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ORIGINAL PAPER

Efficiency of percutaneous nephrolithotomy in pediatric patients using adult-type instruments

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Abstract To evaluate the efficiency of percutaneous nephrolithotomy using adult-type instruments in children with kidney stones. Between September 2004 and October 2009, 18 children (19 renal units) underwent percutaneous nephrolithotomy using adult-type instruments. Following percutaneous access under fluoroscopy, 20–30F tract dilatation was performed (1,92,427F), and lithotripters were used. Postoperatively, kidney–ureter–bladder X-ray and antegrade pyelography were performed to evaluate residual stones and contrast passage to the bladder. 8 boys and 10 girls with a mean age of 9.8 ± 4.56 years were evaluated. Mean stone burden was 338 ± 196.21 mm². Stones were located in the left and right kidneys in 16 (84.2%) and 3 (16.8%) patients, respectively. Horse-shoe kidney was present in one patient. Mean operation (including cystoscopy) and fluoroscopy times were 106 ± 49.60 and 5.2 ± 2.14 min, respectively. Postoperatively, 10(52.6%) patients were stone free and 4 (21.1%) patients had clinically insignificant stones. Saline extravasation developed in three patients and surgery was aborted in one patient. Stone fragments migrated into the ureter in two patients and managed by additional endourological interventions. Nephrostomy catheters were kept for a mean of 2.6 ± 1.12 days. Four patients required blood transfusion due to bleeding. Postoperative fever of <39°C developed in five patients and >39°C in one patient. Mean hospitalization time was 5.3 ± 3.12 days. Overall, 73.7% of our patients were stone free, including patients with clinically insignificant stones. Particularly in children with a high-stone burden, the use of adult-type instruments might have a positive impact on stone-free rate, operation time and fluoroscopy time without increasing the complication rate.

Keywords Percutaneous nephrolithotomy · Pediatric patients · Adult-type instruments · Efficiency · Outcomes

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Introduction

Although urolithiasis is a rare disease in children in the developed countries [1], it is more commonly seen in the pediatric patient group in the developing countries [2]. Almost 20% of the urinary tract stone disease is detected in children in Turkey [2]. The size of the urinary tract is smaller in children as compared to the adults and the ureter is flexible and mobile therefore, children can pass the stone fragments spontaneously [1]. Children with renal stones should also be evaluated regarding the possibility of underlying metabolic diseases that could cause to stone recurrence [3].

Since the first introduction of percutaneous nephrolithotomy (PNL) in 1976 for the surgical management of urolithiasis, PNL took the place of open surgery in the surgical management of kidney stones [4, 5]. Pediatric stones can be managed by PNL and extra-corporeal shock wave lithotripsy (ESWL) successfully [4, 5]. Furthermore, stones which do not respond to ESWL can be treated with PNL effectively [5]. Retrograde endoscopic procedures performed by rigid or flexible endoscopic instruments, laparoscopic and open surgical procedures are the other treatment modalities used in the surgical treatment of urinary tract stone disease in children [1].

Although most urologists tend to use smaller sized instruments to treat pediatric renal stones by PNL, others prefer to use adult-type instruments. In this retrospective study, we report our experience of PNL in children with kidney stone disease using adult-type instruments.

Materials and methods

Between September 2004 and October 2009, 18 children with 19 renal units underwent PNL using adult-type instruments at our department. One of the patients who had cystine stones had bilateral kidney stones and we performed sequential PNL on this patient. Patients were preoperatively evaluated by history, physical examination, routine laboratory tests, including blood chemistry and intravenous urography. Operations were performed if the patients had sterile urine. In case of infection, patients were treated with a sensitive antibiotic until the urine became sterile. Urinary tract culture revealed urinary tract infection in two patients preoperatively whom were treated with antibiotics and were operated after the urine cultures were negative. All patients underwent antibiotic prophylaxis with two doses of cephalosporin preoperatively and postoperatively. PNL procedures were performed patients in prone position under general anesthesia following a ureteral catheter (4–6F) insertion via cystoscopy. Following percutaneous access obtained using a 19-G needle and a glide wire under fluoroscopy, 20–30F Amplatz dilatators were introduced. 27F adult-type Richard Wolf nephroscopes (used in three patients), 19 and 24F adult-type Olympus nephroscopes (used in 14 and two patients, respectively) and pneumatic lithotripters were used. A 16-F Foley catheter was inserted as a nephrostomy tube into the kidney after the completion of the PNL procedures. Stone size and location, operation time and fluoroscopy time, complications types and rates, blood transfusion rates (peroperative and postoperative) were all recorded. For the detection of postoperative residual stones, kidney–ureter–bladder (KUB) X-ray and antegrade pyelography were performed to evaluate contrast passage to the bladder when required.

