

The importance of instrument type in paediatric percutaneous nephrolithotomy

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Abstract We reported our experience with percutaneous nephrolithotomy in children and compared the outcomes, including the morbidity and success rates, regarding the instruments of different sizes. One hundred and seventy-three paediatric patients, who underwent percutaneous nephrolithotomy in our clinic between 1999 and 2013, were assessed. According to the size of instruments used during surgery, three different groups were formed and the pre- and postoperative outcomes were compared between the groups. 76 girls and 97 boys with a mean age of 9.24 (≤ 17) years were assessed. Stone-free rates were 75.6 % in group 1 ($n = 82$) using 17 F nephroscope, 79.4 % in group 2 ($n = 73$) using 24 F nephroscope and 72.2 % in group 3 ($n = 18$) using 26 F nephroscope. Postoperative fever was seen in four, five and one patient in group 1, 2 and 3, respectively. Urinary infection was seen in one patient in group 1 and four patients in group 2. Mean haematocrit drop and stone burden were significantly lesser in group 1. No significant difference was seen in the duration of nephrostomy and hospitalization between the groups. The success rates obtained in the groups using different instrument types (paediatric or adult) were similar. However, age, weight, height, stone burden and bleeding were significantly lesser in group 1 that used paediatric type of instrument. As the most frequent complication of PNL, bleeding seems to be associated with

stone burden, the diameter of dilatation and the calibre of instrument. To decrease the particular complications, paediatric type of instruments are convenient and do not affect the success.

Keywords Urolithiasis · Percutaneous nephrolithotomy · Paediatric age · Instrument type

Introduction

The incidence of urolithiasis in the paediatric age group varies according to region and is of particular concern in developing countries. Moreover, almost 20 % of urolithiasis patients are from the paediatric age group in Turkey [1]. In addition to anatomical and metabolic abnormalities, malnutrition and racial factors are known to be important risk factors for the high incidence and recurrence rate in children [2, 3]. Due to the high risk of recurrence in paediatric patients, minimally invasive treatment modalities have become important. Although most paediatric renal stones < 2 cm in size can be treated with extracorporeal shock wave lithotripsy (ESWL), stones that are larger or more complex and unbroken by ESWL can be managed safely with stone-free rates in the range of 80–90 % after a single treatment session with percutaneous nephrolithotomy (PCNL) [4–6].

With the introduction of PCNL in 1976, open surgical approaches have begun to lose their popularity in the treatment of urolithiasis [7]. While PCNL has been accepted as a minimally invasive treatment modality, because of the possible complications including bleeding and injury of the collection system, the first study of paediatric PCNL was reported in 1985 [8]. To reduce the possibility of such complications, paediatric-sized

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instruments, with shaft calibres of 12–20 F, have been used. These instruments have even been used in adult patients, instead of the adult-sized instruments, with diameters ranging from 24 to 30 F [9]. In this retrospective study, we reported our experience with PCNL in children, and compared the outcomes, including the morbidity and success rates, with regard to instruments of different sizes.

Materials and methods

This retrospective study, which was approved by the ethics committee of clinical research in Malatya, Turkey (protocol number 2013/43), was conducted in a single urology clinic to review the medical data of 173 children (176 renal units), up to the age of 17 years, who underwent PCNL between August 1999 and March 2013. Preoperative patient histories, physical examinations and routine laboratory tests, including blood biochemistry, urinalysis and urine cultures, were evaluated. An abdominopelvic ultrasound, plain abdominal films and intravenous urography were used as diagnostic imaging tools to determine stone size, location and anatomical clues, as well as for planning treatment. Renal scintigraphy and computerized tomography were done in patients suspected of having renal abnormalities, allergies of the contrast medium and the presence of a retro-renal colon, and in patients with non-opaque stone. Patients with sterile urine underwent PCNL with antibiotic prophylaxis. However, patients with urinary infections were operated on after treatment with an antibiotic prescribed after urine culture and sensitivity test.

After the placement of a ureteral catheter via cystoscopy, in the lithotomy position under general anaesthesia, the patient was placed in a prone position. PCNL access was gained using a 19-G needle and a guide wire passed from inside, under biplanar fluoroscopic guidance. Using Amplatz dilators, the percutaneous tract was dilated up to 26 F for the 17 F paediatric-type nephroscope (Karl Storz, Germany), and up to 30 F for the 24 and 26 F adult-type nephrosopes (Karl Storz, Germany), according to the patient's age, physique, caliceal dilatation and the size of the stone(s). Following the breakage of the stones using a pneumatic lithotripter (Swiss Lithoclast), a 14–22 F Malecot or Foley catheter was placed into the renal tract.

