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ORIGINAL PAPER

Comparison of microperc and mini-percutaneous nephrolithotomy for medium-sized lower calyx stones

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Abstract The objective of this study was to present the outcomes of comparative clinical study of microperc versus mini-percutaneous nephrolithotomy (mini-PNL) in the treatment of lower calyx stones of 10–20 mm. Patients with lower calyx stones treated with microperc (Group-1) or mini-PNL (Group-2) between 2011 and 2014 were retrospectively analyzed. Demographics of the patients were compared, including age, gender, BMI, stone size, laterality and procedural parameters (operation and fluoroscopy time), and outcomes (success and complication rates). A total of 98 patients were evaluated, assigned to Group-1 ($n = 58$) and to Group-2 ($n = 40$). Groups were statistically similar in terms of age, stone size, and BMI ($p = 0.3$, 0.07, 0.6, respectively). The mean procedure and fluoroscopy duration for Group-1 were 43.02 ± 27.98 min and 112.05 ± 72.5 s, and 52.25 ± 23.09 min and 138.53 ± 56.39 s in Group-2 ($p = 0.006$ and 0.006). The mean hematocrit drop was significantly higher in Group-2 compared to Group-1 (3.98 vs. 1.96 %; $p < 0.001$); however, none of the cases required blood transfusion. Overall complication rates exhibited no statistically significant difference ($p = 0.57$). Stone-free status was similar (86.2 vs. 82.5 %, $p = 0.66$). The tubeless procedure rate was significantly higher in Group-1 ($p < 0.001$). In Group-2, duration of hospitalization was significantly longer than in Group-1 (2.63 vs. 1.55 days; $p < 0.01$). Outcomes of the present retrospective study show that microperc is a treatment option for medium-sized lower calyx stone, being associated with lower blood loss, procedure, reduced fluoroscopy and hospitalization time, and a higher tubeless rate.

Keywords Medium-size lower pole kidney stone · Micro-percutaneous nephrolithotomy · Mini-percutaneous nephrolithotomy · Efficacy · Safety

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Introduction

The main stone-related parameters affecting the selection of the modality for the treatment of nephrolithiasis include stone size and location. The treatment of lower pole stones with the size of 1–2 cm is still a controversial topic [1]. Although shockwave lithotripsy (SWL) is the recommended modality for kidney stones smaller than 2 cm, its stone clearance rate is lower than that of other modalities, especially for lower calyx stones [2–4]. Technological advancements and the increased experience of endourologists using flexible ureterorenoscopy (f-URS) have resulted in the increase of successfully performed surgeries, especially for small- and medium-sized renal calculi. Success rate is decreased, however, in cases of anatomical factors of the lower calyx [5].

Because of its higher success rate, PNL is the recommended treatment modality for large renal calculi. Recently, with the decrease in the size of the optics and working elements used during procedure, PNL technique has been applied through smaller renal tract sizes and has led to decreased morbidity and comparable outcomes.

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Modified PNL techniques used for stone treatment are mini-percutaneous nephrolithotomy and, with the smallest tract sizes, microperc. The studies presented in the literature show that both the techniques are efficient and feasible alternative methods to PNL and both have similar outcomes and decreased morbidity [6–8].

We report herein our comparative clinical study of microperc versus mini-PNL in the treatment of lower pole stones of 10–20 mm. To the best of our knowledge, this is the first report to compare these two modalities.

Patients and methods

Patients with lower calyx stones treated with microperc or mini-PNL between 2011 and 2014 in three referral centers were retrospectively analyzed. Microperc and mini-PNL were primarily performed for lower pole stones of 10–20 mm in the case of SWL resistance or failure of f-URS. Selection of the treatment modality was based on patient preference and availability of the appropriate instruments or equipment. Excluded were patients with urinary tract infections, bleeding diathesis, and those under the age of 18. Demographics of the patients were compared, including age, gender, BMI, stone size, laterality and procedural parameters (operation and fluoroscopy time), and outcomes (success and complication rates).

