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Comparison of retrograde intrarenal surgery and percutaneous nephrolithotomy results for 20-30 mm kidney stones: A matched-pair analysis

20-30 mm böbrek taşları için uygulanan retrograd intarenal cerrahi ve perkütan nefrolitotomi sonuçlarının karşılaştırılması: Eşleşmiş çift analizi

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ÖZET

Amaç: 20-30 mm böbrek taşlarında retrograd intrarenal cerrahi ve perkütan nefrolitotomi sonuçlarını karşılaştırmayı amaçladık.

Gereç ve Yöntemler: Ocak 2013 ile Temmuz 2022 tarihleri arasında 20-30 mm böbrek taşı nedeniyle retrograd intrarenal cerrahi ve perkütan nefrolitotomi uygulanan 324 hastanın demografik, radyolojik, klinik ve cerrahi ile ilgili verileri retrospektif olarak incelendi. Tüm hastalar yapılan cerrahiye göre retrograd intrarenal cerrahi grubu ve perkütan nefrolitotomi grubu olarak iki gruba ayrıldı. Yaş, taş sayısı, taş yerleşimi, taş boyutu ve taş yoğunluğu açısından iki grup eşleştirildikten sonra 122 hasta (retrograd intrarenal grupta 61 hasta ve perkütan nefrolitotomi grubunda 61 hasta, 1:1 oranında) çalışmaya dahil edildi.

Bulgular: Retrograd intrarenal cerrahi grubu (%78.7) ve perkütan nefrolitotomi grubu (%80.2) başarı oranları benzerdi (p=0.823). Enfektif ve enfektif olmayan komplikasyonlar açısından iki grup arasında fark yoktu (sırasıyla, p=0.752 ve p=0.61). Ameliyat süresi ve hastanede yatış süresi açısından iki grup arasında istatistiksel olarak anlamlı fark vardı. Retrograd intrarenal cerrahi grubunda ortanca ameliyat süresi 70 (30-100) dakika ve ortanca hastanede kalış süresi 1 (1-28) gün, perkütan nefrolitotomi grubunda ise ortanca ameliyat süresi 90 (50-160) dakika ve ortanca hastanede kalış süresi 4 (2-10) gün idi (p<0.001).

Sonuç: 20-30 mm böbrek taşlarının cerrahi tedavisinde retrograd intrarenal cerrahi, benzer başarı ve komplikasyon oranları, daha kısa operasyon süresi ve hastanede kalış süresi ile iyi bir alternatiftir.

Anahtar Kelimeler: *perkütan nefrolitotomi, retrograd intrarenal cerrahi, taş, ürolitiyazis*

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This study was approved by the Ankara City Hospital Ethics Committee of Clinical Researches (Approval Number: E2-22-2398, Date: 2022-10-12). All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

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ABSTRACT

Objective: To compare the results of retrograde intrarenal surgery and percutaneous nephrolithotomy for 20-30 mm kidney stones.

Material and Methods: The demographic, radiologic, clinic and surgery related data of 324 patients who underwent retrograde intrarenal surgery and percutaneous nephrolithotomy for 20-30 mm kidney stones between January 2013 and July 2022 were retrospectively analyzed. All patients were divided into two groups as retrograde intrarenal surgery group and percutaneous nephrolithotomy group according to the surgery performed. After matching two groups in terms of age, number of stones, location of stones, stone size and stone density, 122 patients were included in the study (61 patients in retrograde intrarenal group and 61 patients in percutaneous nephrolithotomy group as 1:1).

Results: The success rate of retrograde intrarenal surgery group (78.7%) and percutaneous nephrolithotomy group (80.2%) were similar (p=0.823). There was no difference between two groups in terms of infective and non-infective complications (respectively, p=0.752 and p=0.61). There were statistically significant difference between the two groups in duration of operation and hospitalization. The median operation time was 70 (30-100) minutes and the median hospital stay was 1 (1-28) days in the RIRS group, while the median operation time was 90 (50-160) minutes and the median hospital stay was 4 (2-10) days in the PNL group (p<0.001).

