# Comparison of Percutaneous Nephrolithotomy and Retrograde Intrarenal Surgery in Treating 20-40 mm Renal Stones

Gokhan Atis[1]*, Meftun Culpan[1], Eyup Sabri Pelit[2], Cengiz Canakci[1], Ismail Ulus[1], Bilal Gunaydın[1], Asıf Yildirım[1], Turhan Caskurlu[1]

**Purpose:** To compare the outcomes of percutaneous nephrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS) in treating renal stones between 20 and 40 mm in diameter.

**Materials and Methods:** 146 patients, who were treated with RIRS and 146 patients, who were treated with PCNL for renal stones between 20 and 40 mm in diameter were compared retrospectively using a matched-pair analysis. The operative and post-operative outcomes of both groups were analyzed retrospectively.

**Results:** The mean age, gender, body mass index and stone laterality were similar between the groups. The mean stone size was 28.39 ± 4.67 mm for the PCNL group and 25.08 ± 6.07 mm for the RIRS group (*P* =.21). The mean operative times were statistically longer in the RIRS group, whereas the fluoroscopy times, hospitalization times and post-operative visual analogue scores were statistically higher in the PCNL group. The stone- free rates (SFR) after a single procedure were 91.7% in the PCNL group and 74% in the RIRS group (*P* = .04). After auxiliary procedures, the overall SFRs reached 94.4% for the PCNL group and 92.3% for the RIRS group (*P* = .52). No major complications were observed for both groups. Minor complication (Clavien 1–3) rates were 6.8% and 3.4% for the PCNL and RIRS group, respectively (*P* =.18).

**Conclusion:** RIRS has some advantages over PCNL such as shorter hospitalization times, shorter fluoroscopy times and less post-operative pain in treating renal stones between 20 and 40 mm in diameter. However, PCNL has a higher SFR with only a single session.

**Keywords:** percutaneous nephrolithotomy; nephrolithiasis; retrograde intrarenal surgery

## INTRODUCTION

The management of patients with renal stone has been changing with the advances in laser technology and instruments miniaturization. Today; percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS), shock-wave lithotripsy (SWL) and laparoscopic stone surgery are the most preferable treatment choices for renal stones[(1)].

The recommendation of the EAU guideline revealed PCNL as a first line treatment choice for renal stones > 2 cm and RIRS and SWL for renal stones < 2cm[(2)]. 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 and has been associated with lower complications than PCNL[(3-5).] The stone-free rate (SFR) of RIRS has been reported as 77% to 96.7% with staged procedures for renal stones > 2 cm[(6)]. RIRS is becoming a safe alternative procedure for renal stones > 2 cm[(3-6)].

At the other side, PCNL achieves higher SFR when compared with RIRS after a single session, however, some major complications such as bleeding requiring embolization, sepsis, urinoma and organ injury after PCNL may occur[(2)].

In this study, we aimed to compare the outcomes of PNL and RIRS in treating renal stones between 20 and 40mm in diameter using a match-paired analysis. To our knowledge, our study group is one of the largest patient series in the literature.

## PATIENTS AND METHODS

### *Study population*

A total of 292 patients with renal stones ranging between 20 – 40 mm in diameter who were treated in our clinic with RIRS (n:146) or PCNL (n:146) were included. The choice of treatment modality was made according to the patient and surgeon preferences. The data of both groups were analysed retrospectively. Demographic parameters including age, sex, size-number-laterality-location of the stones, operative time, flouroscopy time, hospitalization time were recorded. Pre-operative evaluation of the patients included intravenous urography (IVU), and/or non-contrast computed tomography (NCCT), urine culture, coagulation tests, platelet counts, hemoglobin measurements and serum biochemistry. All patients had sterile urine cul-

[1] Istanbul Medeniyet University Goztepe Training and Research Hospital, Urology, Istanbul, TR.

[2] Harran Universitesi School of Medicine, Urology, Sanliurfa, TR.

*Correspondence: Istanbul Medeniyet University Goztepe Training and Research Hospital, Urology, Istanbul, TR.

