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Original Article

Comparison of retrograde intrarenal surgery and percutaneous nephrolithotomy for the treatment of renal stones greater than 2 cm

İki santimetreden büyük böbrek taşlarının tedavisinde perkütan nefrolitotomi ve retrograd intrarenal cerrahinin karşılaştırılması

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ABSTRACT

Objective: To evaluate the safety and efficacy of retrograde intrarenal surgery (RIRS) in the treatment of kidney stones greater than 2 cm and to compare its results with those of percutaneous nephrolithotomy (PCNL).

Material and methods: We retrospectively analyzed a total of 143 patients: 86 patients (53 males and 33 females) who underwent PCNL and 57 patients (37 males and 20 females) who underwent RIRS between October 2009 and October 2013.

Results: The mean duration of operation was 100.26±33.26 min in the RIRS group and 75.55±21.5 min in the PCNL group (p<0.001). The hospital stay was significantly shorter in the RIRS group (1.56±0.8 vs. 4.57±2.1 days in the RIRS and PCNL groups, respectively; p<0.001). Stone-free rates after one session were 66.6% and 91.8% of the RIRS and PCNL groups, respectively. The stone-free rate of the RIRS group improved to 87.7% after the second session. Blood transfusions were required in two patients in the PCNL group. Complication rates were higher in the PCNL group.

Conclusion: This study revealed that RIRS can be an alternative to PCNL in the treatment of kidney stones with a diameter of 2–4 cm especially in patients with comorbidities.

Keywords: Kidney stones; flexible ureteroscopy; percutaneous nephrolithotomy; retrograde intrarenal surgery.

ÖZET

Amaç: İki cm'den büyük böbrek taşlarının tedavisinde retrograd intrarenal cerrahinin (RİRC) güvenilirliğinin ve etkinliğinin değerlendirilmesi ve sonuçlarının perkütan nefrolitotomi (PNL) ile karşılaştırılması.

Gereç ve yöntemler: Eylül 2009 ile Eylül 2013 tarihleri arasında PNL operasyonu olan 86 (53 erkek, 33 bayan) ile RİRC yapılan 57 (37 erkek ve 20 bayan) toplamda 143 hasta retrospektif olarak değerlendirildi.

Bulgular: Ortalama operasyon süresi RİRC yapılan hasta grubunda 100,26±33,26 dakika iken PNL yapılan hasta grubunda 75,55±21,5 bulundu (p<0,001). Ortalama hastanede kalış süresi RİRC yapılan hasta grubunda anlamlı olarak daha kısa bulundu (RİRC ve PNL gruplarında sırası ile 1,56±0,8'e karşı 4,57±2,1 gün, p<0,001). İlk girişim sonrası taşsızlık oranı sırası ile RİRC grubunda %66,6 iken PNL grubunda %91,8 bulunurken RİRC grubunda ikinci girişim sonrası taşsızlık oranı %87,7 olarak bulundu. PNL sonrası 2 hastaya kan transfüzyonu yapıldı. Komplikasyon oranı PNL yapılan grupta daha yüksek bulundu.

Sonuç: Bu çalışma iki cm'den büyük böbrek taşı olan komorbid hastalarda RİRC'ın PNL'e alternatif olabileceğini ortaya koymaktadır.

Anahtar kelimeler: Böbrek taşı; fleksibl üreteroskopi; perkütan nefrolitotomi; retrograd intrarenal cerrahi.

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Introduction

Developments in the treatment of urinary stones have made minimally invasive techniques such as percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS), extracorporeal shock wave lithotripsy (ESWL), and laparoscopic stone surgery feasible treatment options in cases that previously could only be treated with open surgery. European Urology Guidelines recommend ESWL as the first treatment option in renal stones smaller than 2 cm in size and PCNL in stones larger than 2 cm.[1] With advances in technology, new generation flexible ureteroscopes with safe and effective lithotripters such as holmium laser have been developed and RIRS became an important alternative in the treatment of large urinary stones.

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In this study, we retrospectively analyzed and compared the outcomes of patients who had PCNL or RIRS due to renal stones greater than 2 cm in size.

