Comparison of the results of 16 to 20 French percutaneous access dilatation of mini-percutaneous nephrolithotomy in pediatric patients

Numan Baydilli, Emre Can Akinsal, Gokhan Sonmez, Deniz Demirci
Original article

Comparison of the results of 16 to 20 French percutaneous access dilatation of mini-percutaneous nephrolithotomy in pediatric patients

Numan Baydilli, Emre Can Akinsal, Gokhan Sonmez, Deniz Demirci

Department of Urology, Faculty of Medicine, Erciyes University, Kayseri, Turkey

Address correspondence to:
Numan Baydilli, M.D
Department of Urology
Erciyes University Faculty of Medicine
Address: Köşk Mahallesi, Prof. Dr. Turhan Feyzioğlu Cad. No:42
38039 Melikgazi
Kayseri Turkey
Tel: +903522076666-21134
E mail: dr_numan38@hotmail.com
ABSTRACT

Objective: To compare the efficiency and complications of mini-percutaneous nephrolithotomy (mini-PCNL) using 16 F and 20 F access sheaths in pediatric population

Design: Retrospective study

Setting: Erciyes University, Faculty of Medicine, Kayseri, Turkey

Subjects and methods: Data from 122 patients under 13 years of age who underwent mini-PCNL were reviewed retrospectively. The patients were classified into two groups according to the dilatation size of 16 F (group 1) and 20 F (group 2).

Intervention: Mini-PCNL (percutaneous nephrolithotomy) using 16 F and 20 F sheath

Main outcome measures: Comparison efficiency and complications between two different size access sheaths which are commonly used for mini-PCNL in pediatric population

Results: Mean ages of both groups were 5.1 ± 3.3 years. The median stone burden was 200 (100-400) mm² in group 1 and 225 (120-300) mm² in group 2. There was no statistically significant difference between groups’ data in terms of stone localization, stone burden, operation time, hemoglobin drop, nephrostomy duration and length of hospital stay. Fluoroscopy time was significantly lower in group 1 than group 2 (median 4 vs. 6 minute, respectively p ≤0.009). The complication rates did not differ between the groups according to the modified Clavien classification system.

Conclusions: We found no difference between 16 F and 20 F percutaneous access dilatation of the kidney in terms of stone-free rates and complications. However, mini-PCNL procedure using 16F sheath appears to decrease fluoroscopy time and exposure the radiation as compared to 20F procedure.

Keywords: mini percutaneous nephrolithotomy, pediatric age, stone surgery, urolithiasis

INTRODUCTION

Stone disease has more propensity of recurrence in the pediatric population than in adults because of predisposition factors like anatomical and metabolic abnormalities, genetic factors, malnutrition and infections\[1\]. Therefore, it is becoming increasingly important to use minimal invasive techniques for treatment of pediatric stone disease. Recently, open surgery procedures have become almost completely obsolete. Minimally invasive procedures like shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS) are being used\[2\]. At first, adult type PCNL instruments and sheaths 24-30 French (F) percutaneous access sheaths were used for pediatric patients with renal stones. These are both overlarge for children’s relatively small kidneys and associated with complications such as bleeding and damage to the renal parenchyma\[3\]. In the last decade, standard PCNL instruments have been miniaturized to decrease morbidity. Helal et al first defined a technique for pediatric stone disease using 10 F pediatric cystoscope through 16 F size access tract\[4\]. Minimally invasive PCNL (Mini-PCNL or Mini-Perc) procedure in pediatric population was first described by Jackman et al by using 11 F access tract\[5\]. Since then mini-PCNL procedures have been developed. Besides, ultra-mini PCNL and micro-PCNL have become more popular\[6-8\].

