Minimally invasive approaches and their efficacy in pediatric urolithiasis

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ABSTRACT

Objective: We compared the frequency of usage and success of minimally invasive approaches in the management of pediatric urolithiasis in our clinic.

Material and methods: Data from pediatric patients (≤ 16 years of age) who had undergone percutaneous nephrolithotomy (PNL), ureterorenoscopy (URS), and extracorporeal shock wave lithotripsy (ESWL) between January 2001 and December 2011 were retrospectively investigated.

Results: In this study, 415 pediatric patients, who were treated for 291 renal, and 124 ureteral stones, were evaluated. The patients were treated with PNL (n=148; 82 boys, 66 girls), URS (n=99; 58 boys, and 41 girls) or ESWL (n=168; 91 boys, and 77 girls). The mean patient ages were 7.3 (1-16), 9.1 (1-16), and 8.8 (1-16) years in the PNL, URS, and ESWL groups, respectively. The stone-free rates after treatment with PNL, URS, and ESWL were 77, 83.8 and 88.7%, respectively.

Conclusion: It is important that selected therapies are properly planned, and the use of minimally invasive approaches is important in pediatric patients due to potentially high recurrence rates. Currently, ESWL, PNL and URS are performed with high success rates for the treatment of stones, and open surgery is rarely used due to the success obtained with minimally invasive approaches.

Key words: ESWL; minimally invasive approach; pediatric urolithiasis.

Introduction

Urinary system stone disease is a widespread disease in our country with a prevalence of 14.8% as estimated in a multicentered study.

^[1] In the Eastern, and Southeastern Anatolia where warm climate is dominant, its incidence is still higher. Stone disease, and treated in the childhood gains extra importance because of its potential recurrence in later years. Nowadays, new minimally invasive methods have been developed, and introduced into routine practice in line with technological advancements. Effectiveness, safety, and reliability of new methods have been emphasized in many studies which resulted in almost complete extinction of open stone surgery nowadays. In this study we compared incidence, and success rates of minimally invasive treatment approaches used in our clinic in the treatment of pediatric stone disease.

Material and methods

For our retrospective study, approval from Inonu University Malatya Clinical Researches Ethics Committee was obtained on 17.07.2012 with the protocol 2012/129. In our clinic, data, and information about pediatric patients younger than 16 years of age who had undergone percutaneous nephrolithotomy (PNL), ureterorenoscopy (URS) or extracorporeal shock wave lithotripsy (ESWL) in our clinic between January 1, 2001-December 31, 2011 were retrospectively analyzed. Age, and gender of the patients, stone location, type of the procedure, and its success rate were evaluated. Patients without completely accessible data were excluded from the evaluation.

Statistical analysis

For the statistical evaluation of the collected data arithmetic means were used.

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Results

In the present study, a total of 415 patients with complete clinical data who were treated for 291 renal, and 124 ureteral stones were evaluated (Table 1). PNL was applied for the first time in 144 of 148 patients. Study population consisted of 82 male, and 66 female patients with a median age of 7.3 (1-16) years. Right (n=76), left (n=69) sided, and also in the same session bilateral (n=3) PNLs were performed. Stone-free rates were achieved in 114 patients. Mean stone size was 2.32 cm², stones were located in the upper pole (n=1), middle pole (n=101), lower pole (n=22), renal pelvis (n=16), and in various locations of the collecting system (n=18). Besides partial (n=1), and complete staghorn stones (n=3) were detected. Any comorbidities were not found in the patients. PNL was achieved through access into upper pole (n=1), middle pole (n=127) lower pole (n=25), and multiple tracks (n=9). Access tracks were enlarged using 20, 26, and 30 Fr Amplatz dilators in consideration of patient's age, renal anatomy, and the procedure was achieved with 17, 24, and 26 Fr rigid nephroscopes. The stones were fragmented using pneumatic lithoriptors. At the end of the procedure, renal collecting system was drained using 14-16 Fr Foley catheters.