Material and methods

Ethics approval for the study was obtained from the local ethics committee of Firat University. A total of 143 patients admitted to our clinic and underwent PCNL (86 patients, 53 males and 33 females) or RIRS (57 patients, 37 males and 20 females) between October 2009 and October 2013 were reviewed retrospectively. Patients with severe comorbidities, renal failure, history of previous pyelonephritis, preoperative diagnosis of a renal scar, and morbidly obese patients and patients by whom multiple access was required during surgery were not included in the study. Demographic data of the patients, the size and the site of stones, the duration of operation, stone free rates, and the duration of the hospital stay were analyzed. The stone-free state was determined at the postoperative third month on computerized tomography (CT). Complete blood count, serum creatinine, bleeding and clotting times, and urine culture of the patients were analyzed. The patients with a positive urine culture had surgery after treatment with antibiotics for an appropriate duration. All patients had X-Ray direct urinary system X-ray or urinary system ultrasonography and spiral CT without contrast. Before surgery, all patients signed informed consent forms. The stone size was determined as the surface area calculated according to the guidelines of European Association of Urology.[2]

Standard conventional PCNL was used in patients who were treated by PCNL. Standard treatment included dilatation with standard Amplatz dilatation equipment, a nephroscope (26 F Storz; Karl Storz GmbH & Co. KG, Tuttlingen, Germany), and a pneumatic lithotripter (Vibrolith®, Elmed, Ankara, Turkey) for stone fragmentation. The procedure was performed using a C-arm X-ray device (PHILIPS BV ENDURA, Netherland). All PCNL procedures were performed in the standard prone position. For RIRS, a guidewire and a ureteral access sheath (11 or 12 F) were placed into the ureter and the procedure was performed using a Storz FLEX-X2 ureterorenoscope (Tuttlingen, Germany). A holmium laser device was set at the energy of level 1.0–2 J and the rate of 5–10 Hz. Later, stone-free rates were followed up in the outpatient clinic at the postoperative third month, with low-dose spiral CT.

Complications were scored according to the modified Clavien-Dindo classification in two groups.[3,4] Group 1 consisted of grade 1 and grade 2 complications and was classified as the "minor complication group," whereas group 2 consisted of grade 3, 4, and 5 complications and was classified as the "major complications group." The most common complication was postoperative fever (Modified Clavien 1) and was observed in nine patients in group 1, where it regressed after medical therapy. This complication was not observed in group 2. There was a need for blood transfusion in nine patients in group 1 (Modified Clavien 2) but not in any of the patients in group 2. In both groups, additional treatment was required because of stone street (steinstrasse) in two patients of each group (Modified Clavien 3b).

Statistical analysis

Statistical analysis was performed with Statistical Package for the Social Sciences 18.0 program (SPSS for Windows, Chicago, IL, USA). The chi-square test (χ^2 test) was used for comparisons of the categorical variables and the Student's t-test was used for the comparison of the two groups. Pearson correlation analysis was used to analyze correlations among the variables. The confidence interval was set at 95% and $p<0.05$ was considered statistically significant.

Results

There were a total of 143 patients: 86 patients in the PCNL group and 57 patients in the RIRS group. The size, location, and number of the stone(s); age; gender of the patient; prior history of open surgery or ESWL; degree of hydronephrosis; duration of hospital stay; stone-free rates; and complications were compared between the groups. Two groups showed statistically significant differences in prior history of surgery, localization of the stone, and mean stone size; however, they were similar in the other parameters examined. Table 1 shows the demographic characteristics of the patients and the characteristics of the stones.

The mean duration of surgery was 75.55±21.5 min in the PCNL group and 100.26±33.26 min in the RIRS group and the difference was statistically significant ($p<0.001$). All complications were seen more frequently in the PCNL group, with statistically significant results. Blood transfusions were required in two patients who underwent PCNL; however, none of the patients in the RIRS group required blood transfusions. None of the patients in the PCNL group developed hydrothorax or pneumothorax. Postoperative fever was seen in nine patients in the PCNL group; however, no patients in the RIRS group had this complication. The patients with postoperative fever were administered antibiotics according to their urinary culture results. Stone street (steinstrasse) formation was seen in two patients in the RIRS group and in two patients in the PCNL group; these patients underwent ureter stone surgery using a rigid ureteroscope in another session.