The mini-PCNL procedure is the general name given to PCNL procedures that are performed via smaller percutaneous access dilatation lower than 20 F\[9\]. Percutaneous dilatation size and preferred
nephroscope size may vary according to the age of the child, size of stone, dilatation degree of the kidney and the preference of the surgeon. It is obvious that a smaller nephroscope applies less force to the renal parenchyma, infundibulum and calyx neck. It has been reported that dilatation size is one of the main parameters that cause complications\textsuperscript{10}.

There are many studies that compare the outcomes between standard PCNL and mini-PCNL\textsuperscript{1,11,12} However, it is still unclear what size of the access sheath is more appropriate for the stone burden. There is a paucity of literature comparing the outcomes of the size of sheath in mini-PCNL in pediatric groups which match with age and sex. In this clinical study, we compared the efficiency and complication rates of mini-PCNL procedure in pediatric population using 16 F and 20 F access sheaths.

**SUBJECTS AND METHODS**

The records of 122 cases under 13 years of age who underwent mini-PCNL for renal stone disease between February 2011 and February 2017 in a single center were evaluated retrospectively. This study was approved by the institutional ethics committee. Informed consents were obtained from parents of all the cases before the operation. Preoperative patients’ records were reviewed including complete blood cell counts, blood urea levels, serum creatinine levels, coagulation tests, urine analyzes, and urine culture results. The patients who had positive urine culture results were treated with appropriate antibiotics. Radiological evaluation was performed with plain Kidney-Urinary-Bladder (KUB) radiography and ultrasound imaging. Computerized tomography was performed if required. Patients whose kidney stones were larger than 20 mm were treated with mini-PCNL. Stones which were 10 - 20 mm localized in the lower calyx or unbroken by SWL were treated with mini-PCNL. Stone burden was calculated by multiplying the two longest distances of stone in millimeters. A single dose of Ceftriaxone calculated for weight was used for preoperative prophylaxis in all patients. Stones were classified into five categories; isolated caliceal stones (upper calyx and lower calyx), isolated renal pelvis stones, staghorn stones and multiple caliceal stones, which are named if stones are localized in more than two calyx. The patients were classified into two groups which matched with age and sex according to the percutaneous dilatation size of 16 F (group 1) and 20 F (group 2).

**Technique**

All mini-PCNL procedures were performed under general anesthesia and prone position. An open-end ureteric catheter (5F) was inserted into the renal pelvis with fluoroscopy guidance in the lithotomic position. The catheter was fixed to a Foley catheter, which was placed into the bladder, and then the patient was placed in a prone position. The gonads were protected from radiation by using a lead shield. Insertion to the proper calyx of the kidney was achieved using an 18 G Chiba needle (Boston Scientific, Natic, MA, ABD) with the guidance of C arm fluoroscopy. In general, the lower pole posterior calyx was preferred to access the renal collector system. After reaching the urinary system, dilatation was performed to up to 16 F or 20 F using Amplatz dilators over a 0.035-inchguide wire. The temperature of the irrigation fluid (0.9% NaCl) was kept between 24 - 26 °C to avoid hypothermia. 12 F pediatric nephroscope (Karl Storz, Germany) was used from inside the 16F Amplatz sheath and a 17 F pediatric nephroscope (Karl
Storz, Germany) was used from inside the 20 F Amplatz sheath. A holmium-YAG laser and pneumatic lithotripsy (Elmed litotriptor, Turkey, Lithoclast) were used in both groups for stone disintegration. Fragmented stones were extracted with forceps or irrigation fluid. After the operation, a 10 F - 12 F nelaton catheter or 14 F re-entry catheter was used for diversion.