Conclusion: Retrograde intrarenal surgery is a good alternative in the surgical treatment of 20-30 mm kidney stones with similar success and complication rates and also shorter operation time and hospitalization time.

Keywords: *percutaneous nephrolithotomy, retrograde intrarenal surgery, stone, urolithiasis*

INTRODUCTION

Urinary system stone disease is very common and its increasing incidence and prevalence confer to an exponentially growing burden in terms of therapeutic procedures and financial resources (1). Operative management of stones comprises the main therapeutic option of stone disease and its evolvement through the last decades is taking place at a rapid pace. Following this involvement, indications, and limitations relating to each stone disease category have changed tremendously during the last years.

Regarding renal stones, they represent a demanding subset of stone disease cases, which in the past was managed mainly through open surgical extraction of the stone burden, while nowadays minimally invasive extraction is taking place through endourological approaches. Large renal stones (>2 cm) are mostly characterized by increased stone volume, therefore their complete removal is considered challenging. According to the European guidelines for urolithiasis, percutaneous nephrolithotomy (PNL) is still the standard option for kidney stones of the above category, while retrograde intrarenal surgery (RIRS) through flexible ureteroscopy (fURS) is kept as an alternative for cases with a contraindication for PNL, such as patients under anticoagulant therapy (2). The rationale of the above strategy is related to a tendency for a lower stone-free rate (SFR) after RIRS. Similarly, the guidelines of the American Urological Association (AUA) recommend PNL as the first option for removal of kidney stones >2 cm, while ineligible for PNL should be managed by staged RIRS (3).

From the historical perspective, fURS was performed for the first time in 1964 to diagnose disorders of the upper urinary tract (4). Regarding the management of renal stones, the first series of cases operated through fURS were reported in the late 1990s, which was after the successful application of holmium laser through ureteroscopes with a suitable working channel (4). Continuously growing experience and improved equipment allowed the successful performance of stone removal even in cases with renal stones >2 cm, yet only in the last years fURS was officially recognized as an effective alternative to the standard option of PNL.

Currently, a number of technological innovations are driving the performance of modern RIRS. These innovations include the increase of power of stone disintegrating systems, the application of improved

optics, the introduction of new laser energy types, the improved application of irrigation during the procedures, and the use of single-use equipment (5). The above innovations have allowed the more efficient removal of the stone burden from renal cavities with lower intrarenal pressure, which is crucial for the reduction of complications. Future directions for the fURS and RIRS include the improved control of temperature in the renal cavities during the procedures, the application of artificial intelligence for optimal adjustment of procedural parameters, and the multiple-axis tip deflection (5). These developments are expected to contribute to the further extension of fURS indications and to improve the results and the safety profile of the respective procedures.

Given the continuously increasing popularity of RIRS, many urologists support the opinion, that the role of PNL in the removal of renal stones will be diminished in the future, which also refers to stones >2 cm. Indeed, RIRS has demonstrated promising results and a review by Breda et al. summoned the studies reporting results of RIRS for renal stones >2.5 cm and concluded that an SFR of 89.3% was feasible with an average of 1.6 procedures per case and low complication rate (6). However, comparable results of RIRS to PNL are achievable frequently through staged procedures in high-volume centers, which suggests that RIRS is not yet equivalent to PNL (7). Moreover, technological developments are also contributing to the optimization of PNL procedures, with the miniaturization of the respective scopes and access sheaths, which makes PNL less invasive and safer in terms of complication rate (7).

As a conclusion, the evolvement of the above surgical approaches increases the overlap in the indication range of each modality, so that the selection can be made also with subjective criteria, e.g. the surgeon's preference. Based on the current characteristics of performing the above approaches in our clinic, the aim of this study was to compare the results and safety profile of RIRS to PNL in removing renal stones with a maximal diameter of 2-3 cm. According to our opinion, this size category represents the first ''grey zone'', where the newest clinical data may drive to a change of the official recommendations in favor of RIRS.