On the first postoperative day, plain abdominopelvic radiography and antegrade pyelography (if needed) were used to assess stone clearance, and to detect any pathology of the pelvicalyceal system that occurred during surgery. Stone pieces that appeared smaller than 4 mm on plain film were accepted as clinically insignificant residual fragments (CIRF). Stone burden and location, number, size and location of the renal tract, types of instruments, complications, stone clearance, duration of nephrostomy and

hospitalization time were recorded as pre- and postoperative factors. Patients with missing data, which were decided to be used in the comparison of the groups, were excluded from this study.

The data were analysed using the SPSS software program for Windows, version 21.0 (SPSS Inc., Chicago, IL, USA), and given as a mean \pm SD, median (min–max) and frequencies with percentages. Normality was assessed using the Shapiro–Wilk test. The one-way analysis of variance, Kruskal–Wallis, Pearson Chi-square and Fisher's exact tests were used for statistical analyses where appropriate. Multiple comparisons were carried out by using the Tukey and Mann–Whitney *U* test with Bonferroni correction. $p < 0.05$ was considered to be statistically significant.

Results

One hundred and seventy-six PCNL procedures, which were conducted in 173 patients (76 girls and 97 boys; mean age, 9.24 years; range 8 months–17 years) in our clinic, were evaluated. The mean body weight was 31.64 kg (range 6.5–61 kg) and mean patient height was 125.37 cm (range 63–161 cm). Twenty-five and 24 of the patients had previous ESWLs and PCNLs, respectively, and 22 had histories of spontaneous stone passage before the surgery. The PCNL procedure was performed in 94 renal units on the right side, and 82 renal units on the left side.

The mean stone burden was 1.571 ± 0.434 cm². The locations of the stones and access calyces are shown in Table 1. The pre- and postoperative characteristics of the patients, which were evaluated in three groups according to the size of the nephrosopes used, were compared and listed (Table 1). Eighty-two (47.3 %), 73 (42.1 %) and 18 patients (10.4 %) were operated on using 17, 24 and 26 F nephrosopes, respectively. The mean patient age was 8 years in group 1, 10.6 years in group 2 and 9.2 years in group 3. The mean stone burden, which was 1.358 ± 0.255 , 1.675 ± 0.467 and 2.106 ± 0.311 cm² in groups 1, 2 and 3, respectively, was significantly different between the groups ($p < 0.001$). In group 1, the mean tract size was significantly lower than that in groups 2 and 3 ($p < 0.001$).

As shown in Table 1, there was no meaningful difference in the complication rates between the groups, according to the modified Clavien classification system. Fevers (>37.8 °C) and urinary infections occurring postoperatively were treated with antipyretic and antibiotic therapies. The mean haematocrit drop in group 1 (0.916) was significantly lower when compared with the other two groups (2.027 and 1.355) ($p < 0.001$); nevertheless, only two patients in group 2 required blood transfusions.