**Follow up**

After the operation, hemoglobin drop was controlled with complete blood count if required. Foley catheters were removed on the first postoperative day unless there was hematuria. The nephrostomy tube was removed if there was no hematuria, fever or urine leakage on the postoperative second day. Postoperative complications were evaluated using the modified Clavien Grading System\cite{13}. The Clavien classification system which is termed as a classification of surgical complications (Grade I-V) has been proposed to grade complications of general surgery. First proposed in 1992 and modified in 2004, the modified Clavien grading system has been validated in a large patient cohort\cite{13,14}. It is increasingly becoming popular in urology and has been used to date in common procedures in PCNL interventions\cite{15}. Three weeks after the operation, patients were evaluated with KUB radiograph and ultrasound imaging in order to evaluate stone-free rate. Stones fragments smaller than 3 mm were considered as clinically insignificant residual fragments (CIRFs). Age, sex, size and localization of stone, operation time, fluoroscopy time, hemoglobin drop, initial stone-free rate, auxiliary methods and complications were compared according to sheath size. Final stone-free rate was evaluated after auxiliary procedures.

**Statistical analysis**

Using the SPSS statistical package (version 15.0; SPSS, Inc., Chicago, IL, USA), data was analyzed. Data was given as median (percentiles 25% - 75%) and frequencies as percentages. Normality was evaluated using the Shapiro-Wilk test. Abnormally distributed data was compared with the Mann-Whitney U test. To evaluate categorical data, the Pearson Chi-square test was used. P-value of <0.05 was considered statistically significant.

**RESULTS**

A total 122 children who underwent mini-PCNL was evaluated in this study. Groups of PCNL have been equalized according to age and sex for homogeneous distribution between groups. It was noted that the children in each group had the same age, the same number and the same sex. Mean age of each group was 5.1 ± 3.3 years (38 male, 23 female) and median age of each group was 4 years (25\textsuperscript{th} and 75\textsuperscript{th} quartiles 2 and 8 respectively) (range= 1 to 13 years). The median stone burden was 200 mm\textsuperscript{2} in group 1 and 225 mm\textsuperscript{2} in group 2. The most frequent localizations of stones were pelvis and multiple calyxes in both groups, respectively. The percentages of pelvis and multiple caliceal stones were 45.9% - 27.9% in group 1 and 62.3% - 13.1% in group 2, respectively. The percentages of staghorn stones were 9.8% in group 1 and 13.1% in group 2. Comparisons of groups' data according to the sheath size of percutaneous access are summarized in Table 1. There were no statistically significant differences between groups’ data in terms of stone laterality, stone localization, stone burden, operation time, hemoglobin drop, nephrostomy duration
Fluoroscopy time was significantly lower in group 1 than group 2 ($p \leq 0.009$) (median 4 vs. 6 minute, respectively). The median operative time was 80 minutes in group 1 and 70 minutes in group 2. No statistically significant difference was present when initial stone-free rates were compared (86.9% in group 1, 78.7% in group 2). These rates increased to 95.1% and 90.2% with auxiliary treatment methods (SWL or mini-PCNL), respectively. There was also no statistically significant difference between the groups in terms of final stone-free success rate. The complication rates did not differ between the groups according to the modified Clavien classification system (Table 2). Three patients (4.9%) in group 1 and 4 patients (6.5%) in group 2 had fever that decreased with symptomatic treatment in the postoperative period (grade I). While two patients (3.2%) received blood transfusion in group 2, no patients received in group 1 (grade II). Four patients (6.5%) in group 1 and two patients (3.2%) in group 2 were treated with antibiotic due to urinary tract infection in the postoperative period (grade II). While a total of three patients (4.9%) experienced grade IIIb Clavien complications in group 1, four patients (6.5%) experienced in group 2. Because of urine leak from the nephrostomy tract, double J stent was inserted into the renal pelvis in three patients (4.9%) in both groups. One patient (1.6%) had blood retention requiring cystoscopy in group 2. None of the patients had any major complications.

