Laparoscopic Pyelolithotomy for the Management of Large Renal Stones with Intrarenal Pelvis Anatomy

Nasser Simforoosh[1], Mohammad Hadi Radfar[1]*, Reza Valipour[2], Mehdi Dadpour[1], Amir H Kashi[1]*

Purpose: The role of laparoscopic pyelolithotomy (LPL) in the management of renal stones is evolving. One of the challenges in LPL for renal stones is patients with intrarenal pelvis. Here we present our experience with laparoscopic pyelolithotomy for the management of renal stones with intrarenal pelvis anatomy.

Materials and Methods: Patients candidate for laparoscopic pyelolithotomy from February 2014 to March 2015 were included. Intrarenal pelvis was defined as > 50% of the renal pelvis area contained inside renal parenchyma. Laparoscopic pyelolithotomy was done by transperitoneal approach. Residual stones were checked by computed tomography and/or intravenous pyelography and ultrasonography 6 weeks after the operation.

Results: 28 patients were included in this study. The mean±SD of patients' age was 45.8±12.5 years. 19 patients (68%) were male. Stone locations were pelvis, multiple, and staghorn in 22, 3, and 3 patients respectively. The mean±SD of operation duration was 160±48 minutes. Residual stones were observed in 3 patients with multiple (n=2) or staghorn (n=1) stones. Urinary leak was observed in 3 patients and was managed conservatively in 2 patients. In one patient ureteral stent was inserted by cystoscopy. No conversion to open surgery or re-operation occurred.

Conclusion: Laparoscopic pyelolithotomy is a feasible operation for patients with renal stones and intrarenal pelvis in centers with adequate experience in laparoscopy. However, the success of LPL decreases in patients with multiple stones and intrarenal pelvis.

Keywords: intrarenal; kidney anatomy; laparoscopy; urolithiasis

INTRODUCTION

The management of renal stones has dramatically changed after the 1980's. With the introduction of shock wave lithotripsy and minimally invasive interventions (e.g. ureteroscopy, percutaneous nephrolithotomy (PCNL), and laparoscopy) the role of open stone surgery is now limited to < 5% of the cases.(1-3)
Currently, PCNL is the gold standard treatment modality for the management of large renal stones.(4,5) Complications related to PCNL include bleeding, premature termination, sepsis, adjacent organ injury, and hydro or pneumothorax, especially for very large and complex stones.(6,7) Therefore the management of very large and complex stones is still a challenge for many urologists.(2)

Laparoscopic pyelolithotomy (LPL) was first described by Gaur et. al. more than 2 decades ago.(8) There have been some descriptive and comparative studies reporting the results of LPL or comparing its results with PCNL.(1,9-15) Some recent studies have reported satisfactory or even better overall results and/or complications with LPL in comparison with PCNL.(4,12,16,17) Nevertheless, the total cases reported by LPL are still limited and are mostly from non-randomized studies. Currently, the indications for LPL in the management of renal stones have not been clearly defined.(9,12)
The majority of reported LPLs include patients with an extrarenal pelvis.(2,4,15) LPL for patients with an intrarenal pelvis is challenging due to surgical difficulty releasing enough surface of renal pelvis to remove the stone en bloc. Here we report our experience with LPL for renal stones with intrarenal pelvis anatomy.

MATERIALS AND METHODS

From February 2014 to March 2015 patients who were candidate for stone surgery with solitary renal stones and/or a limited number of stones in renal calices were included in the study. In our department, PCNL is routinely provided to patients with renal stones with an average of 900-1000 PCNLs each year. LPL is also provided based on surgeons' and patients' preferences to some patients and at the time of the study was performed in an average of 50-60 operations each year. Preoperative evaluation included clinical history taking, physical examination, urine analysis and culture, serum creatinine, electrolytes and hemoglobin, intravenous pyelography (IVP) or computerized tomography (CT) scan, and renal ultrasonography. Renal pelvic anatomy was reviewed on preoperative imaging (CT and/or IVP). Intrarenal pelvis was defined by a novel

[1]Urology and Nephrology Research Center (UNRC), Shahid Labbafinejad Medical Center, Shahid Beheshti, University of Medical Sciences (SBMU), Tehran, Iran.
[2]Azad University of Medical Sciences, Tehran, Iran.
*Correspondence: Urology and Nephrology Research Center (UNRC), Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences (SBMU), Tehran, Iran. Email: ahkashi@gmail.com
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Table 1. Patients' characteristics.

