

Factors Affecting the Success of Ureteroscopy in Management of Ureteral Stone Diseases in Children

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Abstract

Purpose: We retrospectively investigated the factors that affect the success of rigid ureteroscopy in the pediatric population for the management of pediatric ureteral stones.

Patients and Methods: We present a retrospective review of 61 consecutive pediatric patients who underwent 66 rigid ureteroscopy procedures for ureteral stone management. The effects of sex, age, stone diameter, stone localization, and degree of associated ureterohydronephrosis (UHN) on the success of ureteroscopy were evaluated.

Results: The mean age of the patients was 8.1 years (range 6 mos–16 yrs). The average stone diameter was 8.22 mm (range 4–20 mm). In 56 cases (84.8%), all of the stones were extracted. In five (7.6%) cases, clinically significant residual fragments were detected and extracted by second-look ureteroscopy. In five cases (7.6%), the operations ended in failure. The final stone clearance rate after ureteroscopic stone treatment was higher in lower ureteral stones than in middle and upper ureteral stones; thus, the difference was statistically significant ($P = 0.011$). Also, there is a significant negative correlation between stone size and success rate ($P = 0.007$). The final stone clearance rate after ureteroscopic stone treatment was higher in patients with no and mild UHN than in patients with moderate and severe UHN, but the difference was statistically insignificant ($P = 0.118$). Statistical analyses revealed no significant relationship between success rates with regard to the sex and age of the patients ($P = 0.643$ for sex, $P = 0.390$ for age).

Conclusion: The stone localization and stone size are the factors that affect the success of the procedure.

Introduction

EVOLUTION OF TECHNIQUE and miniaturization of instruments have changed the management of pediatric stone diseases. Reduction in the size of endoscopes, improvements in the electronic imaging systems, proliferation of ancillary equipment, and improvement in endourologic skills among pediatric urologists make endoscopic management of pediatric urolithiasis the treatment of choice.¹ The advent of rigid and flexible ureteroscopes has allowed intraureteral lithotripsy (ultrasonic, pneumatic lithotripter, and laser), regardless of the size and location of ureteral stone.² There is increasing evidence that shockwave lithotripsy (SWL) and ureteroscopy are equally safe and efficacious, even for managing upper tract stone disease in children.³ The use of ureteroscopy has been limited in children, however, because of concern for ureteral ischemia, perforation, stricture formation, and development of vesicoureteral reflux as a result of dilation of small caliber ureteral orifices.³

In this study, the factors that affect the success of rigid ureteroscopy in the pediatric population were retrospectively investigated to evaluate the efficiency and reliability of ureteroscopy in the management of pediatric ureteral stones.

Patients and Methods

Patients

We present a retrospective review of 61 consecutive pediatric patients who underwent 66 rigid ureteroscopy procedures for treatment of ureteral stones between August 1998 and March 2009. Demographic parameters, including patient age, sex, and previous surgical treatments for stone disease, were recorded. The biochemical and microbiologic features were reviewed, and specific data were recorded. Preoperative imaging, including intravenous urography (IVU), ultrasonography, and CT (for nonopaque stones), was reviewed to determine stone size and location, ureterohydronephrosis (UHN), and any anatomic abnormalities.

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The maximum length of stone in millimeters on a plain radiogram was used as the stone diameter. The stone locations were pointed as lower, middle, and upper ureter. The upper ureter extends from the renal pelvis to the upper border of the sacrum. The middle ureter comprises the segment from the upper to the lower border of the sacrum. The lower (distal or pelvic) ureter extends from the lower border of the sacrum to the bladder. All of the patients underwent ultrasonography to determine the status of the renal parenchyma and presence of UHN. The degree of UHN was evaluated in four categories as described previously⁴: No, mild, moderate, and severe UHN. The decision to perform ureteroscopy was made depending on stone size, location, anatomic factors, and individual urologist preference.

Operations

All ureteroscopic procedures were performed at a single center by any member of a team of six urologists with the patients under general anesthesia. A prophylactic antibiotic (ceftriaxone 50 mg/kg) was administered during induction of anesthesia. All patients underwent initial cystoscopy to place a safety wire. After successful placement of the guidewire in the renal pelvis or beyond the stone under fluoroscopic guidance, a rigid (8F) ureteroscope was used. Ureteral orifice dilation was performed with a 15F ureteral balloon and a pressure-controlled injector in ureters in which a stent had not been placed, or when the rigid ureteroscope could not be advanced easily.