Table 1 Characteristics of the groups with comparison of the findings

	Group 1 (17 F)	Group 2 (24 F)	Group 3 (26 F)	Total	<i>p</i> value
Total cases <i>n</i> (%)	82 (47.3)	73 (42.1)	18 (10.4)	173	
Renal units <i>n</i>	84	74	18	176	
Laterality (right:left) <i>n</i>	42:42 (2 bilateral)	41:33 (1 bilateral)	11:7	94:82	0.685
Sex distribution (male:female)	43:39	43:30	11:7	97:76	0.648
Age (years) (mean ± SD)	8 ^a	10.6	9.2	9.24 ± 4.52	<0.001
Weight (kg) (mean ± SD)	28.08 ± 10.08 ^a	35.05 ± 9.99	33.83 ± 15.39		<0.001
Height (cm) (mean ± SD)	121.10 ± 17.42 ^a	129.70 ± 14.26	127.06 ± 23.20		<0.001
Mean size of stone (cm ²) (mean ± SD)	1.358 ± 0.255 ^b	1.675 ± 0.467	2.106 ± 0.311		<0.001
Site of stone					
Upper calyx <i>n</i> (%)	0 (0)	3 (100)	0 (0)	3	0.358
Middle calyx <i>n</i> (%)	54 (51.4)	37 (35.2)	14 (13.3)	105	
Lower calyx <i>n</i> (%)	11 (47.9)	12 (52.1)	0 (0)	23	
Pelvis <i>n</i> (%)	9 (52.9)	7 (41.1)	1 (6)	17	
Multiple calyx <i>n</i> (%)	6 (30)	13 (65)	2 (5)	20	
Partial staghorn stone <i>n</i> (%)	1 (100)	0 (0)	0 (0)	1	
Complete staghorn stone <i>n</i> (%)	1(33.3)	1 (33.3)	1 (33.3)	3	
Access					
Upper calyx <i>n</i> (%)	0 (0)	2 (100)	0 (0)	2	0.168
Middle calyx <i>n</i> (%)	68 (51.1)	50 (37.5)	15 (11.2)	133	
Lower calyx <i>n</i> (%)	9 (31)	18 (62.1)	2 (6.9)	29	
Multiple calyx <i>n</i> (%)	5 (55.6)	3 (33.3)	1 (11.1)	9	
Mean diameter of dilatation (mean ± SD) (min–max)	22.64 ± 1.17 (20–26) ^b	25.97 ± 0.62 (26–30)	30 ± 0.00 (30–30)		<0.001
Complications					
Clavien I	4	5	1	10	0.618
Clavien II	1	4	0	5	0.158
Clavien > II	0	0	0		
Haematocrit drop (mean ± SD)	0.916 ± 1.99 ^b	2.027 ± 3.15	1.355 ± 1.59	1.43 ± 2.56	<0.001
Difference in creatinine (mean ± SD)	0.02 ± 0.12	0.004 ± 0.11	0.011 ± 0.13	0.01 ± 0.12	0.873
Result					
CIRF <i>n</i> (%)	20 (24.3)	15 (20.6)	5 (27.8)	40	0.730
Stone free <i>n</i> (%)	62 (75.6)	58 (79.4)	13 (72.2)	133	
Duration of nephrostomy (day) (mean ± SD)	3.14 ± 0.37	3.04 ± 0.45	3.11 ± 0.32		0.351
Hospitalization (day) (mean ± SD)	5.42 ± 1.11	5.68 ± 2.10	5.39 ± 0.91		0.547

p < 0.05 is statistically significant

^a Significantly different from group 2

^b Significantly different from group 2 and group 3

There was no significant difference between the pre- and postoperative creatinine levels (*p* = 0.873). The mean stone-free and CIRF rates were 75.6 and 24.3 % for group 1, 79.4 and 20.5 % for group 2, and 72.2 and 27.7 % for group 3, but there was no statistically meaningful difference between the groups (*p* = 0.730). The mean duration of nephrostomy was 3.09 days, and in comparing the groups no significant differences were found (*p* = 0.351) (Table 1). Furthermore, two patients were treated tubelessly and 17 patients with double J stents in addition to the

nephrostomy tubes. The mean duration of hospitalization was 5.42 ± 1.11, 5.68 ± 2.10 and 5.39 ± 0.91 days for groups 1, 2 and 3, respectively, and there was no significant difference between the groups in this regard (*p* = 0.547).

Discussion

Paediatric renal stone disease and treatment are serious issues, varying from those of adults, especially in terms of

the differences in anatomy and recurrence rates [5, 10]. Due to the requirement of minimally invasive treatment, ESWL, PCNL and flexible ureteroscopy have become the main modalities in appropriate indications. Although ESWL is considered to be a reliable and effectual therapy, due to unclear long-term effects on the kidneys and adjacent viscera, decreasing impact with increasing stone size and increased risk of urinary infection [11–13], PCNL has become the popular approach for kidney stones in children (when surgery is needed) [14]. To reduce the procedure-induced damage of the renal parenchyma, which increases morbidity and mortality rates (especially when formed during the dilatation of the percutaneous tract), new nephroscopes with smaller diameters have been used with smaller sheaths [15–17].