Variable	
Age, years; mean±SD	45.8±12.5
Gender, male; N(%)	19(68)
Side, left; N(%)	15(54)
Stone size, mm; mean±SD	26.1±9.9
Stone location; N	
Pelvis, multiple, staghorn	22,3,3
History of stone surgery; N	
Nil, SWL,PCNL,OSS	19,6,1,2

Table 2. Operations' characteristics and postoperative complications

Variable	Mean ± SD
Creatinine before operation, mg/dl	1.15 ± 0.44
Creatinine 1st postop day, mg/dl	1.26 ± 0.43
Hb before operation, mg/dl	14.2 ± 1.9
Hb 1st postop day, mg/dl	13.2 ± 2.1
Operation duration, minutes	160 ± 48
Hospitalization days; mean (range)	5.8(3-14)
Clavien-Dindo grade of complications; N(%)	
Grade II	4 (14)
Grade III	1 (4)

method proposed by Tomaszewski et al.[18,19] (**Figure 1**) Briefly, a line was drawn connecting two polar lines of renal pelvis border with renal parenchyma (**dots A and B in Figure 1**) on excretory phases cross imaging and the percentage of renal pelvic area (by linear dimensions) contained inside the volume of renal parenchyma was calculated. Intrarenal pelvis was defined when > 50% of renal pelvic area was contained inside renal parenchyma. (**Figure 1**) Data was gathered prospectively. Prophylactic antibiotics were administered on the day of surgery before the operation. LPL was performed as described before[2,3] and is summarized below:

After general anesthesia, the patient was positioned in the modified lateral decubitus with minimal fiexion. A 12-mm camera port was inserted in the umbilicus by open access. Three 5-mm working ports were inserted under direct vision in the midline,10 cm above the umbilicus, in the midclavicular line parallel to the umbilicus, and below the umbilicus lateral to the rectus muscle. The white line of Toldt was incised, and the colon was medially reflected. The pelvis and ureter were identified, the renal pedicle was exposed, and then the renal pelvis was freed from surrounding peripelvic fat up to the junction of pelvis with renal parenchyma.(**Figure 2**) A transverse pyelotomy incision was made away from ureteropelvic junction to prevent ureteropelvic junction stenosis by electrocautery or cold scissors. This incision was made on the renal pelvis as much needed to extract the stone(s) cautiously to prevent excessive pelvis tearing. The tip of the pelvic stone was freed from the ureteropelvic junction, and then the stone was extracted with a curve grasper and/or Babcock grasper. The pelvic incision was extended as needed to allow removal of the branches of staghorn stones or large stones if needed. Additional stones were removed if present using graspers and direct vision of the pelvicalyceal system by laparoscope and the pyelocalyceal system was washed out with normal saline. A double pigtail ureteral stent was inserted, and the edge of the incision line on the renal pelvis was re-approximated using 4-0 Vicryl (Ethicon, Inc., Johnson & Johnson,Somerville, NJ) suture according to the running fashion or by few interrupted sutures when continuous suturing was felt difficult. The stones were extracted from the abdominal cavity using a surgical glove or an endobag. A drain was fixed in the peritoneal cavity near the operative