**DISCUSSION**

Minimally invasive treatment of kidney stones has evolved dramatically in the last four decades. SWL is the treatment procedure for most pediatric renal stones. According to the European Association of Urology guidelines, PCNL is recommended as the primary treatment option for large renal stones (>20 mm) and also for stones measuring between 10-20 mm in the lower renal pole\textsuperscript{[16]}. Standard PCNL access sheaths are large (24–32 F), especially for the treatment of large renal stones and are associated with high risk of bleeding, renal scarring and more pain. For this reason, smaller access sheaths and procedures have been developed, primarily in pediatric patients\textsuperscript{[5]}. The main goal of surgical treatment of urinary stone disease with smaller instruments is to achieve high stone clearance with minimal complications. The use of smaller instruments is also increasing in adult patients due to the lower risk of complications\textsuperscript{[17]}. Lately, the access sheaths have been reduced in size from standard 30 F access down to 20 F or less such as mini-PCNL, ultramini-PCNL (11-13 F) and now micro-PCNL (4.8 F). The use of the mini-PCNL technique is becoming increasingly popular in the treatment of kidney stones in pediatric populations because of the small kidneys and their low tolerability to blood loss.

Mini-PCNL has some advantages including decreased blood loss, increased maneuverability, less postoperative pain and decreased hospital stay\textsuperscript{[18]}. However, mini-PCNL has some disadvantages such as prolonged operation time and difficulty in removing residual stone fragments because of the necessity to disintegrate stones into the small enough fragments to fit through a reduced size sheath. Celik \textit{et al} reported the number of blood transfusion units in groups that used 26 F ($n = 82$), 20 F ($n = 89$), and 12 F ($n = 50$) tract sizes as 2, 1, and 0, respectively. They reported that the drop in hemoglobin was significantly lower in the 12 F group\textsuperscript{[19]}. Kukreja \textit{et al} reported that the 22 F tract size was associated with less blood loss than standard dilatation (28 F)\textsuperscript{[10]}. Another study which compared the different tract sizes (26 F, 20 F, 14 F) in PCNL reported that more blood transfusions were performed when 26 F and 20 F tract sizes were
used than with 14 F tract size\(^{[1]}\). Overall, the blood transfusion ratio was only 1.6% in our study. We routinely did not control hemoglobin value of every patient in the postoperative period unless more bleeding occurred during the operation. In our study, solely two patients in the group 2 received a blood transfusion. No patient received blood transfusion in group 1. There were no significant differences regarding hemoglobin drop between the groups.

Celik et al reported their stone burden as 126 mm\(^2\) in the 12 F group, 168 mm\(^2\) in the 20 F group and 208 mm\(^2\) in the 26 F group. Their stone-free rate was 78% in the 12 F group, 75.8% in 20 F group, and 71.4% in the 26 F group. The reason why higher success rate in the 12 F group was considered is the relatively lower stone burden. In our study, there was similar stone burden between the groups; stone free rate was higher in group 1, but this difference was not statistically significant. A recently published review reported that initial stone free rates of mini-PCNL series ranged from 80.6% to 91.9%. Stone burden is also ranging from 170 mm\(^2\) to 1456 mm\(^2\)\(^{[20]}\). In our study, overall stone burden was 200 mm\(^2\) and overall stone free rate was 86.8% and showed correlation with this studies. There was no statistically significant difference between groups in terms of stone burden and stone-free rates.

Theoretically, a lower calibration access size may increase the operation time and is not preferred for larger stones. Giusti et al reported their study which was performed to evaluate the result of mini PCNL and standard PCNL that operation time was longer in mini PCNL than standard PCNL (155.5 vs. 106.6 min, respectively)\(^{[21]}\). Zeng et al reported operation time as 77.5 minute using 14 - 16 F percutaneous access and Resorlu et al reported operation time as 76.3 minute using 12 - 20 F percutaneous access. In our study, the overall median operation time was 80 minutes. Although group 1’s operation time was longer than group 2 (80 vs. 70 min, respectively), the difference was not significant (p = 0.265). This prolongation of operation time is acceptable when considering that none of the patients required any blood transfusion.