All patients were primarily assessed by laboratory tests and radiological methods. Patients with urinary tract infections were treated according to the urine culture test. Plain radiography of kidneys, ureters and bladder (KUB), and non-contrast abdominal computed tomography (CT) were done preoperatively to determine stone size and location. Stone burden was determined by the longest stone or, in the case of multiple lower calyx stones, by the sum of the sizes.

Microperc technique

After placement of a 6-Fr open-ended ureteral catheter over the guide-wire to the collecting system, the patient was turned to the prone position. The collecting system was opacified with contrast medium, and access to the desired calyx was reached using a 4.8 Fr all-seeing needle under fluoroscopy guidance. A three-way connector was attached to the proximal tip of the needle after proper access was obtained. A laser fiber and optic was inserted into the micro-shaft through this adaptor. Stone fragmentation was accomplished using the 200 μ Ho:YAG laser with the settings of 0.5–0.8 J at 10–20 Hz. After assessment of stone-free status, the procedure was terminated in the tubeless fashion. At the completion of the surgery, a ureteral double-J stent was inserted in most of the cases in order to prevent postoperative renal colic.

Mini-PNL technique

Percutaneous renal access was achieved using an 18G access needle. The tract was dilated over the guide using Amplatz dilators under fluoroscopy. Nephroscopy was done using 12–17 Fr nephroscopes through 15–20 Fr Amplatz sheaths. After the stone disintegration with lithotripters, fragments were retrieved with graspers. Placement of the nephrostomy tube was based on surgeon preference but was not inserted in cases of lack of significant bleeding, rest calculi, or collecting system perforation.

After evaluation of patients with KUB, ureteral and Foley catheters were removed on postoperative day 1. Patients with no complications in the follow-up were discharged on postoperative days 1–3 depending on the presence of the nephrostomy tube. At the 1-month follow-up appointment, all patients underwent a radiological assessment with KUB or US or both. The procedure was considered successful in cases where no residual fragments appeared on KUB and/or ultrasonography images. CT was used in cases with radiolucent stones or suspected residual fragments on KUB. Postoperative complications were classified using the Clavien grading system [9].

Data collections were performed using the SPSS statistical package (ver 18.0 J; SPSS, Inc., Chicago, IL). Patient- and operative-related parameters were compared between the groups using the Mann–Whitney U test for numerical variables and χ^2 test for categorical variables. p values of less than 0.05 for the Mann–Whitney U test were considered statistically significant.

Results

A total of 98 patients were evaluated and assigned either to Group-1 ($n = 58$) for microperc or to Group-2 ($n = 40$) for mini-PNL. Their mean ages were 45.9 ± 14.4 and 43.1 ± 12.3 years, respectively ($p = 0.339$). Mean stone size was comparable in both the groups (13.9 ± 3.6 vs. 16.1 ± 6.9 mm; $p = 0.078$). The groups were statistically similar in terms of BMI and stone laterality ($p = 0.64$, 0.44). The summary of the patient demographics and stone characteristics are listed in Table 1.

The mean procedure and fluoroscopy durations for microperc were, respectively, 43.02 ± 27.98 min and 112.05 ± 72.5 s, and 52.25 ± 23.09 min and 138.53 ± 56.39 s in the mini-PNL group ($p = 0.006$ and 0.006). The mean hematocrit drop was significantly higher in the mini-PNL compared to the microperc group (3.98 ± 2.44 vs. 1.96 ± 1.73 %; $p < 0.001$); however, none of the cases required blood transfusion. Overall complication rates exhibited no statistically significant difference ($p = 0.57$). A total of 3 complications (5.1 %) were

