Original Article

A comparative study of morbidity between percutaneous nephrolithotomy and laparoscopic pyelolithotomy for renal pelvic calculus

Rajeevan Ambala Tharakkal, Midhun P. Gopalakrishnan, Felix S. Cardoza

Department of Urology, Government Medical College, Kozhikode, Kerala, India

Abstract

Objective: In this study, our objective is to compare the morbidity (up to 3 months) between percutaneous nephrolithotomy (PCNL) and laparoscopic pyelolithotomy (LPL) in patients undergoing surgery for renal pelvic calculus in our population.

Materials and Methods: This was a retrospective study done in a urology tertiary care center from January 1, 2016, to December 31, 2018, among patients who had undergone PCNL or LPL for renal pelvic calculus. The sample size was 70, with 35 cases in each group.

Results: In LPL arm, there was a significant reduction in the day of the drain or nephrostomy removal ($P = 0.013$) and in the number of patients with persistent leak after removal of drain or nephrostomy ($P = 0.048$). Apart from this, the median of postoperative hospital stay was also significantly less in LPL arm ($P = 0.00005$). However, the mean duration of surgery was significantly higher in the LPL arm ($P = 0.00001$).

Conclusion: This study shows LPL and PCNL morbidity results are almost comparable except in a few factors. However, this study was a retrospective analysis of our work and it needs high quality randomized controlled study to establish the difference among these two procedures among our population.

Keywords: Complications and morbidity, laparoscopic pyelolithotomy, percutaneous nephrolithotomy

Address for correspondence: Dr. Midhun P. Gopalakrishnan, Paramjyothi Kizhakkethil House, Eyyal (PO), Kechery, Thrissur - 680 501, Kerala, India.
E-mail: drmidhungopalakrishnan@gmail.com

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) remains the gold standard procedure in the management of large renal calculi. However, the risk of certain intraoperative and postoperative complications such as hemorrhage, arteriovenous fistula, and pseudoaneurysm still exist despite the latest advances in percutaneous approaches.[1] Laparoscopic pyelolithotomy (LPL), having procedural similarity to open pyelolithotomy is not only nephron-sparing but also nephron reviving and, consequently, could eventually become accepted as the procedure of choice in selected groups of patients with renal calculus disease.

In this study, our objective was to compare the morbidity (up to 3 months) between PCNL and LPL in patients undergoing surgery for renal pelvic calculus in our population.

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MATERIALS AND METHODS

This was a retrospective study done in a urology tertiary care center from January 1, 2016, to December 31, 2018, among patients who had undergone PCNL or LPL for renal pelvic calculus. As per our institution protocol, preoperative noncontrast computed tomography (CT) scan was taken for all patients with stone disease. All patients who had undergone either type of surgery for renal pelvic stones with size >2 cm and with the extra renal pelvis on preoperative CT scan imaging were included in this study. Patients with staghorn calculus, stone size <2 cm, stones in intra renal pelvis, and those patients who lost for follow-up were excluded from the study.

According to the data collected from the operation theater register, the number of patients who had undergone PCNL and LPL for renal pelvic calculus who satisfies the inclusion criteria, who consented for study and those who were on regular follow-up was taken as 70. Among these, 35 patients underwent PCNL and another 35 patients underwent LPL. Equal numbers of patients were included in each arm by taking the first 35 cases that entered this study during data collection. A detailed consent form for the willingness to participate in the study was sent by post to the addresses of study patients and signed consent forms were obtained. The study was started after getting institutional ethics committee approval.

Pre-, intra-, and postoperative variables of patients who had undergone either PCNL or LPL were collected from operation theater register and their case records. Other data collected included name, age, sex, address, education status, occupation, and body mass index (BMI) of the patient. Details regarding the history of any comorbidities, history of any previous renal surgery, and details of taking any medicines such as anticoagulants and antiplatelets were collected. Preoperative variables included were the degree of hydronephrosis by imaging, size of the stone, density of stone by CT scan in Hounsfield unit, stone complexity by Guy's stone score grading, and side of surgery. Intraoperative variables such as the duration of surgery, details regarding the injury to adjacent structures, if any, happened during surgery were collected.

Details of postoperative period in the hospital like the day of drain/nephrostomy tube removal, whether there was any persistent leak from nephrostomy site in PCNL cases and if the leak was present, how many days of the leak was present, whether any complications like postoperative fever, chest infection, urosepsis, systemic complications other than infections happened were collected. Those patients who had blood transfusion or those who underwent any procedure for bleeding were considered as patients with significant postoperative bleeding. Furthermore, days of hospital stay after surgery and the presence of residual stones at 1 month follow-up were recorded. Data regarding any surgical procedures done for complications were also collected. Later, postoperative morbidity was graded according to the Clavien–Dindo scale.