The mean hospital stay was significantly shorter in the RIRS group (1.56±0.8 days in the RIRS group and 4.57±2.1 days in the PCNL group) ($p<0.001$). The stone-free rate in the RIRS group was 66.6% for one entry and 87.7% for two entries. In the PCNL group, the stone-free rate was 91.8% with one entry (Table 2).

Table 1. Demographic characteristics of the patients and the characteristics of the stones

Parameters	PCNL	RIRS	p
Number of patients	86	57	
Mean age	46.76±14.09	44.04±14.79	0.269
Gender			
Female	33 (38.4%)	20 (35.1%)	0.691
Male	53 (61.6%)	37 (64.9%)	
Prior history of open surgery			
(–)	11 (12.8%)	20 (35.1%)	0.002
(+)	75 (87.2%)	37 (64.9%)	
History of ESWL			
(–)	7 (8.1%)	6 (10.5%)	0.643
(+)	79 (91.9%)	51 (89.5%)	
Degree of hydronephrosis			
None or mild	66 (76.7%)	49 (86%)	0.174
Moderate or severe	20 (23.3%)	8 (14%)	
Number of stones			
One	33	19	0.540
Multiple	53	38	
Localization of stone			
Upper calyx	0	7	
Middle calyx	7	10	
Lower calyx	12	17	<0.001
Pelvis	39	15	
Complex	8	8	
Mean stone size (cm)	2.93±0.71	2.50±0.66	<0.001

PCNL: percutaneous nephrolithotomy; RIRS: retrograde intrarenal surgery; ESWL: extracorporeal shock wave lithotripsy

Table 2. Postoperative data and complications

Parameters	PCNL n=86	RIRS n=57	p
Duration of surgery (min)	75.55±21.5	100.26±33.26	<0.001
Hospital stay (days)	4.57±2.1	1.56±0.8	<0.001
Postoperative amount of fall in hemoglobin (g/dL)	2.39±1.77	0.48±0.50	<0.001
Complication			
Fever	9	0	0.12
Blood transfusion	2	0	0.24
Stone street	2	2	0.54
Number of patients with residual stones	7	19	<0.001
Postoperative increase in creatinine	-	-	

PCNL: percutaneous nephrolithotomy; RIRS: retrograde intrarenal surgery

Discussion

Urinary system stone disease is the third most common pathological condition following urinary tract infections and prostate disorders that affects the urinary tract. The size, site, and number (single or multiple) of stone(s), characteristics of the urinary system, comorbidities, age, and activity of the patient are important for the treatment plan. The aim of the urinary stone treatment is achieving the highest stone-free rate with the lowest morbidity. Thus, currently, less invasive endourological methods are used in urinary stone treatment. PCNL is the treatment of choice for stones larger than 300 mm² as well as for complex renal stones.[2] Although this procedure has a high stone-free rate, it has significant complications despite technological advancements.[5-7]

The low success rate of ESWL and the high morbidity of PCNL in lower calyx stones directed investigators to other alternatives. RIRS is a reasonable alternative to PCNL and ESWL in low-volume lower calyx stones, because it has a lower complication rate compared with PCNL and a stone-free rate similar to that of ESWL. Bozkurt et al.[8] compared the results of 42 PCNL and 37 RIRS patients treated for clearance of renal stones with sizes of 1.5–2 cm. They reported the success rate as 92.8% for PCNL and 89.2% for RIRS. Lately, RIRS can be used in stones greater than 2 cm thanks to advances in technology. Cumulative success rate of RIRS after multiple sessions has been reported as 77%–93% in renal stones greater than 2 cm.[9-14] Grasso et al. used fiberoptic ureteroscope for noninfectious stones greater than 2 cm that were not suitable for PCNL and reported their success rate as 93%. Breda et al.[9] reported a cumulative post-procedural success rate of 93% after 2.3 sessions on average in stones with a diameter of 2–2.5 cm. Riley et al.[13] performed 1.8 procedures on average for stones greater than 2.5 cm and reported a success rate of 90.9%. Although a number of studies compared the results of PCNL and RIRS in intrarenal stones smaller than 2 cm, only a few studies have investigated their results in renal stones greater than 2 cm.[11-15]

