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Original Article

Comparison Between Laparoscopic Ureterolithotomy and Push Back Percutaneous Nephrolithotomy in the Treatment of Upper Ureteric Stone

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ABSTRACT

Background: Upper ureteric stones represent a major clinical challenge, often requiring surgical intervention when conservative measures fail. Minimally invasive approaches such as laparoscopic ureterolithotomy and push-back percutaneous nephrolithotomy are widely adopted, but comparative evidence on postoperative pain outcomes remains limited. Objective: To compare postoperative pain, hospital stay, operative time, and stone clearance rates between laparoscopic ureterolithotomy and push-back percutaneous nephrolithotomy in patients with upper ureteric stones. Methods: A randomized controlled trial was conducted at the Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar, from January to June 2025. Sixty patients aged 18–60 years with radiologically confirmed upper ureteric stones were randomized to laparoscopic ureterolithotomy (n=30) or push-back percutaneous nephrolithotomy (n=30). Pain was assessed using the Visual Analogue Scale (VAS) at 4 and 12 hours postoperatively. Secondary outcomes included operative time, hospital stay, and stone clearance confirmed by imaging. Statistical analyses included t-tests, chi-square tests, and regression adjustment for confounders. Results: Pain scores were significantly lower in the laparoscopic group at both 4 hours (6.2 ± 0.9 vs 7.4 ± 0.8, p<0.001) and 12 hours (4.8 ± 1.1 vs 6.1 ± 0.9, p<0.001). Operative time was longer for laparoscopy (98.4 ± 18.6 vs 76.2 ± 14.8 minutes, p<0.001), but hospital stay was shorter (2.3 ± 0.8 vs 3.1 ± 1.2 days, p<0.001). Stone clearance rates were high and comparable (96.7% vs 93.3%, p=0.55). Conclusion: Laparoscopic ureterolithotomy provides superior postoperative pain control and shorter hospitalization compared with push-back percutaneous nephrolithotomy, without compromising stone clearance.

Keywords: ureterolithotomy, percutaneous nephrolithotomy, upper ureteric stone, laparoscopy, postoperative pain.

INTRODUCTION

Urolithiasis remains one of the most common urological conditions, with global prevalence ranging between 7–13% in North America, 5–9% in Europe, and up to 1–5% in Asia, reflecting both geographic and lifestyle variations (1). Stones that migrate into the upper ureter pose particular clinical challenges because they may cause obstruction, severe pain, hydronephrosis, infection, or even renal impairment if not treated appropriately (2). While smaller calculi may pass spontaneously or respond to medical expulsive therapy, larger and impacted stones often require active intervention (3).

The composition of urinary calculi varies, with calcium oxalate and phosphate stones accounting for the majority, while uric acid, struvite, and cystine stones comprise a smaller proportion (4). These compositional differences, along with anatomical and patient-related factors such as obesity, renal anomalies, and prior interventions, complicate treatment decisions (5). Historically, open ureterolithotomy was the standard approach, but advances in minimally invasive surgery have largely replaced it due to shorter recovery time, lower morbidity, and reduced hospital stay (6). Among minimally invasive procedures, laparoscopic ureterolithotomy (LU) has emerged as a reliable alternative for large, impacted upper ureteric stones, offering the advantage of direct stone retrieval under visualization with high clearance rates (7).

In parallel, percutaneous nephrolithotomy (PCNL) and its modifications, including the push-back PCNL technique, have become established strategies for managing large or complex renal and proximal ureteric stones (8,9). Push-back PCNL involves repositioning the stone into the renal pelvis followed by nephrolithotomy, facilitating access and clearance, but at the potential cost of renal parenchymal trauma, postoperative bleeding, and longer recovery compared with laparoscopic techniques (10). Although both LU and push-back PCNL are widely used in contemporary practice, their comparative performance in terms of post-operative pain outcomes remains inadequately studied. Pain control is particularly relevant as it directly influences patient satisfaction, mobilization, length of hospital stay, and healthcare costs (11,12).

