Our experience with percutaneous nephrolithotomy in pediatric renal stone disease

İlknur Oral[1], İsmail Nalbant[2], Ufuk Öztürk[3], Nevzat Can Şener[3], Süleyman Yeşil[4], H. N. Göksel Göktuğ[3], M. Abdurrahim İmamoğlu[3]

ABSTRACT

Objective: In this paper, we present our experience with percutaneous nephrolithotomy (PNL) in a pediatric patient group.

Material and methods: From June 2007 to September 2010, we performed PNL on 57 pediatric patients. children with a mean age of 7.56 (1-15) years.

Results: Study population consisted of 30 male, and 27 female children with a mean age of 7.56 (1-5) years. Mean stone burden was calculated to be 312.2 (95-1550) mm^2. Percutaneous access was performed under fluoroscopy. Tract dilatation was accomplished with 20 F Amplatz dilators. Pneumatic lithotripsy was used to fragment the renal calculi. Mean operating time was 34 (3-80) minutes. With a single session of PNL, complete stone-free rates were achieved in 55 (96.4%) patients. Residual fragments were remained in 2 (3.5%) patients. Two patients had a febrile episode without signs and symptoms of bacteremia. Subcostal access was used in all of the patients, and none of the patients had any complications.

Conclusion: Based on our experience, we conclude that PNL is a safe and effective method in the management of pediatric stone disease.

Key words: Pediatric patient; percutaneous nephrolithotomy; urolithiasis.

[1]Clinic of Urology, Ankara Sincan Community Hospital, Ministry of Health, Ankara, Turkey

[2]Clinic of Urology, Ankara Yenimahalle Community Hospital, Ministry of Health, Ankara, Turkey

[3]Clinic of Urology, Ankara Dışkapı Yıldırım Beyazıt Teaching and Research Hospital, Ministry of Health, Ankara, Turkey

[4]Department of Urology, Gazi University Faculty of Medicine, Ankara, Turkey

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Correspondence:
Nevzat Can Şener
Clinic of Urology, Ankara Dışkapı Yıldırım Beyazıt Teaching and Research Hospital, Ministry of Health, 06010 Ankara, Turkey
Phone: +90 312 596 22 44
E-mail: cansener14@gmail.com

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Introduction

Pediatric age stones account for 1-5%, and 30% of all urinary stone diseases in the developed, and developing countries, respectively.[1,2] In pediatric cases where urinary stone disease with reportedly higher recurrence rates, have been detected in children, minimally invasive treatment modalities should be chosen, and complete stone-free state should be achieved.[3] In the management of renal pelvic stones less than 2 cm in diameter in pediatric patients, extracorporeal shock wave lithotripsy (ESWL) is the first-line therapy.[4-7] In many centers, ESWL has been applied successfully with favourable results. However in the presence of anatomical abnormalities preventing clearance of fragmented particles of large, and complex stones or hard stones as cystine stones, and in cases where ESWL failed to fragment the stone, and congenital anomalies which should be corrected during stone management, implementation of invasive methods are required.

In line with these information, in our study we present the results of our experience with PNL procedures performed for the management of pediatric renal stones.

Material and methods

A total of 57 patients aged ≤15 years who had been undergone PNL with the indication of renal stone between June 2009, and April 2012 were included in the study. Indications for PNL were accepted as lower pole or renal pelvic stones larger than 2 cm in diameter, stones refractory to ESWL or pelviocalyceal anatomy not amenable to the stone clearance, and family's preference for PNL.

Preoperatively, the patients were evaluated with urinalysis, urine cultures, serum creatinine measurements, and biochemical analyses, whole blood counts, coagulation tests, intravenous pyelography (IVP), and US. In patients with non-opaque stones, non-contrasted com-

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puted tomograms were obtained. The greatest diameter, and its perpendicularly intersecting diameter of the stones were measured with a ruler, and these two estimates were multiplied to calculate the stone burden in mm^2. In multiple stones, all stones were measured individually, and total stone burden was estimated.

Technique

To minimize the risk of hypothermia, the patient was laid on an electric blanket spred on the operating table. Then, the patients were anesthetized in the supine position, and placed in the lithotomy position. Afterwards a 4.8 F open ended ureteral catheter was inserted into the ureter with the aid of a pediatric cystoscope. Subsequently, the patient was placed in the prone position, and following antiseptic cleansing, and sterile draping of the operating field with utmost care to avoid the risk of hypothermia, C-arm scopy was oriented at 90°, and 30° to mark the stone location, and the calyx to be entered with the clamp. Then with a 18 gauge diamond tipped needle, the targeted calyx was entered under the guidance of the fluoroscopy. When collecting system was presumably entered, stylet of the needle was withdrawn to observe outflow of the urine which suggested entry into the collecting system. Then a 0.035 inch, a J tipped guidewire was advanced through the needle into the collecting system. Over the guidewire firstly fascial dilators, then Angiocath™ were delivered. Then renal parenchyma was dilated up to 20 F with Amplatz dilators. A 20 F working sheath was placed inside the collecting system, and an 18 F nephroscope (Karl-Storz, Germany) was sent through the sheath into the collecting system. Using a pneumatic lithotriptor (Lithoclast; EMS, Switzerland) delivered through the nephroscope, the stones were fragmented. Blood transfusion was required for the patients who developed perioperative bleeding in consideration of periopearative hematoctrit results, and hemodynamic evaluation of the anesthesia team. Postoperatively, blood transfusions were administered for patients with deficient whole blood counts.

