

Efficacy and Safety of Retroperitoneal Laparoscopic Pyelolithotomy in the Management of Staghorn Renal Stones

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ABSTRACT

Objective: The objective of this study was to evaluate the efficacy, safety, and postoperative recovery of retroperitoneal laparoscopic pyelolithotomy (RPPL) in the management of staghorn renal stones, with an emphasis on stone clearance rates, operative time, complication profiles, and recovery.

Materials and methods: This observational study was conducted at a tertiary care teaching institute in North India. A total of 68 patients diagnosed with staghorn renal calculi were included in the study. Preoperative assessments included imaging studies, kidney function tests, and urinalysis. All patients underwent RPPL, with modifications aimed at improving access and stone clearance. Postoperative outcomes, including stone clearance, complications, operative time, and hospital stay, were recorded.

Results: The stone clearance rate achieved was 94.11%, with a mean operative time of 88.4 minutes. The average hospital stay was 2.3 days, and the average duration of postoperative drainage was 42 ± 8.6 hours. No major complications, such as hemorrhage or infections requiring blood transfusions, were reported. Four patients required conversion to open pyelolithotomy due to dense perinephric adhesions, and two patients required extracorporeal shock wave lithotripsy (ESWL) for residual stone fragments.

Conclusion: Retroperitoneal laparoscopic pyelolithotomy is a safe and effective alternative to traditional treatments for staghorn stones, offering high stone clearance rates, faster recovery, and fewer complications. It provides a promising minimally invasive solution, especially for complex cases where other methods may be less effective.

Keywords: Minimally invasive surgery, Renal calculi, Retroperitoneal laparoscopic pyelolithotomy, Staghorn stones, Stone clearance.

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INTRODUCTION

Staghorn renal stones are large, branching calculi that fill the renal collecting system, involving multiple calyces and the renal pelvis.¹ These complex stones are associated with high recurrence rates and severe morbidities, such as urinary tract infections (UTIs), renal failure, and even life-threatening conditions if left untreated.² The extensive stone burden and frequent renal infection complicate treatment, making management challenging for urologists.³

Traditional treatment options include extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and open surgery. However, each has its limitations.⁴ Extracorporeal shock wave lithotripsy is ineffective for large, dense stones, often requiring multiple sessions, risking incomplete fragmentation and recurrent infections. Percutaneous nephrolithotomy, while effective for larger stones, involves multiple punctures, which can cause renal damage, blood loss, and prolonged recovery. Open surgery, though once standard, carries significant risks, including longer hospital stays, infection, and scarring.⁵

Recent advancements in laparoscopic and retroperitoneoscopic techniques have provided minimally invasive alternatives. Retroperitoneal laparoscopic pyelolithotomy (RPPL) stands out as a promising approach, offering direct access to the kidney while minimizing risks like peritoneal contamination, adhesions, or bowel injury.⁶ Retroperitoneal laparoscopic pyelolithotomy is associated with faster recovery, reduced blood loss, and quicker return to normal activities compared with traditional methods.⁷

Despite its success with smaller stones, the role of RPPL in managing staghorn renal stones remains underexplored. Given the complexity and recurrence rates of these stones, there is a need for more effective, minimally invasive treatments.

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This study aims to evaluate the efficacy, safety, and postoperative recovery of RPPL for staghorn renal stones, assessing stone clearance rates and complication profiles, with the goal of establishing RPPL as a viable alternative to traditional treatment methods.

MATERIALS AND METHODS

This observational study was conducted at a tertiary care teaching institute in North India, after obtaining approval from the institution's ethical committee.

A total of 68 consecutive patients diagnosed with staghorn renal calculi, confirmed by intravenous pyelography, were enrolled. Preoperative assessments included plain X-rays, kidney function tests, urinalysis, urine cultures, and imaging studies, such as ultrasound of kidney, ureter, and bladder and renal scans when indicated.

Inclusion criteria were based on the diagnosis of staghorn stones, while exclusion criteria involved patients unfit for laparoscopic surgery, those with previous open renal surgery, or those with anatomical anomalies preventing RPPL. All patients underwent preoperative placement of a double-J ureteral stent, followed by RPPL performed using techniques previously described in the literature, with modifications to improve access and stone clearance.

Retroperitoneal laparoscopic pyelolithotomy was performed using a retroperitoneal approach. The pelvis was extensively dissected, including the Gil–Vernet plane, to facilitate an extended pyelolithotomy. A curvilinear incision was made on the renal pelvis and extended into the appropriate calyx to ensure complete stone extraction. In cases of large or dense stones, additional fragmentation was performed using holmium laser.⁸ Postoperative drainage was maintained, and patients were monitored closely for any complications.

RESULTS

The study included 68 patients, comprising 44 males and 24 females, with an average age of 42.4 ± 5.2 years. Among the cases, 30 were classified as borderline staghorn, 24 as partial, and 14 as complete staghorn stones. Stone clearance was achieved in 94.11% of cases. Four cases required conversion to open pyelolithotomy due to dense perinephric adhesions, and two cases necessitated ESWL for residual stone fragments. The mean size of the stones was 5.8 ± 0.7 cm.

The surgical success rate for pyelotomy closure was 88.23%, and the mean operative time was 88.4 ± 16.6 minutes. The average duration of postoperative drainage was 42 ± 8.6 hours, with an average hospital stay of 2.3 ± 1.5 days. No major complications, such as hemorrhage or infections requiring blood transfusions, were reported.

DISCUSSION

In our study, RPPL demonstrated an impressive stone clearance rate of 94.11%, with only four cases requiring additional interventions. This is consistent with previous reports that have highlighted the success of RPPL in smaller renal stones and partial staghorn cases.

