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ORIGINAL ARTICLE

Comparison of miniaturized percutaneous nephrolithotomy and flexible ureterorenoscopy for the management of 10–20 mm renal stones in obese patients

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Abstract

Purpose To evaluate and compare effectivity and safety of flexible ureteroscopy (F-URS) and mini-percutaneous nephrolithotomy (mPNL) for 10–20 mm renal stones in obese patients.

Methods Between 2012 and 2015, charts of patients who were treated with F-URS or mPNL for 10–20 mm kidney stone(s) were analyzed. Patients with BMI > 30 kg/m^2 were enrolled into the study. Total of 315 patients were treated with mPNL, and 56 patients were matched our inclusion criteria. In the same period, F-URS was performed in 669 patients, and 157 of them had 10–20 mm kidney stones, and their BMI values were >30 kg/m^2. The patients were retrospectively matched at a 1:1 ratio to index F-URS–mPNL cases with respect to the patient age, gender, ASA score, BMI and size, number, and location of stone.

Results Gender, age, BMI, stone size, stone number, location of stone(s), and ASA scores were similar between groups. The mean operation time was significantly longer in mPNL group (p: 0.021). However, the mean fluoroscopy time was similar (p: 0.270). Hemoglobin drop requiring blood transfusion and angioembolization was performed in two and one patients after mPNL, respectively. Overall complication rate was significantly higher in mPNL group than F-URS group (30.3 vs. 5.3 %, p: 0.001).

Conclusion Our results demonstrated that both F-URS and mPNL achieve acceptable stone-free rates in obese patients with 10–20 mm renal stones. However, complication rates were significantly lower in F-URS group.

Keywords f-URS · MiniPNL · Obesity · Percutaneous nephrolithotomy

Introduction

Obesity is defined as a body mass index (BMI) greater than or equal to 30 kg/m^2 according to World Health Organization (WHO) [1]. In last decades, as a result of sedentary lifestyle, decreased physical activity, and high-fat diet, prevalence of obesity has increased all around world [2]. It is well known that obesity is associated with higher incidence of diabetes mellitus, hypertension, and nephrolithiasis [3]. Metabolic disorders in obese patients such as hypercalciuria, hyperoxaluria, hyperinsulinemia, and low urine volume are strong predisposing factors for stone formation. Additionally, increased BMI is regarded as a risk factor for surgical complications including atelectasis, venous thromboembolism, and longer recovery period [4].

Flexible ureterorenoscopy (f-URS) and miniaturized percutaneous nephrolithotomy (mPNL) are minimally invasive treatment modalities for renal stones with acceptable stone-free and complication rates [5, 6]. Some authors reported that obesity did not affect f-URS outcomes, but on the other hand, success rates of f-URS were decreased, and requirement of additional interventions was increased with the increase in stone size [7, 8]. Multiple interventions may be associated with higher anesthetic and surgical complications in obese patients. Otherwise, mPNL provides less blood loss and less postoperative morbidity but has longer operation time when compared with conventional PNL [9].

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Although, there are many studies showing the effectiveness of f-URS and mPNL on kidney stones in the literature, there is no study comparing f-URS and mPNL in patients with BMI > 30 kg/m^2. In this study, we aimed to evaluate and compare the efficacy and safety of f-URS and mPNL for 10–20 mm renal stones in obese patients.

Materials and methods

In two tertiary centers, charts of patients treated with f-URS or mPNL for kidney stone between January 2012 and June 2015 were analyzed, retrospectively. Patients who had 10–20 mm kidney stone and BMI > 30 kg/m^2 were enrolled into the study. Total of 315 patients were treated with mPNL, and 56 patients were matched our inclusion criteria. In the same period, f-URS was performed in 669 patients, and 157 of them had 10–20 mm kidney stones, and their BMI values were above 30 kg/m^2. We selected 56 patients to serve as the control group from this cohort. The patients were retrospectively matched at a 1:1 ratio to index f-URS–mPNL cases with respect to the patient's age, gender, ASA score, BMI and size, number, and location of stone to avoid bias between groups. Exclusion criteria were patients under 18 of age and patients with renal abnormalities. The selection of procedural technique was primarily based on the patients' choice.