Table 1 Demographic values of the patients

	Micro-PNL (Group-1)	Mini-PNL (Group-2)	*p*
N	58	40	
Male/female	34/24	24/16	0.78
Age (years)[a]	45.90 ± 14.44	43.08 ± 12.31	0.33
BMI (kg/m^2)	27.8 ± 4.0	27.5 ± 4.4	0.64
Stone site (right/left)	24/34	18/22	0.44
Stone size (mm)[a]	13.97 ± 3.62	16.13 ± 6.97	0.07

BMI body mass index

[a] Mean ± SD

observed in the microperc group. Two patients with urinary tract infection were appropriately treated with antibiotics (Clavien II). In addition, persistent renal colic ($n = 1$) requiring stent insertion (Clavien IIIb) was observed in the microperc group. In the mini-PNL group, 3 cases of urinary tract infection were medically treated (Clavien II).

At the first-month follow-up, stone-free status was achieved in 86.2 % of the cases in the microperc group and in 82.5 % of the cases in the mini-PNL group ($p = 0.66$). The tubeless procedure rate was significantly higher in the microperc group ($p < 0.001$). A total of 4 patients (2 from each group) required conversion to mini-PNL or standard PNL because of technical problems such as impaired visualization or inability to reach the stone due to short optic size. In Group-2, duration of hospitalization was significantly longer than in Group-1 (2.63 vs. 1.55 days; $p < 0.01$). The clinical and operative outcomes are summarized in Table 2.

Discussion

Although PNL is the recommended standard treatment option for large renal calculi, the treatment of medium-size stones is regarded as a topic of debate because of the variety of treatment options. In the last three decades, SWL has been applied for renal calculi with acceptable success rates. However, since unfavorable anatomical factors such as infundibulo-pelvic angle, length of infundibulum, and spatial arrangements of the lower pole calices may affect the stone clearance following SWL [10, 11], EAU guidelines recommend SWL as the primary treatment modality for stones 10–20 mm in size. In cases with challenging anatomical factors, endourological methods (f-URS and PNL) are treatment alternatives [1].

PNL is considered a more efficient treatment modality than SWL and is not affected by anatomical factors. In the study comparing outcomes of PNL and SWL in lower calyx stones, stone-free rates were reported to be 90 and 59 %, respectively [3]. In a randomized, prospective study comparing SWL and PNL for renal calculi ≤3 cm, success rates of PNL for lower calyx stones were significantly higher than with SWL [12]. According to the findings of that study, success of SWL was clearly affected by stone size. The complication rate was higher in the PNL group, but the difference was not statistically significant ($p = 0.087$).

With the introduction of new generation of flexible ureterorenoscopes and the Holmium YAG laser, f-URS has gained wide acceptance in the treatment of kidney stones; however, like SWL, the success of f-URS significantly decreases in cases of unfavorable anatomical factors such as a long, lower calyx infundibulum and acute infundibulo-pelvic angle (<30°) [11]. In the studies comparing treatment options for lower calyx stones, the success of f-URS is reported to be higher than for SWL but lower than for PNL [4, 13]. Despite the high stone-free rate, PNL has a statistically higher complication rate than f-URS and SWL for 1–2 cm kidney stones (13.19, 5.26, and 3.16 %, respectively; $p < 0.05$) [13]. Although studies comparing different treatment options have been published, this is the first to compare the mini-PNL and microperc techniques for dealing with lower calyx stones.

Table 2 Comparison of postoperative outcomes

	Micro-PNL	Mini-PNL	*p*
Operative time (min)[a]	43.02 ± 27.98	52.25 ± 23.09	0.006
Fluoroscopy time (s)[a]	112.05 ± 72.5	138.53 ± 56.39	0.006
Hospitalization (days)[a]	1.55 ± 0.95	2.63 ± 1.31	<0.001
Hematocrit drop (%)[a]	1.96 ± 1.73	3.98 ± 2.44	<0.001
Stone-free rate (*n*, %)[b]	50/58 (86.2)	33/40 (82.5)	0.669
Tubeless rate (*n*, %)	54/58 (93.2)	32/40 (80)	<0.001
Complications (*n*, %)	3 (5.1)	3 (7.5)	0.57
Urinary tract infection (Clavien II)	2	3	
Renal colic requiring D-J stent insertion (Clavien IIIa)	1	0	