Adress: Istanbul Medeniyet University Goztepe Training and Research Hospital, Urology, Istanbul, TR

Received August 2016 & Accepted January 2017

ture before the surgery. Stone size was determined as the longest diameter on plain radiography or NCCT. Patients with renal abnormalities, pediatric patients and patients who had small stones (< 2 cm) were not included in the study.

### *Surgical technique*

### *PCNL technique*

After induction of general anesthesia, a 6 F open-end ureteral catheter was placed with cystoscope after then patients were turned to the prone position. Renal collecting system access was performed via 18 Gauge diamond tip needle from lower or middle calyx under fluoroscopic guidance. A guidewire was pushed forward to the collecting system through the needle and tract was dilated with amplatz renal dilatators up to 28 F-30 F. Fragmentation and aspiration of the stones were accomplished using ultrasonic and/or pneumatic lithotripter through 26 F nephroscope. Some stone fragments were taken out with basket catheter for stone analysis. A 12 F re-entry catheter inserted to the renal pelvis as a nephrostomy tube after fragmentation completion. Operation time was calculated from inserting ureteral catheter to the nephrostomy tube placement.

### *RIRS technique*

After induction of general anesthesia, we performed semirigid ureteroscopy (8,5 / 11,5 F ,Wolf, Knittlingen, Germany ) for ureteral dilation and placing a hydrophilic guidewire to the renal pelvis. RIRS was performed by using a 7.5 F flexible ureteroscope (Karl Storz Flex-X2, Tutlingen, Germany) through the ureteral access sheath (UAS). 9.5/11.5 Fr UAS placement was attemped through the ureter in all patients. In failing of the UAS, RIRS was performed without using the UAS. Holmium laser was used with a 273 µm fiber for disintegration of the stone. Holmium laser energy was set to 0.6 -1.5 J and frequency was set to 10-15 Hz. A basket catheter was used for taking some stone fragments for stone analysis. At the end of the procedure, a Double-J stent was placed and was removed after two weeks.

### *Outcome assessment*

Operation time was calculated from the beginning of the semirigid ureteroscopy to the urethral catheter placement.

In follow-up, plain radiography and NCCT were performed to determine SFRs at the first postoperative day and 3 month following the surgery, respectively. Patients were considered stone-free in the absence of residual fragments. The re-treatment decision was made in the presence of residual fragments on NCCT performed at 3 month following the surgery. No pre-operative analgesics were given prior to the surgery, however, analgesics were given to the patients who complained from pain post-operatively. Postoperative first day visual analogue score was recorded for all patients before analgesic medication. Complications were divided into two groups as minor and major complications. Minor complications involved Clavien-Dindo grades 1-2-3 and major complications involved grade 4-5[7-8]. SPSS software, version 20,0 (IBM, Armonk, NY) was used to perform statistical analysis. Distribution of variables normality was checked with Kolmogorov-Smirnov test. Numeric variables were analysed with Student 's t test and Mann–Whitney U test. To compare categorical variables, Chi-square test or Fisher' s exact test were used. Statistical significance was set at $P < .05$.

## RESULTS

In this study, there were 146 patients in the PCNL group and 146 patients in the RIRS group.

The baseline demographic data were similar between the two groups, in terms of age, gender, stone laterality and locations (**Table 1**). The mean stone size differences was not statistically significant between the two groups, 25.08 ± 6.07mm for the RIRS group and 28.39 ± 4.67mm for the PCNL group ($P = .21$).

The mean fluoroscopy times, hospitalization times and visual analogue scores (VAS) at post-operative day 1 were statistically higher in the PCNL group (**Table 2**). The mean operative time for PCNL and RIRS groups were 55.36 ± 17.93 and 66.86 ± 12.82, respectively ($P = .002$).