In the present study, to assess the actual success rate of the PCNL procedures, the stone-free and CIRF rates were given separately, rather than as the total success ratio. As it was reported, the residual stone fragments (even CIRFs) are risk factors for recurrence in children [18]. Additionally, we believe that the absolute stone-free rate is more considerable than the total success rate. According to our results, the total stone-free rate obtained, regardless of the type of instruments used, was 76.8 %. This rate was reported to be between 68 and 100 % after a single session in previous studies [19, 20]. On the other hand, although the mean stone-free rate in group 2 (in which a 24 F nephroscope was used) was higher when compared with the other groups, the difference between the results obtained with paediatric or adult-type instruments was not statistically significant in the current study. In similar studies with a small number of patients, the stone-free rates after a single PCNL session with paediatric and adult-type instruments were between 81.3 and 100 %; however, the differences between the stone-free rates of these different instrument types were also reported as being meaningless [15, 16].

It is believed that large renal access and nephroscopes with large shaft calibres are considered to cause more bleeding and renal trauma [19, 21]. However, many studies have reported that smaller access and using smaller calibre instruments have similar results with regard to complications, such as bleeding and renal scarring in children [6, 10, 22]. In our study, the difference between the pre- and postoperative creatinine levels was not significant when compared with the instruments of different sizes ($p = 0.873$); however, bleeding was more prominent with adult instruments. The use of paediatric instruments significantly reduced the haematocrit drop when compared with the other groups ($p < 0.001$).

Zeren et al. [21] reported that intraoperative bleeding was correlated with sheath size, stone burden and operative time. In the same manner, Desai and Unsal et al. [16, 19]

reported the relationship between bleeding and the calibre and number of percutaneous tracts. In our study, the stone burden was significantly less in group 1, in which haemorrhage was significantly less than in the other groups. However, the number of percutaneous tracts was not significantly different when compared with the other groups using adult-sized nephroscopes.

In addition to bleeding, fevers and urinary infections are frequently seen complications after PCNL procedures. In the previous studies, the rate of postoperative fever and urinary infection were reported to be up to 29.3 and 5.5 %, respectively [22, 23]. In a similar study, Unsal et al. [16] reported that fever was seen in 10.3 and 13.3 % of the patients using paediatric and adult-type instruments, respectively. However, the rate of urinary infection was 3.4 and 13.3 %, respectively, in the same study. In our series, fever was seen in 4.9, 6.8 and 5.5 % of the patients using 17, 24 and 26 F nephroscopes, respectively; however, the differences between the groups were not significant ($p = 0.618$). The rate of urinary infection was 1.2, 5.4 % and 0 in groups 1, 2 and 3, respectively; however, the differences were not significant ($p = 0.158$). None of the patients had positive urine cultures in the postoperative period.

In our routine application, following the control of the urinary system and the clearance of stones, the nephrostomy tube was removed, and afebrile patients without drainage from the nephrostomy tract during follow-up were discharged from the hospital. According to our results, there was no significant difference in the duration of nephrostomy between the groups. While the duration of hospitalization was shorter in group 3 (using the 26 F nephroscope), there was no significant difference between the groups (Table 1). In a similar study, no difference was reported in the average postoperative duration of hospitalization between the groups using paediatric and adult-type instruments [16].

The limitation of this study is that it is retrospective and lacks data from the chemical analyses of the retrieved stones. On the other hand, data from such a large series from a single clinic reflect a more accurate assessment. The number of patients in our study provides a meaningful statistical evaluation. Nevertheless, a well-designed prospective study comparing the results obtained with the use of instruments of different sizes for a particular stone size allows for a better evaluation.

Conclusion

To prevent the recurrence of urolithiasis, there has been increase in the use of PCNL, which provides almost complete clearance of the stones (even in one session) in

the paediatric age group. In our series, the total clearance rate, including CIRF, was 100 % after a single session of PCNL in children. The success rates obtained in groups using different instrument types (paediatric or adult) were similar. Moreover, there were no significant differences in the stone site, localization and number of accesses, minor complications (including fever and urinary infections), pre- and post-operative creatinine levels, and duration of nephrostomy and hospitalization between the groups using paediatric and adult instruments. However, age, weight, height, stone burden and bleeding were significantly lower in group 1, in which paediatric instruments were used. As the most frequent complication of PCNL, bleeding seems to be associated with stone burden, the diameter of dilatation and the calibre of instrument used. Nonetheless, in skilful hands, PCNL can be useful in the management of stone disease, with a high clearance rate in children. To decrease the particular complications of this procedure, paediatric instruments can be conveniently used, without affecting the success of the procedure.

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Conflict of interest The authors declare no conflict of interest.

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