Evidence from a recent comparative study reported mean postoperative pain scores of 6.87 ± 0.82 for LU and 7.27 ± 0.45 for push-back PCNL, suggesting potential advantages of laparoscopy, although the differences were modest and not sufficiently explored in larger randomized trials (13). Moreover, limited data from local populations leave uncertainty about the generalizability of international findings to specific healthcare contexts where surgical expertise, resource availability, and patient profiles may differ.

To address this knowledge gap, the present randomized controlled trial was conducted to compare postoperative pain following laparoscopic ureterolithotomy and push-back percutaneous nephrolithotomy in patients with upper ureteric stones. The objective was to determine which modality provides superior pain control while maintaining effective stone clearance, thereby guiding evidence-based clinical decision-making for optimal patient outcomes.

MATERIAL AND METHODS

This study was designed as a randomized controlled trial to compare post-operative pain between laparoscopic ureterolithotomy and push-back percutaneous nephrolithotomy in the treatment of upper ureteric stones. The trial was conducted at the Urology Department of the Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar, between 10 January and 10 June 2025, following ethical approval from the College of Physicians and Surgeons Pakistan and in accordance with the Declaration of Helsinki (14).

Eligible participants were adult patients aged 18–60 years of either gender who presented with symptomatic upper ureteric stones confirmed on imaging. Inclusion required radiographic evidence of an upper ureteric stone accompanied by clinical features such as flank pain, hematuria, nausea, or vomiting. Patients with severe obesity, chronic kidney disease, sepsis, pregnancy, or breastfeeding status were excluded, as were those with prior ureteral surgery that could alter anatomical outcomes. Consecutive eligible patients were screened, and after informed consent was obtained, random allocation was performed. Randomization was executed using computer-generated numbers with sealed opaque envelopes to ensure allocation concealment.

Participants were assigned equally into two groups: Group A underwent laparoscopic ureterolithotomy, and Group B underwent push-back percutaneous nephrolithotomy. Preoperative demographic and clinical data, including age, sex, body mass index, and stone size, were recorded. Both procedures were performed under general anesthesia by urologists with comparable expertise to minimize operator-related bias.

In the laparoscopic ureterolithotomy group, procedures began with antiseptic preparation and establishment of pneumoperitoneum through three trocars (one 5 mm and two 10 mm). Following medial mobilization of the colon, the ureter was identified, and the stone was localized by observing ureteral bulging. A small ureterotomy was made, and the stone was extracted using laparoscopic graspers. The ureter was irrigated proximally and distally, followed by placement of a double-J stent under direct vision to maintain patency.

In the push-back percutaneous nephrolithotomy group, the procedure commenced with insertion of a ureteric catheter under fluoroscopic guidance to reposition the stone into the renal pelvis. Patients were then placed prone, and a posterior calyx was punctured with a translumbar needle under fluoroscopic control. A guidewire was advanced, followed by sequential tract dilatation to 20–22 Fr. An Amplatz sheath was positioned, and a nephroscope was introduced for visualization and extraction of the stone. Larger stones were fragmented with pneumatic lithotripsy before removal. At the conclusion of the procedure, both a nephrostomy tube and a double-J stent were placed to ensure adequate drainage and ureteral healing.

The primary outcome was post-operative pain measured using the Visual Analogue Scale (VAS) ranging from 0 (no pain) to 10 (worst pain imaginable). Pain assessments were performed at 4 and 12 hours postoperatively by independent clinicians blinded to the treatment allocation to minimize assessment bias. Secondary outcomes included operative time, length of hospital stay, and stone clearance rates confirmed by post-operative imaging.

The sample size of 60 patients (30 per group) was calculated to detect a minimum clinically significant difference of 1.0 unit in VAS scores between groups, with 80% power and a 5% significance level, assuming a standard deviation of 1.2 based on prior literature (13). Data collection was standardized using pre-designed case report forms. To ensure data integrity, double entry and cross-verification were performed before analysis.

