Pediatric Percutaneous Nephrolithotomy Using Adult Sized Instruments

Our Experience

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Purpose: To evaluate the safety and efficacy of pediatric percutaneous nephrolithotomy (PCNL) using adult sized instruments in the management of pediatric urolithiasis.

Materials and Methods: We retrospectively reviewed the medical records of 38 children younger than 15 years who had undergone 45 PCNLs with adult sized instruments in our center between August 2007 and February 2010.

Results: There were 26 boys and 12 girls, with a mean age of 8.4 ± 4.24 years (range, 12 months to 13 years). Twelve patients had complete staghorn stone. Mean stone burden was 2.93 ± 0.89 cm. The tract was dilated between 26F and 30F. Standard PCNL was performed in 8 patients and tubeless PCNL in the next 37 subjects. Simultaneous transurethral lithotripsy was done in 9 patients. Stone clearance rate was 67%. Mean pre and postoperative hemoglobin levels were 12.67 ± 1.7 and 11.39 ± 1.6 g/dL, respectively. Mean hospitalization was 3.5 ± 1.1 days. Eight subjects had postoperative fever beyond day 1. Blood transfusion was required in only one patient. In one patient (3 years old) with a staghorn stone, hyponatremia and seizure occurred, which were treated conservatively without any adverse sequela. There was a significant difference in hospital stay between tubeless and standard PCNL groups ($P < .02$).

Conclusion: We concluded that PCNL using adult sized instruments was relatively safe in children, with a clearance rate of 67%. We suggest prospective randomized studies to compare mini-perc and adult sized instruments use in pediatric PCNL.

Keywords: percutaneous nephrolithotomy, child, kidney calculi, treatment outcome

INTRODUCTION

Urolithiasis affects 12% of the population in developed countries, of which 1% to 3% are children.[1,2] Certain factors, such as anatomical and metabolic abnormalities, small kidney size, and high recurrence rates influence children stone treatment.[3] Surgical management of stone has evolved over the past two decades. Since the advent of shock wave lithotripsy (SWL) in the 1980s, most stones have been treated with this modality.[4]

Although SWL is the treatment of choice for stones in children, percutaneous nephrolithotomy (PCNL) is recommended under various conditions, including large stone burden, cysteine stones, and residual stones after failed SWL or open surgery.[2] The first PCNL in adults was done by Fernstrom and Johansson in 1976[5] and the first PCNL in pediatrics was reported by Woodsides and colleagues with adult sized instrument in 1985.[6] Today, PCNL is a well established treatment option for pediatric nephrolithiasis.

Concerns about major complications and sequelae of renal puncture with adult sized instruments lead to the design of small sized instruments and the mini-perc technique.[7] Nonetheless, single-photon emission computed tomography (CT) using dimercaptosuccinic acid (DMSA) demonstrated that there was no significant change in the global uptake despite a significant functional decrease in the tract site.[8] Wadhwa and associates used diethylene triamine pentaacetic acid (DTPA) and DMSA scans pre-operatively and 3 months after the procedure, and showed that adult sized instruments had no adverse effect on renal function and glomerular filtration rate (GFR); renal function improved after stone removal and there was no new scar on renal DMSA scan after standard PCNL.[9] Similarly, other studies using radioisotope scans found no change in differential renal function or any significant scarring, and a significant increase in GFR in the long-term follow-up after PCNL.[10,11]

Li and coworkers prospectively showed that acute phase markers, such as tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), IL-10, and C-reactive protein did not significantly differ between mini-PCNL (MPCNL) and conventional PCNL; thus, the benefit of MPCNL in terms of lower invasiveness remains unproven.[12] It is reported that bleeding and transfusion are more common after standard PCNL.[13,14] In this study, we present our exprience in this area.

MATERIALS AND METHODS

Study Population

We retrospectively reviewed medical records of 38 children younger than 15 years who had undergone 45 PCNL procedures between August 2007 and February 2010.

The pre-operative workup included urinalysis, urine culture, serum level of creatinine, coagulation profile, complete blood count, ultrasonography, and intravenous pyelography (IVP) or non-contrast abominal CT scan. Patients with positive urine culture were treated with culture-specific antibiotics. Prophylactic antibiotics were administered to all other children.