Detailed medical history was obtained, and physical examination was performed for all patients. Renal stone and kidney characteristics were assessed by IVP and/or non-contrast abdomino-pelvic CT preoperatively. Patients' demographic parameters including sex, age, ASA score, BMI, stone size, stone number, and location were recorded. Preoperative laboratory tests were hemoglobin measurements, serum creatinine level, platelet counts, and coagulation screening tests. All patients had sterile urine culture prior to surgery. Lastly, all patients signed an informed consent form before surgery.

F-URS technique

A standardized f-URS procedure was performed in all cases. After induction of general anesthesia, safety guide wire was placed into the renal pelvis, and semirigid ureteroscopy was performed for visual assessment of ureter and to facilitate placing ureteral access sheath (9.5/11.5Fr). A 7.5-F fiber optic flexible ureterorenoscope (Storz FLEX-X2, Tuttlingen, Germany) with a 200- or 273-μm laser fiber were used for treatment. Stone fragmentation was performed with holmium laser with an energy of 0.8–1.5 J and a rate of 5–10 Hz. Stone fragments <2 mm were left for spontaneous passage, and basket retrieval was performed for >2 mm stone fragments. A 4.8-F JJ stent was routinely placed in each patient at the end of procedures. Operation time was calculated as the time passed from insertion of the cystoscope to the completion of JJ stent placement. In the second week of operation, JJ catheter was removed by using a cystoscope.

mPNL technique

In the lithotomy position, a 5-Fr ureteral catheter was inserted up to the kidney under general anesthesia. In the prone position, the calyceal system configuration was demonstrated using contrast media and access was performed to proper calyx, using an 18-G needle under the C-armed scopy unit. After a 0.035-inch hydrophilic guide wire was placed into pelvicaliceal system, dilatation was performed using Amplatz dilatators, and an 18- or 20-Fr Amplatz sheath was inserted. With using 17-F rigid nephroscope, stone fragmentation was performed using laser or ultrasonic lithotripter, and stone removal was performed using a stone extraction forceps. At the end of the procedure, nephrostomy tube was placed under fluoroscopy in case of a pelvicaliceal perforation, presence of residual fragments, or according to the surgeon's choice. The operation time was defined as the period starting from the insertion of the cystoscope for ureteral catheterization to the placement of the nephrostomy tube.

Operation success was evaluated with a kidney–ureter–bladder radiogram at hospital discharge. Afterward, follow-up stone-free rates were re-assessed in an outpatient setting between 1 and 3 months postoperatively with non-contrast CT. The procedure was regarded as successful if the patient was stone free and patients' residual fragments were under 2 mm. Complications were classified according to the Clavien classification system [10].

Statistical analysis

During statistical analyses, values were evaluated as numbers, means, percentages, and intervals. Numbers and percentages were compared using Chi-square test. Before the comparison of means of values, the values were evaluated for homogeneity. Homogenously distributed values were compared using Student *t* test and heterogeneously distributed values (operation time, fluoroscopy time, hospitalization time, hemoglobin drop) were compared using Mann–Whitney *U* test.

Results

According to the study design, kidney stone characteristics were similar between the two groups in terms of stone size and location of stone(s) (p: 0.069 and p: 0.511).

Also gender, age, BMI and stone opacity were comparable between groups (*p*: 0.566, *p*: 0.248, *p*: 0.591, *p*: 0.067, respectively). Preoperative parameters were summarized in Table 1.

The mean operation time for the mPNL and f-URS groups were 80.9 ± 35.2 (range 28–164 min) and 67.8 ± 22.1 (range 30–135 min) min, respectively (*p*: 0.021). Although, the mean fluoroscopy screening time was longer in the mPNL group, there was no statistically significant difference between groups (*p*: 0.270). Additionally, the mean hospitalization time was significantly longer in mPNL group ($p < 0.001$). The mean postoperative hemoglobin drop in mPNL group was calculated as 1.17 ± 1.26. On the other hand, hemoglobin value was not routinely assessed postoperatively in the f-URS group unless any uneventful complication was occurred. The tubeless mPNL was performed in 23 cases (41.1 %).

