Symposium

Management of ureteric stone in pediatric patients

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ABSTRACT

The management of ureteral stones in children is becoming more similar to that in adults. A number of factors must be taken into account when selecting one's choice of therapy for ureteral stone in children such as the size of the stone, its location, its composition, and urinary tract anatomy. Endoscopic lithotripsy in children has gradually become a major technique for the treatment of ureteral stones. The stone-free rate following urteroscopic lithotripsy for ureteral stones has been reported in as high as 98.5–100%. The safety and efficacy of Holmium:YAG laser lithotripsy make it the intracorporeal lithotriptor of choice. Given its minimally invasive features, extracorporeal shock wave lithotripsy (ESWL) has become a primary mode of treatment for the pediatric patients with reno-ureteral stones. Stone-free rates have been reported from 59% to 91% although some patients will require more than one treatment session for stone clearance. It appears that the first-line of therapy in the child with distal and mid-ureteral stones should be ureteroscopic lithotripsy. While ESWL is still widely considered the first-line therapy for proximal ureteral calculi, there is an increasing body of evidence that shows that endoscopic or ESWL are equally safe and efficacious in those clinical scenarios. Familiarity with the full spectrum of endourological techniques facilitates a minimally invasive approach to pediatric ureteral stones.

Key words: ESWL, pediatric urolithiasis, ureteroscopy

INTRODUCTION

The incidence of urolithiasis in the pediatric population is on the rise. While once considered a rarity, it is now evident that children do form urinary tract stones and do so with an increasing frequency. While there are many opinions regarding the management of the pediatric patient who is presented with a stone, few would disagree that any patient who has a surgically active ureteral stone should have the stones removed expeditiously. Van Savage *et al*. have published their recommendations for modifying the adult American Urological Association (AUA) guidelines to be applied to the pediatric patient.[1] They concluded that calculi <3 mm would pass spontaneously whereas calculi larger than 4 mm would require surgical management. The management of ureteral stones in children is becoming more similar to that in adults. With the ever-continuing advance of technology, stone management has evolved from an open surgical approach into techniques that are significantly less invasive. A number of factors must be taken into account when selecting one's choice of therapy for ureteral stone in children such as the size of the stone, its location, its composition, and urinary tract anatomy.

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DISCUSSION

Endoscopic lithotripsy

Endoscopic lithotripsy in children has gradually become a major technique for the treatment of ureteral stones. This progression has been on the basis of the development of appropriate endoscopes and effective working instruments. Enhancements in video technology coupled with improved optics have increased the ability to evaluate and endoscopically treat ureteral stones in even in the case of smallest children. Pediatric urologists, initially reluctant to be aggressive in endourologic techniques, now are exposed to younger colleagues who are not hesitant to tackle even tough ureteroscopic scenarios. Currently, calculi throughout the entire upper urinary tract in children can be treated endoscopically using semi-rigid or flexible ureteroscopes with proven effectiveness and safety.[2–7] The stone-free rate

following urteroscopic lithotripsy for ureteral stones has been reported in as high as 98.5–100%.[8,9] Large stones (stone burden exceeding 10 mm) have a slightly lower clearance rate following one procedure.[9] In terms of overall safety, pediatric ureteroscopy has been validated as a safe modality in contemporary series. Intraoperative complications, defined as ureteral injury (ischemia, perforation, and avulsion) or postoperative complications (mainly ureteral stricture) have shown to be extremely rare. The overall complication rates have shown to range from 0% to 5.2%.[4,8,9] Flexible instruments are useful for antegrade ureteroscopy, as well as achieving ureteral access in children with complex anatomy.

