ORIGINAL ARTICLE

Vol. 41 (2): 245-251, March - April, 2015
doi: 10.1590/S1677-5538.IBJU.2015.02.09

Intrarenal Surgery vs Percutaneous Nephrolithotomy in the Management of Lower Pole Stones Greater than 2 cm

Hakan Koyuncu [1], Faruk Yencilek [1], Mehmet Kalkan [2], Yavuz Bastug [3], Esin Yencilek [4], Ahmet Tunc Ozdemir [1]

[1] Department of Urology, Yeditepe University Medical Faculty; [2] Department of Urology, Fatih University Medical Faculty; [3] Department of Urology, Beykoz State Hospital, Istanbul, Turkey; [4] Department of Radiology, Haydarpasa Training and Research Hospital, Istanbul, Turkey

ABSTRACT

Purpose: To compare the efficacy of RIRS and PNL in lower pole stones ≥2 cm.
Materials and and Methods: A total of 109 patients who underwent PNL or RIRS for solitary lower pole stone between April 2009 and December 2012, were retrospectively analyzed. Lower pole stone was diagnosed with CT scan. Stone size was assessed as the longest axis of the stone. All patients were informed about the advantages, disadvantages and probable complications of both PNL and RIRS before the selection of the procedure. Patients decided the surgery type by themselves without being under any influences and written informed consent was obtained from all patients prior to the surgery. Patients were divided into two groups according to the patients' preference of surgery type. Group 1 consisted of 77 patients who underwent PNL and Group 2 consisted of 32 patients treated with RIRS. Stone free statuses, postoperative complications, operative time and hospitalization time were compared in both groups.
Results: There was no statistical significance between the two groups in mean age, stone size, stone laterality, mean follow-up periods and mean operative times. In PNL group, stone-free rate was 96.1% at first session and 100% after the additional procedure. In Group 2, stone-free rate was 90.6% at the first procedure and 100% after the additional procedure. The final stone-free rates and operative times were similar in both groups.
Conclusions: RIRS should be an effective treatment alternative to PNL in lower pole stones larger than 2 cm, especially in selected patients.

ARTICLE INFO

Key words:
Calculi; Nephrostomy, Percutaneous; Surgical Procedures, Operative; Retrograde Obturation

Int Braz J Urol. 2015; 41: 245-51

Submitted for publication:
April 30, 2014

Accepted after revision:
May 22, 2014

INTRODUCTION

Kidney stones greater than 2 cm have long been treated with percutaneous nephrolithotomy (PNL) (1, 2). PNL is also recommended as a primary treatment in the management of renal stones ≥2 cm by European Association of Urology (EAU) guidelines (3). Although PNL has stone-free rates higher than 90% regardless of stone size and location, PNL has several disadvantages such as invasiveness, bleeding, adjacent organ injury, partial renal loss, urinary extravasation and long hospitalization (4, 5). In addition, in patients with significant morbidities such as morbid obesity and bleeding diatheses, PNL may not be the best choice. These limitations of PNL have forced urologists to spend more attention on non-invasive procedures like retrograde intrarenal surgery (RIRS) in the management of large lower pole stones.

RIRS has become popular in the last decade with the technical advancements in endourologic equipments and increased surgeon experience. Today, in the management of renal stones, RIRS provides an alternative way to PNL by minimizing the risks related to PNL. Recent studies reported stone-free rates from 77% to >90% for RIRS of renal stones and 62% to 85% for the management of lower pole stones (2, 6-9). Furthermore, several studies have reported significant success rates with RIRS in the management of large renal stones (10). Recently, studies reporting the efficacy of RIRS in lower pole stones have increased (5). In addition, the complication rates of RIRS are lower and the only disadvantage of this technique is the possible need for repetition. To our knowledge, there is no study comparing the efficacy of RIRS and PNL in lower pole stones greater than 2 cm. In this study, our aim is to compare the efficacy of RIRS and PNL in lower pole stones ≥2 cm.

