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The comparison of perioperative outcomes between percutaneous nephrolithotomy and retrograde intrarenal surgery in elderly patients

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Abstract

Objectives: In this study, we aimed to compare the outcomes and complication rates of percutaneous nephrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS) in elderly patients.

Materials and Methods: Between April 2011 and January 2020, patients who underwent PCNL and RIRS for renal stone in elderly patients were retrospectively evaluated. The two groups' perioperative values, stone-free rates and complication rates were compared. Post-operative complications were noted according to the Clavien scoring system.

Results: There were 89 and 72 patients in the PCNL and RIRS group respectively. The median age was 67 years in both the groups ($P = .192$). The stone size were 22.2 ± 3.5 mm and 19.9 ± 7.1 mm in the PCNL and RIRS group, respectively ($P = .082$). Stone-free rates were significantly higher in PCNL group ($P = .021$, $P = .034$). Also we found that overall complication and major complication rates were significantly higher in PCNL group ($P = .016$, $P = .029$).

Conclusion: Despite there was higher stone clearance in PCNL, the complication rates were higher compared with RIRS. So RIRS might be a safe alternative treatment method to PCNL in older patients.

What's known

Currently, retrograde intrarenal surgery and percutaneous nephrolithotomy are the most favoured treatment options for renal stones. However, which technical should be preferred in geriatric patients with low cardiopulmonary performance and kidney reserves is not clear.

What's new

In this study, we aimed to decide which technique will be used for geriatric patients with low cardiopulmonary performance and kidney reserve.

1 | INTRODUCTION

Currently, retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL) are the most favoured treatment options for renal stones.[1] According to EAU guideline, PCNL is the standard treatment for renal stones >2 cm, and RIRS and shock wave lithotripsy (SWL) for renal stones <2 cm.[2] However, despite the recommendations of the EAU guideline on management of renal stones,

RIRS has been widely used to treat renal stones >2 cm by several investigators.[3,4] So, for renal stone between 10 and 30 mm, RIRS and PCNL are both options, and the choice of treatment will depend on anatomical and stone characteristics. However, surgical complications are associated with PCNL; therefore, for elderly patients, minimally invasive procedures, especially RIRS, are preferable. On the other hand, PCNL has an excellent success rate in clearing stone burdens at reported rates of up to 96.1%.[5] The stone-free rate (SFR) for RIRS has been reported as 77% to 96.7% with staged procedures for renal stones >2 cm.[6]

The increase in the average human life expectancy and aging population will result in more geriatric patients with kidney stones admitted for treatment. The most appropriate method should be preferred when treating kidney stones in elderly patients because of multiple comorbidities and age-related deterioration in the metabolic, cardiovascular and pulmonary system.

Therefore, urologists have to make a difficult decision regarding the technical that should be preferred in geriatric patients with low cardiopulmonary performance and kidney reserves.

In this study, we aimed to compare the outcomes of PCNL and RIRS in treating renal stones in elderly patients.

2 | MATERIALS AND METHODS

This study is a retrospective analysis of patients over 65 years of age who were undergoing PCNL or RIRS for kidney stones at the Ministry of Health University Izmir Bozyaka Training and Research Hospital between April 2011 and January 2020. The data were driven from the electronic medical records of all the patients consecutively. Patients who had history of neuromuscular disease, congenital renal anomalies, coagulopathy, morbid obesity, skeletal deformity, solitary kidney and <65 years of age were excluded from the study. A total of 161 patients were divided into two groups according to surgical technique; PCNL Group n = 89, and RIRS Group n = 72. Comparisons were made among patient demographics, and perioperative and postoperative outcomes.