SFRs were 74% in the RIRS group and 91.7% in the PCNL group after a single procedure ($P = .04$). In the RIRS group, 38 (26%) patients underwent an additional RIRS procedure because of the residual stone fragments > 4 mm. 12 (8.3%) patients in the PCNL required auxiliary procedure, 5 of whom were treated with RIRS and the remaining 7 patient underwent SWL due to the residual stone fragments > 4mm. The re-treatment rate was significantly higher in the RIRS group than the PCNL group ($P < .001$). After auxiliary procedures, the overall SFRs reached to 94.4% in the PCNL group and to 92.3% in the RIRS group ($P = .52$). Two patients in the PCNL group and 3 patients in the RIRS group with residual stones < 4 mm were followed up.

No major complications were observed in both group. Minor complication rates were 6.8% (10 patients) and 3.4% (5 patients) for the PCNL and RIRS groups, respectively ($P = .18$). Blood transfusion was required in 3 (2%) patients in the PCNL group. Intravenous antibiotic therapy was required in 4 (2.7%) patients because of the urinary tract infection postoperatively in the PCNL group. Double J catheter was inserted to 3 (2%) patient due to urine leakage after removal of the nephrostomy tube. In the RIRS group, none of the patients received blood transfusion. Four (2.7%) patients were treated with antibiotic therapy for urinary infection postoperatively. Rigid ureteroscopy was performed for 1 (0.6%) patient due to steinstrasse after removal of DJ stent.

## DISCUSSION

PCNL is recommended as a first-line treatment modality for renal stones > 2 cm according to EAU guidelines [2]. This procedure has been associated with high SFR, however, major complications after this procedure may still occur[2]. At the other side, with advances of flexible ureterorenoscopes and Holmium laser technology, RIRS has been also used in treating renal stones > 2 cm by several investigators in the management of these renal stones despite the requirement of the repeated procedures[9-11]. Although some authors have compared the safety and efficiency of the PCNL and RIRS, in current literature the present study has the highest case number. We also compared the outcomes of PCNL and RIRS in treating renal stones between 20-40 mm in diameter to investigate the advantages and disadvantages of both procedures.

The SFR of RIRS for renal stones > 2 cm varies from

**Table 1.** Patients characteristics of the groups

| | PCNL group[a] | RIRS group[a] | *P* value |
|---|---|---|---|
| No. Patient (n) | 146 | 146 | |
| Age(years) | 46.33 ± 12.34 | 47.23 ± 15.16 | 0.780 |
| Gender | | | 0.327 |
| Male (n) | 104 | 98 | |
| Female (n) | 42 | 48 | |
| Stone size (mm) | 28.39 ± 4.67 | 25.08 ± 6.07 | 0.214 |
| Stone laterality | | | 0.752 |
| Right (n) | 76 | 80 | |
| Left (n) | 70 | 66 | |
| Stone location | | | 0.165 |
| Lower calyx | 108 | 90 | |
| Middle calyx | 30 | 35 | |
| Upper calyx | 8 | 21 | |

[a]Data is presented as mean ± SD or numbers.

77% to 96.7% in the published articles after repeated procedures[6]. On a comparative study, Akman et al. reported SFRs of 91.2% and 73.5% after a single procedure for PCNL and RIRS. In their study, SFR was reported to reach to 88.2% for RIRS after a second procedure, which was similar to the SFR of PCNL[9]. In the study of Bryniarski et al., it was demonstrated that PCNL had higher efficacy (94%) in comparison with RIRS (75%) in a single session[10]. On the other hand Palmero et al. reported that the PCNL procedure was associated with a higher success rate than RIRS (80.6% vs. 73.6%); however the difference was not statistically significant ($P$ = .40) and SFRs after repeated sessions were almost same for PCNL and RIRS (94.3% vs. 93.5%, respectively, P = .88)[11]. Similarly, in the study of Koyuncu et al. that compared RIRS and PCNL for lower pole stones greater than 2 cm, the SFRs after PCNL and RIRS were similar even after single procedures (96.1% vs 90.6, respectively, $P$ = .26)[12]. In the present study, the SFRs were 74% and %91.7 after a single procedure in the RIRS and PCNL groups respectively, and after auxiliary procedures, these rates reached to 92.3% for the RIRS group and 94.4% for the PCNL group. The difference of the reported SFRs in the literature may be resulted from complexity of the stones, patients' characteristics or surgeons experience. Stone localization can be considered a predictive factor for stone-free status. In the present study, although there were no statistically significant differences in stone locations between the two groups, the upper calyceal localizations of the stones were higher in the RIRS group, which are easier for RIRS and more difficult for PCNL procedures. It may also affect the SFRs after the procedures.