In 2011, Akman et al.[15] studied patients with renal stones 2–4 cm in size and reported a success rate of 73.5% with a single session of RIRS and 91.2% with a single session of PCNL, and the stone-free rate was found to be 91.2% after 1.2 RIRS sessions on average. In our study, stone-free rates were 91.8% for a single session PCNL and 66.6% for a single session RIRS; however, the stone-free rate increased to 87.7% after the second session of RIRS. Our rates were similar to those reported in previous studies.

The duration of surgery reported by Mariani et al.[16] was 64 min, by Hyam et al.[17] was 74 min, and by Breda et al.[18] was 66 min for ureteroscopic treatment of renal stones between 2 and 4 cm in size. In our study, the duration of surgery was 75.55±21.5 min for PCNL and 100.26±33.26 min for RIRS, which showed

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statistically significant differences between them. On the other hand, the durations of both operations in our study were longer compared with those reported in other studies in the literature.

The relation between the duration of surgery and complications in PCNL were examined.[19,20] Most of the reported complications occurred during the access procedure, and they were related to injury of the renal parenchyma and neighboring organs. Complications of PCNL include bleeding that required blood transfusion, septicemia, colon injury, hemothorax, fever, and urinary infection. Bleeding requiring blood transfusion is a major complication, and the reported incidence is 0.8–45%.[21-23] Akman et al.[19] reported that when the duration of surgery exceeded 58 min, the need for blood transfusion increased in patients with PCNL. In our study, two of 86 patients with PCNL had bleeding that required blood transfusion; however, blood transfusion was not required in any of the patients with RIRS despite a long duration of operations. No studies in the current literature have investigated the relation between bleeding in RIRS and the duration of operation.[24] On the other hand, high intrarenal pressure during RIRS has been reported to cause temporary intrarenal reflux affecting the renal function.[15,25]

A significant postoperative increase in creatinine was not seen in any of the patients included in the present study. In our study, only two patients in the PCNL group and two patients in the RIRS group developed stone street and were treated with an additional rigid ureteroscopic procedure. The reason for stone street formation may be the use of a pneumatic lithotripter instead of a holmium laser in the PCNL group and the leaving of large-sized stones to be passed spontaneously in the RIRS group. Consistent fragmentation of a greater residual stone burden during RIRS into smaller particles (<1–2 mm) substantially decreases the risk of stone street formation.[15]

When compared with the RIRS group, the hospital stay was longer in the PCNL group. The most important reasons for this were the nephrostomy catheter placed for drainage, the need for analgesia, and the need for follow-up after blood transfusion. Recent studies showed that PCNL procedures performed without tubes decreased the hospital stay significantly.[26,27] In our study, the mean hospital stay was 4.57±2.1 days in the PCNL group and 1.56±0.8 days in the RIRS group. Similar to the literature results, hospital stay was significantly shorter in the RIRS group compared with the PCNL group ($p<0.001$).[24,28]

The limitations of our study are its retrospective nature, small number of patients included, being a single-center study, and a short follow-up time. Because of the retrospective nature of our study, attention was focused on the diameter of the stone. Localization of the stone and prior history of stone surgery were not evaluated in the analysis of the results; this can be assumed as a limitation. Treatment of lower calyceal kidney stones requires highly experienced urologists. Currently, both PCNL and RIRS provide high success rates in the treatment of lower calyceal kidney stones. RIRS is used as the primary option in morbid obese patients with stones smaller than 2 cm, in patients with musculoskeletal deformities or bleeding diatheses, in patients with the need for complete clearance of kidney stones, and in case of previous unsuccessful ESWL treatment. Currently, PCNL is the gold standard treatment for kidney stones greater than 2 cm. However, single or multi-session RIRS may provide successful results in stones greater than 2 cm. Therefore, RIRS with a holmium laser may be an alternative to PCNL in selected patients with large-sized renal stones. Nevertheless, these results must be confirmed by further prospective randomized trials.

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