All of the patients were evaluated by standard non-contrast computed tomography (CT), pre-operatively. The following data were recorded by the experienced surgeons immediately post-operatively: patient demographics (age, gender, body mass index, operation side, location of the stones, stone burden and Metabolic Syndrome: there were at least two illnesses (diabetes mellitus, hypertension, hyperlipidaemia and obesity) and pre-operative data (Table 1). Hounsfield unit values were measured as previously described by Celik et al[7] for the largest diameter of the stone (longitudinal or transverse) with bone window and large magnification. Perioperative data included surgery time, fluoroscopy time, length of stay, change in Hgb and CHANGE in creatinine (Table 2). Post-operative complications were noted according to the Clavien scoring system (Table 3).[8] Complications according to Clavien scoring system were divided into two groups; Minor complications =Clavien grades I-II, and Major complications = Clavien grades III-IV-V.

TABLE 1 Demographic and pre-operative characteristics of the patients

Variables	PCNL (n = 89)	RIRS (n = 72)	*P* value[a]
Age, y, median (25th-75th)	67 (66-70.75)	67 (65-72)	.192
Gender, n (%)			
Female	40 (44.9)	32 (44.4)	.949[b]
Male	49 (55.1)	40 (55.6)	
Laterality, n (%)			
Right	44 (49.4)	25 (34.7)	.061[c]
Left	45 (50.6)	47 (65.3)	
BMI, kg/m^2, median (25th-75th)	26.1 (24.2-29.3)	26.7 (24.6-29.6)	.494
Metabolic syndrome, n (%)	21 (23.6)	22 (30.6)	.416[c]
Mean pre-operative GFR, mL/min	78.6 ± 19.1	82.1 ± 21.2	.289[d]
Previous history of			
ESWL, n (%)	15 (16.9)	17 (23.6)	.384[c]
Ipsilateral stone surgery, n (%)	17 (19.1)	25 (34.7)	.039[c]
Stone location, n (%)			
Pelvis	35 (39.3)	19 (26.4)	.129[e]
Proximal ureter	2 (2.2)	5 (6.9)	
Single calyx	19 (21.3)	22 (30.6)	
Pelvis + one calyx	21 (23.6)	12 (16.7)	
Multiple calyx	12 (13.5)	14 (19.4)	
Stone density, HU	980 ± 346	988 ± 357	.593[d]
Stone size, mm	22.2 ± 3.5	19.9 ± 7.1	.082

Note: Each superscript letter denotes a subset of PNL and RIRS categories whose column proportions do not differ significantly from each other at the 0.5 level.

Abbreviations: BMI, body mass index, ESWL, extracorporeal shock wave lithotripsy, ASA, The American Society of Anesthesiologists (ASA) Physical Status Classification.

[a]Mann-Whitney *U*-test.

[b]Pearson chi-square test.

[c]Yate's chi-square test.

[d]Independent sample *t*-test.

[e]Exact test.

Sterile urine culture was detected in all patients before operation. Ceftriaxone was given as prophylaxis before the operation and continued until the nephrostomy tube was removed. No nephrotoxic drugs were used before, during or after the operation for any patient.

Stone size was calculated with longest diameter of the stone (longitudinal or transverse). In multiple intrarenal stones, stone size was calculated one by one and then all of them were collected. The estimated GFR was calculated using the Cockcroft-Gault formula (CrCl = ([140-age] × weight in kg)/(serum creatinine × 72) × 0.85 (if female).[9] All PCNL and RIRS interventions were performed by experienced surgeons.

TABLE 2 Comparison of intra-operative and post-operative outcomes in the PCNL and RIRS groups

Variables	PCNL (n = 89)	RIRS (n = 72)	*P* value[a]
Change in Hgb, g/dL	1.10 (0.6 to 2.0)	−0.2 (−0.3 to 0.0)	**<.001**
Change in creatinine, mg/dL	0.10 (0.0 to 0.22)	0.10 (0.02 to 0.20)	.402
Change in e-GFR, mL/min	−9.92 (−16.9 to 0)	−9.05 (−15.3 to −3.1)	.768
Operation time, min	90 (60 to 101.25)	80 (60 to 90)	.154
Fluoroscopy time, s	61.5 (33.75 to 87.75)	11 (6 to 21)	**<.001**
Length of hospital stay, d	3 (2 to 4)	2 (1 to 3)	**<.001**
Blood transfusion requirement, n (%)	4 (4.6)	0	.127[b]
Stone-free rates, n (%)	80 (89.9)	56 (77.8)	**.021**[c]
Complication rates, n (%)	29 (32.6)	12 (16.7)	**.034**[c]
Minor complication rates (Clavien grades I-II), n (%)	20 (22.5)	11 (15.3)	.342[c]
Major complication rates (Clavien grades III-IV-V), n (%)	9 (10.1)	1 (1.4)	**.024**[d]