[a] Mean ± SD

[b] Stone-free rate at first month

In order to achieve a greater success rate and reduce complication rates, the PNL procedure has been applied to smaller sized tracts. Mini-PNL was initially introduced as a modified PNL technique performed through smaller tract sizes (<20 Fr), especially for pediatric cases [14, 15]. Today mini-PNL is the recommended treatment alternative because of its acceptable success rate and lower complication rate for medium-size renal calculi. With the recent advances in optic technology, the microperc system has been developed, allowing safe access with an all-seeing needle and stone fragmentation with a laser fiber [16, 17]. Owing to its ability to deal with the smallest tract size (4.8 Fr), this technique has the advantage of needing no tract dilation.

Tepeler et al. presented the outcomes of microperc for symptomatic lower calyx stones with a mean size of 17.8 mm. In their retrospective study, the authors achieved stone-free status in 18 cases (85.7 %) [8]. Complications (urinary tract infection and renal colic requiring DJ stent insertion) were observed in 2 patients (9.5 %). The mean hemoglobin drop was reported to be 0.8 g/dl and blood transfusion was not needed in any of the cases. On the other hand, microperc limitations are inability to remove fragments, risk of increased intrarenal pressure, low optic resolution, and a fine needle shaft that hinders excessive torque. Compared to microperc, mini-PNL allows better visualization and fragment removal through a tract enlarged by multiple steps of tract dilation. Nagele et al. used mini-PNL to treat 29 patients with lower pole stones of 8–15 mm [6]. In their study, they reported a mean hemoglobin drop of 1.2 g/dl and duration of hospitalization to be 3.2 days. Stone-free status was achieved in 28 cases (96.5 %). In the present study, the stone-free rate was comparable in both the groups (86.2 vs. 82.5 %; $p = 0.66$).

A recently published study comparing SWL, f-URS, microperc, and mini-PNL for medium-sized (10–20 mm) renal calculi reported stone-free rates of 77.2, 86.1, 88.8, and 83.6 %, respectively ($p = 0.006$) [18]. Stone location significantly affected the success of SWL, but not of the f-URS or PNL techniques. Microperc had a significantly lower complication rate compared to mini-PNL (6.7 vs. 21.8 %). Blood transfusion rate was statistically higher in the mini-PNL group compared to the other groups ($p = 0.001$). No statistically significant difference was reported in terms of hospitalization time between the groups. Besides the findings of this study that examined stones in different locations in the kidneys, to the best of our knowledge, the present study is the first to compare the success rates of mini-PNL and microperc for medium-sized lower calyx stones. Specifically, in the microperc group, fluoroscopy and hospitalization times were significantly shorter than their mean values in the mini-PNL group ($p = 0.006$, 0.006, respectively; $p < 0.001$). These differences may be related to the microperc group's lack of need for tract dilation as well as its high tubeless procedure rate. Similar to the findings of a previously mentioned article, in the present study the microperc procedure was found to be associated with decreased blood loss ($p < 0.001$).

Some limitations of this study should be highlighted, particularly the retrospective design and relatively small sample size. The other limitation is that the data were obtained from three referral centers. Due to concerns of radiation exposure, CT with the highest specificity in detecting small residual fragments was not used in all cases for the assessment of stone-free status. Despite the limitations, we trust that this study contributes to the literature regarding the treatment of medium-sized lower calyx calculi.