Within the same time interval, in our clinic, 99 URS procedures were applied for the management of ureteral stones in 58 male, and 41 female patients with a median age of 9.1 (1-16) years. For the management of ureteral stones, URS was applied for the left (n=44), and the right-sided (n=52) ureteral stones, and also for bilateral stones in 3 patients with a complete stone-free rate in 83 patients. The stones of 36 cases were detected in the upper (n=36), and lower one-third (n=29) ureter, and midureter (n=34). Mean stone size was 1.13 cm², and the procedures were realized using 7.5-8 Fr rigid ureterorenoscopes. Stones were fragmented with the aid of Holmium-YAG laser, and pneumatic lithotripter. Besides, ESWL was employed for residual stones in 18 patients. In 5 patients urinary tract infection developed which required inpatient treatment.

During this period, 168 stone-disease patients underwent ESWL therapy in our clinic. Median age of 91 male, and 77 female

patients who underwent ESWL was 8.8 (1-16) years. ESWL was applied for the right renal stone (n=72), left renal stone (n=71) or right (n=12), left (n=13) ureteral stones, and complete stone-free rates were achieved in 149 patients. Median renal, and ureteral stone sizes were 1.08 cm², and 0.82 cm², respectively. Pelvic (n=39), upper (n=25) middle (n=47), and lower (n=28) pole stones were also detected. However in 4 cases stones were in multiple locations within renal collecting system. Upper (n=13), and lower (n=5) ureteral, and also midureteral (n=7) stones were detected. Treatment of the patients were realized using PCK LITHO 3 PTR (V5) device which delivered approximately 2000 W energy in an average of 1.1 sessions. Besides, in 4 patients, additional application of URS, and stenting were required. As a complication steinstrasse (n=3), urinary tract infection (n=3), and febrile episodes (n=1) were observed.

Discussion

Prevalence studies on stone disease have revealed prevalence of stone disease as 5.2% in patients aged <18 years, and 1-3% in the pediatric age group.^[2,3] In a study performed by Akinci et al.^[1] prevalence of stone disease was found as 14.8% in our country. Though limited number of publications are available on pediatric age group, in a screening study urinary stone disease was encountered in 0.8% of school age children.^[4] A complex process involving metabolic, and anatomic factors, and infections may result in formation of urinary system stone, and its treatment differs between children, and adults. Pediatric stone disease is a risk factor for the recurrence of stone disease in later years. In a study performed in Turkey, median stone disease recurrence has been reported as 15% in patients aged between one month, and 6 years, however in patients with metabolic disorders a recurrence rate of 37.5% has been indicated which may predict higher probability of increased number of related interventions in the future.^[5] Therefore, use of minimally invasive treatment modalities in pediatric patients as far as possible gains additional importance.

To invention of extracorporeal shock wave lithotripsy devices, and endoscopic instruments which can be used in the pediatric age group, minimally invasive interventions have been performed with success as is seen in adult patients. Therefore need for open surgery, complication rates, and duration of hospitalization have decreased. In clinics where endourological interventions are performed intensively, and with higher success rates, open surgical procedures are rarely performed (0.7-4%) for the treatment of stone disease.^[6,7] Even in cases with recurrent stone disease, endourological procedures have been repeatedly, and successfully performed, and in the long-term postoperative follow-up period a significant urinary system damage has not occurred after applications of ESWL, PNL, and URS.^[8-12] Management of stone disease with ESWL was firstly

Table 1. Success rates of PNL, URS, and ESWL

	Total number of patients	Number of patients who demonstrated complete stone-free state	Success rate (%)
PNL	148	114	77
URS	99	83	83.8
ESWL	168	149	88.7

PNL: percutaneous nephrolithotomy; URS: ureterorenoscopy; ESWL: extracorporeal shock wave lithotripsy

reported in 1986 by Newman et al.^[13] As is the case with adult patients, in pediatric patients ESWL is accepted to be the first-line treatment alternative in the management of renal stones smaller than 2 cm in diameter.^[14-17] Comparable success rates of ESWL have been reportedly achieved in children, and adults. In various studies performed, success rates have changed between 60, and almost 100 percent, and mainly depend on size, and composition of the stone, and type of the device used. Higher success rates have been achieved in the treatment of smaller stones. A renal pelvis stone smaller than 2 cm in diameter will be an ideal choice for ESWL treatment.^[18-23] Dimensions, location, and composition of the stone, anatomy of the renal calyx, superposition of bone on ureter are the most important factors effecting success rates of ESWL.