Bold value indicates the statistical significant of *P* value < .05.

[a] Mann-Whitney *U*-test.

[b] Exact test.

[c] Continuity correction.

[d] Fisher's exact test.

TABLE 3 Classification of complications according to Clavien scoring system

Complications	PCNL (n = 89)	RIRS (n = 72)	*P* value[a]
Grade 0, n (%)	60 (67.4)	60 (83.3)	**.032**[a]
Grade I, n (%)	15 (16.9)	6 (8.3)	.110[b]
Pain	3	1	
Fever	3	2	
Bleeding not requiring blood transfusion	4	3	
Transient elevation of SCr (> 0.5 mg/dl)	2	—	
Urine leakage managed by watchful waiting	2	—	
Intestinal obstruction managed without nasogastric decompression	1		
Grade II, n (%)	5 (5.6)	5 (6.9)	.753
Minor pelvic/ureter perforation	2	—	
Bleeding requiring blood transfusion	3	—	
Postoperative fever (>38°C) managed with antibiotics in the ward	—	5	
Non-obstructive steinstrasse	—	—	
Grade III	**5 (5.6)**	1 (1.4)	.226
Grade III A, n (%)	5		
Urine leakage managed by ureteric stenting without general anaesthesia	4	—	
Perinephric abscess managed by percutanous drainage	1	—	
Grade III B, n (%)	—	1	
Stent migration	—	1	
Grade IV, V			.129
Grade IV B, n (%)	2 (2.2)		
Sepsis	2	—	
Grade V, n (%)	2 (2.2)		
Any complication leading to death	2	—	

Bold value indicates the statistical significant of *P* value < .05.

[a]Fisher's exact test.

[b]Continuity correction.

2.1 | PCNL procedure

After general anaesthesia, 5 or 6 F ureter catheter was inserted to the collecting system of the patient's kidney with stones in the lithotomy position. And ureter catheter fixed to a Foley catheter. Then patient was positioned to prone. Access was obtained under fluoroscopy with 18-gauge needle, and tract was dilated with Amplatz dilatators to 30 F calibre. Stone fragmentation was accomplished using a pneumatic lithotripter (Vibrolith; Elmed). At the end of the procedure, 14 F nephrostomy tube was inserted, and antegrade pyelography was performed. Nephrostomy tube was removed in the first or second post-operative day in the absence of fever or significant haematuria. The fluoroscopy time was recorded for every fluoroscopy use from the access to the collecting system of the kidney to antegrade pyelography was performed. Operation time was calculated from the patient was placed in the prone position to the nephrostomy tube was placed.

2.2 | RIRS procedure

After general anaesthesia, firstly semi-rigid ureteroscopy was performed to evaluate and actively dilate the ureter before flexible ureteroscopy. Thereafter, a 12/14 Fr ureteral access sheath (UAS) (Flexor 12/14Fr, Cook Medical Bloomington, Navigator 11/13Fr, Boston Scientific) was placed over the guidewire under fluoroscopic guidance. All the RIRS were performed using Flex-X2 or Flex-XC (Karl Storz Endoscope) through the ureteral access. If UAS cannot be placed, double-J ureteral catheter was inserted to the kidney collecting system for passive dilatation ~1-2 weeks before resurgery. The stones were fragmented using a 200/273 μm Holmium laser fibre (Dornier Med-Tech GmbH, Medilas H20). Surgery was concluded after stone-free status (ureteroscopic inspection and fluoroscopy), or detection of bleeding which blocked the surgeon's view or decision. When the AUS was withdrawn, the ureter was examined with flexible ureteroscopy. If there were any injuries, DJ was applied at the end of the procedure, according to surgeon's judgment. DJ stent was removed 2-3 weeks after surgery in all patients.