The complications following PCNL includes transfusion (7%), embolization (0.4%), urinoma (0.2%), fever (10.8%), sepsis (0.5%), thoracic complication (1.5%) and organ injury (0.3%)[2]. Post-operative complications such as febrile urinary tract infection, acute urinary retention, subcapsular hematoma, fever, steinstrasse, pyelonephritis and bleeding may also be seen after RIRS, however, most of these complications are minor and can be treated conservatively[13,14]. Abou-marzouk et al. conducted a metanalysis of nine studies with 445 patients who were treated with RIRS for renal stones > 2 cm and reported an overall complication rate of 10.1% [6]. In the present study, although there was no statistically difference in complication rates among the two groups, minor complication rates were higher in the PCNL group. Additionally, 2 % of patients in the PCNL group required blood transfusion, whereas none of the patients received blood transfusion in the RIRS group. According to the findings of the present study, RIRS is more advantageous in terms of complication rate for treating renal stones when compared to PCNL.

For renal stones > 2cm, the reported mean operative time for RIRS and PCNL varies from 28 to 215 and 58 to 112 minutes in the non-comperative and comperative articles respectively[6,15]. In the present study, the mean operative times for RIRS and PCNL were 66.86 ± 12.82 and 55.36 ± 17.93 minutes, respectively ($P$ = .002). Our reported operative times are in concordence with the published articles in the literature.

Post-operative pain after renal stone surgery is a major problem, that may lead the patient to use post-operative narcotic analgesics because of the discomfort. This has been associated with nephrostomy tube or Double-J stent placement post-operatively by several investigators[16,17]. In the present study, we placed a nephrostomy tube after PCNL and a Double-J stent after RIRS in all patients and found lower post-operative pain scores after RIRS. Similarly, in the study of Bryniarski et al., the post-operative VAS and narcotic analgesics use of patients in the PCNL group were higher than patient in the RIRS group[10]. To our best knowledge, post-operative pain is important and may affect the hospitalization time and comfort of the patients.

The present study has some limitations. First, the pres-

**Table 2.** Perioperative and postoperative data of the groups

| | PCNL group[a] | RIRS group[a] | *P* value |
|---|---|---|---|
| Operative times (min) | 55.36 ± 17.93 | 66.86 ± 12.82 | 0.002 |
| SFR after a single procedure (%) | 134 (91.7%) | 108 (74%) | 0.040 |
| Re-treatment rate (%) | 12 (8.3%) | 38 (26%) | 0.001 |
| SFR after additional procedures (%) | 138 (94.4%) | 135 (92.3%) | 0.520 |
| Fluroscopy time (sec) | 161.4 ± 107.4 | 4.85 ± 3.71 | 0.0001 |
| Hospitalization time (day) | 3.97 ± 1.92 | 1.41 ± 1.16 | 0.0001 |
| Visual analogue scores | 4.69 ± 1.39 | 2.41 ± 1.43 | 0.0001 |
| Minor complication rates | 10 (6.8%) | 5 (3.4%) | 0.18 |

[a]Data is presented as mean ± SD or number(percent).

ent study is a retrospective analysis of patients who were treated with PCNL or RIRS in a single center. Second, the cost analysis of each procedure was not evaluated which may be an important factor on decision of the surgical technique. Therefore, studies with large population of patients in a prospective-randomized design are needed to assess the best treatment option in this group of patients.

## CONCLUSIONS

Both of RIRS and PCNL are safe and effective treatment options for large size renal stones. According to our findings, RIRS has some advantages such as less post-operative pain, shorter hospitalization and fluoroscopy time in treating 20-40 mm renal stones. However, PCNL poses a higher SFR only with a single session. The treatment modality should be decided with patients by discussing advantages and disadvantages of each procedure.