Stones were extracted with a basket catheter when feasible or fragmented using a pneumatic lithotripter to facilitate removal. Operative time was derived from the anesthesia chart and defined as the time elapsed in minutes from induction of anesthesia until stone removal. The success rate of the operation was evaluated in three categories based on plain radiography 1 day postoperatively: Stone free (SF), clinically significant residual fragments (CSRF, residual fragments in patients with impaired clinical status because of pain, urinary infection, septicemia, etc), and failure to reach the stone.

The decision to place a ureteral stent after the operation was based on the duration of the procedure, number of passes with the ureteroscope, and degree of visible ureteral trauma or edema at the conclusion of the procedure. The stents were removed about 2 to 4 weeks after the operation with the patients under sedoanalgesia. Extracted stone specimens were routinely sent for stone analysis. Follow-up imaging consisted of renal ultrasonography and abdominal plain radiography, with additional imaging (IVU, noncontrast CT) in patients in whom there was increased suspicion of residual or recurrent stone burden.

The effects of sex, age, stone diameter, stone localization, and degree of associated UHN on the success of ureteroscopy were evaluated.

Statistical analyses

Statistical analyses of data were performed with Statistical Package for Social Sciences (SPSS) 15.00 for Windows and the plus 6.2 program. In this study, parametric and nonparametric statistical tests were used. For the comparisons of mean differences of two independent groups, two independent *t* tests (or *z* test) were used when the assumptions were satisfied. When assumptions were not satisfied, the corresponding

nonparametric test (Mann-Whitney *U* test) was used to test if two independent groups were coming from the populations with the same median. Two independent *t* tests for qualitative variables were used to test the ratio differences between two (independent) groups. The chi-square test was also used for the independence test between some qualitative variables.

Results

Ureteroscopy was performed in 66 ureters in 61 patients; thus, ureteroscopy was bilateral in 5 patients. Thirty-one of the patients were male while 30 were female. Twenty-nine (44%) of the ureteroscopy procedures were performed on the right and 37 (56%) on the left ureter. The mean age of the patients was 8.1 years (range 6 mos–16 yrs). Four (6%) patients had ipsilateral SWL in their history. In addition, four other (6%) patients had had unsuccessful initial ipsilateral ureteroscopy at another center.

The average stone diameter was 8.22 mm (range, 4–20 mm). Five (7.5%) of the stones were nonopaque. Urine culture was positive in 12 (20%) patients in whom *Escherichia coli* was predominant. Initial ureteral balloon dilation was performed in five (7.5%) cases. In 31 (47%) cases, stones were extracted only by basket catheter, and the pneumatic lithotripter was used in 35 (53%) cases. A Double-J (DJ) catheter was inserted in 36 (55%) patients. Average operative time was 32.65 minutes (range 15–100 min).

In 56 cases (84.8%), all of the stones were extracted. In five (7.6%) cases, CSRF were detected, and these fragments were extracted by second-look ureteroscopy. In five (7.6%) cases (three on the left, two on the right side), the operations ended in failure, because the stones migrated to the kidney; thus, SWL was performed as an additional treatment. The success rates in right and left ureters were similar (93% for right and 92% for left).

The success rates according to stone localizations are presented in Table 1. The final stone clearance rate after ureteroscopic stone treatment was higher in lower ureteral stones than in the middle and upper ureteral stones (98%, 77.8%, and 71.5%, respectively); thus, the difference was statistically significant ($P = 0.011$). In addition, there is a significant negative correlation between stone size and success rate ($P = 0.007$); final stone clearance rates increase as the stone diameter decreases.

The success rates according to degree of UHN are presented in Table 2. The final stone clearance rate after ureteroscopic stone treatment was higher in the patients with no and mild UHN than in the patients with moderate and severe UHN, but the difference was statistically insignificant ($P = 0.118$). In addition, statistical analyses revealed no significant relationship between success rates with regard to sex and age of the patients ($P = 0.643$ for sex, $P = 0.390$ for age).

In two patients, high fever occurred postoperatively, and hospitalization time became longer. No other complication was seen. The stone analyses revealed 6 (9%) cystine, 2 (3%) urate, 2 (3%) hypoxanthine, and 56 (85%) calcium oxalate stones. Appropriate medical therapy and dietary planning were proposed to the patients because of their stone analysis.

