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ORIGINAL PAPER

Comparison of two percutaneous nephrolithotomy methods for the treatment of pediatric kidney stones: Mini-percutaneous nephrolithotomy and standard percutaneous nephrolithotomy

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Summary

Objective: In this study, the aim was to compare the results of mini and standard percutaneous nephrolithotomy (PCNL) for the treatment of pediatric kidney stones.
Materials and Methods: Data for 128 patients < 18 years of age who underwent mini and standard PCNL due to pediatric kidney stones were retrospectively examined. Patients were divided into two groups: mini-PCNL (16-20 Fr) and standard PCNL (26 Fr). Surgery time, number of punctures to the pelvicalyceal system, hospital stay, postoperative hemoglobin drop, complications and stone-free status (SFR) were compared between the groups. Additional surgical intervention (double-J stent, ureterorenoscopy, secondary PCNL) performed after the surgery was recorded. The absence of residual stones or < 3 mm residual stones on kidney, ureter and bladder radiography (KUB) and ultrasonography (USG) performed in the third postoperative month were accepted as success criteria.
Results: There were 32 (43.8%) patients in the mini-PCNL group and 41 (56.2%) patients in the standard PCNL group. The mean age was 9.3 ± 4.1 years in the mini-PCNL group and 10.1 ± 5.4 years in the standard PCNL group. Mean stone size in the mini-PCNL group was 2.1 ± 1.2; while for standard PCNL it was 2.3 ± 1.4. The mean surgery time was statistically significantly higher in the mini-PCNL group (p = 0.005). There was no difference between the groups in terms of intraoperative double J stent use, postoperative complications and SFR. A double J stent was inserted in two patients in the mini-PCNL group and in one patient in the standard PCNL group due to urine leakage from the nephrostomy tract in the postoperative period. Although the postoperative hemoglobin drop was found to be significantly higher in standard PCNL (p = 0.001), hematuria and blood transfusion rates were low in both groups. Mean hospital stay was shorter in the mini-PCNL group compared to standard PCNL (3.6 ± 1.2 days vs. 2.5 ± 1.1; p = 0.018).
Conclusions: Although mini-PCNL has longer surgery time compared to standard PCNL, it should be preferred for the treatment of pediatric kidney stones due to advantages such as similar success and complication rates to standard PCNL, short hospital stay and less postoperative hemoglobin drop.

KEY WORDS: *Mini percutaneous nephrolithotomy; Standard percutaneous nephrolithotomy; Pediatric Kidney Stones.*

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INTRODUCTION

Although kidney stones are less common in children compared to adults, their recurrence rate is higher (1,2). Therefore, in this age group, complete removal of stones with a less traumatic method is important for future kidney health. In the past, pediatric kidney stones were treated with open surgery. However, today, extracorporeal *shock wave lithotripsy* (SWL) treatment is widely used for most pediatric kidney stones (3). The main disadvantages of the SWL method are that it is performed under general anesthesia and requires a high number of sessions (4). *Percutaneous nephrolithotomy* (PCNL) is a frequently used treatment method, especially for the treatment of large and complex stones (3). EAU guidelines recommend PCNL as the first treatment option for pediatric kidney stones larger than 2 cm and stones larger than 1 cm in the lower calyx. However, the possibility of bleeding requiring transfusion increases as the sheath diameter, number of punctures, and surgery time increase in PCNL (5, 6). This is why mini-PCNL has become popular today. With the mini-PCNL method, it is expected that there will be less renal parenchymal damage and fewer complications since the working channel is smaller.
Because pediatric kidneys are small and mobile, have thin parenchyma, and the pelvicalyceal area has small volume, the large instruments used in standard PCNL can be traumatic (7).
Therefore, the importance of mini-PCNL increases for these patients. Our study aimed to compare the results of mini and standard PCNL, along with their morbidity and success rates, for pediatric kidney stones.

MATERIALS AND METHODS

The data for 128 patients < 18 years of age who underwent PCNL for pediatric kidney stones between June 2013 and December 2022 were retrospectively examined. Patients who had previously undergone PCNL, had chronic kidney disease, were operated for ureteral stones in the same session, had skeletal anomalies, and with missing postoperative follow-up data were excluded from the study. Patients were divided into two groups: mini-PCNL

(16-20 Fr) and standard PCNL (26 Fr). Preoperatively, urinalysis, urine culture, complete blood count, kidney and liver function tests, coagulation tests, urinary *ultrasonography* (USG), *kidney, ureter and bladder* radiography (KUB) and *non-contrast whole abdominal computed tomography* (NCCT) were performed on all patients. Those with active urinary tract infection were treated with appropriate antibiotics, and those with no growth in the control urine culture were taken for surgery. Stone size was defined as the maximum diameter of the stone. In the presence of multiple stones, the sum of the longest diameter of each stone was accepted as the stone size.