Surgical Technique

Under general anesthesia, a 4 or 5F ureteral catheter was inserted in retrograde fashion for opacification of the pelvicaliceal system. C-arm fluoroscopy-guided punctures were made at the lower posterior calyx with the patient in the prone position followed by tract dilation with polytetrafluoroethylene dilators and placement of a 26, 28, or 30F Amplatz sheath based on the degree of hydronephrosis observed at flouroscopy after contrast injection and surgeon preferance. Intercostal access was obtained by creating skin punctures over the lateral portion of the rib during full expiration. Pneumatic and/or ultrasonic stone fragmentation

Table 1. Basic information in the tubeless and standard PCNL.*

Variable	Tubeless PCNL	Standard PCNL	*P*
Gender			.033
Male	18	8	
Female	12	0	
Side			.030
Right	22	1	
Left	15	7	
Mean age, y	8.4 ± 4.7	6.3 ± 2.2	.08
Mean stone burden, cm	3.0 ± 0.9	2.5 ± 0.5	.19

*PCNL indicates percutaneous nephrolithotomy.

was done using the Swiss LithoClast Master. A nephrostomy tube was left in the kidney at the end of the procedure in our first 8 patients.

During our experience with standard PCNL, we observed that spontaneous displacement of the nephrostomy tube in some of our patients caused no significant complication, such as prolonged fever, protracted urine leakage, or transfusion; thus, we performed tubeless PCNL in our next subjects.

Stone clearance was defined as the absence of residual fragments or the presence of fragments less than 4 mm on the kidney, ureter, bladder (KUB) x-ray or ultrasonography 2 weeks after the surgery.

This study was approved by the Medical Ethics Committee of Hasheminejad Clinical Research Development Center and was fully explained to the patients' parents. A written informed consent was obtained from all the parents.

Statistical Analysis

The data were analyzed using SPSS software (the Statistical Package for the Social Sciences, Version 17.0, SPSS Inc, Chicago, Illinois, USA). Univariate analyses were perfomed to detect any significant association between each of the dependent and independent variables. The 95% confidence interval was calculated.

RESULTS

There were 26 boys and 12 girls, with a mean age of 8.4 ± 4.24 years (range, 12 months to 13 years). Percutaneous nephrolithotomy was done on the right side in 23 renal units and on the left in 22; 7 subjects had bilateral PCNL (Table 1).

The most common symptoms were flank pain and urinary tract infection (UTI). There was a positive family history of stone disease in 30% of patients. Three patients had history of open surgery and 6 had unsuccessful SWL. Twelve patients had compelete staghorn stones. Mean stone burden was 2.93 ± 0.89 cm.

Access was gained from the lower posterior calyx in all the subjects except 4, who had upper pole access. The tract was dilated to 30F in 33 renal units and 26F in 12 renal units. Tubeless PCNL was done in 37 renal units and a nephrostomy tube was inserted in 8 patients. In 37 renal units, there was subcostal access, 7 had intercostal access, and one was a transplanted kidney. Simultaneous transurethral lithotripsy was done in 9 patients. Table 1 shows patients' characteristics in the standard and tubeless PCNLs. Table 2 shows a comparison of pre and postoperative parametres in the standard and tubeless groups. Based on the 2-week postoperative KUB and ultrasonography,

Table 2. Pre and postoperative parameters in tubeless and standard percutaneous nephrolithotomy.*

Parameters	Tubeless	Standard	*P*
Pre-operative Hb, g/dL	12.67 ± 1.7	12.71 ± 1.9	.95
Postoperative Hb, g/dL	11.39 ± 1.6	11.15 ± 1.8	.65
Pre-operative Cr, mg/dL	0.73 ± 0.19	0.83 ± 0.52	.60
Postoperative Cr, mg/dL	0.78 ± 0.20	0.63 ± 0.19	.11
Mean Hb drop, g/dL	1.19 ± 0.82	1.5 ± 0.69	.24
Mean hospital stay, day	3.5 ± 1.1	5 ± 1.6	.001

*Hb indicates hemoglobin; and Cr, creatinine.

Table 3. Frequency of complications in the tubeless and standard percutaneous nephrolithotomy.

Complication	Tubeless	Standard
Transfusion	1	0
Fever	6	2
Extravasation	0	0
Pleural injury	0	0
Colon injury	0	0
Hyponatremia (seizure)	1	0

stone clearance rate was 67% (68.2% in tubless and 65.8% in standard groups).

Eight subjects had postoperative fever beyond day 1 up to 7th postoperative day, and were treated conservatively without any other intervention. No readmission occurred because of fever or other complications. Transfusion was required only in one patient because of Hb drop below 7 g/dL. The irrigation fluid was 24 to 26 ºC reverse osmosis sterile water. In a 3-year-old patient with staghorn stone, seizure occurred after tubeless PCNL; workup showed hyponatremia (Na = 113 meq/dL). The patient was transferred to the intensive care unit (ICU) and treated conservatively through slow correction of hyponatremia, and discharged from the ICU without any adverse sequela in 48 hours. Table 3 compares complications in the two groups.

There was a significant difference in hospital stay between tubeless and standard PCNL groups ($P <$ .02) in the multivariate anlysis adjusted for postoperative fever, stone burden, Hb drop, and Amplatz sheath size. There were no significant intergroup differences in Hb drop and Amplatz size ($P >$ .7) adjusted for age, amplatz sheath size, and access site.