MATERIALS AND METHODS

A total of 109 patients who underwent PNL or RIRS for solitary lower pole stone between April 2009 and December 2012 were retrospectively analyzed. Data were obtained from the patients' files which were recorded with electronic data management system. Patient assessment included detailed medical history, physical examination and laboratory tests including urinalysis, urine culture, complete blood count, and serum biochemistry. Lower pole stone was diagnosed with computed tomography (CT) (including axial, sagittal and transverse sections). Stone size was assessed as the longest axis of the stone on CT scan. All patients were informed with the same diagrams and photos about the advantages, disadvantages and probable complications of both PNL and RIRS before the selection of the procedure. Patients decided the surgery type by themselves without being under any influences and written informed consent was obtained from all patients prior to the surgery. Patients with the history of previous urinary stone surgery or urinary anomaly were excluded. Patients were divided into two groups according to the patients' preference of surgery type. Group 1 consisted of 77 patients who underwent PNL and Group 2 consisted of 32 patients treated with RIRS. All patients were evaluated with serum biochemistry and blood count at the day after surgery. In addition, all patients underwent CT for the stone clearance, at the first postoperative month. Treatment success was defined as stone-free status or clinically insignificant residual fragments ≤2 mm. Patients were followed up every 3 months with urinalysis, urine culture and ultrasonography.

Stone-free status, postoperative complications, operative time and hospitalization time were compared in both groups. Chi-square and t-test were used for statistical analysis and statistical significance was defined as p value <0.05 at 95% confidence interval.

PNL Technique

All procedures were performed under general anesthesia. All patients received a third generation cephalosporin at the induction of anesthesia. A 6F ureteral catheter was placed within the cystoscope and the bladder was drained with a 16F urethral Foley catheter. After ureteral catheterization, patients were placed in the prone position, and percutaneous access was achieved under fluoroscopic guidance with the use of an 18-gauge needle and a guide wire. Tract dilation was accomplished by using Amplatz dilators up to 30F. Pneumatic lithotripter was used for fragmentation and stone removal was accomplished with retrieval graspers through a rigid 22F nephroscope. The operations were completed when residual fragments were not detected on fluoroscopic imaging. After completion, a 16F re-entry catheter was inserted into the kidney and ureteral passage was controlled with antegrade pyelography. The re-entry catheter was removed on postoperative days 1 or 2 after removing the ureteral catheter and performing an antegrade pyelography confirming the ureteral passage. Then the patient was discharged on the next day.

RIRS Technique

All procedures were performed by 7.5-Fr (Karl Storz, FLEX-X2, Tuttlingen, Germany) flexible ureteroscope. All patients received a third generation cephalosporin at the induction of anesthesia. Under general anesthesia, patients were placed in the lithotomy position on a fluoro-endoscopic table. Rigid ureteroscopy was routinely performed before flexible ureteroscopy in all patients for dilatation of the ureter and to place a hydrophilic guidewire into the renal pelvis. After passing a 0.038-inch safety guidewire into the renal pelvis, a ureteral access sheath (9.5/11.5 or 12/14Fr) was placed to allow for optimal visualization, to maintain low intrarenal pressure, and to facilitate extraction of stone fragments. For the cases in which the 12/14Fr ureteral access sheath could not progress regularly under the fluoroscopic control, 9.5/11.5Fr sheath was used. The stones were fragmented by a holmium: YAG laser (Lisa; Sphinx 30 W, Katlenburg University, Germany) (272µ caliber fiber) until they were deemed small enough to pass spontaneously. At the beginning of the laser lithotripsy, the laser functioning parameters were 1.5 Joule/11 Hertz and when the stone sizes decreased to 10 mm the parameters were changed to 10 J/12 H in order to avoid the pneumatic effect of the laser, which could migrate the stone to other poles. Basket extraction of residual fragments was not routinely performed; however, some residual fragments were removed by tipless nitinol baskets for stone analysis. At the end of the procedure, a double-J stent was placed routinely in all patients. JJ stents of the patients were removed at the postoperative first month.

RESULTS

Stone caracteristics and demographic data of the patients in both groups are presented in Table-1. There was no statistical significance between the two groups in mean age of patients (p=0.947), stone size (p=0.142) and stone laterality (p=0.820). The mean follow-up period was 13.5±4.71 months (range 3 to 22 months) in Group 1 and 12.5±5.26 months (range 3 to 19 months) in Group 2, respectively. No statistical significance was observed in mean follow-up periods in both groups (p=0.270). Mean operative time in both groups were similar; 62.5±20.67 minutes (range 38 to 107 min) in Group 1 and 67.5±22.34 (range 42 to 110 min) min in group 2 (p=0.671).

