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Original Article

Micropercutaneous nephrolithotomy results in adults and pediatric patients: Is it safe for children?

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ABSTRACT

Objective: To compare the safety and effectivity of micropercutaneous nephrolithotomy (MicroPNL) in adults and children.

Material and methods: Twenty children and 20 adult patients who underwent MicroPNL were evaluated prospectively and consecutively, between June 2016 and December 2017, who were not suitable for retrograde intrarenal surgery. Demographic data, stone free rates, length of hospitalization, duration of the operation, fluoroscopy time, transfusion rates, requirement of double J (D-J) catheter implantation, and complications were examined.

Results: Seventeen patients with complete data in each group were evaluated within the scope of the study. The mean age was 40.76 ± 14.96 (18-67) years in adults and 5.38 ± 3.84 (10 months to 14 years) years in children. There were no differences found between two groups for the mean operation time, fluoroscopy time, and the length of hospitalization. The total success rate was noted as 94.11% in each group ($P = 1$). Whereas no complications were seen in adults, three complications were developed in the pediatric group ($P = .07$). One patient in children group had steinstrasse. In addition, intraperitoneal fluid extravasation occurred in one pediatric patient during the operation. After paracentesis, post-operative period was observed uneventfully. Also, one pediatric patient had high fever due to the urinary tract infection. Whereas there was no need for perioperative D-J catheter implantation in adults, it was implanted in six (35.29%) pediatric patients, due to the fragmented stone burden ($P = .007$).

Conclusion: According to our results, MicroPNL is a safe and effective treatment option for symptomatic renal stones smaller than 2 cm, especially in adults. However, it needs more attention due to the risk of complications in pediatric population.

Keywords: Complication; micropercutaneous nephrolithotomy; pediatric; renal stone.

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Introduction

Stone disease has kept its clinical significance throughout the history because it is prevalent and significantly affect the quality of life. Prevalence of the urinary system stone disease is reported as 10% during the lifetime.[1] Treatment options are varied in parallel to the technological developments in recent years. In the European Association Urology (EAU) guidelines, the extra corporeal shock wave lithotripsy (ESWL) is considered as the primary treatment modality in the treatment of renal stones lower than 2 cm. However, if the stone fragmentation is not achieved after three sessions of ESWL, endoscopic surgeries such as retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PNL) can be performed.[2,3] With the advances in technology, open surgery requirement is reported as 0.7-4%.[4]

After the widespread use of PNL, alternative minimally invasive techniques have been developed. It has been shown that the degree of dilatation and the size of the instrument are

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proportional to the amount of bleeding.[5] With the creation of smaller tracts, less parenchymal and vascular damage are expected in narrow infundibulums and in calices, which cannot be dilated. Jackman after Helal et al. developed the mini-PNL technique in pediatrics by using smaller devices in order to reduce the complications after the conventional PNL technique.[6,7] In recent years, with the help of developing technology, "micropercutaneous nephrolithotomy (MicroPNL)" has emerged after mini-PNL. The biggest advantage of MicroPNL or the original name "all-seeing needle" method is to create access at one stage without renal dilation or multiple maneuvers. Thus, the operation time is shortened, less radiation exposure is provided, and complications such as bleeding and perforation are prevented during tract dilation.[8,9] Microperc should be preferred primarily in patients who are not appropriate for RIRS; infundibulopelvic angle <45, calyx neck narrower than 5 mm, calyx length longer than 10 mm, and in the cases which retrograde ureteral access cannot be done.[10]

In this study, we aimed to compare the efficacy and safety parameters of MicroPNL, between adults and pediatric patients.

Material and Methods

Patient Selection

After obtaining ethical approval from the University of Gaziantep (protocol number: 02.10.2012/374), 40 patients (20 adults and 20 pediatrics) who underwent MicroPNL were evaluated prospectively and consecutively, between June 2016 and December 2017.

MicroPNL was performed in patients with renal stones smaller than 2 cm (<400 mm^2), and who is resistant to ESWL, who had narrow caliceal neck (<5 mm), anomalous kidney, and who could not operate by retrograde access. We included the unsuccessful patients in the ESWL treatment in this study. Stones were not fragmented in 15 (88.2%) adult patients and 13 (76.4%) pediatric patients. In the remaining patients, stones were fragmented to large as two or three parts. Patients were excluded from the study if they had coagulation disorder, uncontrolled hypertension, and were pregnant, as general exclusion criteria. Patients who had stones larger than 400 mm^2, ureteral obstruction, nonopaque stones, and urinary tract infection were also excluded from the study.