Qualitative variables will be summarized using percentages, and quantitative variables will be summarized using mean with standard deviation and median with range. Qualitative variables will be compared using Chi-square test and quantitative variables will be compared using analysis of variance test. The difference between two groups will be considered significant if the $P < 0.05$. All analyses will be performed using SPSS software (SPSS Inc. Released 2009. PASW statistics for windows, version 18.0. SPSS Inc., Chicago, USA).

Operative techniques

Percutaneous nephrolithotomy

The entire procedure was done under general anesthesia. Prophylactic antibiotics were given according to institutional protocol. After placing the patient in the lithotomy position, retrograde ureteric catheterization with a 6 F ureteric catheter (Aster Medispro, Bangalore, India) was performed using a rigid cystoscope (30° Karl Storz with 22 F outer sheath, Tuttlingen, Germany). Then the patient was kept in the prone position, and all pressure points were adequately padded. The selected calyx was accessed by the attending urologist using C-arm fluoroscopy (Shimadzu, Kyoto, Japan). The 16G initial puncture needle (Aster Medispro, Bangalore, India) was placed in the preferred calyx. The floppy tipped guidewire was then passed into the collecting system through the needle. A working channel was established using a serial metallic dilator system under fluoroscopy control, and 28–32 F Amplatz sheath (Rusch Teleflex, Morrisville, USA) was placed over the dilated tract. A nephroscope (20° R. Wolf with 24 F outer sheath, Illinois, USA) was then placed directly into the kidney through the Amplatz sheath. The stones were fragmented using a pneumatic lithotripter (Status medical equipment, Satara, India). Forceps and irrigating fluid were used to remove stone fragments. At the end of the procedure, the ureteric catheter would be retained, and the same removed the next day if there were no complications. A nephrostomy tube (16 F) was placed in all patients and clamped for 8 h.[2] A Per urethral 16 F Foley's catheter was retained.

Laparoscopic pyelolithotomy

The procedure was done under general anesthesia. As for all other major urological procedures, prophylactic

antibiotics were given according to hospital policy. The patient was catheterized using 16 F per urethral Foley's catheter. The patient was positioned in a lateral position with the application of kidney bridge, and head-end break was given. One 10 mm port in midclavicular line at the level of umbilicus with two 5 mm port; one each in the subxiphoid position and another one in the lateral position of the ipsilateral side of abdomen cephalad to the anterior superior iliac spine was placed. An additional port of 5 mm was placed in the right hypochondrium medial to 5 mm port of subxiphoid position for liver retraction in cases of right-sided LPL. Later 30° laparoscope (Stryker, Kalamazoo, USA) was introduced through 10 mm port. Transperitoneal approach was done. The colon was mobilized by incising the peritoneum along white line of Toldt using laparoscopic hook diathermy and reflecting it medially. The ureter was identified and dissected. Later renal pelvis was identified after tracing ureter upwards. Pyelotomy done using laparoscopic scissors on the posterior aspect and stones were removed. Pyelotomy was later closed using 4-0 polyglactin sutures after putting a JJ stent (Aster Medispro, Bangalore, India) inside the ureter. 16 F drain was put through lateral most 5 mm port after attaining hemostasis. Later, the remaining two ports were closed using 2-0 port polyglactin sutures.

RESULTS

Age and sex

A total of 35 patients underwent PCNL. Of this 23 patients (65.71%) were male and 12 patients (34.29%) were female. The mean age of the study population was 45.02 ± 12.87 years. Another group of 35 patients underwent LPL. Twenty-seven patients (77.14%) were male and 8 patients (22.86%) were female in this study. The mean age of this population was 45.57 ± 15.26 years.

Body mass index

BMI of patients in each group are shown in Figure 1 (underweight: <18.5, normal: from 18.5 to 24.9, overweight: from 25 to 29.9, obese: >30).