Conclusion

Treatment alternatives for medium-sized lower calyx stones include microperc and mini-PNL. These share similar success and complication rates; however, outcomes of the present retrospective study show that microperc is preferable, being associated with lower blood loss, reduced fluoroscopy, and hospitalization time, and a higher tubeless rate.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Türk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub A, Seitz C (2013) Guidelines on urolithiasis. European Urology Association, Arnhem, pp 1–104
2. Donaldson JF, Lardas M, Scrimgeour D, Stewart F, MacLennan S, Lam TB, McClinton S (2014) Systematic review and meta-analysis of the clinical effectiveness of shock wave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy for lower-pole renal stones. Eur Urol 67:612–616
3. Albala DM, Assimos DG, Clayman RV, Denstedt JD, Grasso M, Gutierrez-Aceves J et al (2001) Lower pole I: a prospective randomized trial of extracorporeal shock wave lithotripsy and percutaneous nephrostolithotomy for lower-pole nephrolithiasis—initial results. J Urol 166:2072–2080
4. Pearle MS, Lingeman JE, Leveillee R et al (2005) Prospective, randomized trial comparing shock wave lithotripsy and ureteroscopy for lower pole caliceal calculi 1 cm or less. J Urol 173:2005–2009

5. Resorlu B, Oguz U, Resorlu EB, Oztuna D, Unsal A (2012) The impact of pelvicaliceal anatomy on the success of retrograde intrarenal surgery in patients with lower pole renal Stones. Urology 79:61–66
6. Nagele U, Schilling D, Sievert KD, Stenzl A, Kuczyk M (2008) Management of lower-pole stones of 0.8–1.5 cm maximal diameter by the minimally invasive percutaneous approach. J Endourol 22:1851–1853
7. Kirac M, Bozkurt ÖF, Tunc L, Guneri C, Unsal A, Biri H (2013) Comparison of retrograde intrarenal surgery and mini-percutaneous nephrolithotomy in management of lower-pole renal stones with a diameter of smaller than 15 mm. Urolithiasis 41:241–246
8. Tepeler A, Armagan A, Sancaktutar AA et al (2013) The role of microperc in the treatment of symptomatic lower pole renal calculi. J Endourol 27:13–18
9. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240:205–213
10. Sampaio FJ, Aragao AH (1994) Limitations of extracorporeal shockwave lithotripsy for lower caliceal stones: anatomic insight. J Endourol 8:241–247
11. Elbahnasy AM, Shalhav AL, Hoenig DM, Elashry OM, Smith DS, McDougall EM, Clayman RV (1998) Lower caliceal stone clearance after shock wave lithotripsy or ureteroscopy: the impact of lower pole radiographic anatomy. J Urol 159:676–682
12. Lingeman JE, Siegel YI, Steele B, Nyhuis AW, Woods JR (1994) Management of lower pole nephrolithiasis: a critical analysis. J Urol 151:663–667
13. Ozturk U, Sener NC, Goktug HN, Nalbant I, Gucuk A, Imamoglu MA (2013) Comparison of percutaneous nephrolithotomy, shock wave lithotripsy, and retrograde intrarenal surgery for lower pole renal calculi 10–20 mm. Urol Int 91:345–349
14. Jackman SV, Hedican S, Peters CA, Docimo SG (1998) Percutaneous nephrolithotomy in infants and preschool age children: experience with a new technique. Urology 52:697–701
15. Helal M, Black T, Lockhart J, Figueroa TE (1997) The Hickman peel-away sheath: alternative for pediatric percutaneous nephrolithotomy. J Endourol 11:171–172
16. Bader MJ, Gratzke C, Seitz M, Sharma R, Stief CG, Desai M (2011) The “all-seeing needle”: initial results of an optical puncture system confirming access in percutaneous nephrolithotomy. Eur Urol 59:1054–1059
17. Desai MR, Sharma R, Mishra S, Sabnis RB, Stief C, Bader M (2011) Single-step percutaneous nephrolithotomy (microperc): the initial clinical report. J Urol 186:140–145
18. Kiremit MC, Guven S, Sarica K, Ozturk A, Buldu İ, Kafkasli A (2015) Contemporary management of medium-sized (10–20 mm) renal stones: a retrospective multicenter observational study. J Endourol 29(7):838–843