant morbidity. Metabolic disorder, urological abnormalities and urinary tract infection (UTI) are all possible underlying causes for urinary stones among this age group.[4,5] Positive urine culture was present in 30% of our patients, a finding that is similar to that of Sternberg et al, who reported the presence of UTI in 8%–70% of children with urolithiasis.[6] 23% of our patients had metabolic abnormalities in the form of idiopathic hypercalciuria, in keeping with the results of other studies that identified this underlying metabolic risk factor in 12%–80% of children with urolithiasis.[6,7]

Technological advances in medicine, particularly in endourology, have enabled the surgical management of ureteric stones in children to be similar to that in adults.[8] At present, open surgery, *in situ* extracorporeal shock wave lithotripsy as well as antegrade and retrograde ureteroscopy using intracorporeal lithotripsy devices such as electrohydraulic, ultrasonic lithotripsy, pneumatic lithoclast and pulsed-dye or holmium YAG laser are all available options for the treatment of ureteric stones.[8-10] There are different modalities of intracorporeal lithotripsy, and each method has its own advantages and disadvantages. Electrohydraulic lithotripsy carries a high risk of

ureteric perforation and stricture formation, with a narrow safety margin,[11] especially if visual control is less than perfect.[1] Moreover, it is unable to fragment all the stone compositions.[12] Two major problems that occur with pneumatic lithotripsy are retrograde migration of the stone or its fragments[13] and the loss of lithotripsy power with significant deflection of the probe.[12] However, there are no cavitation or thermal effects on the tissue,[12] and short bursts of energy result only in superficial erosion or oedema,[14] thus keeping the risk of tissue injury to a minimum.

Ureteral perforation can be induced by prolonged firing directly on the mucosa.[14] The lithotripter is effective at fragmenting all types of stones, and smaller, more flexible probes are also available.[15] No evidence of intraoperative or long-term complications, fibrosis or stricture in relation to its use has been found.[14] The pneumatic lithotripter is affordable and offers a short learning curve. The use of laser holmium YAG lithotripsy in paediatric ureteric stones has shown excellent results,[16] as it is associated with minimal stone migration,[13] and can be used in all types of urinary stones[17] and with rigid or flexible ureteroscopes. However, a high level of caution must be exercised; the tip of the laser probe must be kept in direct vision so as to avoid subsequent tissue or endoscopic damage during blasting of the stone, and the operating staff must thus be experienced in the use of this technique.[18] In addition, due to the high cost of the device and other related disposable and maintenance issues, laser ureterolithotrispy may not be available in all urological centres. Therefore, there is no single device that is ideal for use in all situations. The availability of the equipment, financial resources and level of experience of the surgeon are all factors that determine the method of intervention and choice of ureterolithotripsy technique used.

Reviews on paediatric ureteroscopy have reported a 77%–100% stone-free rate following one procedure,[8-10] and secondary procedures usually bring this rate closer to 100%.[19] In the current study, the initial overall stone-free rate for mid- and distal ureteric stones was around 84.6%, and the stone size did not appear to affect the result of clearance. This is in keeping with the results of Dogan et al.[20] The ureteric orifices and intramural parts of ureters were not actively dilated in all patients, which was similar to the findings of Herndon et al[21] and Scarpa et al.[22]

As a training and referral centre, most of the patients who attended our institution had to travel a long distance to receive medical care. We therefore attempted to place a double J stent in all our patients as a safety measure and to avoid severe colic or urinary sepsis when the patients returned home. Our study noted no complications related to stent insertion, similar to the findings of Dogan et al[20] and Tan et al.[23] We do not routinely evaluate our patients postoperatively with voiding cystourethrography for vesicoureteral reflux (VUR) secondary to ureteroscopy. The incidence of VUR has been reported to be mostly transient and low-grade, at 0%–17%.[9,24] Minevich et al have recommended voiding cystourethrography only for patients with upper tract dilation or UTI.[25] None of our patients had persistent dilation of the upper tract or UTI after treatment. The reported complication rate of retrograde semi-rigid or flexible paediatric ureteroscopy is 0%–7%,[22] and the reported incidence of ureteric perforation by a guidewire is 0%–4.3%.[8,10,22] Impacted stones, a narrow ureter, awkward guidewire manipulation and attempts to fragment impacted and hard stones in one session likely contributed to the two unsuccessful cases in our study.

There are two limitations to the current study. Firstly, we used only one modality of treatment for all the cases, and secondly, the number of patients studied was small. Despite these limitations, we have found semi-rigid ureteroscopy and pneumatic lithotripsy to be safe and effective when used in the paediatric and adolescent age group. In experienced hands, the procedure can be performed without ureteric dilatation. However, the endourological anatomy and the physiological changes that occur during the procedure must be well understood and visualised in order to avoid possible complications associated with the procedure. It is the preferred first-line intervention for mid- and distal ureteric stones in most patients at or below 18 years of age.

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