The pediatric urologist has a large variety of ancillary instruments to treat urinary tract stones anywhere along the ureter (or inside the kidney) in a minimally invasive fashion. Several different energy sources for intraluminal lithotripsy exist. Electrohydraulic lithotripsy (EHL) is widely available and cost-effective. The small flexible EHL probes can be used with both semi-rigid and flexible ureteroscopes. This lithotripter does not fragment all types of calculi and has poorly controlled energy, which occasionally can cause ureteral wall thermal trauma. For these reasons, now a days, EHL is used less frequently. Among the currently available lithotripsy devices, laser lithotripsy has gained the most popularity. The safety and efficacy of Holmium:YAG laser lithotripsy make it the intracorporeal lithotriptor of choice.[8-11] The energy necessary to fragment the stones is delivered via small flexible fibers, allowing the use of semi-rigid or flexible instruments. Laser fragmentation is precise, producing easily passable calculus fragments. Complications after ureteroscopic laser lithotripsy are uncommon and usually related to passage of the ureteroscope than from laser action. In the older pediatric patients, basketing the stone is also an option but should be undertaken with extreme caution because of the risk of basket entrapment or ureteral avulsion. We recommend using Nitinol retrieval baskets if necessary. These tipless, nickel–titanium stone baskets with soft wires have memory, resist kinking, and therefore, open safely and reliably.

The practice of routine dilatation of the ureteral orifice and intramural ureter prior to performing an ureteroscopic procedure in children remains controversial. There is a belief (albeit, unproven) that a controlled dilatation using the balloon dilator or a gradually dilating catheter may be less traumatic to the ureter than dilatation with the ureteroscope itself. A caveat regarding the former approach, however, is the possibility (again, unproven) that it may be associated with an increased risk of developing ureteral strictures and/or vesicoureteral reflux. Until definitive studies of any risks associated with ureteral dilatation have been undertaken, the decision to perform ureteral dilatation will likely depend upon the surgeon's preferences and complication rate stemming from the procedure. In most contemporary studies, dilatation of the vesicoureteral junction is usually not necessary to successfully accomplish the planned ureteroscopic procedure.[8,12] We agree with others that temporary (1–2 weeks) prestinting with an indwelling ureteral stent provides a safe and effective alternative in achieving access to pediatric ureter without active dilatation.[9] This technique was associated with higher overall stone-free rate in adults.[13] If dilatation is necessary to advance the ureteroscope, we prefer gradual dilatation using ureteral dilators that, in our opinion, causes the least possible trauma to the intramural orifice. Ureteral access sheaths (9.5Fr to 12Fr) should be used in cases with large stone burdens when multiple passages of the ureteroscope are anticipated.[14] Ureteral stricture rates following the use of access sheath seem to be extremely low.[15]

The true incidence of vesico-ureteral reflux (VUR) in children after ureteroscopy with and without ureteral dilatation is unknown. Most reported cases of postoperative VUR are of low grade and resolved spontaneously.[16,17] On the basis of our own observation and the reports of others, we do not recommend routine postoperative screening to rule-out VUR.[2,16,18] In our opinion, a voiding cystogram should be reserved for children in whom postoperative upper tract dilatation or urinary tract infection are evident.

Postoperative stenting after ureteroscopic lithotripsy remains controversial in the adult literature.[19] Most pediatric urologists prefer to stent the ureter after endoscopic manipulation.[16,20] Although the rationale for stent placement has traditionally been a potential decrease in stricture formation, postoperative pain, and acute pyelonephritis, ureteral stents can actually cause significant pain and bladder spasms.[21] Postoperative stent placement (for 1–2 weeks) is usually at the discretion of the surgeon, and is often based on the difficulty and complexity of the specific case. Most children are able to tolerate the attached string and the stent can be removed 5–7 days later without the use of an additional anesthetic.

Recently, De Dominicis *et al*. made an important contribution to the ongoing debate regarding the most effective management of distal ureteral stones in children.[22] Their prospective randomized study demonstrated statistically significantly higher success rate of ureteroscopy with intracorporeal lithotripsy (a success rate of 94% after one treatment), compared to extracorporeal shock wave lithotripsy (ESWL) (42% after one session, 64% after two).