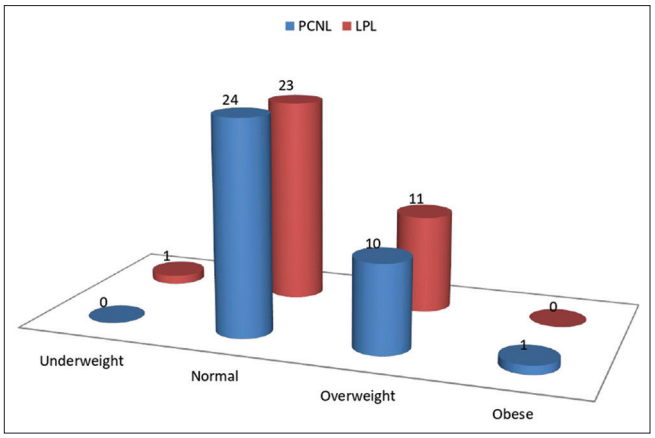

Figure 1: Body mass index of patients

Preoperative findings

Comparison between preoperative findings of PCNL and LPL groups is shown in Table 1.

Among the PCNL group, Guy's stone score was one for 33 patients (94.29%) and two for 2 patients (5.71%). In the LPL category, Guy's stone score was one for 27 patients (77.14%) and two for 8 patients (22.86%). Grade of hydronephrosis in PCNL and LPL are shown in Figure 2.

Intra operative findings

Among 35 patients of the PCNL group, 12 patients (34.29%) had left-sided surgery and 23 (65.71%) had right-sided surgery. In the LPL group, 18 patients (51.43%) had left-sided surgery and 17 (48.45%) had right-sided surgery. Two cases (5.71%) had adjacent structure injury in the form of large bowel serosal injury while mobilizing the colon in the LPL group. Serosal injuries were sutured laparoscopically with 3-0 polyglactin sutures. Comparison between intraoperative and postoperative findings among these two groups is shown in Table 2.

There was persistent leak from nephrostomy track after its removal in 8 cases (22.86%) in PCNL group. Of these 8 cases, 6 had residual stones. This could be attributed to the use of pneumatic lithotripter for fragmenting stones as the stone fragments might have scattered to renal calyces. We might have been able to reduce the incidence of residual stones if we would have used ultrasonic lithotripters with simultaneous continuous suction or laser lithotripsy. Among this subset of patients with residual stones, they were managed by extracorporeal shock wave lithotripsy (ESWL) in 4 cases and by redo PCNL in 2 cases after 3 months of the first surgery. In LPL, there was a persistent leak from the drain track after its removal in 2 cases (5.71%).

Among PCNL patients, 2 (5.71%) had significant hematuria or bleeding from the nephrostomy drain. Bleeding was managed with blood transfusion in one patient. In that patient, bleeding started within 6 h after surgery and it lasted for the next 30 h and it got settled by itself. The other patient started to have severe bleeding with hypotension within 3 h after the initial surgery. Emergency open re-exploration and suturing of nephrostomy tract was done by horizontal mattress sutures encompassing renal parenchyma around the tract using 1-0 polyglactin

Table 1: Comparison of preoperative findings between percutaneous nephrolithotomy and laparoscopic pyelolithotomy

Preoperative findings	PCNL	LPL
Patients with hypertension	6	4
Patients with diabetes mellitus	9	3
Patients with coronary artery disease	1	2
Patients with no comorbidity	19	26
Patients with history of same side renal surgery in the past	1	1
Patients with raised creatinine	4	6
Mean stone size	23.62±2.03 mm	23.68±3.19 mm
Mean stone density	1151.03±315.62 HU	1214.74±254.40 HU

PCNL: Percutaneous nephrolithotomy, LPL: Laparoscopic pyelolithotomy

Table 2: Comparison of Intra operative and postoperative findings between percutaneous nephrolithotomy and laparoscopic pyelolithotomy

	PCNL (*n*=35)	LPL (*n*=35)	Analysis of variance test *F* value	Chi-square value after Yates correction	*P*
Patients with adjacent structure injury	0	2	-	0.215	0.642
Mean duration of surgery	91.57±19.05 min	156.28±16.46 min	231.19	-	0.00001
Median day of nephrostomy/drain removal	3 with range 9	2 with range 11	6.435	-	0.013
Number of patients with persistent leak	8	2	-	0.048	0.048
Median day of postoperative hospital stay	8 with range 14	5 with range 14	18.366	-	0.00005
Patients with significant postoperative bleeding	2	0	-	0.606	0.606
Patients who had postoperative fever	6	8	-	0.259	0.259
Number of patients with postoperative urosepsis	6	6	0.094	-	0.759
Number of patients with postoperative chest infection	0	1	1.014	-	0.314
Number of patients with residual stones	10	6	-	0.560	0.560
Patients with systemic complications other than infection	1	0	-	0.960	0.960
Patients who had additional procedures done for complications	11	6	1.296	-	0.255