In Group 1, all procedures were performed by a single access procedure. Stone-free rate was 96.1% (74/77) at first session. Since the three patients had more than 3 residual fragments, they underwent an additional procedure (ESWL) and stone free rate increased to 100%. Thirty five (45.5%) patients were discharged at the postoperative 2nd day and 45 (54.5%) in 3rd day after confirming the ureteral passage with antegrade pyelography. Mean hospital stay was 2.4±0.49 days. One patient (0.9%) needed conservative management because of the persistent fever (Clavien grade I). Four patients (5.1%) needed blood transfusion because of hemorrhage (Clavien grade II) and one of them with significant bleeding (Clavien grade III) was treated with open surgical techniques (nephrolithotomy and primary renal parenchymal suturing). In Group 1, mean hemoglobin drop was 1.98±1.26 g/dL (range 0.3 to 8 g/dL). A JJ stent was placed into one patient (having persistent lumbar pain) (0.9%) because of the ureteral obstruction and removed at the 7th postoperative day. There was no urinary leakage, no adjacent organ

Table 1 - Stone Characteristics and Demographic Data of Patients.

	PNL Group (n=77)	RIRS Group (n=32)	p value
Mean age±SD	38.7±13.6	40.7±15.8	0.947
Male/Female	45/32	20/12	0.902
Mean stone size±SD (mm)	2.5±1.2 mm	2.3±1.2 mm	0.142
Lower pole localization (anterior/posterior)	12/65	4/28	0.236
Side (Right/Left)	50/27	21/11	0.820

injury, no kidney loss or deaths. Chemical composition of stones in Group 1 were calcium oxalate dehydrate (54/77, 70.1%), mixed (calcium oxalate dehydrate and monohydrate) (16/77, 20.7%), uric acid (5/77, 6.4%) and cystine stones (2/77, 2.5%).

In Group 2, stone-free rate was 90.6% (29/32) at the first procedure and 100% after the additional procedure (ureteroscopy). Three patients (3.2%) needed an additional procedure because of more than 3 residual fragments (three residual fragments in two patients and four in one patient, sized approximately 2 mm, in the kidney), at the first month control. In the course of removing the JJ stents of these three patients, flexible ureteroscopy was performed and all residual fragments were removed by tipless nitinol basket with no use of access sheath or holmium laser. Three patients (3.2%) with lumbar pain and persistent hematuria (Clavien grade I) were managed conservatively and discharged at the postoperative 2nd day. Recent patients (29/32, 90.6%) in RIRS group were discharged at the postoperative 1st day. In Group 2, mean hemoglobin drop was 0.18±0.18 g/dL (range 0 to 0.8 g/dL) and mean hospital stay was 1.09±0.29 days. No intraoperative complications such as ureteral perforation and no ureteral stricture at follow up period were observed. Stone analysis revealed calcium oxalate dehydrate in 23 patients (71.8%), mixed in 7 (21.8%) and uric acid in 2 (6.2%).

The treatment results of both groups are summarized in Table-2. The final stone-free rates and operative times (p=0.671) were similar in both groups. Hospitalization time (p=0.038) and hemorrhage (p<0.01) was higher in Group 1, however minor complications were similar in both groups (p=0.51).

DISCUSSION

Renal stones greater than 2 cm have traditionally been treated with PNL (1, 2). PNL is also recommended as a first line treatment option in the management of renal stones ≥2 cm in EAU and American Urological Association guidelines (3, 11). Several studies concerning about the treatment of larger renal stones, have reported stone free rates of PNL up to 95% (4, 12). PNL has also proved to be highly effective in lower pole stones. In a study, the stone-free rate of PNL was reported as 92% and 86 % for lower pole stones 1 to 2 cm and more than 2 cm, respectively (4). In a comparative study, PNL was the most effective approach for the management of lower pole stones between 1 to 2 cm, compared with RIRS and shock wave lithotripsy (13). Similar success rate was confirmed in another comparative study with a stone-free rate of 83% in lower pole stones between 1.5 to 2 cm (14). Despite the reported stone-free rates, ranging from 85% to 95%, several complications of PNL constitute a concern. The incidence of probable complications of PNL are reported in significant rates, including bleeding requiring blood transfusion 11.2% to 17.5%, fever 21% to 32.1%, sepsis 0.25% to 1.5%, pneumothorax 0% to 4% and colonic injury <1%. In consideration of other complications such as arteriovenous fistula, hypothermia, volume overload, colo-cutaneous fis-

Table 2 - Treatment Results in Both Groups.

	PNL group	RIRS group	p value
Initial stone free rate (%)	96.1% (74/77)	90.6% (29/32)	0.26
Final stone free rate (%)	100%	100%	-
Mean operative time	62.5±20.67	67.5±22.34	0.671
Hospital stay (day)	2.4±0.49	1.09±0.29	0.038
Transfusion rate (%)	5.1% (4/77)	0%	<0.01
Minor complication(%)	5/77 (6.4%)	3/32 (9.3%)	0.51

tula, electrolyte imbalance, pulmonary embolism and death, complication rate of PNL ranges from 0.03% to 10% in general (2, 10, 15). Additionally, in patients with significant comorbidities such as morbid obesity and bleeding diathesis, PNL is contraindicated due to the higher incidence of complications (11, 16). Finally, placement of the patient in a prone position increases the anesthetic risk because of the contractions of extremities and difficult airway.