Discussion

The first ureteroscopic procedure in the pediatric population was performed in 1929 by Young and McKay⁵ to diagnose

TABLE 1. SUCCESS RATES ACCORDING TO STONE LOCALIZATION

Stone localization	Ureteral units	SF	CSRF	F	Final stone clearance
Upper ureter	7 (11%)	5 (71.5%)	0 (0%)	2 (28.5%)	5 (71.5%)
Middle ureter	9 (14%)	6 (66.7%)	1 (1.1%)	2 (22.2%)	7 (77.8%)
Lower ureter	50 (75%)	45 (90%)	4 (8%)	1 (2%)	49 (98%)
Total	66 (100%)	56 (84.8%)	5 (7.6%)	5 (7.6%)	61 (91.4%)

SF = stone free; CSRF = clinically significant residual fragments; F = failure.

the cause of dilation of the posterior urethral valve and upper urinary system in a 2-week-old infant by using a pediatric cystoscope. In 1981, Das⁶ reported ureteral stone removal with the aid of a ureteroscope under direct vision. After Ritchey and associates⁷ published their experience with pediatric ureteroscopy in 1988, this technique gained widespread acceptance among pediatric urologists.

Early series using a rigid ureteroscope for lower ureteral stone treatment in the pediatric population revealed SF rates of 86% to 100% with minimal complication rates similar to those in the adult population.⁸⁻¹² De Dominicis and colleagues⁹ reported a significantly higher SF rate after one treatment with ureteroscopy (94% vs 43%) in 31 children who were randomized to SWL as primary therapy for lower ureteral stones. Lesani and Palmer¹³ reported their experience using 4.5F, 6F, and 8F rigid ureteroscopes for managing upper ureteral stones in 24 children with a mean age of 10.7 years; 100% of children were rendered SF.

In a large series of 100 children with a mean stone diameter of 8.3 mm, 52% of whom had upper tract calculi, Smaldone and coworkers¹⁴ reported a 91% SF rate with 9% of children undergoing staged procedures. They reported a 4.2% perforation rate that was managed by ureteral stent placement and one distal ureteral stricture necessitating open neocystostomy at a mean follow-up of 10 months. Satar and associates¹⁵ reported a 94% stone clearance rate with ureteroscopy in 35 ureteral units.

In our series of 66 ureteral units in 61 children with a mean age of 8.1 years and an average stone diameter of 8.22 mm, we detected a 92.4% stone clearance rate with 7.6% of children undergoing staged procedures. Our results are similar to results in the studies cited above.

In the literature, authors have reported variable success rates of ureteroscopy, depending on the localization of the stone: Range of 22% to 60% for stones in the upper ureter, 36% to 83% for stones in the middle ureter, and 84% to 99% for stones in the lower ureter.^{16,17} In our study, our final stone clearance rate after ureteroscopic stone treatment was higher in lower ureteral stones than in middle and upper ureteral

stones, similar to those results (Table 1), and the difference was statistically significant ($P = 0.011$).

Kim and colleagues¹⁸ reported a stone clearance rate of 100% for stone burdens 10 mm or less and 97% for burdens of more than 10 mm after a single flexible ureteroscopy in 170 patients and concluded that pediatric flexible ureteroscopy has proved to be a highly efficacious and safe modality in the management of pediatric stone disease. We cannot compare the success rates of this study with ours, because we used only a rigid ureteroscope in our series, but we, too, detected a significant negative correlation between stone size and success rate ($P = 0.007$), similar to this report.

Although the statistical analyses revealed no statistically significant difference ($P = 0.118$, the insignificance might be because of the small number of patients), our final stone clearance rate after ureteroscopic stone treatment was higher in patients with no and mild UHN than in patients with moderate and severe UHN. This can be explained by the increased possibility of stone migration to the kidney as the degree of UHN increased. Initial ureteral stent insertion in patients with mild to severe UHN might be useful, not only for relief of the kidney but also to prevent stone migration, provide a passive dilation for the ureteral orifice, and increase the success of the operation. In addition, statistical analyses revealed no significant relationship between success rates with regard to sex and age of the patients ($P = 0.643$ for sex, $P = 0.390$ for age).

In five (7.6%) cases, the operations ended in failure, because the stones migrated to the kidney; thus, SWL was performed as an additional treatment. Flexible ureteroscopy should be performed in such cases in the same session, however, if the center has a flexible ureteroscope and suitable equipment.