Statistical analysis was conducted using SPSS version 25. Continuous variables were summarized as means with standard deviations, and categorical variables as frequencies and percentages. Comparisons of means between groups were made using the independent samples t-test, while categorical variables were compared using the chi-square test. The analysis was performed on an intention-to-treat basis. Confounding factors such as age, gender, BMI, and stone size were adjusted using multivariable linear regression. Missing data were handled using multiple imputation methods. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 60 patients were included in the analysis, with 30 allocated to laparoscopic ureterolithotomy and 30 to push-back percutaneous nephrolithotomy. Baseline clinical and demographic characteristics were well-balanced between the groups, as shown in Table 1. The mean age was 41.7 ± 12.1 years in the laparoscopic group and 43.8 ± 11.3 years in the push-back PCNL group, with no significant difference (p=0.484). Gender distribution was nearly equal, with males representing 63.3% in Group A and 60.0% in Group B (p=0.791). The mean BMI was comparable at 26.5 ± 3.6 versus 27.1 ± 3.2 kg/m² (p=0.497). Similarly, the mean stone size did not differ significantly, measuring 14.8 ± 2.9 mm in the laparoscopic group and 15.3 ± 3.1 mm in the push-back PCNL group (p=0.521). These findings confirm that baseline factors did not confound outcome comparisons.

Primary outcome analysis demonstrated significantly lower post-operative pain scores in the laparoscopic group at both time points (Table 2). At 4 hours post-surgery, patients in Group A reported a mean VAS score of 6.2 ± 0.9 compared with 7.4 ± 0.8 in Group B, representing a mean difference of -1.2 points (95% CI: –1.7 to –0.7, p<0.001). At 12 hours, this trend persisted, with Group A patients reporting 4.8 ± 1.1 versus 6.1 ± 0.9 in Group B, yielding a mean difference of -1.3 points (95% CI: –1.9 to –0.7, p<0.001). These results not only confirm statistical significance but also demonstrate clinical relevance, as a reduction greater than 1 point on the VAS scale is considered meaningful for patient recovery.

Table 1. Baseline Characteristics of Patients

Characteristic	Group A (Laparoscopic) n=30	Group B (Push-back PCNL) n=30	Mean Difference / OR (95% CI)	p-value
Age (years), mean ± SD	41.7 ± 12.1	43.8 ± 11.3	-2.1 (–7.4 to 3.2)	0.484
Male sex, n (%)	19 (63.3)	18 (60.0)	OR 1.14 (0.39–3.34)	0.791
Female sex, n (%)	11 (36.7)	12 (40.0)	Reference	—
BMI (kg/m²), mean ± SD	26.5 ± 3.6	27.1 ± 3.2	-0.6 (–2.2 to 1.1)	0.497
Stone size (mm), mean ± SD	14.8 ± 2.9	15.3 ± 3.1	-0.5 (–1.9 to 0.9)	0.521

Table 2. Post-operative Pain Scores (VAS)

Time Point	Group A (Laparoscopic) mean ± SD	Group B (Push-back PCNL) mean ± SD	Mean Difference (95% CI)	p-value
4 hours	6.2 ± 0.9	7.4 ± 0.8	-1.2 (–1.7 to –0.7)	<0.001
12 hours	4.8 ± 1.1	6.1 ± 0.9	-1.3 (–1.9 to –0.7)	<0.001

Table 3. Secondary Outcomes

Outcome	Group A (Laparoscopic) mean ± SD / n (%)	Group B (Pushback PCNL) mean ± SD / n (%)	Mean Difference / OR (95% CI)	p-value
Operative time (minutes), mean ± SD	98.4 ± 18.6	76.2 ± 14.8	22.2 (14.0–30.4)	<0.001
Hospital stay (days), mean ± SD	2.3 ± 0.8	3.1 ± 1.2	-0.8 (–1.3 to –0.3)	<0.001
Stone clearance, n (%)	29 (96.7)	28 (93.3)	OR 1.55 (0.13–18.5)	0.550