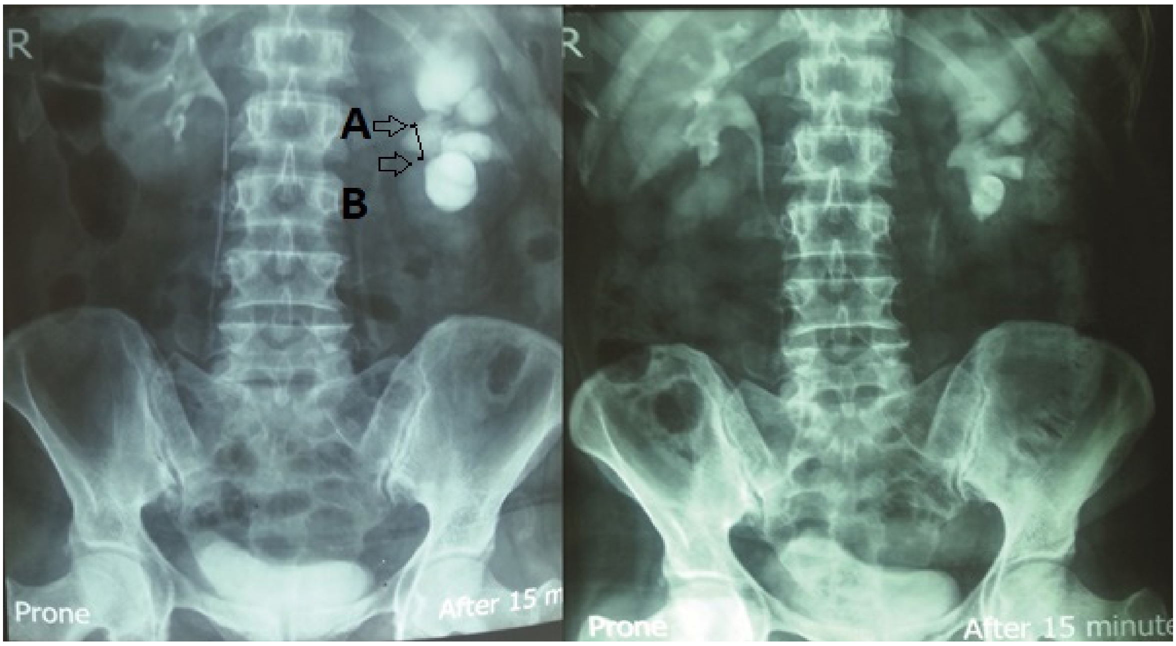

Figure 1. Preoperative (left) and postoperative (right) intravenous pyelography of a patient with intrarenal pelvic stone operated by laparoscopic pyelolithotomy.
Points A (upper border) and B (lower border) show the junction of pelvis with renal parenchyma in cross imaging and the line drawn illustrates that the most part of pelvis is intarenal (more than 50% of pelvis surface in cross imaging is intrarenal)