MATERIAL AND METHODS

Patient

The local ethics committee approved the study (Approval number: E2-22-2398).

The results of 324 patients who had operated with RIRS and PNL to treat 20-30 mm kidney stones in urology depatrment between January 2013 and July 2022 were retrospectively analyzed. RIRS group consisted of the patients who preferred RIRS because it was a less invasive surgery despite the presence of 2-3 cm kidney stones in our study.

The surgical method (RIRS, PNL), age, gender, body mass index [BMI], stone side, number of stones, stone location, stone size, stone density, history of urinary tract infection, history of previous stone surgery, duration of operation, presence of residual stones, infective complications and non-infective complications were evaluated. Two groups were formed as RIRS group and PNL group according to the surgery performed. Then, the two groups were matched 1:1 with respect to age, stone number, stone location, stone size and stone density. Thus, it was possible to match 61 patients in the RIRS group and 61 patients in the PNL group, and 122 patients were included in the study. These two groups were compared in terms of the data mentioned above. Only single session RIRS and PNL results were included in the study.

Kidney stones of all patients was diagnosed by preoperative non-contrast computed tomography. Stone size was defined as the measurement of the longest diameter of the stone in millimeters. If there is more than one stone, the stone sizes was summed up.

At least 7 days treatment with antibotics to the urinary tract infection were applied. None of the patients were operated without sterile urine culture. 2 g cefazoline were given 1 hour before surgery for the prophylaxis.

Surgical Technique

RIRS was applied to all patients under general anesthesia and in the lithotomy position. The genital area was cleaned with 10% povidone iodine solution and covered sterile. Before RIRS, 9.5 F rigid ureter-

orenoscope (URS) was used for the ureterorenoscopy and dilatation. In sufficiently dilated ureters, access sheath was directed to collecting system. Then, 7.5 F flexible (URS) was used for to reach the stone through the access channel. DJ stent was placed in patients with ureteral stenosis and the operation was postponed for 2 weeks.

Pecutaneous nephrolithotomy was performed in the prone or supine position. The choice of method in PNL was made by the surgeon according to the surgeon's experience. An 18-G needle was inserted through the appropriate calyx by using fluoroscopy. After the dilatations of tract with facial dilators, through 30-Ch Amplatz sheath, 26 Fr nephroscope was used. For the fragmentation of the stones pneumatic lithotriter was used and the fragments were collected with forceps.

In supine PNL, the patient raised about 30° same side of the stone in supine position. All other procedures were as mentioned above.

A 22 Fr nephrostomy catheter was placed in the kidney. The catheter was removed if the urine was clear on the third day after the operation and there was no extravasation in the controle pyelogram. The duration of the operation was accepted as the time from the entry of the rigid ureterorenoscope through the urethra to the insertion of the catheter for RIRS. For PNL, it was calculated as the time to insertion of the nephrostomy tube. The length of hospital stay was evaluated as 1 day of surgery. At the first month control abcence of residual stone in imaging methods, was accepted as succesful operation.

Statistical Analysis

SPSS 22 software package program was used for statistical analyzes and to code the data Shapiro-Wilk tests were used for distribution of data. For the non categorical parameters comparision Mann-Whitney U test was used. Chi-square test was used for categorical variables. The p value below 0.05 were considered statistically significant.

RESULTS

The median age of 122 patients included in the study was 43 (20-71) years. The rate of male patients were 67.2%. The median stone size was 25 (20-30) mm, and the median stone density was 1288 (569-1714) HU. There was no significant difference between two groups in terms of age, stone number, stone location, stone size and stone density ($p>0.05$). In addition, the groups were similar in terms of gender, BMI, stone side, stone surgery history and urinary tract infection history ($p>0.05$).