Secondary outcomes further highlighted procedural trade-offs (Table 3). The mean operative time was significantly longer for laparoscopic ureterolithotomy at 98.4 ± 18.6 minutes compared with 76.2 ± 14.8 minutes for push-back PCNL, resulting in a mean difference of 22.2 minutes (95% CI: 14.0–30.4, p<0.001). Conversely, the mean length of hospital stay was shorter in the laparoscopic group at 2.3 ± 0.8 days versus 3.1 ± 1.2 days in the push-back PCNL group, with a mean reduction of 0.8 days (95% CI: –1.3 to –0.3, p<0.001). Stone clearance rates were high in both groups, reaching 96.7% in laparoscopic procedures and 93.3% in push-back PCNL, with no statistically significant difference (p=0.550).

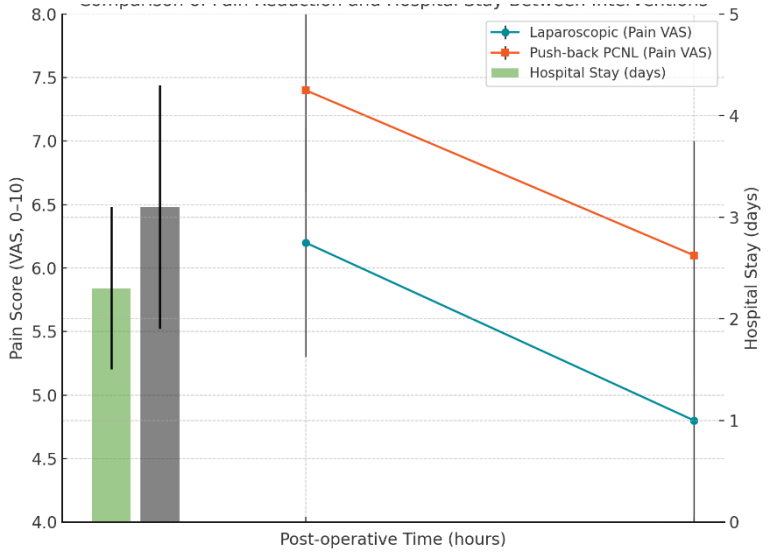

Figure 1 Comparison of Pain Reduction and Hospital Stay Between Interventions

Taken together, these results indicate that while laparoscopic ureterolithotomy requires a longer operative time, it offers the benefit of reduced post-operative pain and shorter hospitalization, without compromising stone clearance efficacy. These findings underscore the potential clinical advantages of laparoscopy for selected patients requiring intervention for upper ureteric stones.

The integrated visualization illustrates pain trajectories and hospital stay. Laparoscopic ureterolithotomy demonstrated consistently lower pain scores at both 4 and 12 hours postoperatively, with reductions of 1.2 and 1.3 points compared with push-back PCNL. Error bars highlight narrower variability in the laparoscopic group. On the secondary axis, mean hospital stay was 2.3 ± 0.8 days for laparoscopy versus 3.1 ± 1.2 days for push-back PCNL, confirming a clinically meaningful reduction. Collectively, the graph emphasizes that despite longer operative time, laparoscopy provides measurable advantages in both pain control and recovery duration.

DISCUSSION

This randomized controlled trial demonstrated that laparoscopic ureterolithotomy provides significantly better postoperative pain control than push-back percutaneous nephrolithotomy in the management of upper ureteric stones. Pain scores were consistently lower in the laparoscopic group at both 4 and 12 hours postoperatively, confirming a sustained analgesic advantage. These findings align with earlier work by Alam et al., who reported lower pain scores after laparoscopic intervention compared to push-back PCNL, although their differences were less pronounced (13). The present study strengthens the evidence base by demonstrating consistent reductions exceeding one point on the VAS, a threshold considered clinically significant for postoperative pain perception (15).