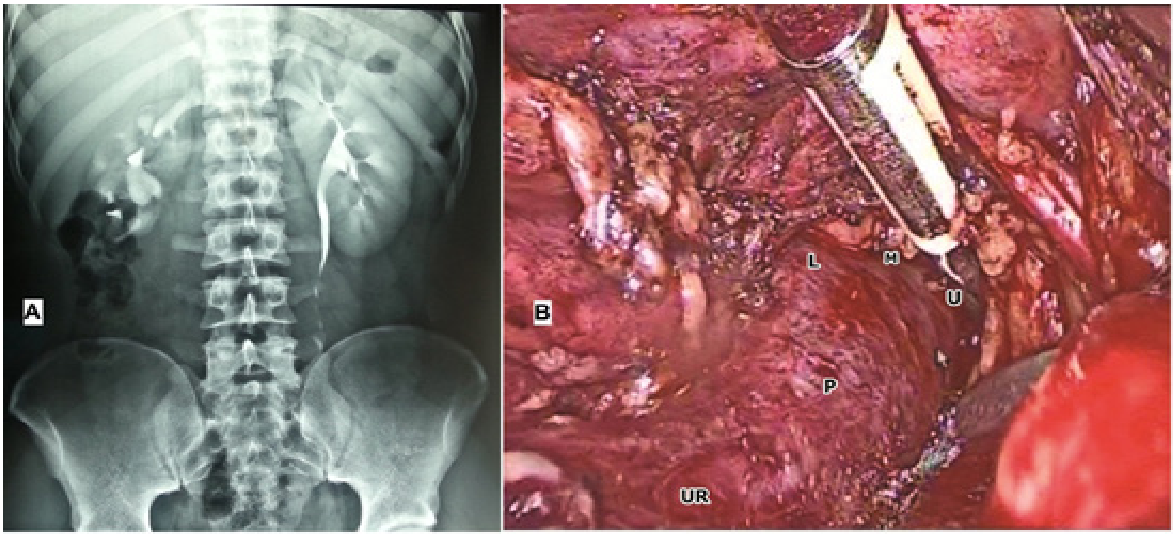

Figure 2. Preoperative pyelography of a patient with intrarenal pelvis **(left side: A)** together with intraoperative picture of the pelvis **(right side: B)** after removing peripelvic fat and exposing surface of renal pelvis and the major calices of upper, middle and lower poles. (UR = ureter, *P* = pelvis, L=lower calyx, M = middle calyx, U = upper calyx)

field and was subsequently removed 3-6 days after the operation. The Foley catheter was retained for 3-5 days. The ureteral stent was removed 4-6 weeks after the surgery.

The assessment of residual stones was performed by using plain abdominal radiography one day after the operation and intravenous pyelography and/or non-contrast computed tomography six weeks after the operation (**Figure 1**). This latter intravenous pyelography and/or computed tomography were employed to assess the structure and function of renal pelvicalyceal anatomy after the operation.

Patients were consulted regarding alternative treatment strategies for their renal stones and informed consent was obtained.

RESULTS

28 patients were enrolled from Feb 2014 to Mar 2015. Patients' demographic and operative characteristics have been outlined in **Tables 1 and 2**. Preoperative and postoperative intravenous pyelography of one patient has been presented in **Figure 1**.

Intraoperative ureteral catheter was not inserted in 6 patients. Our routine protocol was the insertion of ureteral catheter and omission of its insertion in these 6 cases was technical difficulty of ureteral catheter insertion in these cases due to intrarenal pelvis and the narrow window for passage of the distal end of the ureteral catheter from renal pelvis opening to the upper ureter. Out of these 6 patients, in one patient, postoperative urinary leak was observed. This patient was a 46-year-old man with a previous history of open stone surgery and shock wave lithotripsy. He had a staghorn 45 mm stone with multiple stones in lower calices. Ureteral catheter was inserted on the 7th postoperative day due to continued leakage. Urinary leak subsided after ureteral catheter insertion. He also experienced fever from the 3rd postoperative day that was managed conservatively by intravenous antibiotics. Fever subsided on the 11th postoperative day.

Urinary leak was observed in 3 patients. In one patient, intraoperative ureteral catheter was not inserted which was commented on above. In the other two patients, an intraoperative ureteral catheter had been inserted. One patient was a 34-year-old man with a pelvis stone in a horseshoe kidney. Urinary leak subsided after 13 days with conservative management. In another patient with a 44 mm stone in the right pelvis, urinary leak lasted 8 days and subsided on the 9th postoperative day.

Postoperative fever was observed in 5 patients. Three patients were patients with a postoperative urinary leak. Fever in all these 5 patients was managed by intravenous antibiotics and in patients without urinary leak by intravenous fluids. Residual stones were observed in 3 patients with staghorn (n=1) or multiple stones(n=2).