## CONFLICT OF INTEREST

The authors report no conflict on interest.

## REFERENCES


1. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12:e86-96
2. Turk C, Knoll T, Petrik A, et al. Guidelines on Urolithiasis, 2015: 1–71. Available at: http://uroweb.org/wp-content/uploads/EAU-Guidelines-Urolithiasis-2015-v2.pdf
3. Resorlu B, Unsal A, Ziypak T, et al. Comparison of retrograde intrarenal surgery, shockwave lithotripsy, and percutaneous nephrolithotomy for treatment of medium-sized radiolucent renal stones. World J Urol. 2013 ;31:1581-6.
4. Wiesenthal JD, Ghiculete D, D'A Honey RJ, Pace KT. A comparison of treatment modalities for renal calculi between 100 and 300 mm2: are shockwave lithotripsy, ureteroscopy and percutaneous nephrolithotomy equivalent? J Endourol 2011;25:481-5.
5. Bozkurt OF, Resorlu B, Yildiz Y, Can CE, Unsal A. Retrograde intrarenal surgery versus percutaneous nephrolithotomy in the management of lower-pole renal stones with a diameter of 15 to 20 mm. J Endourol 2011; 25:1131-5.
6. Aboumarzouk OM, Monga M, Kata SG, Traxer O, Somani BK. Flexible ureteroscopy and laser lithotripsy for stones > 2 cm: a systematic review and meta-analysis. J Endourol 2012; 26: 1257-63.
7. Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. Surgery 1991;111:518-26
8. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-13.
9. Akman T, Binbay M, Ozgor F, et al. Comparison of percutaneous nephrolithotomy and retrograde flexible nephrolithotripsy for the management of 2-4 cm stones: a matched-pair analysis. BJU Int. 2012;109:1384-9.
10. Bryniarski P, Paradysz A, Zyczkowski M, Kupilas A, Nowakowski K, Bogacki R. A randomized controlled study to analyze the safety and efficacy of percutaneous nephrolithotripsy and retrograde intrarenal surgery in the management of renal stones more than 2 cm in diameter. J Endourol. 2012 Jan;26:52-7.
11. Palmero JL, Durán-Rivera AJ, Miralles J, Pastor JC, Benedicto A. Comparative study for the efficacy and safety of percutaneous nefhrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS) for the treatment of 2-3,5 cm kidney stones. Arch Esp Urol. 2016;69:67-72.
12. Koyuncu H, Yencilek F, Kalkan M, Bastug Y, Yencilek E, Ozdemir AT. Intrarenal Surgery vs Percutaneous Nephrolithotomy in the

Management of Lower Pole Stones Greater than 2 cm. Int Braz J Urol. 2015;41:245-51.

13. Hyams ES, Munver R, Bird VG, Uberoi J, Shah O. Flexible ureterorenoscopy and holmium laser lithotripsy for the management of renal stone burdens that measure 2 to 3 cm: a multi-institutional experience. J Endourol 2010; 24: 1583-8.

14. Breda A, Ogunyemi O, Leppert JT, Schulam PG. Flexible ureteroscopy and laser lithotripsy for multiple unilateral intrarenal stones. Eur Urol 2009; 55: 1190–6.

15. De S, Autorino R, Kim FJ, et al. Percutaneous nephrolithotomy versus retrograde intrarenal surgery: a systematic review and meta-analysis. Eur Urol. 2015;67:125-37.

16. Agrawal MS, Agrawal M, Gupta A, Bansal S, Yadav A, Goyal J. A randomized comparison of tubeless and standard percutaneous nephrolithotomy. J Endourol 2008; 22: 439–42.

17. Knoll T, Wezel F, Michel MS, Honeck P, Wendt-Nordahl G. Do patients benefit from miniaturized tubeless percutaneous nephrolithotomy? A comparative prospective study . J Endourol 2010; 24: 1075–9.