'Stone-free' status was defined as stones of less than 2 mm or no evidence of stones on 1-month post-operative CT.

2.3 | Statistical analysis

Categorical data are presented as numbers and percentages. The Shapiro-Wilk test was used to determine whether the distributions of continuous variables were normal. While normal distributed data are presented as mean and standard deviation, non-normally distributed data are given as median and 25th to 75th percentile. Independent *t*-test was used to compare two independent normal distributed data, while Mann-Whitney *U*-test was used for non-normally distributed data. The frequencies of categorical variables were compared using Pearson Chi-Square, Continuity Correction or Fisher's exact test, when appropriate. A $P < .05$ was considered statistically significant. All data were analysed using the Statistical Pack0061ge for Social Sciences, version 20.0 (SPSS) software program.

3 | RESULTS

In our study, there were 89 and 72 patients in the PCNL and RIRS group respectively. The median age of both groups was 67 years. The stone sizes were 22.2 ± 3.5 and 19.9 ± 7.1 in PCNL and RIRS group respectively ($P = .082$). Groups were similar in terms of patient and stone characteristics (gender, body mass index (BMI), metabolic syndrome, pre-operative glomerular filtration rate (GFR), SWL history, stone location and stone density). The demographic data and pre-operative characteristics are summarised in Table 1.

The length of hospital stay, fluoroscopy time and change in Hgb were significantly higher in PCNL group ($P < .001$ for all three).

Stone-free and complication rates were significantly higher in PCNL group ($P = .021$, $P = .034$). Also major complication rates were significantly higher in PCNL group ($P = .024$). After a single procedure, the stone-free rates were 89.9% and 77.8% in PCNL group and RIRS group respectively ($P = .021$).

Regarding the subgroup rates of Clavien scoring system, there was no statistically significant difference in each subgroups between the groups. Details of complication according to Clavien classification system are summarised in Table 3.

4 | DISCUSSION

The increase in the average human life expectancy and aging population will result in more geriatric patients with kidney stones admitted for treatment. Developments in technology, especially in endoscopy and optic quality, have led to numerous stone treatment modalities in elderly patients.[10] PCNL and RIRS have become important management modalities in this area. PCNL is considered to be an effective and safe treatment option for large renal stones.[11] Despite proof of the effectiveness of the procedure, complications ranging from 20% to 83% were reported in the literature, including haemorrhage requiring transfusion, pleural injury and colonic injury. Technological innovations have meant that RIRS has become accepted as important treatment modality of renal stones, with higher success and lower complication rates. Previous studies clearly demonstrated that RIRS can be successfully performed for moderate-size renal stones.[12] In a different study, Gupta and colleagues concluded that PCNL provides better one-time stone-free rates (>90%) compared with other procedures.[13] Knoll et al emphasised that one in two patients receiving RIRS required two procedures for a mean stone size of 19 mm.[14] This is undesirable because multiple anaesthesia exposure is problematic for elderly patients. In recent study, we found that the stone-free rates were 89,9% and 77.8% in PCNL group and RIRS group respectively. Total complication rates

were 32,6% and 16,7% in PCNL group and RIRS group respectively ($P = .034$). Also, major complication rates was higher in PCNL group ($P = .024$).