DISCUSSION

Laparoscopic pyelolithotomy has been introduced more than 2 decades ago. Nevertheless, it has not been popularized among many urologists due to its long learning curve together with an already established PCNL technique.[12]

Currently, LPL is employed for the management of large, hard, impacted renal stones; as a salvage procedure after failed SWL or endourology; renal and anatomical abnormalities; and before embarking to open surgery.[2,9,12] Yet it is believed that the indications for LPL have not been sharply defined.[9,12] Many urologists believe that LPL should be used for patients with extrarenal pelvis. The technical difficulties associated with suturing of intrarenal pelvis and fear of postoperative urinary leak have caused many authors to exclude cases with intrarenal pelvis from the series of LPL.[15] Despite these difficulties and technical challenges, promising results in comparison of PCNL and LPL has been recently published highlighting the feasibility of LPL and reporting better stone free rate, hemoglobin drop, and complications with LPL[4,20,21]

We have previously reported our experience of laparoscopic pyelolithotomy in the management of staghorn renal stones[2] and bilateral renal and ureteral surgeries[22].

In this series, we reported 28 patients with intrarenal pelvis as defined by Tomaszewski et al. who were operated by LPL[18]. This series included 3 patients with staghorn renal stones and 3 patients with multiple stones in pelvicaliceal system. Urinary leakage was observed in 3 cases (11%). In two patients, urinary leak was managed conservatively. In the third patient in whom the operation was completed without insertion of ureteral catheter, we inserted a ureteral stent (double pigtail) by cystoscopy and urinary leak resolved after ureteral catheter placement. No difference was observed in the frequency of urinary leak between patients with intraoperative ureteral catheter insertion and patients without it, however, the frequency of patients was few to detect a reasonable difference. We excluded the insertion of a ureteral stent in patients in whom it was technically difficult because of narrow window and acute entry angle for ureteral stent in some patients as described previously but we recommend the insertion of a ureteral catheter as the standard procedure if possible during laparoscopy and if not possible through cystoscopy at the end of operation after turning position of the patient to lithotomy to obviate the possibility of urinary leakage until further confirmation of the safety of excluding ureteral catheter insertion in difficult cases in large scale studies.

Residual stones were observed in 3 patients with staghorn or multiple stones in calices which were difficult to extract by laparoscopy. In such cases, there is the possibility of residual stones by other conventional minimally invasive surgical approaches (PCNL or endourology). PCNL stone free rate for staghorn stones in CROES global study was 57%; however, there is not head to head comparative study between the two approaches[23]. The stone free rate for multiple/staghorn stones in this study is 50%. (3 out of 6 patients) We did not use flexible instruments (nephroscopy or ureteroscope) during laparoscopy in such cases due to its unavailability in our center in the time of the study, however, we recommend to use flexible nephroscope or ureteroscope to increase stone free status in cases of multiple stones and / or solitary stones in calyces in addition to pelvis stone.

The following tips will help in LPL for stones in intrarenal pelvis:

- It is advisable to dissect the renal pelvis from surrounding fat and tissues to the border of renal parenchyma and by elevating the parenchymal border even to expose the proximal parts of the major calices. This maneuver will help in extracting large stones or stones with a branch in a major calyx.
- In a few cases in whom urinary leak develops after the operation and does not respond to conservative measures, a ureteral catheter can be inserted by cystoscopy.
- If the anterior surface of the renal pelvis cannot be approached because of aberrant vessels, the kidney can be turned medially and the posterior pelvis surface can be approached.

This series is limited in number, however, paves the way for management of renal stones for a subgroup of patients with renal stones in whom the LPL is technically difficult and challenging. It is very important to consult with the patient about the alternative options in this group of patients as LPL is technically challenging and may be associated with relatively higher complications compared to patients with extrarenal pelvis. Another limitation of this study is the absence of long term follow-up in patients.

CONCLUSIONS

We think that laparoscopic pyelolithotomy is a feasible option for renal stones with intrarenal pelvis if adequate laparoscopy experience is available and the patient is willing to undergo laparoscopy given alternative choices. However, in cases with multiple stones associated with intrarenal pelvis anatomy the stone free rate will decrease.

CONFLICT OF INTEREST

The authors report no conflict of interests.

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