Al-Hunayan et al. compared laparoscopic pyelolithotomy using the transperitoneal [transperitoneal laparoscopic pyelolithotomy (TLP)] and retroperitoneal (RPPL) routes in 48 patients with renal pelvic stones >30 mm.⁷ They found that RPPL had a shorter operative time (112.1 vs 93.2 minutes, $p = 0.01$), quicker oral intake (1.9 vs 1.2 days, $p < 0.01$), and shorter hospital stay (5.2 vs 3.8 days, $p < 0.01$), while stone-free rates (88.9 vs 90.5%, $p = 0.86$) were similar.

Bozkurt et al. performed RPPL in a patient with an ectopic pelvic kidney and found it to be an effective treatment option.⁹ The procedure took 130 minutes with <50 mL blood loss, and the patient was discharged on the second postoperative day without complications, highlighting the advantages of the retroperitoneal approach in avoiding complications.

Chander et al. compared RPPL and ESWL for renal stone management in 168 patients.¹⁰ They found that RPPL provided

better stone clearance, fewer hospital visits, reduced analgesic requirement, and faster resumption of normal activities compared with SWL, making it an effective alternative in high-volume centers.

Chander et al. also evaluated retroperitoneoscopic pyelolithotomy in 56 patients with renal calculi.¹¹ The procedure achieved stone clearance in all but two cases, with a postoperative hospital stay averaging 4 days. Patients were ambulatory within 24 hours and returned to work in 7 days. Complications were minimal, and the procedure was deemed safe, effective, and minimally invasive for renal stone management.

Chen et al. compared RPPL and PCNL for treating large pelvic calculi in chronic kidney disease patients.¹² Retroperitoneal laparoscopic pyelolithotomy had a significantly shorter hospitalization time (3.90 vs 4.72 days, $p < 0.05$), better stone-free rate (100 vs 88.7%, $p < 0.05$), and less postoperative complications, making it a safer and more efficient option despite a longer operation time.

Gaur et al. reported the successful use of RPPL in five of eight patients using a balloon technique.³ This minimally invasive approach, considered for economic reasons, showed potential as an alternative for managing medium-sized pelvic stones not suited for ESWL or PCNL, especially when these methods are unavailable.

Gaur et al. also demonstrated the feasibility of RPPL in three patients with staghorn renal calculi, ranging from 22 to 45 mm.¹³ All patients, initially considering open pyelolithotomy, successfully underwent laparoscopic stone removal without complications. This study highlights the potential of retroperitoneal laparoscopy in treating select staghorn stone cases.

Jiang et al. evaluated retroperitoneoscopy technique-assisted PCNL in five patients with renal stones and complexity horseshoe kidney (HSK).⁸ The procedure had a mean operation time of 77.5 minutes, with a stone-free rate of 80%. No major complications occurred, and the procedure was considered a safe and effective alternative for managing stones in complex HSK.

Pakmanesh and Salari compared transperitoneal laparoscopic pyelolithotomy (TLP) and RPPL in 104 patients with large renal pelvic stones.¹⁴ They found that RPPL resulted in shorter hospital stays (2.36 vs 3.23 days, $p = 0.0001$), less hemoglobin drops (1.17 vs 1.53 gm/dL, $p = 0.04$), and lower postoperative fever rates (0 vs 12.7%, $p = 0.01$), with similar stone-free rates between the two approaches.

Pakmanesh et al. also compared retroperitoneal (RPPL) and transperitoneal (TLP) laparoscopic pyelolithotomy in 273 patients with large renal stones.¹⁵ They found no significant differences in operation duration, hospital stay, stone-free rates, or complications between the two approaches. However, postoperative fever was significantly higher in the TLP group (21.6 vs 0%, $p < 0.001$), suggesting RPPL may be a preferable alternative due to fewer complications.

Shi et al. assessed the effectiveness of RPPL with a prolonged renal posterior lower segment incision for treating unilateral staghorn renal stones and concurrent UTIs.⁵ The procedure was successful in all 28 patients, with a 100% stone-free rate at 3 days and 6 months. Postoperative complications were mild, and no patient required blood transfusion or further surgical intervention. The study concluded that RPPL with this approach is a safe and effective option for managing these complex cases.

Singal and Dhar compared RPPL with open pyelolithotomy in 1,700 cases of solitary renal pelvic stones.¹⁶ They found that RPPL had a longer operative time (94.43 vs 74.83 minutes, $p < 0.001$), but resulted in less blood loss (63 vs 103 mL) and a shorter hospital stay ($p < 0.03$). Additionally, RPPL reduced postoperative pain and

complications, making it a safer option despite its higher equipment costs and the need for specialized training.

Soares et al. evaluated the efficacy of retroperitoneoscopy in treating renal and ureteral stones in 34 patients.¹⁷ The procedure, performed via a lumbar approach, achieved a 94% stone-free rate. The mean operative time was 140 minutes, with a hospital stay averaging 3 days. Minor complications occurred in 17.6% of patients, and retroperitoneoscopy was deemed an effective, low-morbidity alternative for stone removal, especially in cases resistant to extracorporeal lithotripsy or ureteroscopy.

Limitations

This study has several limitations that warrant attention. Firstly, the sample size was relatively small, with only 68 patients enrolled, which may limit the generalizability of the results. Additionally, the study only includes patients from a single institution, which could introduce biases based on the hospital's specific practices or patient population. Furthermore, the follow-up duration was limited, and long-term outcomes, such as recurrence rates and renal function preservation, were not assessed. Finally, due to the retrospective observational design, the study lacked a control group, limiting its ability to make definitive comparisons with other treatment methods.

CONCLUSION

Retroperitoneal laparoscopic pyelolithotomy is a viable and effective treatment option for staghorn stones, demonstrating high success rates and faster recovery compared with traditional methods. It offers a promising alternative in renal stone management.

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