DISSCUSION

Anatomic and metabolic abnormalities in children have made stone recurrence and multiple surgical interventions more likely. To avoid any sequela, less invasive procedures, such as SWL and PCNL, are treatments of choice.[2]

Stone-free rates after pediatric PCNL range from 67% to 100%.[15] Large retrospective studies have shown success rates as high as 90% with PCNL monotherapy.[16] Mahmud and Zaidi achieved a stone-free rate of 60% with PCNL monotherapy, which was improved to 100% with SWL sandwich therapy.[17] Our stone-free rate was 67% at 2-week follow-up. Since our center is a referral center over the country, many patients are followed up elsewhere and most of our patients were lost due to long-term follow-up period. Our relatively lower stone-free rate can be attributed to more complex stones and usage of a single tract only. Although multiple access tracts increase the stone-free rate, we refrained from this approach

to avoid the associated complications. On the other hand, attempts to extract staghorn stones from a single tract can result in nephroscope torque on the renal parenchyma and inadvertent injury and bleeding; therefore, we did not stress on this maneuver.

In an effort to decrease renal damage, Jackman and colleagues introduced the "mini-perc" technique using a 15F peel-away vascular sheath that needs a smaller skin incision and smaller tract size, and low complication rates and less pain were reported.[18] Gunes and associates reported a higher incidence of complications, such as bleeding, in children younger than 7 years with adult sized instruments and standard PCNL.[19] Although we did not use the mini-perc technique, our study did not show significant bleeding or prolonged hospital stay. The reason for lower complications at our center may be that pediatric PCNL is only performed by experienced surgeons.

Wadhwa and coworkers showed marginal renal function improvement after stone removal on isotope scan.[9] Although creatinine level is not a sensetive indicator for small parenchymal damage, access to patients' renal radioisotope scans was limited due to the retrospective nature of the study; thus, we used increasing serum levels of creatinine as a proxy for renal function. There were no significant differences in creatinine level pre and postoperatively in our subjects. Despite encouraging results, concern remains regarding safety of endourologic treatment in pediatric patients and its subsequent effects on the growing kidney.[20]

According to Samad and colleagues, 26% of their candidates for pediatric PCNL had UTI in the past.[14] A history of documented UTI was positive in 13.3% of our patients probably because of the general use of antibiotics without any evaluation in febrile children.

During PCNL, fluid absorption occurs that may result in overload and hyponatremia; hence, a low pressure system and isotonic irrigation fluid should be used to prevent this complication.[21] At the same time, irrigation solutions must be warmed to prevent hypothermia,[22] which can occur quickly in small children. We used 24 to 26 C^{o} reversed osmosis sterile water as irrigation fluid and significant hyponatremia occurred in only one subject, who had a prolonged operative time because of a staghorn stone. We had no case of hypothermia, and assume that we can use reversed osmosis sterile water for irrigation in children without fear of hyponatremia, especially in patients with small stone burden.

It was reported that two significant factors in Hb drop and transfusion rate were number and size of the tract.[23] Mean Hb decrease in our study was 1.2 ± 0.8 g/dL, and there was no significant difference in Hb drop between tubeless and nephrostomy cases or those done with two different Amplatz sheath sizes. Zeren and associates reported a 24% transfusion rate, and suggested that longer operative time and larger Amplatz sheath and stone burden were associated with greater transfusion rates.[16]

In line with other studies,[14,24] the most common complication in our study was fever, which persisted for 2 days starting from the 1st postoperative day. Only one of our patients with a large stone (3 cm) and negative pre-operative urine culture had fever for 6 days. All the patients with fever were managed conservatively without any intervention.

Samad and colleagues reported a stone-free rate of 59% with PCNL monotherapy and a 3.6% transfusion rate.[14] Only one of our patients (2.2%) required transfusion. This may be due to our high threshold (Hb < 7 g/dL) for transfusion or our patients' higher levels of pre-operative Hb. Tubeless PCNL is less painful and less troublesome for adults and it shortens their hospital stay.[13] The literature on this subject in the pediatric population is scant.[13] Our study showed that

hospital stay was significantly lower in the tubeless group compared to the standard group. In the pediatric population, urolithiasis is more prevalent in boys, with a male_to_female ratio of 1.4:1 to 2.1:1.[15] We also had a 2.1:1 male_to_female ratio; this may be because of the higher incidence of anatomical abnormalities in the male gender. This study has some limitations, such as lack of a control group, short follow-up period, and low sample size.

CONCLUSION

In our study, PCNL using adult sized instruments appeared to be safe and effective. However, further prospective randomized studies with larger sample sizes are needed to compare mini-perc with adult sized instruments used in PCNL.

CONFLICT OF INTEREST

None declared.

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