Postoperative complications, according to Clavien classification system, were significantly common in mPNL group (*p*: 0.001). Postoperative fever requiring antibiotic therapy was seen in one and two patients in f-URS and mPNL group, respectively. Hemoglobin drop requiring blood transfusion in two patients was another Clavien class 2 complications in mPNL group. The angioembolization was performed in one patient after mPNL. A JJ stent was inserted under general anesthesia in four patients in mPNL group because of persistent leakage of urine after the removal of the nephrostomy tube.

Table 1 Comparison of preoperative demographics of patients

	Groups		*p*
	F-URS	mPNL	
Number	56	56	
Gender (male/female)	22/34	25/31	0.566
Age[a] (years)	54.2 ± 10.6	51.4 ± 14.3	0.248
BMI[a] (kg/m^2)	34.4 ± 5.0	34.0 ± 3.3	0.591
ASA Score	1.94 ± 1.55	1.88 ± 1.62	0.884
Stone size[a] (mm)	18.3 ± 3.2	19.5 ± 3.9	0.069
Stone localization			0.511
Multiple calyceal	14	21	
Pelvis	22	14	
Lower	15	15	
Middle	1	1	
Upper	4	5	
Operation side (R/L)	19/37	31/25	0.023
Stone opacity (opaque/non-opaque)	53/3	47/9	0.067

BMI body mass index, *ASA score* American Society of Anesthesiologists score

[a] Mean

Table 2 Comparison of perioperative parameters and outcomes

	Groups		*p*
	f-URS	mPNL	
Number	56	56	
Operation time (min)[a]	67.8 ± 22.1	80.9 ± 35.2	0.021
Fluoroscopy time (min)[a]	1.17 ± 1.22	5.22 ± 4.19	0.270
Hospitalization time (h)[a]	28.9 ± 25.5	60.7 ± 36.4	<0.001
Mean hemoglobin drop (g/dl)[a]	NA	1.17 ± 1.26	
Complications	3 (5.3 %)	17 (30.3 %)	0.001
Grade 1	2	8	
Grade 2	1	4	
Grade 3a	0	1	
Grade 3b	0	4	
Stone-free status			0.371
Residual stone after single session	15	11	
Stone-free status after first session	41 (73.2 %)	45 (80.4 %)	
Final stone-free status	43 (76.7 %)	45 (80.4 %)	

[a] Mean

The stone-free rate was 73.2 % for the FURS group and 80.4 % for the mPNL group after a single session procedure (p = 0.371). A second f-URS was required for two patients in f-URS group. Both patients were completely stone free, resulting in an overall success rate of 76.7 % (Table 2).

Discussion

The European Association of Urology Guidelines recommends SWL as one of the first-line treatment modalities for kidney stones <20 mm [11]. On the other hand, in obese patients, longer skin-to-stone distance (SSD) and difficulties to focus the stone under ultrasonography or fluoroscopy guidance reduce SWL success rates. Also, thick fat tissue leads weakening of the shock wave signal, and the weight-carrying capacity of endoscopy table limits the effectiveness of SWL sessions [12]. Thus, in obese patients with renal stone(s), urologists tend to perform endourological procedures such as f-URS and PNL.

Nonetheless, anesthetic and pre-surgical problems can be challenging for urologists in obese patients. Prone positioning can compromise venous return and respiratory functions and may lead to pressure sores following PNL procedure. Also, changing position of an obese patient from lithotomy to prone position requires special attention and more trained personnel [13]. According to the listed information above, f-URS seems to have advantages over prone PNL. The ASA scores were similar between two groups in our study (*p*: 0.884), and we did not observe any anesthetic complication and any problem during patient positioning. We believe that high stone patients' volume in our clinics resulted in increased experience of surgeon, anesthetist, and personnel that prevent unfortunate preoperative events. Additionally, supine PNL may overcome problems mentioned above. Comparison of efficiency and safety between f-URS and supine mPNL in obese patients may be the subject of another study.

In our study, we achieved 73.2 and 76.7 % stone-free rates after first and second f-URS sessions. Doizi et al. [14] performed 327 f-URS procedures including 87 obese patients and reported that there was no difference between success rates of normal weight and obese patients. The mean stone size of their study in obese patients was same as our study (18.3 vs. 18.3 mm), and they obtained 68 % SFR after single session, similar with our outcomes. But their SFR was slightly higher than our results after second f-URS. Also, Sari et al. [7] supported these findings with 73.6 % SFR in obese patients and 63.9 % overall SFR (p: 0.079).