Following the surgical intervention, 14 Fr Freentry Malecot catheters were mostly engaged in renal pelvis. Generally, urethral catheters of all patients were removed on the postoperative 1. day. Nephrostomy tubes of the clinically stable patients without hematuria were clamped, and removed 12 hours later on the postoperative 1. day, provided that any problem was not encountered. Antibiotic prophylaxis was performed using a cephalosporine. Postoperative fever over 38°C was considered as statistically significant. Urine, and blood cultures were obtained from the febrile patients, treatment was administered based on the isolated pathogen.

Results

Fifty-seven patients who underwent PNL were included in this study. Mean age of the operated patients was 7.56 (1-14) years. Study population consisted of 30 (52.6%) male, and 27 (47.4%) female patients. None of the patients had been operated before with the indication of a renal disease. As anatomical anomalies, horseshoe kidneys (n=4), and anterior rotation abnormalities (n=2) were detected. As comorbidities, cerebral palsy (n=1), epilepsy (n=1), and serious scoliosis were found. The stones were localized in renal pelvis (n=31; 54.3%), calyces (n=14; 24.5%), and both renal pelvis, and calyces (n=12; 21%). Mean stone burden was 312.2 (95-1550) mm^2. Mean intrarenal access time was 2.3 (0.89-5.66 mins). minutes. As replacement therapy, 4 (7%) patients received one unit erythrocyte suspension. However, any major complication as organ injury, and serious bleeding was not observed. Although increments of at most 0.1 mg/dL, and 17 mg/dL were seen in postoperative respective creatinine, and blood urea nitrogen values when compared with the preoperative levels, they were still within normal limits. Postoperatively, hyperfebrile episodes which responded to medical therapy were seen in 2 (7.4%) patients. In none of the patients, complications as urinoma or perirenal hematoma was observed. Stone-free rate was 96.4% (55/57), and postoperatively ESWL was required for remaining residual stones in 2 patients. None of the patients required ureterorenoscopy. Operative parameters are shown in Table 1.

Discussion

Urinary system stone disease can be defined as onset of a series of urinary, and/or systemic signs following alterations in the concentration of urinary metabolites with resultant accumulation of urine components, and stone formation secondary to congenital or acquired etiological factors. Urinary system stone disease is one of the important problems which occupy minds of physicians dating back to Hippocrates. Incidence of stone disease in the whole population is around 2-3%, and its recurrence rate within 10 years is nearly 50 percent.[8]

Treatment of the pediatric stone disease is much more important than that seen in adults, and should be realized using minimally invasive methods because of potential recurrences which might happen in the future. Since predisposing factors such as metabolic disorders, infection and/or congenital anomalies in pediatric patients with stone disease are more frequent, the probability of anticipated recurrences is higher than that seen in adults. In a study performed in Turkey, mean recurrence rate of 15% was reported in patients aged between one month, and 6 years, the recurrence rate was indicated as 37.5% in patients with metabolic disorders.[9] In the same study, etiological factors for pediatric stone disease were detected as infectious diseases (32%), anatomic defects (30%), and metabolic disorders (26), while in 12% of the children any causative factor could not be found (idiopathic). Therefore, the aim of the treatment should be complete stone clearance in addition to the treatment of infection, and correction of the underlying metabolic, and anatomic disorders.[10]

Table 1. Procedural parameters		
Entry site	Lower pole	45 (78.9%)
	Middle pole	12 (21%)
Operating time		34 (13-80) min
Fluoroscopy time		2.77 (1.1-12.5) min
Decrease in hematocrit		3.7 (0-10%)
Requirement for transfusion		4 (7%) case
Time to removal of the nephrostomy tube		2.67 (2-5) days
Hospital stay		2.9 (1-12) days
Stone-free rate		55/57 (96.4%)
Results of stone analysis	calcium oxalate	45 patients
	uric acid	8 patients
	magnesium ammonium phosphate	3 patients
	magnesium ammonium urate	1 patient

In pediatric patients, the first-line therapy for the management of renal pelvic stones smaller than 2 cm in diameter is extracorporeal shock wave therapy (ESWL).[4-7] Stone-free rates reported for changes between 50, and 100 percent. Success rates are higher in smaller children.[10] Many centers practice ESWL in the treatment of pediatric stone disease with higher success rates. However, large, and complex stones, obstructed kidney, hard stones like cystine stones or stones refractory to ESWL, ureteropelvic obstruction associated with stone disease constitute main indications of percutaneous nephrolithotomy (PNL).[11-13] European Association of Urology guidelines recommend PNL as the first-line therapy for the stones measuring between 1-2 cm, ESWL-refractory pelvic stones, stones bigger than 2 cm or lower calyceal stones larger than 1 cm.