Today, RIRS is an excellent minimally invasive treatment alternative for intrarenal stones smaller than 2 cm and reported stones-free rates are higher at this stone size (8, 17, 18). Increased experiences of the urologists and developments in the technology have created the substructure of this success. Development of new generation (bidirectional 270° flexion capacity, small caliber shaft and improved optics) flexible ureteroscopes, improved flexibility of holmium laser fibers, different and small diameter stone retrieval devices with the capability of facilitating intrarenal maneuvers have resulted in increased treatment success and decreased procedure related morbidity, in the management of renal stones (19-21). In addition, ureteral access sheaths provided lower intrarenal pressure during prolonged procedures and facilitated the retrieval of multiple stone fragments (22, 23). All these innovations and especially increased experience in RIRS aroused the urologists' interest to the success of this procedure in larger and lower calyceal renal stones.

Several studies reported their success rates of RIRS in the management of large renal stones. Grasso et al. reported an overall stone free rate of 91% for 66 renal stones >2 cm in 55 renal units. They reported that one third of patients have required second procedure (8). Breda et al. achieved a 93.3% success rate after an average of 2.3 procedures, in 15 patients with a single renal stone sized between 20 and 25 mm (24). In another study, authors showed an 87.5% stone free rate for renal stones between 2 and 3 cm with 43% of patients requiring second procedure (25). In a study including 22 patients with renal stones larger than 2.5 cm, authors reported a 91.6% stone free rate with an average 1.9 procedures (18). Similarly, the success rate of RIRS was evaluated in a study including 90 patients with different sized (<10mm ≥20 mm) lower pole stones. They concluded an 82% final stone free rate for lower pole stones >2 cm, after a second procedure (9). Accordingly, recent studies report up to 85% stone free rates of RIRS for the management of lower pole stones (8, 17). With these similar results, all of these studies have showed that RIRS should be an efficient treatment modality for larger renal stones as PNL which is more invasive. Nevertheless, to our knowledge, there is no study comparing the success rates of RIRS and PNL in lower pole stones >2 cm. In the management of lower pole stones greater than 2 cm, we have demonstrated a final 100% stone-free rate of RIRS with similar stone free rates of PNL. We suggest that this higher success rate in RIRS group may be related with the increased experience and the predominance of posterior localized lower pole stones in the kidney.

Furthermore, the association of longer operative time and endoscopic management of large renal stones were emphasized in the literature. However, recent reports demonstrated a rational operative time for ureteroscopy. Mariani et al. reported a mean operative time of 64 minutes (range 30 to 240 min) for the RIRS of renal stones between 2 and 4 cm (26). We also reported similar mean operative times in both groups, RIRS and PNL.

RIRS is known to have less complications compared to PNL (18). Major complications secondary to RIRS are less common and decrease in time. Today, with the decreasing size of instruments, significant complications such as ureteral avulsion are extremely rare. In addition, RIRS has been provided safe in patients with high risk and co-morbidities such as pregnant woman, morbid obesity, bleeding diathesis and in whom PNL may be contraindicated (27, 28) In a study, with a decreased ureteroscope size, a significant decrease in complications (from 6.6% to 1.5%) was reported. (29). Likewise, in our study, similar results regarding minor complication rates were demonstrated in PNL and RIRS groups. However, intraoperative bleeding needed intervention or transfusion was significantly higher in PNL group. Also, mean hospitalization time in PNL group was longer than RIRS group.

On the other hand, several limitations of our study must be addressed: 1. the number of patients included is rather low (especially in Group 2) therefore, further multicentric series with larger and equal number of study population have to be performed; 2. This study was a retrospective analysis. We suggest that a prospective study will exactly clarify the efficacy of RIRS in large lower pole stones.

CONCLUSIONS

RIRS can be an effective treatment alternative to PNL in lower pole stones larger than 2 cm, especially in selected patients. Further, multicentric comparative studies with larger study population are needed to confirm these results.

CONFLICT OF INTEREST

None declared.

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Correspondence address:
Hakan Koyuncu, MD
Department of Urology, Yeditepe University Hospital
Devlet Yolu Ankara Cad. 102/104
34752, Kozyatagı, Istanbul, Turkey
Fax: + 90 21 6578-4956
E-mail: mdhasbey@hotmail.com