The success rate was 78.7% in the retrograde intrarenal surgery group and it was 80.2% in the PNL group ($p=0.823$). Infective complications developed in 6 (9.8%) patients in the RIRS group and in 5 (8.2%) patients in the PNL group. These complications were fever in 4 patients, urinary tract infection in 1 patient and sepsis in 1 patient in the RIRS group, while fever in 3 patients and urinary tract infection in 2 patients in the PNL group. Infective complications were similar between two groups ($p=0.752$). There were non-infective complications in 8 (13.1%) patients in the RIRS group and in 10 (16.4%) patients in the PNL group. These complications were minimal mucosal injuriy in 3 patients, mucosal injury requiring stent in 2 patients, bleeding requiring transfusion in 1 patient, transient creatinine elevation in 1 patient, and stent migration in 1 patient for the RIRS group. In the PNL group, urinary extravasation requiring stenting occured in 4 patients, bleeding requiring transfusion in 3 patients, transient creatinine elevation in 2 patients, and perinephric abscess complications in 1 patient. The two groups were similar in terms of non-infective complications ($p=0.61$).

Duration of operation and hospitalization were different between two groups. The median operation time was 70 (30-100) minutes and the median hospital stay was 1 (1-28) days in the RIRS group, while the median operation time was 90 (50-160) minutes and the median hospital stay was 4 (2-10) days in the PNL group ($p<0.001$) (Table 1).

Table 1. Comparative analysis of demographic, clinical and perioperative results of patients who underwent retrograde intrarenal surgery and percutaneous nephrolithotomy for 20-30 mm kidney stones

	Total (n=122)	*RIRS (n=61, 50%)*	*PNL (n=61, 50%)*	*p*
Age (years) (median [min-max])	43 (20-71)	44 (20-71)	43 (21-69)	0.802[m]
Gender				0.7[c]
Male, n (%)	82 (67.2)	42 (68.9)	40 (65.6)	
Female, n (%)	40 (32.8)	19 (31.1)	21 (34.4)	
BMI (kg/m²) (median [min-max])	25.9 (20.5-34.7)	25.9 (21.5-34.5)	25.7 (20.5-34.7)	0.518[m]
Stone size (mm) (median [min-max])	25 (20-30)	25 (20-30)	25 (20-28)	0.932[m]
Stone density (HU) (median [min-max])	1288 (569-1714)	1327 (569-1714)	1278 (620-1668)	0.971[m]
Number of stones				
Single, n (%)	64 (51.8)	31 (50.8)	33 (54.1)	0.365[c]
Multiple, n (%)	58 (48.2)	30 (49.2)	28 (45.9)	
Stone location				
Pelvis, n (%)	32 (26.2)	15 (24.6)	17 (27.9)	
Upper calyx, n (%)	16 (13.1)	9 (14.8)	7 (11.5)	
Middle calyx, n (%)	12 (9.8)	5 (8.2)	7 (11.5)	0.938[c]
Lower calyx, n (%)	13 (10.7)	7 (11.4)	6 (9.8)	
Multicalyx, n (%)	49 (40.2)	25 (41)	24 (39.3)	
Stone side				
Right, n (%)	51 (41.8)	30 (49.2)	21 (34.4)	0.099[c]
Left, n (%)	71 (58.2)	31 (50.8)	40 (65.6)	
History of previous stone surgery				0.586[c]
Yes, n (%)	58 (47.5)	31 (50.8)	27 (44.3)	
No, n (%)	64 (52.5)	30 (49.2)	34 (55.7)	
History of previous urinary tract infection				0.752[c]
Yes, n (%)	11 (9)	5 (8.2)	6 (9.8)	
No, n (%)	111 (91)	56 (91.8)	55 (90.2)	
Duration of operation (min) (median [min-max])	75 (30-160)	70 (30-100)	90 (50-160)	**<0.001[m]**
Success rate, n (%)	97 (79.5)	48 (78.7)	49 (80.3)	0.823[c]
Infective complication, n (%)	11 (9)	6 (9.8)	5 (8.2)	0.752[c]
Non- Infective complication, n (%)	18 (14.8)	8 (13.1)	10 (16.4)	0.61[c]
Hospital stay (days) (median [min-max])	3 (1-28)	1 (1-28)	4 (2-10)	**<0.001[m]**

