Original Article

Comparative Study between Retrograde Intrarenal Surgery and Percutaneous Nephrolithotomy for the Treatment of Renal Stones

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Abstract

Background*: The prevalence of urolithiasis has increased during the last decades and now affects approximately 9% of the adult population specially in developed countries. European Urology Guidelines recommend PCNL in stones larger than 2 cm in size and ESWL in stones smaller than 2 cm in size as the first treatment option. 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.* ***Objective****: To evaluate the safety and efficacy of retrograde intrarenal surgery (RIRS) in the treatment of kidney stones and to compare its results with those of percutaneous nephrolithotomy (PCNL).* ***Materials and Methods****: We retrospectively analyzed a total of 50 patients ─ 27 patients (20 males and 7 females) who underwent PCNL and 23 patients (17 males and 6 females) who underwent RIRS between January 2015 and December 2017.* ***Results****: The mean duration of operation was 60.65 ± 23.56 minutes in the RIRS group and 50.55 ± 12.77 minutes in the PCNL group (p<0.047). The hospital stay was significantly shorter in the RIRS group (2.21 ± 0.9 vs 5.29 ± 1.53 days in the RIRS and PCNL groups, respectively; p<0.016). Stone-free rates after one session were 88.6% and 84.8% in the RIRS and PCNL groups respectively. Blood transfusions were required in five patients in the PCNL group. Complication rates were higher in the PCNL group.* ***Conclusion****: This study reveals that RIRS can be an alternative to PCNL in the treatment of kidney stone.*

Key words*: Kidney stones; Flexible ureteroscopy; Percutaneous nephrolithotomy; Retrograde intrarenal surgery*

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Introduction

The prevalence of urolithiasis has increased worldwide affecting approximately 9% of the adult population specially in developed countries.[1] It was estimated that 25% of these patients undergo a surgical procedure to remove stones.[2] About 50% of patients with previous urinary stones have a recurrence within 10 years.[3] The formation of kidney stones depends on age, gender, race, geographic location, climate and occupation. With development of new technology in medical science, treatment of renal stone has shifted to noninvasive and minimally invasive surgery. Minimally invasive procedures have become widely accepted over the past two decades and have almost entirely replaced open surgery. European Urology Guidelines recommend ESWL as the first treatment option in renal stones smaller than 2 cm in size and percutaneous nephrolithotomy (PCNL) in stones larger than 2 cm.[4] With advances in technology,

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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.

Percutaneous nephrolithotomy (PCNL) is one of the minimally invasive surgeries and is recommended as the treatment of choice for large renal stones (>20 mm) and for lower calyceal stones sized 10 to 20 mm with unfavorable factors for ESWL according to updated European Association of Urology guidelines.[4] A small skin incision is made and a nephroscope is passed into the kidney to examine the stones. Stones are fragmented by either laser, ultrasonic or electrohydraulic through the nephroscope and then stones are removed. Finally, a nephrotomy tube is placed to drain fluid from the kidney.

Retrograde intrarenal surgery (RIRS) can be used as a primary treatment in patients with renal stones smaller than 2 cm. It is a minimally invasive surgical procedure using flexible ureteroscope which enters the urethra through bladder and ureter into the kidney. This procedure is a retrograde approach to the intrarenal urine-collecting part and normally done under anesthesia. The stones can be seen through the scope, then treated with intracorporeal lithotriptors and grasping devices. Potential advantages of RIRS include shorter hospital stay, decreased cost due to decreased use of disposable appliances and decreased potential trauma associated with PCNL.

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

Material and Methods

Ethical approval was obtained from the local ethical committee of Enam Medical College. A total of 50 patients admitted to our hospital who underwent PCNL (27 patients, 20 males and 7 females) or RIRS (23 patients, 17 males and 6 females) between January 2015 and December 2017 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 for 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 hospital stay were analyzed. The stone-free state was determined at the postoperative third month on plain X-Ray KUB region. Complete blood count, serum creatinine, bleeding and clotting time, 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 KUB region, ultrasonography and IVU. The stone size was measured by ultrasonography and X-Ray KUB region. Before surgery, all patients signed informed consent forms.

Standard conventional PCNL was used in patients who were treated by PCNL. Standard treatment included dilatation with standard Amplatz dilatation equipment, a nephroscope, and a pneumatic lithotripter for stone fragmentation. The procedure was performed using a C-arm X-ray device. 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 ureterorenoscope. 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 X-Ray KUB region.