PCNL: Percutaneous nephrolithotomy, LPL: Laparoscopic pyelolithotomy

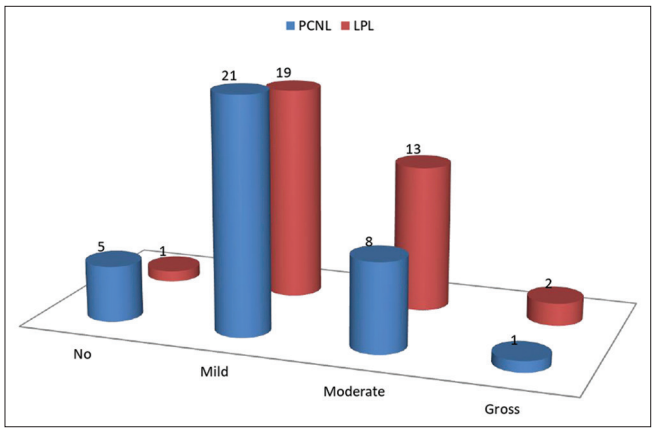

Figure 2: Grade of hydronephrosis preoperatively by ultrasonography in percutaneous nephrolithotomy and laparoscopic pyelolithotomy arm

in addition to renorrhaphy sutures using 2-0 polyglactin. Blood transfusion was also given in that patient. The bleeding was arterial in nature and most probably from the infundibular artery, which might have injured during puncture and dilatation of nephrostomy tract. Among LPL patients, no patient had hematuria or excessive bleeding from the drain.

In PCNL group, 6 (17.14%) patients had postoperative fever. All these six patients had postoperative urinary infection confirmed by positive urine culture. Four patients among this subset started fever on postoperative day 1 and two patients developed a fever on postoperative day 2. After sending urine for culture and sensitivity, they were started on cefoperazone with sulbactam 1.5 g intravenous injection twice daily as per institution protocol. When we got a culture report after 72 h all of them had *Escherichia coli* infection. Five patients were sensitive to cefoperazone with sulbactam itself, for whom we continued the same antibiotic for the next 5 days. One patient who was resistant to cefoperazone with sulbactam was sensitive to amikacin, and we started him on 1 g intravenous dose in the morning for the next 5 days. All the patients showed response within 48 h to respective antibiotics. As per our hospital protocol, follow-up urine culture was sent after 5 days of antibiotics and all the results were sterile. Even though the preoperative urine culture can be sterile and still stones may harbor infection inside it, maybe a possible cause for infection in this group. As we take strict sterile precautions according to the hospital infection control protocol, the iatrogenic introduction of infection is unlikely though it cannot be ruled out completely. Among LPL patients, 8 (22.86%) had postoperative fever. Of these 8 patients, 6 had postoperative urinary infection confirmed by positive urine culture. Five patients started fever on postoperative day 1 and one patient developed a fever on postoperative day 2. All of them had *E. coli* infection and were sensitive

to cefoperazone with sulbactam. All of them responded well to this antibiotic and were managed according to our institution guidelines, as stated previously. One had bronchopneumonia, who was started on piperacillin with tazobactam injection 4.5 g intravenously thrice daily after getting a sputum culture report of pseudomonas and its sensitivity. One case did not have any confirmed focus of infection.

Ten patients (28.57%) had residual stones in the PCNL group and ESWL was done for 6 cases. Two cases underwent JJ stenting, and ESWL was done for them later. Criteria for doing ESWL in our scenario were stone density >1000 Hounsfield units and patients with favorable skin stone distance (<10 cm). All the stones in this group were in renal calyces. The maximum size of residual stone in this group was 15 mm. Two patients with residual stone underwent PCNL after 3 months. Indications for doing PCNL in these two patients were their stone density was <1000 Hounsfield units making stone localization using C-arm during ESWL difficult and obesity (BMI >30 kg/m^2) which increased the skin stone distance which may cause incomplete fragmentation. The sizes of the stone were 16 mm and 14 mm, and both of them were in the inferior calyx. Among LPL patients, 6 (17.14%) had residual stones and ESWL was done for 4 cases. The maximum size of residual stone here was 12 mm. Two patients with residual stones of size 7 mm and 6 mm, respectively, in upper ureter underwent JJ stenting when they were identified, and stones passed off in the follow-up imaging.

With respect to systemic complications, one patient developed myocardial infarction with pulmonary edema and died in PCNL arm. No patients had any systemic complications other than infection in the LPL arm.

Morbidity grade

Postoperative morbidity of 3 months was assessed. This was graded according to the Clavien–Dindo classification, as shown in Table 3.