***SD:** Standart Deviation, **BMI:** Body Mass Index, **HU:** Houndsfield Unit, min: minute,*
***m:** Mann Whitney U Test, **c:** Chi-squareTest*

DISCUSSION

Renal stones >2 cm represent a significant challenge in achieving complete stone burden removal under maximal safety for the patient. In this clinical setting, improved RIRS equipment seems to compensate for the diminished stone burden evacuation capability compared to PNL. In the current study, we included two patient groups with relatively large total stone volumes, which were comparable in terms of factors affecting the results of stone removal surgery, in order to reduce any bias from these factors. The modalities used for the stone removal achieved high success rates, with PNL resulting to complete stone extraction in 80.2% of the patients, which was slightly higher, but not statistically significant compared to the respective rate of RIRS. Infective complications manifested also at an almost similar rate in the com-

paring patient groups. Non-infective complications were slightly but not significantly higher in the PNL group. More interestingly, RIRS procedures were characterized by shorter duration, a difference that was statistically significant and confirms the increased efficiency of the modern fURS armamentarium. Another significant difference was observed in the hospital stay duration, where patients managed with RIRS were able to be dismissed at an earlier time point than PNL patients.

Regarding the publications on the comparison of the above modalities in the treatment of renal stones >2 cm, the reported data are heterogeneous. In 2014, Zheng et al. found a significant difference in bleeding events in favor of RIRS, while SFR and fever events were not different compared to PNL (8). On the contrary, a meta-analysis by Kang et al. proved the advantage of PNL in terms of stone extraction (9). In 2017, a meta-analysis by Zhu et al. demonstrated a significantly lower SFR, shorter hospital stay, and longer operation duration for RIRS in cases with renal stones >2 cm (10). The most recent meta-analysis found during literature search, which compared mini PNL (mPNL) to RIRS for renal stones 2-3 cm, showed an advantage of mPNL over RIRS in terms of SFR, need for an auxiliary procedure, while blood loss, fluoroscopy time and hospital stay were significantly different in favor of RIRS (11). A very recent prospective randomized controlled trial on the same topic demonstrated no significant difference in any of the comparing parameters, while stone clearance was only slightly higher in the PNL group (12).

In our opinion, RIRS has expanded its indications due to technological advances, but it is still strongly subject to the effect of stone size, which is also documented by respective studies (13). This fact does not exclude the possibility, that RIRS can demonstrate equivalent results with PNL, even in the challenging stone size category of >2 cm. The continuously improving performance of RIRS combined with its inherent tendency for the rare manifestation of complications is reflected in the modern operative practice for renal stones. More specifically, the number of RIRS procedures and their percentage in the whole of surgical procedures for renal stones are steadily increasing, while the respective parameters for PNL procedures are increasing to a minor degree, or remain stable, representing 5% of stone treatments (14, 15).

There are some limitations in our study. This is a retrospective study of a single center. In addition, the results of one session of the relevant surgery were given in the study. If more than one session was applied, the results might differ.

The above changes in trends of nephrolithiasis management are expected to be officially introduced in the respective guidelines. Since the first zone for the establishment of equivalence of RIRS is represented by the stone size category of 2-3 cm, we chose exactly this case subset to examine the performance of RIRS and PNL in terms of SFR and complication rate. Another advantage of the current study is the matching process of the comparing groups, which contributed to the objectivity of the respective comparisons. As in any clinical question, prospective studies have to be conducted to support the change in the operative practice of renal stone treatment with maximally unbiased data.

CONCLUSION

In the surgical treatment of 20-30 mm kidney stones, RIRS can be applied as an alternative to PNL with similar success and acceptable complication rates. In addition, it can provide advantages of shorter operation time and hospitalization time.

Conflict of Interest: The authors declare to have no conflicts of interest.