In both groups, the surgeries were performed in prone position under general anesthesia and with antibiotic (cephalosporin) prophylaxis. Previously, a 4-6 Fr ureteral catheter was inserted in patients in the lithotomy position. Diluted opaque material was administered through the ureteral catheter to visualize the collecting system. Then, after determining the appropriate calyx under fluoroscopy, entry was made with a two-piece needle with an 18-gauge trocar tip (*Cook Urological, Bloomington, IN, USA*). When necessary, additional entries were made before dilation began. A 0.035 inch hydrophilic nitinol (*Terumo, Tokyo, Japan*) guide wire was sent through the needle to the collector system. In the mini-PCNL group, 16-20 Fr dilatation was performed over the guide wire with the help of Amplatz dilators and a sheath was placed. The kidney was entered with a 15 Fr rigid nephroscope (*Olympus*), and a pneumatic lithotripter was used when necessary, along with a holmium laser, to break up the stones. The broken stone pieces were removed by washing, using forceps and a basket. Patients in the standard PCNL group underwent 26 Fr dilation and surgeries were performed with a 24 Fr nephroscope. A pneumatic lithotripter was used to break up the stones. At the end of the procedures, the presence of residual stones was checked with fluoroscopy. If no residual stone could be seen during both fluoroscopy and endoscopic examination, the operation was considered completed. Double-J stents were emplaced antegradely in those who were thought to have infection stones, with injuries in the renal pelvis, and stenosis in the ureteropelvic junction. At the end of the procedure, a 12-14 Fr Foley catheter was inserted as a nephrostomy tube. On the first postoperative day, all patients underwent KUB and their urethral catheters were removed; the nephrostomy tube was removed on the first or second day. Patients who had no fever, hematuria, or discharge from the nephrostomy tract during follow-up were discharged.

Surgery time, number of punctures to the pelvicalyceal system, hospital stay, postoperative hemoglobin drop, complications and *stone-free status* (SFR) were compared between the groups. In both groups, the duration of surgery was defined as the time from the first puncture of the pelvicalyceal system until the placement of the nephrostomy catheter. The first follow-up after discharge was performed two weeks later (those with a DJ stent had their stents removed). The success criteria were defined as no additional postoperative surgical intervention (double-J stent, ureterorenoscopy, secondary PCNL), no residual stones or < 3 mm stones at KUB and USGs performed 3 months later.

Statistical analysis

Data were analyzed using SPSS. The chi-square test was used to compare proportions. Fisher's exact test was used when the expected number of > 20% of cells in the table fell below five. Student t test was used to compare the means of two groups. A P value of 0.05 was considered statistically significant. Univariate analyses were performed to detect a significant relationship between each of the dependent and independent variables. A 95% confidence interval was also calculated.

Results

A total of 73 pediatric patients were included in the study. There were 32 (43.8%) patients in the mini-PCNL group and 41 (56.2%) patients in the standard PCNL group. The mean age was 9.3 ± 4.1 years in the mini-PCNL group and 10.1 ± 5.4 years in the standard PCNL group. Mean stone size for mini-PCNL was 2.1 ± 1.2; for standard PCNL it was 2.3 ± 1.4. There were no differences between the groups in terms of demographic, clinical and radiological stone characteristics of the patients (Table 1). The mean surgery time was statistically significantly higher in the mini-PCNL group (p = 0.005). There was no difference between the groups in terms of intraoperative double J stent use, postoperative complications and SFR. The overall SFR was 81.2% in mini-PCNL and 85.4% in standard PCNL. Complications were generally managed with medical treatment. A double J stent was placed in two patients in the mini-PCNL group and in one patient in the standard PCNL group due to urine leakage from the nephrostomy tract in the postoperative period. Although puncture rates were slightly higher in the mini-PCNL group, this was not statistically significant (p = 0.076). Although postoperative hemoglobin drop was found to be significantly higher in standard PCNL (p = 0.001), hematuria and blood transfusion rates were low in both groups. Blood transfusion was performed in one patient in the mini-PCNL group and in two patients in the standard PCNL group. The mean hospital stay was

Table 1.
Comparison of patients' demographic, clinical and radiological parameters.

Variables	Mini PCNL (n = 32)	Standard PCNL (n = 41)	p
Age (mean ± SD)	9.3±4.1	10.1±5.4	0.105
Sex, n (%)			0.196
Male	19 (59.3)	29 (70.7)	
Female	13 (40.7)	12 (29.3)	
BMI (mean ± SD)	19.0±3.6	20.2±3.9	0.388
Stone side, n (%)			0.383
Right	17 (53.1)	24 (58.5)	
Left	15 (46.9)	17 (41.5)	
Stone size (mm), (mean ± SD)	2.1±1.2	2.3±1.4	0.211
Stone complexity, n (%)			0.622
Single stone	11 (34.4)	14 (34.1)	
Multiple stone	16 (50)	17 (41.5)	
Partial staghorn	3 (9.4)	4 (9.8)	
Complete staghorn	2 (6.2)	6 (14.6)	

PCNL: Percutaneous Nephrolithotomy, BMI: Body Mass Index.