Urine culture was received from all patients before the operation. Antibiotics treatment was started for patients with urinary infections; depending on their culture results, procedures were planned after the sterilization of their urine. Kidney-ureter-bladder (KUB) graphs and noncontrast abdomen computerized tomography (CT) were performed. The height and the width of the stones were multiplied, and the stone size was calculated as mm^2 in the preoperative plain abdominal radiographs of each case. We attempted to determine stone density using highest Hounsfield units (HUs) by greatest transverse diameter of stone on CT scans.

All patients were operated by two surgeons who have similar experience on PNL in adult and pediatric patients

Main Points

- MicroPNL is an effective treatment for kidney stones in adult and pediatric patients. Especially, using small caliber ureter catheter in pediatric patients causes obstruction due to stone dust while lithotripsy. It needs more attention due to risk of complication in children such as urinary tract infections and extravasation.
- To be attend using irrigation fluid in pediatric patients because of extravasation to intraperitoneal area.
- The disadvantage of the system is the closed irrigating system; an increase in intrapelvic pressure (IPP) is observed especially during the intervention for the impacted renal pelvis stone.

Micropercutaneous Nephrolithotomy Technique

Under general anesthesia in lithotomy position, an open-ended ureteral catheter was placed in retrograde fashion (5-7 Fr in adults and 3-5 Fr in children). Then, the patient was put into the prone position. The pelvicalyceal system was monitored under the C-arm fluoroscopy (Philips BV 29) by injecting radiopaque material. By using a 0.9 mm optical fiber fixed to 16-gauge (4.85 FR, all-seeing needle) needle (polydiagnost, Pfaffenhofen, Germany), access was done and stone was focused. Then, by using a three-way connection duct optic system, the laser and irrigation pump connection was made, and the stone fragmentation was performed. A 15 W (Stonelight™ Laser Therapy System, USA) laser device was used with a 230 µm fiber. Device setting was adjusted to 0.8-1.2 J power and 5-8 Hz frequency during lithotripsy. Stone dust was cleared by 0.9% NaCl, which was performed by irrigation pump (endognost IP 200).

The localization of the stone, duration of the operation, fluoroscopy time, length of hospitalization, the amount of irrigation fluid usage, need for perioperative double-J (D-J) catheter implantation, blood transfusion in the perioperative–postoperative period, and complications during the MicroPNL procedure were recorded. Blood transfusion criteria were accepted as follows: hemoglobin <10 g/dL and hemodynamic

instability. Following the procedure, stone-free rates were evaluated with KUB in opaque stones and with USG in nonopaque stones, at post-operative second week. The success of the MicroPNL was defined as the patient being stone free, or the presence of insignificant, nonobstructive, noninfectious, and asymptomatic residual fragments with a size of <4 mm.

Statistical Analysis

Statistical Package for the Social Sciences Windows Version 11.5 (SPSS Inc.; Chicago, IL, USA) was used to compare data. The values were provided as mean ± standard deviation of mean (SD). The Shapiro–Wilk test was used for the normality. The Mann–Whitney U test and Chi-squared test were used to determine the difference within groups as for continuous and categorical variables, respectively. A $P < .05$ value was accepted as significant.

Results

Seventeen patients with complete data in each group were evaluated within the scope of the study. The mean age was 40.76 ± 14.96 (18-67) years in adults and 5.38 ± 3.84 (10 months to 14 years) years in pediatric patients. Demographic data of the pediatric and adult patients were shown in Table 1.

There were no significant differences noted between the two groups for the duration of the operation, fluoroscopy time, irrigation fluid usage, the length of hospitalization, and stone density. In each group, one (5.88%) patient had residual stone, and total success rate was calculated as 94.11%. In adults and children groups, operation times were 60.88 ± 22.09 and 60.29 ± 14.30 minutes ($P = .708$), fluoroscopy times were 77.94 ± 72.9 and 59 ± 40.38 seconds ($P = .209$), and stone density was 915.47 ± 395.01 and 727.41 ± 217.51 ($P = .122$), respectively (Table 2).