In pediatric patients with pelvic stones smaller than 2 cm, as the first treatment alternative ESWL is used. However some characteristics related to the patient, and the stone, ESWL fails to eliminate stones which include stones associated with ureteropelvic junction obstruction, calyceal stone, secondary to infundibular stenosis, heavier stone burden, very hard cystine stones, and calyceal diverticular stone. In the presence of these clinical features, percutaneous nephrolithotomy (PNL) should be selected as the first-line therapy. In the treatment of pediatric stone disease, in well-selected cases performed by experienced hands, higher stone-free rates as seen in adults have been achieved. Besides, with its safe application, and patient's comfort, PNL is apparently more advantaageous over open surgery.

In parallel with technological advances, more delicate, and thinner endoscopic instruments with higher quality have been manufactured which made implementation of endoscopic interventions in pediatric patients possible The first pediatric PNL series was reported by Woodside et al.[14] in 1985, and from then, it has become a therapeutical technique used singly or in combination with other methods in children with excess stone burden. Success rates achieved using PNL in the pediatric renal stone disease were not different from higher success rates obtained in adults, and stone-free rates of 73-96% have been reported.[11-13] Probable cause of wider spectrum of success rates is related to diversities in stone burden, and associated renal anatomic abnormalities. Zeren et al.[15] obtained a stone-free rate of 86.9% in 61 pediatric patients who had undergone PNL for their renal stones. In 6 patients, clinically insignificant residual fragments were detected, and two patients required open surgery (n=1) or ESWL (n=1). In a study performed by Gedik et al.[16], stone-free status was achieved in 34 (75.6%) of 45 patients, clinically insignificant residual fragments were detected in 6 patients, and in 6 patients residual stones were detected after ESWL. Still, in a series performed by Akdoğan et al.[17] mean stone burden was 238 (190-900) mm^2, and the authors achieved stone-free rate of 78 percent. Stone-free rates were 78.9, and 68 % in a series conducted by Demirci et al.[18], and Mor et al.[19] respectively. In our series of 27 patients, our stone-free rate was 96.4% (55/57). In two patients, ESWL was required for remaining residual stone fragments.

Urologists performing PNL in pediatric patients have some reservations including potential development of complications during, and after PNL in adults, specific conditions related to pediatric patients including smaller renal units to be operated on, relatively large size of endoscopic instruments, intolerability of the children to bleeding episodes, easier development of hypothermia, fluid absorption, and hypervolemia. One of the most frequently seen complications is bleeding episodes. In children, the most important factor effecting development of bleeding episodes is the diameter, and the number of dilated tracts.[11] Creation of multiple tracts, and dilation of the tract to a diameter exceeding 24 F have been reported to lead to a significant drop in hemoglobin (Hb) levels.[11] Transfusion rates vary between 7, and 24% based on differences in stone burden.[11,13,15,20] Also in our series, only one access tract was used in all patients, and in 4 (7%) patients despite dilation of the tract only up to 20 F, these patients required transfusions. However, this transfusion rate was at an acceptable level.

Postoperative hyperfebrile state, and leakage around nephrostomy tract are frequently seen minor complications in pediatric patients.[15,20] In our study, postoperative hyperfebrile state was observed in 2 patients who responded to antibiotherapy, and anti-inflammatory treatment. Apart from these, complications as urinoma, hematoma, adjacent organ injury, and hydropneumothorax have been published in the literature. Whereas, in our series, any major complications were not seen.

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Currently, retrograde intrarenal surgery (RIRS) has gained increasing popularity among treatment modalities of pediatric stone surgery. In recent years, pediatric RIRS has been used with higher success and lower complication rates. In a multicentered study performed in 2012 by Reşorlu et al.[21], 95 RIRS, and 106 PNL patients were compared, and in both groups success rates approaching to 85% were detected. A statistically significant difference was not found between both groups as for complication rates. In a literature review published by El-Hout et al.[22], the authors emphasized that even though RIRS used in the pediatric stone disease was an effective method, further randomized controlled studies should be conducted for the selection of the first-line treatment modality.

Nowadays stones detected in patients can be successfully treated using effective methods. However, one of the important problems encountered in the treatment of urinary system stone disease in the pediatric age group, is potential requirement for repetitive operations in the future, because of higher risk of recurrence. Therefore, for the treatment of the stones formed because of metabolic abnormalities, medical therapy should be also used. In our study, we arranged the treatment of our patients based on postoperative stone analysis, and metabolic evaluations.

In conclusion, urinary system stone disease is currently, an important health problem in developing countries like ours. When compared with the adult stone disease, it is relatively more important to use minimally invasive methods for the management of pediatric stones in order to prevent recurrences that might occur in the future. As one of the minimally invasive treatment modalities, PNL which can be safely, and efficiently used in children, is becoming increasingly popular in our days. With advanced technology, and accumulating experience, PNL has become one of the first-line treatment modality in the pediatric age group.

In certain cases of stone disease, we recommend application of ESWL, as a less invasive, more effective, and reliable treatment alternative for suitable stones in appropriate centers.

Conflict of Interest: No conflict of interest was declared by the authors.

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