In our mPNL group, success rate was 80.4 % and did not significantly differ from f-URS group. Knoll et al. [15] reported 96 % SFR after mPNL with similar stone size with our study (18 vs. 19.5 mm), but all patients had solitary kidney stones in their study. Twenty-one patients (37.5 %) in our study had multiple calyceal stones that may reduce our SFR. In Kirac's study, multiple calyceal stone rate was 32.4 %. They achieved 91.9 % SFR, but the mean stone size was smaller than our study (10.5 vs. 19.5 mm), and they analyzed only lower pole stone(s) [16]. Even though there are many studies which demonstrated the efficiency and safety of mPNL, there is no comparative study which compares the effectiveness of mPNL between normal weight and obese patients. Additionally, previous studies which investigated the effect of BMI on conventional PNL had demonstrated controversial results [17]. Further studies needed to clarify the impact of BMI on mPNL success.

In our study, the mean operation time was found significantly longer in the mPNL group as regard to the f-URS group. Differently, in Knoll's study, operation time of mPNL was significantly shorter from operation time of f-URS (59 min vs. 106 min) [15]. Also Kirac et al. [16] reported the mean operation time was 53.7 in the mini-PNL group and 66.4 in the f-URS group. We have analyzed only a specific group, patients with BMI > 30 kg/m^2, and that was our explanation for our longer OR in mPNL. In obese patients, identifying anatomical landmarks is difficult, and visualization of pelvicaliceal system and stone with fluoroscopy is inefficient. Also, achieving an adequate access is more complicated. Lastly, movements of nephroscope may be limited because of acute pelvicaliceal angulation [18].

Bleeding mainly originates from renal vascular and parenchymal tissue damage in renal stone surgery [19]. Blood transfusion incidence has been reported to vary between 0.8 and 45 % in conventional PNL. However, with miniaturizing instruments, blood transfusion rates were significantly decreased [21]. Cheng et al. [9] found a 1.4 % blood transfusion rate in mPNL. Abdelhafez et al. [20] demonstrated a 0.5 % blood transfusion rate independent of stone size in 191 patients who have undergone mPNL procedure. Blood transfusion was solely needed for two patients in mPNL group, but our blood transfusion rate was slightly higher (3.5 %). One patient in the mPNL group needed angiography and embolization. During angiography, arteriovenous fistula was detected in the lower pole, and bleeding was stopped by using an embolic material. On the other hand, while reaching kidney stone, f-URS passes through the natural orifices, and on the other side in PNL, vascular and parenchymal tissue damage is inevitable. Because of this, we do not routinely assess hemoglobin level after f-URS.

Ureteral obstruction due to stone fragments and urine leakage are other major problems following renal stone surgery and are treated with JJ stent insertion. We routinely placed JJ stent at the end of each f-URS procedure, and we did not observe any JJ stent migration. After nephrostomy withdrawal in mPNL group, we inserted JJ stent in four patients due to pain and prolonged urine leakage from nephrostomy tract. Instead of dusting with laser lithotripter, fragmentation in larger pieces and removal with baskets may prevent this complication. Also, withdrawal of stone particles by ultrasonic lithotripter in mPNL may prevent obstruction and decrease JJ insertion rate. Fragmentation and lithotripter type in mPNL may be the subject of another study.

Although our study was the first investigation focused on this topic, we are aware of our limited number of patients and the retrospective nature of our study. Moreover, operations were performed in two centers by different surgeons that may influence outcomes. Also, number of tubeless operations was limited in our study that may be associated with the different experience of our surgeons. Most surgeons, including specialists and residents, while completing their learning curve, preferred to place a nephrostomy tube at the end of the procedures. Another weakness point of our study was that we did not evaluate use of anesthetics agent and cost of procedure.

Conclusion

Our study demonstrated that both f-URS and mPNL achieve acceptable stone-free rates in obese patients with 10–20 mm renal stones. However, f-URS is associated with shorter operation and fluoroscopy time. Additionally, f-URS had a lesser complication rate when compared with mPNL. However, our findings must be supported by further prospective, randomized studies with larger patient volume.