Intraoperative and post-operative complications according to the Clavien classification were presented in Table 3. There was no need for perioperative D-J catheter implantation in adult patients; however, it was implanted in six (35.29%) pediatric patients, due to the fragmented stone burden ($P = .007$). Intraperitoneal fluid extravasation (1,000 mL) was observed in one (5.88%) pediatric patient who was 1 year old. Positive end-expiratory pressure and abdominal distention were occurred. The D-J stent was placed perioperatively. Abdominal distention was treated by percutaneous drainage, paracentesis and urine were drained by JJ stent, and no pathology was observed at the post-operative recovery period. In addition, one (5.88%) pediatric patient had high fever due to the urinary tract infection that was occurred in a pediatric patient due to clogged small caliber ureteral catheter at the post-operative period; he was treated with appropriate antibiotics, according to the urine culture. One (5.88%) pediatric patient was operated with rigid ureterorenoscopy (URS) due to steinstrasse; JJ stent was not inserted during MicroPNL, at post-operative first month. No complication was observed in adult group ($P = .07$). In both groups, no bleeding was observed, which required blood transfusion (Table 3).

Table 1. Demographic Data of the Patients

	Adult	Pediatric	*P*
	(n = 17)	(n = 17)	
Age (years) (mean ± SD)	40.76 ± 14.96	5.58 ± 3.84	.001*
Male/female	9/8	6/11	.245
BMI (kg/m^2) (mean ± SD)	28.8 ± 4	21.7 ± 3.85	.001*
Stone burden (mm^2) (mean ± SD)	177.35 ± 84.62	149 ± 50.62	.518
Stone density (HU) (mean ± SD)	915.47 ± 395.01	727.41 ± 217.51	.122
Location of the stone, n (%)			
Renal pelvis	4 (23.5)	8 (47.1)	
Lower calyx	8 (47.1)	1 (5.88)	
Middle calyx	2 (11.76)	3 (17.64)	
Upper calyx	1 (5.88)	2 (11.76)	
Multiple	2 (11.76)	3 (17.64)	

N, number of the patients; BMI, body mass index; HU, Hounsfield units; mm^2, millimetersquare; kg/m^2, kilogram/square meter; SD, standard deviation.

*$P < .05$ value was accepted as significant (Mann–Whitney U test).

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Discussion

Endourological methods such as ESWL, RIRS, MicroPNL, and PNL are the treatment options for renal stones lower than 2 cm. The ESWL is indicated as first-line treatment option in EAU guidelines. Unfortunately, 13.9-53.9% of the patient's need an alternative treatment method due to the insufficiency of ESWL.[2,11]

PNL is a minimally invasive method and has been modified in time. MicroPNL has provided success under direct vision, without the need for dilation. The most important advantages over the standard PNL are reduced bleeding, decreased usage of fluoroscopy, and shortened hospitalization. The disadvantage of the system is closed irrigating system, so the fragmented calculi cannot be cleaned rarely. In addition, stone fragmentation with a laser by focusing directly to the stone, and unaffected from the stone density is the major superiority of the MicroPNL over the ESWL.[8,9,12]

Drainage of fluid from the collector system during MicroPNL is provided by open-ended large ureter catheters (4-7Fr). Due to the 4.85 Fr outer sheath that does not allow the fluid flow, an increase in intrapelvic pressure (IPP) is observed especially during the intervention for the impacted renal pelvis stone, which impairs fluid drainage from the ureteral catheter. Desai et al.[9] reported IPP increase in their first experience with MicroPNL. Increased IPP accelerated the transition of the fluid to the systemic circulation and might cause post-operative fever and sepsis. Tepeler and coworkers[12] evaluated IPP in 20 patients who had kidney stones varied 1-3 cm, and resistant to ESWL. The authors found higher IPP values in the MicroPNL group rather than conventional PNL group. We should be more careful especially in pediatric patients due to IPP increase.

Hatipoğlu et al. reported that their MicroPNL experiences to 140 renal units in 136 patients. Nine patients (6.43%) had residual stones, and D-J catheter implanted in three (2.19%) patients due to the extravasation of irrigation fluid, which

Table 2. Comparison of the Intraoperative and Post-Operative Data

	Adult (n = 17)	Pediatric (n = 17)	*P*
Duration of the operation (minute) (mean ± SD)	60.88 ± 22.09	60.29 ± 14.30	.708
Fluoroscopy time (second) (mean ± SD)	77.94 ± 72.9	59 ± 40.38	.290
Irrigation fluid usage (mL) (mean ± SD)	702.94 ± 470.86	567.65 ± 259.77	.610
Perioperative D-J catheter implantation, n (%)	0	6 (35.29)	.007*
Length of hospitalization (hour) (mean ± SD)	31.64 ± 11.9	41.64 ± 21.48	.170
Stone free rate, n (%)	16 (94.11)	16 (94.11)	1
Complications, n (%)	0	3 (17.65)	.07*

n, number of the patients; mL, milliliter; double-J, D-J.