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Ethical Approval: The study was approved by the Ankara City Hospital Ethics Committee of Clinical Researches (Approval Number: E2-22-2398, Date: 2022-10-12). The study protocol conformed to the ethical guidelines of the Helsinki Declaration.

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REFERENCES

1. Tundo G, Vollstedt A, Meeks W, Pais V. Beyond Prevalence: Annual Cumulative Incidence of Kidney Stones in the United States. J Urol. 2021;205(6):1704-1709. [Crossref]
2. EAU Guidelines. Edn. presented at the EAU Annual Congress Amsterdam 2022: EAU Guidelines Office, Arnhem, the Netherlands; 2022.
3. Assimos D, Krambeck A, Miller NL, et al. Surgical Management of Stones: American Urological Association/Endourological Society Guideline, PART II. J Urol. 2016;196(4):1161-9. [Crossref]
4. Inoue T, Okada S, Hamamoto S, Fujisawa M. Retrograde intrarenal surgery: Past, present, and future. Investig Clin Urol. 2021;62(2):121-135. [Crossref]
5. Juliebø-Jones P, Keller EX, Haugland JN, et al. Advances in Ureteroscopy: New technologies and current innovations in the era of Tailored Endourological Stone Treatment (TEST). Journal of Clinical Urology. 2022;20514158221115986. [Crossref]
6. Breda A, Angerri O. Retrograde intrarenal surgery for kidney stones larger than 2.5cm. Curr Opin Urol. 2014;24(2):179-83. [Crossref]
7. De Lorenzis E, Zanetti SP, Boeri L, Montanari E. Is There Still a Place for Percutaneous Nephrolithotomy in Current Times? J Clin Med. 2022; 11(17):5157. [Crossref]
8. Zheng C, Xiong B, Wang H, et al. Retrograde intrarenal surgery versus percutaneous nephrolithotomy for treatment of renal stones >2 cm: a meta-analysis. Urol Int. 2014;93(4):417-24. [Crossref]
9. Kang SK, Cho KS, Kang DH, Jung HD, Kwon JK, Lee JY. Systematic review and meta-analysis to compare success rates of retrograde intrarenal surgery versus percutaneous nephrolithotomy for renal stones >2 cm: An update. Medicine (Baltimore). 2017;96(49):e9119. [Crossref]
10. Zhu M, Wang X, Shi Z, et al. Comparison between retrograde intrarenal surgery and percutaneous nephrolithotripsy in the management of renal stones: A meta-analysis. Exp Ther Med. 2019;18(2):1366-1374. [Crossref]
11. Ibis MA, Gokce MI, Babayigit M, Yitgin Y, Karagoz MA, Boyuk A, Verep S, Turan S, Tefik T, Kiremit MC, Sonmez MG, Ergul R, Guven S, Sarica K. Could retrograde intrarenal surgery be a safe and effective alternative to mini-percutaneous nephrolithotomy ın the management of relatively large (20-30 mm) stones? A critical evaluation. Int Urol Nephrol. 2022;54(9):2141-2148. [Crossref]
12. Fayad MK, Fahmy O, Abulazayem KM, Salama NM. Retrograde intrarenal surgery versus percutaneous nephrolithotomy for treatment of renal pelvic stone more than 2 centimeters: a prospective randomized controlled trial. Urolithiasis. 2022;50(1):113-117. [Crossref]
13. Goldberg H, Golomb D, Shtabholtz Y, et al. The "old" 15 mm renal stone size limit for RIRS remains a clinically significant threshold size. World J Urol. 2017;35(12):1947-1954. [Crossref]
14. Chung KJ, Kim JH, Min GE, et al. Changing Trends in the Treatment of Nephrolithiasis in the Real World. J Endourol. 2019;33(3):248-253. [Crossref]
15. Rodríguez-Monsalve Herrero M, Doizi S, Keller EX, De Coninck V, Traxer O. Retrograde intrarenal surgery: An expanding role in treatment of urolithiasis. Asian J Urol. 2018;5(4):264-273. [Crossref]