Fluoroscopy time was significantly longer in group 2 than group 1 (6 vs. 4 min respectively, p = 0.009). Saad et al also reported in their study which used 22 F access dilatation as 3.1 ± 1.1 minute for fluoroscopy. Sakr et al reported 4.3 ± 1.3 minutes in their study which used 16.5 F dilatation tract in 81 renal units\(^{[22]}\). In our opinion, larger sheaths require longer fluoroscopy usage to access collecting renal system. The longer duration of fluoroscopy in group 2 may appeared as a disadvantage when exposure to radiation is considered in the pediatric age group.

The composition of the stones which were analyzed was recorded in 44 cases. Stones were composed of calcium oxalate in 54.5% of cases, cystine in 13% of cases, and carbonate apatite in 9% of cases. The remainder of the stones (22% of cases) consisted of mix type (uric acid ± magnesium ammonium phosphate ± calcium oxalate ± calcium phosphate ± calcium carbonate ± carbonate apatite)

Mini-PCNL is a safer procedure for postoperative blood loss when compared with adult dilatation size (26 - 30 F). So, it may be unnecessary to check hemoglobin levels for every patient, unless there is any extraordinary preoperative situation.

Previous studies reported that ratios of grade I and II (fever and urinary tract infection) complications, which were the most common ones, ranged from 8.5% to 23%\(^{[23]}\). Grade III and VI complications, which are considered as major complications, are rare (0% - 13.6%)\(^{[23,24]}\). Total complications vary from 11% to 37.9 % in a review\(^{[20]}\). In our study, overall minor complications (Clavien 1
and 2) were 11.4% in group 1 and 13.1% in group 2. Grade IIIb complications were 4.9% and 6.5%, respectively and there was no Grade IV complication. Our complication rates were similar with previous studies and there were no statistically significant differences between the groups. Therefore, both 16 F and 20 F access sheaths may be safely used in a pediatric patient group.

CONCLUSION
We found no difference between 16 F and 20 F percutaneous access dilatation of the kidney in terms of efficiency and complications. However, mini-PCNL procedure using 16 F sheath appears to decrease fluoroscopy time and exposure to radiation as compared to 20 F procedure.

ACKNOWLEDGMENT
Conflict of interest: No conflict of interest was declared by the authors.
Financial disclosure: The authors declared that this study has received no financial support.