Results

8 boys and 10 girls with a mean age of 9.8 ± 4.56 (range 2–18) years were evaluated. Horse-shoe kidney was present in one patient. Mean stone burden was 338 ± 196.21 mm² (range 89–775). Stones were located in the left kidney in 16 patients (84.2%) and in the right kidney in 3 patients (16.8%). Mean operation time including cystoscopy was 106 ± 49.60 min (range 40–240). Mean fluoroscopy time was 5.2 ± 2.14 min (range 1–10). Following PNL procedures, 10 patients (52.6%) were stone free and four patients (21.1%) had clinically insignificant (<4 mm) residual stones. Five patients with residual stones were referred to ESWL. Of those, two were stone free and one had clinically insignificant (<4 mm) residual stones. Following PNL, stone-free rate was 63.1% and clinically insignificant residual stones were detected in 26.3% of the cases. Using ESWL as an ancillary modality in addition to PNL, stone-free rate with clinically insignificant residual stones was 89.4%.

In our study, postoperative fever of <39°C was detected in five patients (26.3%) and >39°C in one patient. Urine and blood cultures were negative in all patients and none of them required antibiotic treatment. Irrigation fluid (isotonic 0.9% NaCl solution) extravasation developed in three patients and of those surgery was aborted in one patient in whom excessive retroperitoneal extravasation occurred. During surgery, stone fragments migrated into the ureter in two patients, one of which was extracted with simultaneous ureterorenoscopy with retrograde JJ-stent insertion while other patient passed the stone following retrograde JJ-stent placement only. Nephrostomy catheters were kept for a mean of 2.6 ± 1.12 days (range 1–6). Blood transfusion was required in four patients (postoperatively in 3 patients and intraoperatively in 1 patient). Pre and postoperative plasma transfusion was carried out in one patient due to elevated isolated activated partial thromboplastin time (aPTT) of unknown etiology. Postoperatively, perirenal hematoma with a largest diameter of 14 mm was developed in this patient which resolved spontaneously. Postoperative fever of <39°C developed in 5 patients and >39°C in one patient. Mean hospitalization time was 5.3 ± 3.12 days (range 2–15) (Table 1).

Of the 18 patients, stone chemical analysis was available in 16 patients and of those cystine stone was detected in one patient, calcium oxalate monohydrate stones were detected in 10 patients and calcium oxalate dihydrate stones were detected in five patients.

Discussion

Pediatric renal stone disease is an important health problem which is more commonly seen particularly in the developing countries [6, 7]. Stone disease in this age group might be associated with anatomical and metabolic abnormalities or infectious diseases, and the risk of recurrence is high [5]. Previous studies, including children and animal models have reported no significant morbidity in children by 24–26F tract dilatation suggesting that there is no benefit in using a small access based on the renal scarring alone [8, 9].

Table 1 Characteristics and outcomes of PNL procedures performed in pediatric patients by using adult-type instruments in the literature

Reference number	Year	Nr of PNL cases	Mean age	Kidney anomaly	MSB	SFR (%)	MPT (min)	MFT (min)	Complications						
									Saline extravasation (urinoma)	Migration of stone fragments into ureter	Blood transfusion	Hydro/ pneumothorax	Postop fever	Pelvis perforation	Hypothermia
[13]	2010	15	13.2	–	3.41 cm	81.3	77.5	2.7	–	–	2	–	2	–	–
[16]	2009	24	3.1	–	3.3 cm	79.1	93.2	NR	–	1	1	–	3	1	–
[5]	2007	23	13.2	–	382 mm^2	69.5	64.7	4.5	–	–	3	1	2	2	–
[11]	2003	25	12.3	+[a]	342 mm^2	70.8	122	NR	1	1	2	1	3	3	–
[12]	2002	67	7.9	–	283 mm^2	96.7	NR	NR	3	1	16	–	20	–	–
Our series	2010	19	9.8	+[b]	338 mm^2	73.7	106	5.2	3	2	4	–	6	–	–

MSB mean stone burden, *SFR* stone-free rate, % (including clinically insignificant stones), *MPT* mean PNL time (min), *MFT* mean fluoroscopy time (min) (including cystoscopy), *NR* not reported

[a] One patient had horseshoe kidney anomaly

[b] Eight patients had kidney anomalies. Duplicated pelvis and ureter ($n = 1$), duplicated pelves ($n = 3$), infundibular stenosis ($n = 4$)

