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SYMPOSIUM PAPER

How effective is ureteroscopy in the treatment of pediatric stone disease?

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Abstract Pediatric ureteroscopy has been increasingly used to manage both ureteral and renal stones. Unfortunately, there are no current standardized recommendations when treating pediatric stone disease so the modality chosen is left to the treating surgeon. A review of the current literature on pediatric ureteroscopy was used to compile this article. For the purposes of this review, the majority of series include stones $\leq$1 cm. Ureteroscopy is considered to be first-line therapy in treating mid- to distal ureteral stones and is rapidly evolving as an acceptable first-line therapy for renal stones as well. Limitations do exist and include stone composition, location, size, as well as the unique anatomic challenges faced by pediatric urologists in terms of anomalous kidneys and/or reconstructed urinary tracts. In conclusion, ureteroscopy can be considered first-line therapy for mid- or distal ureteral stones, however, it shares a similar efficacy rate as extracorporeal shock wave lithotripsy for the treatment of renal calculi. There is a need for direct comparison in the literature of all modalities treating pediatric stone disease to facilitate guidelines that help treating surgeons choose the most efficacious modality offering the highest success rates with the lowest morbidity.

Keywords Ureteroscopy · Pediatrics · Laser · Intrarenal · Kidney

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Advances in endoscopic equipment as well as the widespread application of the holmium:YAG laser has made ureteroscopy a first-line treatment option for ureteral and renal calculi in the pediatric population. There is a growing body of literature that supports this treatment modality in children with minimal morbidity. Although "ureteroscopy" was initially reported by Young in 1929 when he described using a cystoscope to view the ureter in a child with posterior urethral valves, it was not until 1988 that Ritchey et al. reported the initial application of this evolving technology to treat ureteral stones in children [1, 2].

There are many different ways to manage pediatric stone disease including extracorporeal shock wave lithotripsy (ESWL), ureteroscopy, percutaneous nephrostolithotomy (PCNL), laparoscopic or open stone procedures. The purpose of this paper is to review the current literature on pediatric ureteroscopy. When reporting on any treatment modality, one must first evaluate its efficacy. Efficacy can be judged by many factors, but must be a combination of stone-free rates, patient morbidity, comparison to other modalities for similar patient presentation, and inherent limitations. In general, the number of articles written in PubMed™ on pediatric ureteroscopy has almost quadrupled in the last decade, confirming the widespread use as well as the evolving technology seen with endoscopic equipment.

There are, however, problems with the current literature that make it hard for a clinician to choose the "best" modality to offer his/her patient. For example, there is still no consensus on the definition of "stone-free", which should mean no residual fragments on post-operative imaging or by direct visualization at the time of surgery. In addition, various post-operative imaging modalities are used at different institutions and a major goal in treating pediatric stone disease is to limit ionizing radiation. Some "pediatric" series include patients >18 years of age. Our bias has always been

to limit our series reporting outcomes in pediatric stone disease to patients <14 years old (personal communication). The lack of any randomized, prospective studies or direct comparison between treatments limits our ability to apply the data objectively in everyday practice. As stated earlier, there is no current international consensus in treating pediatric stone disease and therefore current recommendations are based on surgeon experience, stone size, composition if known, location, and specific anatomic challenges seen in children.

In general, most stones <1 cm and some stones up to 2 cm can be managed with ureteroscopy. Ureteroscopy can be considered a primary treatment option in patients with a history or cystine or calcium oxalate monohydrate stones, as these have historically been resistant to ESWL therapy. Pediatric ureteroscopy is very safe in experienced hands. In a large review of patients undergoing pediatric ureteroscopy, Schuster et al. reported a stricture rate of 1%, ureteral perforation rate of 1.3%, and transient reflux in 3.6%. Success rates in the literature demonstrate an 84–100% stone-free rate after a single procedure [3–8]. It is important to remember that the majority of patients reported in these series had ureteral stones, while only 3–33% of patients had renal calculi. It is safe to say that ureteroscopy is the procedure of choice for ureteral stones in children. One small study which randomized ESWL to ureteroscopy showed success rates of 43 versus 94%, respectively [9].

In contrast, the optimal management of renal calculi is not yet known. Currently, there have been only four studies documenting outcomes of pediatric ureteroscopy in managing renal calculi with success rates of 50–97% after a single procedure [7–10]. This wide range of success was a result of multiple factors including: extended versus immediate follow-up, lack of standardized radiographic testing, variable use of a ureteral stent, method of upper tract access, and need for additional procedures. In our experience, the success rate of ureteroscopy for renal stones as a primary procedure was 50% immediately and 58% following 3 months of follow-up [10]. Interestingly, this was similar to our 55% success rate with ESWL for similarly matched stone in both size and location (data not published). We ultimately attained a 76% success with secondary ureteroscopy and a 92% success rate if salvage ESWL or PCNL were included [10]. We found that preoperative stone size and younger patient age significantly predicted for a secondary procedure [10].

Access to the upper tracts can be difficult in some pediatric patients due to the size of the instrumentation or patient anatomic constraints. Some have favored active dilation with the use of an 8/10 coaxial dilator due to its tactile feedback, low complication rate, and because it is done over a working wire, if difficult, a JJ stent can be easily placed [7]. In our experience, we feel that passive dilation with a JJ stent for 10–14 days is an invaluable resource to the pediatric endoscopist having trouble accessing the upper tract. In our series, we passively dilated one-third of the patients at the time of the primary procedure. This method has been shown to be safe and effective in other studies as well [11]. Unfortunately, without a true randomized study, the decision to place a stent is most often left to the treating surgeon. Corcoran et al. [12] attempted to define parameters that would help select those patients in whom to place a stent, however, age, weight, height, and BMI were not predictors. Relative contraindications for pediatric ureteroscopy may include a staghorn calculus, prior bladder neck reconstruction or closure, prior cross-trigonal reimplant, or previous failed endoscopic therapy.

We have also found the ureteral access sheath to be quite useful when performing intra-renal pyeloscopy. There have been advantages and disadvantage to the use of the sheath documented in the literature. Potential advantages include facilitation of repetitive access to the upper tracts, potential to shorten operative times, and the ability to maintain low intrapelvic pressures [13]. In contrast, some have argued against the routine use of the access sheath due to the risk of ureteral ischemia and potential for stricture formation as well as the lack of well designed prospective clinical trials documenting its efficacy [14]. One large study documented a 1.4% (1/71) stricture rate but felt that the stricture was due to multiple ureteroscopic procedures and less likely the access sheath [15]. Anectodally, we have found the placement of ureteral access sheaths to be much easier following passive dilation with a JJ stent for 10–14 days.

Conclusions

In summary, ureteroscopy can be considered first-line therapy for mid- or distal ureteral stones in children. In our hands, ureteroscopy has a similar efficacy as ESWL for renal calculi following a single treatment. Ureteroscopy is safe in prepubertal patients when used by experienced personnel. Passive ureteral dilation is very helpful, albeit at the expense of bothersome symptoms and need for a second anesthetic. Finally, there is a need to standardize our algorithm for the treatment of pediatric stone disease just as in the adult literature. We should focus efforts at coordinating direct comparisons of different therapies to enable surgeons to offer the most efficacious treatment with the highest success rates and the least morbidity to our pediatric patients.

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