Table 3: Number of patients with morbidity according to Clavien-Dindo classification

Morbidity grade	PCNL (*n*=35)	LPL (*n*=35)
Grade 1	2	3
Grade 2	4	4
Grade 3a	8	6
Grade 3b	2	0
Grade 4	1	0
Grade 5	1	0

PCNL: Percutaneous nephrolithotomy, LPL: Laparoscopic pyelolithotomy

DISCUSSION

A meta-analysis by Rui *et al.* suggests that both procedures are effective and safe for removing large renal stones. In this study, the stone-free rate in LPL when compared to PCNL was significantly more ($P = 0.001$). However, the mean duration of surgery was longer for patients with LPL than for those treated with PCNL ($P = 0.002$). There was no difference between procedures with regard to the length of hospital stay or blood loss ($P \geq 0.071$).[3] Another study by Bai *et al.* suggests that LPL is a safe and effective approach for the management of patients with large renal stones. When compared with PCNL, LPL had a significantly higher stone-free rate (odds ratio [OR]: 3.94, 95% confidence interval [CI]: 2.06–7.55, $P < 0.001$), less blood transfusion rate (OR: 0.28, 95% CI: 0.13–0.61, $P = 0.001$), less blood loss (OR: 0.20, 95% CI: 0.06–0.61, $P = 0.005$), less postoperative fever (OR: 0.38, 95% CI: 0.21–0.68; $P = 0.001$), less auxiliary y procedure rate (OR: 0.24, 95% CI: 0.12–0.46, $P < 0.001$) and retreatment rate (OR: 0.20, 95% CI: 0.07–0.55, $P = 0.002$). However, LPL had a longer operative time and hospital stay. There were no significant differences in conversion to open surgery and prolonged urine leakage rates between LPL and PCNL. However, PCNL still suitable for most cases, and LPL can be used as an alternative management procedure with a good selection of cases.[4]

A study by Wang X *et al.* suggests that LPL and PCNL are effective and safe for large renal pelvic calculi, but LPL seems to be more advantageous.[5] Operative time and hospital stays were 50.62 min and 0.66 days shorter in the PCNL group ($P < 0.0001$ and 0.04, respectively). Patients in the LPL group benefited from a less postoperative fever (OR: 0.24, 95% CI: 0.08–0.72), a lower incidence of bleeding (OR: 0.29, 95% CI: 0.10–0.85) and a higher stone-free rate (OR: 4.85, 95% CI: 1.59–14.82). Sensitivity analysis indicated that all results were stable except the stone-free rate showed no statistically significant difference between the two groups (OR: 0.33, 95% CI 0.09–1.17). According to a meta-analysis by Wang J *et al.* LPL is an alternative for the treatment of large solitary renal stones. LPL may have a higher stone-free rate, lesser blood loss, lower postoperation fever rate, while PCNL may have a lower length of hospital stay. Pyelolithotomy is also indicated in combination with pyeloplasty without increasing morbidity or decreasing the success rate.[6]

Hence, according to most of the literature available in the PubMed database, LPL showed a high stone-free rate, less bleeding, less hospital stay, and less postoperative fever rate. However, LPL had significantly more duration of operating time in most of the studies. In this study,

LPL arm had a significant reduction in the day of the drain or nephrostomy removal (P = 0.013) and in the number of patients with persistent leak after removal of drain or nephrostomy (P = 0.048). Apart from this, postoperative hospital stay was also significantly less in the LPL arm (P = 0.00005). However, the mean duration of surgery was significantly higher in LPL arm (P = 0.00001).

However, there was no significant difference between LPL and PCNL in occurrence of postoperative bleeding (P = 0.606), postoperative fever (P = 0.259), residual stones (P = 0.560), systemic complications (P = 0.960), additional procedures done for complications (P = 0.255) and in the postoperative morbidity grade according to Clavien–Dindo scale (P = 0.078).

CONCLUSION

This study shows LPL and PCNL morbidity results are almost comparable except in a few factors. There was early discharge from the hospital and early drain removal with less number of postoperative leaks from the track in LPL. However, mean duration of surgery was more in LPL. In all other factors like postoperative bleeding, postoperative fever, presence of residual stones, systemic complications, additional procedures done for complications and in morbidity grade, both of these procedures did not show any statistically significant differences. However, this study was a retrospective analysis of our work and it needs high quality randomized controlled study to establish the difference among these two procedures among our population.

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Conflicts of interest

There are no conflicts of interest.

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