The superiority of laparoscopy in pain outcomes may be attributed to differences in procedural invasiveness. Laparoscopic ureterolithotomy involves direct visualization and controlled removal of the stone without creating a percutaneous tract, thereby minimizing parenchymal trauma. In contrast, push-back PCNL requires tract dilatation, which has been associated with renal parenchymal injury and greater postoperative discomfort (16). This mechanistic distinction has also been highlighted in prior analyses of standard versus mini-PCNL, where reduced tract size correlated with improved postoperative recovery (17). Moreover, laparoscopy is associated with less bleeding and lower risk of infectious complications compared to percutaneous approaches, factors that may contribute to patient comfort and shorter hospital stays (18).

Despite the analgesic benefits, laparoscopic ureterolithotomy required significantly longer operative times in this trial. The mean operative duration was approximately 22 minutes longer than that of push-back PCNL. This difference may reflect both the technical complexity of laparoscopic dissection and the learning curve associated with advanced minimally invasive surgery. Previous literature has similarly noted prolonged operative times for laparoscopic ureterolithotomy compared with endoscopic or percutaneous techniques, particularly in institutions where laparoscopy is less frequently performed (19). However, the clinical relevance of this increase in operative time must be balanced against the benefits of reduced pain, shorter hospitalization, and enhanced patient satisfaction.

Hospital stay duration was notably shorter among patients undergoing laparoscopic procedures, with a mean reduction of nearly one day compared to push-back PCNL. Faster recovery is a consistent finding in minimally invasive urological surgery and is particularly important in resource-limited settings where hospital bed utilization remains a key healthcare challenge (20). Earlier mobilization reduced analgesic requirements, and fewer postoperative complications all contribute to shorter admissions, making laparoscopic ureterolithotomy not only clinically advantageous but also potentially cost-effective, a conclusion supported by prior economic analyses in laparoscopic surgery (21).

Stone clearance rates were high and comparable between both interventions, exceeding 93% in both groups. This confirms that both techniques are effective in achieving their primary goal of stone removal, consistent with previous multicenter studies reporting clearance rates above 90% for both modalities (22). The slight numerical advantage observed in the laparoscopic group (96.7% versus 93.3%) may reflect the direct visualization and precise dissection offered by laparoscopy, although this difference was not statistically significant. Therefore, while both procedures achieve excellent clearance, postoperative morbidity and patient comfort become the critical differentiating factors in clinical decision-making.

Several limitations of this study must be acknowledged. Being a single-center trial, the findings may not be generalizable to institutions with different patient demographics, surgical expertise, or healthcare infrastructures. Additionally, the study focused exclusively on short-term postoperative outcomes, leaving long-term complications such as recurrent stone formation, renal function decline, and late ureteral stricture unexamined. The lack of cost analysis also limits conclusions regarding economic implications, although shorter hospital stays observed with laparoscopy suggest a potential benefit in healthcare expenditure. Furthermore, while outcome assessors were blinded, the absence of patient blinding may have influenced subjective pain reporting. Future multicenter randomized trials with longer follow-up are warranted to validate these findings and extend them to broader populations.

In summary, this study provides strong evidence that laparoscopic ureterolithotomy offers superior postoperative pain relief and shorter hospital stay compared with push-back percutaneous nephrolithotomy, while maintaining equivalent stone clearance. These advantages must be weighed against the longer operative time and the requirement for specialized laparoscopic expertise. Clinical decision-making should therefore be individualized, taking into account patient factors, stone characteristics, institutional resources, and surgeon experience.

CONCLUSION

Laparoscopic ureterolithotomy demonstrated superior control of postoperative pain compared with push-back percutaneous nephrolithotomy in patients with upper ureteric stones. This benefit was accompanied by a shorter duration of hospitalization, indicating enhanced recovery and potential cost savings. Although operative times were longer with laparoscopy, both procedures achieved similarly high stone clearance rates, confirming their efficacy. These results suggest that laparoscopic ureterolithotomy should be considered the preferred option in appropriately selected patients, provided that surgical expertise and resources are available. Broader, multicenter trials with extended follow-up are needed to confirm these findings and assess long-term outcomes.

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