REFERENCES


### Table 1: Demographic data of patients

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Total</th>
<th>Group 1 (16 F)</th>
<th>Group 2 (20 F)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>122</td>
<td>61</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Gender (male : female)</td>
<td>76:46</td>
<td>38:23</td>
<td>38:23</td>
<td>0.574</td>
</tr>
<tr>
<td>Side of operation (right : left : bilateral)</td>
<td>62:59:1</td>
<td>32:28:1</td>
<td>30:31</td>
<td>0.544</td>
</tr>
<tr>
<td>Age (years)</td>
<td>5.1 ± 3.3 / 4 (2-8)</td>
<td>5.1 ± 3.3 / 4 (2-8)</td>
<td>5.1 ± 3.3 / 4 (2-8)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Stone localization (n, %)</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.164</td>
</tr>
<tr>
<td>Upper pole calyx</td>
<td>3 (2.5)</td>
<td>1 (1.6)</td>
<td>2 (3.3)</td>
<td></td>
</tr>
<tr>
<td>Lower pole calyx</td>
<td>14 (11.5)</td>
<td>9 (14.8)</td>
<td>5 (8.2)</td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td>63 (54.1)</td>
<td>28 (45.9)</td>
<td>38 (62.3)</td>
<td></td>
</tr>
<tr>
<td>Multiple calyx</td>
<td>24 (20.5)</td>
<td>17 (27.9)</td>
<td>8 (13.1)</td>
<td></td>
</tr>
<tr>
<td>Staghorn</td>
<td>14 (11.5)</td>
<td>6 (9.8)</td>
<td>8 (13.1)</td>
<td></td>
</tr>
<tr>
<td>Number of access (n, %) (1:2)</td>
<td>116 (95.1) : 6(4.9)</td>
<td>57(93.4) : 4(6.6)</td>
<td>59(96.7) : 2(3.3)</td>
<td>0.340a</td>
</tr>
<tr>
<td>Stone burden (mm²)</td>
<td>200 (115-305)</td>
<td>200 (100-400)</td>
<td>225 (120-300)</td>
<td>0.601b</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>80 (60-100)</td>
<td>80 (60-100)</td>
<td>70 (60-90)</td>
<td>0.265b</td>
</tr>
<tr>
<td>Fluoroscopy time (min)</td>
<td>5 (3-8.5)</td>
<td>4 (2.7-8)</td>
<td>6 (4.2-10)</td>
<td>0.009b</td>
</tr>
<tr>
<td>Hemoglobin drop (g/dl)</td>
<td>0.5 (0-1.1)</td>
<td>0.5 (0-2.1)</td>
<td>0.5 (0-1.2)</td>
<td>0.965b</td>
</tr>
<tr>
<td>Nephrostomy time (days)</td>
<td>2 (2-3)</td>
<td>2 (2-3)</td>
<td>2 (2-3)</td>
<td>0.406b</td>
</tr>
<tr>
<td>Length of hospital stay (days)</td>
<td>3 (2-4)</td>
<td>3 (2-4)</td>
<td>3 (2-4)</td>
<td>0.412b</td>
</tr>
<tr>
<td>Initial stone-free rate (%)</td>
<td>86.8</td>
<td>86.9</td>
<td>78.7</td>
<td>0.230a</td>
</tr>
<tr>
<td>Auxiliary procedure (n, %)</td>
<td>13 (10.5)</td>
<td>4 (6.6)</td>
<td>9 (14.7)</td>
<td></td>
</tr>
<tr>
<td>SWL</td>
<td>4(3.2)</td>
<td>2(3.3)</td>
<td>2(3.2)</td>
<td></td>
</tr>
<tr>
<td>Mini-PCNL</td>
<td>9(7.3)</td>
<td>2(3.3)</td>
<td>7(11.5)</td>
<td>0.222a</td>
</tr>
<tr>
<td>Final stone-free rate (%)</td>
<td>92.6</td>
<td>95.1</td>
<td>90.2</td>
<td>0.299a</td>
</tr>
</tbody>
</table>

*Pearson Chi-Square; *Mann-Whitney U test; * Significant at 0.05 level

Data were given as median (25% and 75% percentiles)

SWL: shock wave lithotripsy; PCNL: percutaneous nephrolithotomy
## Table 2: Classification of surgical complications according to modified Clavien system

<table>
<thead>
<tr>
<th>Modified Clavien Grading System</th>
<th>Group 1 (16 F) n=61</th>
<th>Group 2 (20 F) n=61</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 (n, %)</td>
<td>3 (4.9)</td>
<td>4 (6.5)</td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>3 (4.9)</td>
<td>4 (6.5)</td>
<td></td>
</tr>
<tr>
<td>Grade 2 (n, %)</td>
<td>4 (6.5)</td>
<td>4 (6.5)</td>
<td>0.955</td>
</tr>
<tr>
<td>Urinary tract infection requiring additional antibiotics</td>
<td>4 (6.5)</td>
<td>2 (3.2)</td>
<td></td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>0</td>
<td>2 (3.2)</td>
<td></td>
</tr>
<tr>
<td>Grade 3b (n, %)</td>
<td>3 (4.9)</td>
<td>4 (6.5)</td>
<td></td>
</tr>
<tr>
<td>Requiring DJ stent insertion for urine leakage &gt; 24h</td>
<td>3 (4.9)</td>
<td>3 (4.9)</td>
<td></td>
</tr>
<tr>
<td>Blood retention requiring cystoscopy</td>
<td>0</td>
<td>1 (1.6)</td>
<td></td>
</tr>
</tbody>
</table>

*Pearson Chi-Square