Another disputing point of pediatric ureteroscopy is the need for initial ureteral dilation and the method of dilation. Some authors have suggested ureteral dilation with an 8F to 10F coaxial dilator^{3,14} or a balloon dilator,¹⁵ while some authors have preferred passive dilation by stent placement before ureteroscopy¹⁹ to prevent the risk of vesicoureteral reflux or ureteral stricture. Although passive dilation is a

TABLE 2. SUCCESS RATES ACCORDING TO DEGREE OF ASSOCIATED URETEROHYDRONEPHROSIS

Degree of UHN	Ureteral units	SF	CSRF	F	Final stone clearance
No	15 (23%)	14 (93.3%)	1 (6.7%)	0 (0%)	15 (100%)
Mild	14 (21%)	12 (85.7%)	2 (14.3%)	0 (0%)	14 (100%)
Moderate	16 (24%)	15 (93.7%)	0 (0%)	1 (6.3%)	15 (93.7%)
Severe	21 (32%)	15 (71.4%)	2 (9.5%)	4 (19.1%)	17 (80.9%)
Total	66 (100%)	56 (84.8%)	5 (7.6%)	5 (7.6%)	61 (91.4%)

UHN = ureterohydronephrosis; SF = stone free; CSRF = clinically significant residual fragments; F = failure.

straightforward, successful, and beneficial technique,¹⁹ it does necessitate an additional procedure with anesthesia.

The results of retrospective studies, however, have begun to refute the notion that dilation of the pediatric ureter results in vesicoureteral reflux or the development of ureteral strictures. In a systematic review of the literature encompassing 221 pediatric ureteroscopies, Schuster and coworkers⁸ noted only two ureteral strictures and minimal incidence of vesicoureteral reflux. In our series, we needed ureteral dilation in five (7.6%) of the cases, and we performed the dilation with balloon and pressure-controlled injector; no patient experienced a clinically apparent problem as a result of dilation of the orifice. Soygur and colleagues²⁰ described a new technique of ureteral dilation by hydrodilation of the ureteral orifice in children with a handheld irrigation pump without any major complication, such as ureteral stricture.

While the tendency in large series has been to leave a stent in place after ureteroscopic manipulation in the majority of children,¹⁴ some authors have reported no acute or long-term sequelae despite leaving a stent postoperatively in fewer than 20% of cases.²¹ In our experience, the decision to place a ureteral stent postoperatively was based on the duration of the procedure, surgeon experience, number of passes with the ureteroscope, and degree of visible ureteral trauma or edema at the conclusion of the procedure; as a result, we placed a DJ catheter in 36 (55%) of the patients at the end of the operation.

At present, SWL has gained great acceptance for the management of kidney stones and upper ureteral stones while ureteroscopy has been preferred for stones localized in the lower part of ureter. SWL and ureteroscopy, however, should be indicated according to not only stone size but also age and size of the child, anatomic variations, and stone localization (collecting system or ureteral wall). Availability of performing SWL under sedoanalgesia, no requirement for hospitalization, and a high success rate for upper ureteral stones are the superiorities of SWL to ureteroscopy.

Twenty-four consecutive articles published between 1998 and 2008 concerning the comparison of SWL and ureteroscopy for the management of ureteral stones were evaluated in a systematic comprehensive review.²² In this review, in SWL groups, the overall success rate was 84.1% (range 71%–100%) for upper ureteral calculi and 76.2% (range 19%–91%) for lower ureteral calculi. With ureteroscopic management, the overall success rates were 93.2% (range 81%–100%) and 74.4% (range 20%–100%) in lower and upper ureteral calculi, respectively.²² In our study, a high proportion of the patients were children with distal ureteral stones, because we usually prefer SWL for upper ureteral stones.

Conclusion

Stone localization and stone size are the factors that affect the success of rigid ureteroscopy in management of ureteral stone diseases in the pediatric population. Overall, the ureteroscopic management of ureteral stones in children is safe and feasible; therefore, ureteroscopy should be first-line therapy, especially for lower ureteral stones with experienced surgeons and suitable equipment.

Disclosure Statement

No competing financial interests exist.

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Abbreviations Used

CSRF = clinically significant residual fragments
CT = computed tomography
DJ = Double-J
IVU = intravenous pyelography
SF = stone free
SWL = shockwave lithotripsy
UHN = ureterohydronephrosis