*P< .05 value was accepted as significant (Mann–Whitney U test and Chi-squared test).

Table 3. Comparing Complications Pediatric Group Versus Adult Group, According to Clavien Classification

		Adult (n, %)	Pediatric (n, %)	*P*
Grade 1	Fever requiring antipyretics	–	1 (5.88)	.07
Grade 2	Blood transfusion	–	–	
Grade 3	Double-J catheter placement	–	6 (35.29)	
		–		
	Percutaneous drainage and paracentesis		1 (5.88)	
		–		
	Performed rigid ureterorenoscopy due to steinstrasse		1 (5.88)	
Grade 4		–	–	
Grade 5		–	–	

Table 4: Published Studies About MicroPNL Complications in Pediatric Patients[15–17]

	Dağgülli et al.	Silay et al.	Dede et al.	Current study
Number of the patients (n)	40	19	24	17
Stone size	16.5 (10-36) mm	14.8 ± 6.8 mm	13.5 ± 3.84 mm	149 ± 50.62 mm^2
JJ catheter placement, n (%)	11 (27.5)	4 (21.05)	4 (16.66)	6 (35.29)
Post-operative fever, n (%)	1 (2.5)	–	2 (8.33)	1 (5.88)
Irrigant fluid extravasation, n (%)	1 (2.5)	1 (5.26)	1 (4.16)	1 (5.88)

caused abdominal distension. Successful rate was noted as 82.14%.[13] In the similar studies, MicroPNL's success rate varies between 85 and 93%.[12,14] Our present study supported the literature, and the success rate in both groups was 94.11%. However, D-J catheter implanted in only six (35.29%) patients who had more fragmented stone burden, in pediatric group. In addition, one (5.88%) pediatric patient was operated with rigid URS due to steinstrasse, at post-operative first month. Also, intraperitoneal liquid extravasation (1,000 mL) was observed in one (5.88%) pediatric patient during the operation. In the current study, we fragmented stones by Holmium laser in dusting mode and then changed the mode for small part of stones and fragmented by popcorn effect in all patients. The disadvantage of the MicroPNL is closed irrigating system, so the fragmented calculi could not be cleaned completely. Using small caliber ureteral catheter (3Fr-4Fr) in pediatric patients was another disadvantage of this method. Small stone fragment clogged ureteral catheter while lithotripsy, and it caused worse visibility. If it continues to pumped irrigation fluid with clogged ureteral catheter, it might result to intraperitoneal extravasation. For these safety reasons, we placed a DJ stent to small-aged patients who had big size stone.

In studies that analyzed complications of MicroPNL in children, Dağgülli et al. reported the largest population (n = 40 patients) with a mean stone size of 16.5 mm (range 10-36). D-J stent was placed in 11 patients, and post-operative fever and extravasation of irrigation fluid were observed in each one patient.[15] In a similar study, Silay et al. examined 19 patients with a mean stone size of 14.8 ± 6.8 mm. JJ stent implantation was required in four patients, and post-operative fever and extravasation of the irrigation fluid were occurred in each one patient.[16] In Dede et al.'s study, 24 patients with a mean of 13.5 ± 3.84 mm were investigated.[17] Researchers implanted JJ stent into four patients perioperatively. One patient had post-operative fever treated with appropriate antibiotic. In one patient, extravasation of the irrigation fluid caused abdominal distension[17] and was managed with percutaneous drainage intraoperatively.[12,15–17] Authors emphasized that the fragmentation of large renal stones without extraction or aspiration might lead to difficulty during the passage of the fragments, so it needed to D-J stent insertion perioperatively[15–17] (Table 4).

Our findings supported the literature, and it was found that MicroPNL was a safe and effective alternative method to RIRS, in both adult and children. However, complication rates were found higher in pediatric patients ($P = .07$). The use of low-caliber ureter catheters and due to the increase in IPP, as well as the fluid extravasation risk constituted the main disadvantages in pediatric patients.