In our study, we performed 20–30F tract dilatation and used 19F, 24F and 27F nephroscopes. Lahme [1] stated that using smallest and least traumatic instruments does not seem to significantly reduce complication rates in performing PNL in children. However, successful results have been reported using small caliber instruments in children following PNL [10]. Gunes et al. [11] reported a higher incidence of complications related to PNL using adult-type instruments in children younger than 7 years as compared to older children. On the other hand, Bilen et al. [5] reported that out of 36 patients, 7 required blood transfusions who underwent PNL using adult-sized instruments, while no patients required any transfusion in the miniperc group ($n = 10$). Zeren et al. [12] reported the outcomes of their PNL experience in a series of 62 pediatric renal units. Their total stone-free rate was 96.7% following PNL, including clinically insignificant residual stones and their blood transfusion rate was 23.9% [12]. They also reported a significant correlation between intraoperative bleeding, operation time, stone burden and sheath size [12]. Unsal et al. [13] reported that the size of dilatation and the number of tracts are probably the most important factors that affect blood loss during surgery due to their experience, including a series of 44 pediatric patients whom the performed PNL using different sized instruments. Blood transfusion was required in four patients (postoperatively in three patients and intraoperatively in one patient). Mahmud and Zaidi [14] reported low complication rate (6%) including hyperprexia and two blood transfusions using 17F nephroscope. Aron et al. [15] stated that torquing a rigid nephroscope is the most important cause of bleeding during PNL; therefore, they used multiple tracts instead of a single tract in their series. Nouralizadeh et al. [16] performed single tract access in their pediatric PNL series which were consisted of 24 renal units and one patient required blood transfusion. We used a single tract in all of our PNL procedures in the pediatric patient group.

Recently, Guven et al. [17] evaluated the efficacy and safety of PNL in children in a multicenter study. Adult-sized instrumentation was used in 80 renal units. Overall, 23 complications were detected (Clavien grade I [$n = 5$], II [$n = 2$], IIIa [$n = 10$] and IIIb [$n = 6$]) [17]. They reported that the success rates with two instrumentation techniques (pediatric vs. adult-type instruments) were comparable ($p = 0.86$) [17]. However, postoperative hemoglobin reduction was significantly greater in children who underwent PNL with adult-sized instruments [17]. On the other hand, Kroovand [18] stated that adult-sized instruments are suitable to use in children including infants and toddles. Ozden et al. [19] stated that modified Clavien system provides a straightforward and validated method to classify postoperative complications in pediatric PNL patients although they did not mention the type of instruments (pediatric vs. adult type) used in their evaluation. In our series, we had 15 complications and due to the modified Clavien system 3 were Grade I, 10 were Grade II and 2 were Grade IIIb.

In addition to patients with normal renal anatomy, successful outcomes were reported in pediatric patients with renal anomaly, renal function failure and bilateral renal stones following PNL [7]. In our series, one patient had a horse-shoe kidney with stones (stone burden of 130 mm^2) and was stone free after performing PNL.

Hypothermia is a potential complication of PNL particularly in the pediatric patient group that is correlated with the duration of the procedure. Mean surgery time was 106 min in our series and hypothermia did not occur in any of the patient in our series. Postoperative fever that may be a sign of pelvicaliceal system injury or sepsis is a common complication after PNL.

Hydro-pneumothorax is another complication that could develop during performing PNL. Gunes et al. [11] reported one hydro-pneumothorax incident in their series of 25 PNL operations for 24 renal units among 23 pediatric patients whom they performed PNL. In our series, hydro-pneumothorax did not occur in any patient; however, retroperitoneal irrigation fluid (isotonic 0.9% NaCl solution) extravasation developed in three patients. PNL procedure was aborted in one patient due to excessive retroperitoneal irrigation fluid extravasation.

Conclusions

Owing to our experience, using adult-type instruments in PNL does not seem to cause significant morbidity in children with kidney stones although some series suggested that the use of small diameter PNL instrumentation is more favorable in bleeding. Stone free was 73.7% in our series, including clinically insignificant stones following performing PNL in children using adult-type instruments. The addition of ESWL increased this rate up to 89.4%. Particularly in children with high-stone burden, the use of adult-type instruments rather than smaller sized pediatric nephroscopes might have a positive impact on stone-free rate, operation time and fluoroscopy time without increasing the complication rate. Randomized studies are needed with similar patient and stone characteristics that evaluate the use of pediatric versus adult-type PNL instruments in pediatric patients. Because kidney stone disease has the possibility of recurrence and re-treatment particularly in the pediatric age group, the impact of repeated use of adult-type PNL instruments on renal scarring is currently not known well and warrants further research.

Conflict of interest None.

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