Table 2.
Comparison of intraoperative and postoperative data.

Variables	Mini PCNL	Standart PCNL	p
Operative duration (min), (mean ± SD)	85.4 ± 18.8	71.7 ± 11.6	0.005
Punctures, n (%)			0.076
Single	24 (75)	37 (90.2)	
Multiple	8 (25)	4 (9.8)	
Intraoperative double J stent insertion, n (%)	5 (15.6)	9 (21.9)	0.225
Hospital stay (days), (mean ± SD)	2.5 ± 1.1	3.6 ± 1.2	0.018
Postoperative complications			0.159
Clavien Grade 1	4 (12.5)	7 (17)	
Clavien Grade 2	3 (9.3)	5 (12.2)	
Clavien Grade 3	2 (6.2)	1 (2.4)	
Clavien Grade 4	0	0	
Postoperative fever, n (%)	5 (15.6)	8 (19.5)	
Postoperative transient hematuria, n (%)	1 (3.1)	2 (4.9)	
Blood transfusion, n (%)	1 (3.1)	2 (4.9)	
Urinoma	0	0	
Prolonged urine leakage (≥ 24 hours)	2 (6.2)	1 (2.4)	
Pleural injury	0	0	
Colon injury	0	0	
Sepsis	0	0	
Mortality	0	0	
Postoperative Hb (g/dL) drop, (mean ± SD)	0.9 ± 0.3	1.6 ± 0.5	0.001
SFR, n (%)	26 (81.2)	35 (85.4)	0.487

PCNL: Percutaneous Nephrolithotomy, SFR: Stone-free Rate.

shorter in the mini-PCNL group compared to standard PCNL (3.6 ± 1.2 days *vs.* 2.5 ± 1.1; p = 0.018) (Table 2).

Discussion

In this study, it was planned to compare the results of standard and mini-PCNL for pediatric kidney stones. Although the surgery time was longer in mini-PCNL, the hospital stay and average postoperative hemoglobin drop were less. SFR and complication rates were similar between the groups. The prevalence of pediatric kidney stones with high recurrence rates is increasing day by day (8). PCNL is a standard treatment method in this age group, especially for the treatment of large kidney stones. Mini-PCNL is the most popular technique in recent times. With this technique, the aim is to cause less damage to the kidney parenchyma, reduce complications, and achieve high SFR by using small-diameter sheaths (9-11). In many studies, the SFR in standard PCNL is 50-98% (5, 10-14). In mini-PCNL, this rate was reported to be 80-85% (5, 8, 14). In similar literature studies comparing mini and standard PCNL in the pediatric population, there was no significant difference between the two techniques in terms of SFR (15-17). If we look at the SFR in our study, it was similar to the literature with rates of 81.2% in the mini-PCNL group and 85.4% in the standard PCNL group.

Many studies showed that the operation time in mini-PCNL is longer than standard PCNL (13, 18, 19). In our study, the operation time was longer in the mini-PCNL group. We think that surgery times are prolonged in mini-PCNL due to reasons such as the slow flow of irrigation fluid due to the use of small-diameter instruments, the limited visual field due to the use of miniaturized endoscopic devices, and the preference for stones to be broken into smaller pieces for removal or grinding, instead of active stone crushing. One of the complicated situations in studies comparing both standards in the literature is the length of hospital stay. Although some studies showed that the postoperative hospital stay is similar for both methods (13, 18-20), some reported that the length of stay is shorter for mini-PCNL (15). In our study, the length of stay after mini-PCNL was found to be significantly shorter. We think that the smaller size of the nephrostomy tract and the resulting reduction in postoperative pain and bleeding result in a shorter hospital stay. After PCNL surgery, patients may experience complications such as fever, urinary tract infection and bleeding. Complication rates in the literature vary between 15-25% (21-26). Although some studies say that complication rates are similar (19, 20), there are also studies showing that intraoperative bleeding, postoperative hemoglobin drop and blood transfusion rates are significantly higher in standard PCNL (13, 18). In our study, although the number of punctures seemed to be slightly higher with mini-PCNL, the postoperative hemoglobin drop was found to be significantly higher with standard PCNL. However, there was no statistically significant difference between the groups in terms of general postoperative complications. Our study has some limitations. Firstly, our study was a retrospective study and the number of patients was small. Secondly, no subgroup analysis was performed according to stone complexity. Thirdly, due to the small number of patients, analysis was not made according to age groups. Additionally, computed tomography could not be used in follow-up imaging to avoid further radiation exposure.

Conclusions

Although mini-PCNL has a longer surgery time compared to standard PCNL, it has similar success and complication rates. In addition, it is a safe and effective method that should be preferred for the treatment of pediatric kidney stone patients due to important advantages such as short hospital stay and less postoperative hemoglobin drop.

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Conflict of interest: The authors declare no potential conflict of interest.