Statistical analysis

Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS 16.0). Chi-square test (χ^2 test) was used for comparisons of the categorical variables and Student's t-test was used for the comparison between two groups. Pearson's 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 50 patients ─ 27 patients in the PCNL group and 23 patients in the RIRS group. The size, location, age, gender of the patient, duration of hospital stay, stone-free rates and complications were compared between the groups. Two groups showed statistically significant differences in location of the stone and mean stone size and they were similar in the other parameters examined. Demographic characteristics of the patients and the characteristics of the stones was shown in Table I.

Table I: Demographic characteristics of the patients and the characteristics of the stones (N=50)

Parameters	PCNL group	RIRS group
Number of patients	27	23
Mean age	47.85	48.69
Gender		
Male	20	17
Female	7	6
Degree of hydronephrosis		
None or mild	6	3
Severe	2	0
Number of stones		
One	19	17
Multiple	8	6
Location of stones		
Upper calyx	2	3
Middle calyx	6	6
Lower calyx	17	3
Pelvis	2	11
Mean stone size	2.92	2.62

Table II shows the postoperative data and complications of the patients of both groups. The mean duration of surgery was 50.55 ± 12.77 minutes in the PCNL group and 60.65 ± 23.56 minutes in the RIRS group and the difference was statistically significant (p=0.047). All complications were found more in the PCNL group, which was statistically significant. Blood transfusion was required in two patients who underwent PCNL but none of the patients in the RIRS group required blood transfusion. None of the patients in the PCNL group developed hydrothorax or pneumothorax. Postoperative fever was seen in four patients in the PCNL group but no patients in the RIRS group had this complication. The patients with postoperative fever were administered antibiotics according to their urine culture results. Stone street (steinstrasse) formation was seen in two patients in the RIRS group and in four patients in the PCNL group; these patients underwent ureteroscopic removal of stone using a rigid ureteroscope in another session.

The mean hospital stay was significantly shorter in the RIRS group (2.21 ± 0.90 days in RIRS and 5.29 ± 1.53 days in PCNL group with p<0.016). The stone-free rate in the RIRS group was 88.6% for one entry whereas in the PCNL group the stone-free rate was 84.8% with one entry.

Discussion

Urinary 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 stones, 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 2 cm as well as for complex renal stones.[5] Although this procedure has a high stone-free rate, it has significant complications despite technological advancements.[6-10]

The low success rate of ESWL and the high morbidity of PCNL, specially 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[11] 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 92.8% for PCNL and 89.2% for RIRS.

Table II: Postoperative data and complications

Parameters	PCNL group (N=27)	RIRS group (N=23)	p values
Duration of surgery (minutes)	50.55 ± 12.77	60.65 ± 23.56	<0.047
Hospital stay (days)	5.29 ± 1.53	2.21 ± 0.90	<0.016
Complications			
Fever	4	0	<0.000
Postoperative bleeding needed blood transfusion	2	0	<0.005
Stone street	4	2	<0.009
Stone-free rates in first session (%)	84.8	88.6	<0.000
Number of patients with residual stones	4	1	<0.012
Postoperative increase in creatinine	-	-	-

Now-a-days RIRS can be used in stones greater than 2 cm because of advances in technology. Cumulative success rate of RIRS after multiple sessions has been reported as 77–93% in renal stones greater than 2 cm.[12-17] Grasso et al[15] 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[12] 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[16] 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.[14-18]

In 2011, Akman et al[18] 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 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.[18]

The duration of surgery for ureteroscopic treatment of renal stones between 2 and 4 cm in size was 64 minutes, 74 minutes and 66 minutes in the studies by Mariani et al[19], Hyam et al[20] and Breda et al[21] respectively. In our study, the duration of surgery was 50.55 ± 12.77 minutes for PCNL and 60.65 ± 23.56 minutes for RIRS, which was statistically significant. On the other hand, the durations of both operations in our study were longer compared with those reported in other studies in the literature.[19-21]

The relation between the duration of surgery and complications in PCNL were examined.[22,23] Most of the reported complications occurred during the access procedure, and those 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%.[24-26] Akman et al[22] reported that when the duration of surgery exceeded 58 minutes, the need for blood transfusion increased in patients with PCNL. In our study, two of 27 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.[27] On the other hand, high intrarenal pressure during RIRS has been reported to cause temporary intrarenal reflux affecting the renal function.[18,28]

A significant postoperative increase in creatinine was not seen in any of the patients included in the present study. In our study, only four 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 leaving 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.[18]

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.[29,30] In our study, the mean hospital stay was 5.29 ± 1.53 days in the PCNL group and 2.21 ± 0.90 days in the RIRS group. Similar to the literature results, hospital stay was significantly shorter in the RIRS group compared with the PCNL group ($p<0.016$).[27,29]

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 only 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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