Although many studies have investigated outcomes of either RIRS or PCNL in elderly patients, there is a lack of comparative studies. Ozgor et al evaluated a total of 118 elderly patients, 60 of them underwent RIRS and 58 mPCNL, and reported stone-free rates of 81.7% and 77.6% respectively.[15] Akman et al found similar success rate between PCNL and RIRS in geriatric patients with moderate-size renal stones (92.8% and 82.1% respectively).[12] In contrast, in the present study, the stone-free rate was significantly higher in PCNL than RIRS (92% and 77.8% respectively) ($P = .021$). Similar to our results, comparing the effectiveness of RIRS and mPCNL in older patients, Hu found that the success rate was statically significant in favour of mPCNL ($P = .025$).[10]

In this study, the mean operative time was longer in PCNL group compared with f-URS group, but this difference was not statistically significant. In contrast, many previous studies reported longer operative times in the RIRS group.[16-18] In a study involving 56 geriatric patients comparing standard PCNL and RIRS, Akman et al found that operative duration was longer in favour of f-URS (64.5 ± 20.9 and 40.7 ± 10.7 min).[12] Another study by Hu et al found no significant difference in terms of operative time in older patients following mPCNL and RIRS.[10] This variability can be attributed to surgical competence and experience, positioning and patient-dependent factors during operation.

Previous reports emphasised that PCNL has a longer hospitalisation times compared with RIRS.[10,12,15] In contrast to the high morbidity of PCNL, for patients undergoing RIRS, there are lower rates of pain, haemoglobin drop and requirement for blood transfusion requirement, and the absence of nephrostomy tubes seems to accelerate post-operative recovery, accounting for the reduced hospital stay. The effect of age and patients' comorbidities on hospitalisation stay is a controversial issue. Okeke et al stated that, after PCNL, hospitalisation time was longer in older compared with younger patients.[19] In contrast, studies conducted by Karami et al and Sahin et al report no significant difference between older and younger patients undergoing PCNL in terms of hospitalisation time.[20,21] Ozgor et al found a significantly longer hospitalization time following mPCNL (56.5 hours) compared with RIRS (23.1 hours) in elderly patients ($P < .001$).[15] In accordance with the literature, our study revealed PCNL was associated with longer hospitalisation stay in older patients.

Elderly patients are more prone to comorbid disease, making them more vulnerable to bleeding and septic complications.[12] Such complications can be fatal. The use of minimally invasive surgical techniques to achieve complete stone clearance with minimal morbidity is an important advance in the management of nephrolithiasis in older patients. de la Rosette et al and Tefekli et al reported that overall complication rates in PCNL were 43.8% and 29.2% respectively.[22,23] In the present study, the overall complication rate (32.6%) was in accordance with other series on PCNL, but it was slightly higher than these aforementioned studies. This can be explained the ages of the patients. Similarly, Okeke's study reported that a significantly higher complication rates in elderly patients compared with younger patients in PCNL.[19] Previous reports emphasised similar and acceptable complication rates for both PCNL and RIRS. Akman et al reported no difference in complication rates in elderly patients following PCNL and RIRS.[12] In studies, conducted by Ozgor et al and Hu et al, no significant difference in terms of complication rates was detected between older patients undergoing mPCNL and those undergoing RIRS.[10,15] However, in present study, overall complication rates were significantly higher in PCNL group ($P = .034$), and here, the Clavien-Dindo grade >2 complications were mainly observed in PCNL group ($P = .043$).

This study has some limitations that need to be highlighted. The first is its retrospective design with small number of patients, which is a possible cause of bias. Second limitation is short patient follow up, with no long-term comparison of complications. There is a need for prospective studies in geriatric patients with a larger series.

5 | CONCLUSION

In conclusion, both PCNL and RIRS are equally effective and acceptable treatment modalities for elderly patients with renal stones. PCNL had significantly higher rates of stone clearance, but higher complication compared with RIRS. RIRS might be a safer alternative treatment method in older patients. Further prospective randomised studies will reveal more detailed insights with larger patient series.

ETHICAL COMPLIANCE

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

DISCLOSURES

The authors declare no conflict of interest.

ETHICAL APPROVAL

Informed consent was obtained pre-operatively from all of our patients which were included in our study.

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