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY

Extracorporeal shock wave lithotripsy has been the treatment of choice for symptomatic upper urinary tract stones in adults since 1980s, when the first-generation machines, featuring spark-gap electrodes, were introduced. Initially reported in 1986 large series of ESWL in children demonstrated complications, safety and stone-free rates similar to those

in adults.[23] To decrease the pain experienced by patient, which is a function of the size of the focal point and the amount of energy focused at that point as well as the surface area over which the shock wave enters, new second- and third-generation machines with electromagnetic generators were introduced. Therefore, intravenous sedation instead of general anesthesia can now be used in older pediatric patients.[24,25] Introduction of newer compact portable ESWL machines allows pediatric urologists to perform outpatient treatment conveniently at their own institution, with the added safety of dedicated pediatric anesthesia. Positioning of the child is extremely simplified and additional endoscopic procedures (ureteral stent placement or removal) can be performed simultaneously since these machines incorporate a universal urological table.[26,27] Radiation exposure during ESWL is minimal and comparable with that of routine diagnostic uroradiological examinations.[28]

Given its minimally invasive features, ESWL has become a primary mode of treatment for pediatric patients with reno-ureteral stones.[29,30] Further studies determining a definitive size cutoff for upper tract stone burden is necessary to recommend the most effective first-line therapy for larger stones (above 1–1.5 cm). Stone-free rates have been reported from 59% to 91%[24,26,27,30,31] although some patients will require more than one treatment session for stone clearance. Current success rates are difficult to interpret from existing literature due to discrepancies among studies regarding the definition of stone-free status, type of lithotriptor, stones locations and sizes, and number of shocks administered. In most pediatric series, the treatment of proximal ureteral stones has achieved similar success rates to renal stones.

Treatment of mid to distal ureteral calculi has historically been avoided in children due to difficulties with localization over the sacroiliac joint and concern regarding possible injury to the developing reproductive system. Thus far there is no evidence that ESWL for distal and mid-ureteral stones in adults exerts any detrimental effect on female and male fertility.[32] In an *in vitro* animal study, rat ovaries were subjected to shock waves. The results showed no differences between experimental and control groups in the rate of subsequent pregnancies, fetal numbers, spontaneous abortions, and malformations.[33] However, this issue has yet to be clarified in the long-term studies in children. For the mid-ureter, the density of bony pelvis is less in children and this probably results in a higher success rate than in adults.

One of the first reports of ESWL monotherapy for ureteral stones in 38 pre-pubertal children demonstrated success rates of 81.5% after one session with an overall stone-free rate of 97.3%.[34] Stones were located in the upper ureter in 17 cases, mid-ureter in 2, and lower ureter in 19. The stone-free rate following one ESWL session was 100% for ureteral calculi smaller than 10 mm regardless of the location and 67% for stones larger than 10 mm. The same group later reported overall success rate of 98.3% in 59 patients with ureteral stones treated with ESWL over a 22-year-period. The three-month stone-free rate did not depend on either stone location or size.[30] The largest to-date published series of ESWL of ureteric stones in children reported results among 192 patients.[24] The overall stone-free rate was 91% with a retreatment rate of 49%. That rate was 94% for all proximal and mid-ureteral stones and 91% distal ureteral stones.

ESWL for ureteral stones is highly satisfactory. The high success rate observed throughout the ureter can possible be explained by the fact that the pediatric ureter is more short, elastic, and distensible. Such structure allows for easier transmission of stone fragments and prevents ureteral impaction. Ureteral stenting before ESWL remains a controversial issue, and often depends on both the stone size and patient's anatomy. It was shown that pediatric ureter is at least as efficient as the adult for transporting stone fragments after ESWL.[35] The incidence of Steinstrasse following ESWL in children without ureteral stents has shown to be very low (significantly lower than for adults).[2,36] As a result, preoperative stenting is generally reserved for children with solitary kidney, severely obstructing stones, or abnormal anatomy.

CONCLUSIONS

There is insufficient experience reported to establish guidelines for treating ureteric stones in children. With no prospective randomized studies currently available, individual surgeon's experience is the most determining factor in counseling patients regarding the most effective primary treatment options for pediatric ureteral stones. It appears that the first-line of therapy (until proven otherwise) in the child with symptomatic distal and mid-ureteral stones should be ureteroscopic lithotripsy, performed by an experienced pediatric urologist. While ESWL is still widely considered the first-line therapy for proximal ureteral calculi <1–1.5 cm, there is an increasing body of evidence that shows that endoscopic or extracorporeal shock wave lithotripsy is equally safe and efficacious in those clinical scenarios. Familiarity with the full spectrum of endourological techniques facilitates a minimally invasive approach to pediatric ureteral stones.

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