Authors contribution F. Ozgor contributed to project development and manuscript writing. F. Elbir, A. Armağan, and O. Sarilar collected the data. Z. G. Gurbuz contributed to manuscript editing. Data collection, data management, and manuscript editing were carried out by A. Tepeler. A. I. Taşcı is acknowledged for data management. M. Binbay contributed to project development and manuscript editing.

Compliance with ethical standards

Conflict of interest None.

Ethical standards Informed consent was obtained preoperatively from all of our patients included in our study.

References

1. de Simone G, Devereux RB, Chinali M et al (2007) Prognostic impact of metabolic syndrome by different definitions in a population with high prevalence of obesity and diabetes: the strong. Diabetes Care 30:1851–1856
2. Krzysztoszek J, Wierzejska E, Zielińska A (2015) Obesity. An analysis of epidemiological and prognostic research. Arch Med Sci 11:24–33
3. Calvert RC, Burgess NA (2005) Urolithiasis and obesity: metabolic and technical considerations. Curr Opin Urol 15:113–117
4. Caskurlu T, Atis G, Arikan O et al (2013) The impact of body mass index on the outcomes of retrograde intrarenal stone surgery. Urology 81:517–521
5. Jacquemet B, Martin L, Pastori J et al (2014) Comparison of the efficacy and morbidity of flexible ureterorenoscopy for lower pole stones compared with other renal locations. J Endourol 28:1183–1187
6. Ferakis N, Stavropoulos M (2015) Mini percutaneous nephrolithotomy in the treatment of renal and upper ureteral stones: lessons learned from a review of theliterature. Urol Ann 7:141–148
7. Sari E, Tepeler A, Yuruk E et al (2013) Effect of the body mass index on outcomes of flexible ureterorenoscopy. Urolithiasis 41:499–504
8. Akman T, Binbay M, Ozgor F et al (2012) Comparison of percutaneous nephrolithotomy and retrograde flexible nephrolithotripsy for the management of 2–4 cm stones: a matched-pair analysis. BJU Int 109:1384–1389
9. Cheng F, Yu W, Zhang X, Yang S, Xia Y, Ruan Y (2010) Minimally invasive tract in percutaneous nephrolithotomy for renal stones. J Endourol 24:1579–1582
10. 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
11. Türk C, Knoll T, Petrik A et al (2015) Guidelines on urolithiasis. European Association of Urology, Madrid
12. Hammad FT, Balakrishnan A (2010) The effect of fat and nonfat components of the skin-to-stone distance on shockwave lithotripsy outcome. J Endourol 24:1825–1829
13. Al-Dessoukey AA, Moussa AS, Abdelbary AM et al (2014) Percutaneous nephrolithotomy in the oblique supine lithotomy position and prone position: a comparative study. J Endourol 28:1058–1063
14. Doizi S, Letendre J, Bonneau C, de Medina SGD, Traxer O (2015) Comparative study of the treatment of renal stones with flexible ureterorenoscopy in normal weight, obese, and morbidly obese patients. Urology 85:38–44
15. Knoll T, Jessen JP, Honeck P, Wendt-Nordahl G (2011) Flexible ureterorenoscopy versus miniaturized PNL for solitary renal calculi of 10–30 mm size. World J Urol 29:755–759
16. Kirac M, Bozkurt OF, 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
17. Pearle MS, Nakada SY, Womack JS, Kryger JV (1998) Outcomes of contemporary percutaneous nephrostolithotomy in morbidly obese patients. J Urol 160:669–673
18. TorrecillaOrtiz C, Martínez AIM, Morton AJV et al (2014) Obesity in percutaneous nephrolithotomy. Is body mass index really important? Urology 84:538–543
19. Ganpule AP, Shah DH, Desai MR (2014) Postpercutaneous nephrolithotomy bleeding: aetiology and management. Curr Opin Urol 24:189–194
20. Abdelhafez MF, Amend B, Bedke J et al (2013) Minimally invasive percutaneous nephrolithotomy: a comparative study of the management of small and large renal stones. Urology 81:241–245
21. Turna B, Nazli O, Demiryoguran S, Mammadov R, Cal C (2007) Percutaneous nephrolithotomy: variables that influence hemorrhage. Urology 69:603–607