In conclusion, according to our results, MicroPNL is an effective treatment option in symptomatic renal stones smaller than 2 cm. Although RIRS is considered as an initial surgical method, access difficulties may arise the MicroPNL preference. Main advantages of the MicroPNL are shorter operation time, fluoroscopy usage, and the length of hospitalization, with a high success rate as 94.11%. However, it needs more attention due to the risk of complications in children.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of University of Gaziantep (protocol number: 02.10.2012/374).

Informed Consent: Written informed consent was obtained from patient who participated in this study.

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References

1. Wein AJ, Kavoussi LR, Partin AW, et al. Urolithiasis, epidemiology and pathogenesis. In *Campbell-Walsh Urology*. 10th ed. Philadelphia: Elsevier; 2012:1257-1287.
2. Türk CC, Neisius A, Petrik A, et al. EAU guidelines: Urolithiasis | uroweb. 2018. Available at https://uroweb.org/guideline/urolithiasis/#3. Accessed June 15, 2020.
3. Massoud AM, Abdelbary AM, Al-Dessoukey AA, Moussa AS, Zayed AS, Mahmmoud O. The success of extracorporeal shockwave lithotripsy based on the stone-attenuation value from non-contrast computed tomography. *Arab J Urol*. 2014;12(2):155-161. [CrossRef]
4. Matlaga BR, Assimos DG. Changing indications of open stone surgery. *Urology*. 2002;59(4):490-493. [CrossRef]
5. de la Rosette J, Zuazu JR, Tsakiris P, et al. Prognostic factors and percutaneous nephrolithotomy morbidity: A multivariate analysis of a contemporary series using the Clavien classification. *J Urol*. 2008;180(6):2489-2493. [CrossRef]
6. Helal M, Black T, Lockhart J, Figueroa TE. The Hickman peel-away sheath: Alternative for pediatric percutaneous nephrolithotomy. *J Endourol*. 1997;11(3):171-172. [CrossRef]
7. Jackman SV, Docimo SG, Cadeddu JA, Bishoff JT, Kavoussi LR, Jarrett TW. The "mini-perc" technique: A less invasive alternative to percutaneous nephrolithotomy. *World J Urol*. 1998;16(6):371-374. [CrossRef]
8. Li JY, Cui Z, Gao XF, et al The "all-seeing needle": Initial results of an optical puncture system confirming access in percutaneous nephrolithotomy. Eur Urol. 2011;59(5):1054-9. *Eur Urol*. 2011;60(5). [CrossRef]
9. Desai MR, Sharma R, Mishra S, et al. Single-step percutaneous nephrolithotomy (microperc): The initial clinical report. *J Urol*. 2011;186(1):140-145. [CrossRef]
10. Grasso M, Ficazzola M. Retrograde ureteropyeloscopy for lower pole caliceal calculi. *J Urol*. 1999;162(6):1904-1908. [CrossRef]
11. Srisubat A, Potisat S, Lojanapiwat B, Setthawong V, Laopaiboon M. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. *Cochrane Database Syst Rev*. 2014;11:2014. [CrossRef]
12. Armagan A, Tepeler A, Silay MS, et al. Micropercutaneous nephrolithotomy in the treatment of moderate-size renal calculi. *J Endourol*. 2013;27(2):177-181. [CrossRef]
13. Hatipoglu NK, Tepeler A, Buldu I, et al. Initial experience of micro-percutaneous nephrolithotomy in the treatment of renal calculi in 140 renal units. *Urolithiasis*. 2014;42(2):159-164. [CrossRef]
14. Piskin MM, Guven S, Kilinc M, Arslan M, Goger E, Ozturk A. Preliminary, favorable experience with microperc in kidney and bladder stones. *J Endourol*. 2012;26(11):1443-1447. [CrossRef]
15. Dağgülli M, Utanğaç MM, Dede O, et al. Micro-percutaneous nephrolithotomy in the treatment of pediatric nephrolithiasis: A single-center experience. *J Pediatr Surg*. 2016;51(4):626-629. [CrossRef]
16. Silay MS, Tepeler A, Atis G, et al. Initial report of microperc in the treatment of pediatric nephrolithiasis. *J Pediatr Surg*. 2013;48(7):1578-1583. [CrossRef]
17. Dede O, Sancaktutar AA, Baş O, et al. Micro-percutaneous nephrolithotomy in infants: A single-center experience. *Urolithiasis*. 2016;44(2):173-177. [CrossRef]