In our clinic 168 pediatric patients underwent ESWL treatment for their renal, and ureteral stones, and complete stone-free state was achieved in 149 (88.7%) patients. (Table 1). Complete stone-free state was accomplished in 126 (88.1%) renal, and 23 (92%) ureteral stone patients who underwent ESWL. In a study by Demirkesen et al.^[17], the authors reported 71.5% stone-free, and 26.5% CIRF (clinically insignificant residual fragments) rates after ESWL procedures applied on 151 renal units. Özgür Tan et al.^[24] reported their success rate in ureteral stones as 81.6 percent.

As is the case with adults, in the pediatric age group, the main indications for PNL include large or staghorn stones, stones which ESWL was failed, obstructive renal stones, and stones associated with ureteropelvic junction obstruction.^[10,25-30] Firstly in 1985, Woodside et al.^[31] reported results of PNL procedures performed in pediatric patients. Success, and complication rates of PNL procedures resemble those in the adult patients.^[32,33] Anatomic abnormalities, stone burden, and clinical experience of the surgeon are main factors influencing success rates.

Complete stone-free state was achieved in 114 (77%) out of 148 patients who underwent PNL in our clinic (Table 1). Besides in 32 (21.6%) patients, clinically insignificant residual stones (CIRFs) smaller than 4 mm were detected. When PNL was deemed to be successful in patients with CIRF, then procedural success rate was found to be 98.6 percent. In various publications stone-free rates of 73-96% were reported, when rates of CIRF were included success rates approached to 100 percent.^[10,25,30,34]

In parallel with technological advances thanks to employment of pneumatic lithotriptors, small-caliber, and flexible ureteroscopes, and laser technologies, high success rates have been achieved. Because of higher effectiveness, and safety in the management of distal ureteral stones, URS is the first-line treatment alternative.^[35-38] Studies related to endoscopic inter-

ventions used in the treatment of pediatric ureteral stone disease have not demonstrated any postprocedural complications as significant ureteral stricture or reflux.^[39,40] For the management of hard non-opaque stones impacted within any segment of the ureter resistant to ESWL treatment, URS is the first-line treatment alternative. Success rates achieved in the management of stone disease with URS have been reported in various studies as 82-100 percent.^[39,41,42] In our clinic, we achieved complete stone-free state in 83 of 99 (83.8%) pediatric patients, while the procedure was deemed to be a failure because of clinically insignificant residual fragments (CIRFs) or inaccessibility to the targeted stone. (n=16; 16.2%) (Table 1). Satar et al.^[43] reported 94% success rate in their pediatric patients in the treatment of a total of 33 ureteral stones (6 of them localized in the upper end of the ureter) using rigid ureterorenoscope, and pneumatic lithotripter. In a recent study, achievement of 100% stone-free state was reported in 22 pediatric patients with renal, and ureteral stones lodged in the upper one-third of the ureter using URS, and holmium: YAG laser.^[42]

In recent years as an alternative to the available treatment approaches for small-moderate-size renal stones, successful applications of retrograde intrarenal surgery (RIRS) using flexible ureterorenoscopes have been cited in various publications.^[44,45]

In conclusion, in pediatric patients, proper planning of the selected treatment, and use of minimally invasive techniques carry importance. Currently, ESWL, PNL, and URS have yielded higher success rates in the management of stone disease with lower morbidity rates. Presently, owing to successful outcomes obtained with safely used minimally invasive methods, in the management of stone disease, open surgical approaches have been almost abandoned.

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