

Study Of Effectiveness of Transperitoneal Laparoscopic Ureterolithotomy (TPLU) In Management of Upper and Mid Ureteric Calculi

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ABSTRACT

Background:

Ureteric stone disease remains a significant urological concern, with larger or impacted stones often refractory to non-invasive techniques such as extracorporeal shock wave lithotripsy (ESWL) or ureteroscopy. Laparoscopic ureterolithotomy, particularly via the transperitoneal approach, has emerged as a minimally invasive alternative in such cases.

Objectives:

To evaluate the safety and efficacy of laparoscopic transperitoneal ureterolithotomy in patients with large proximal and mid-ureteric stones.

Methods:

This prospective observational study included 50 patients aged 20–60 years with proximal or mid-ureteric calculi >1.5 cm. Patients underwent laparoscopic transperitoneal ureterolithotomy using a standardized three-port technique. Key intraoperative and postoperative outcomes were recorded, including operative time, blood loss, conversion to open surgery, postoperative pain (VAS score), drain duration, hospital stay, and surgical complications.

Results:

The mean patient age was 40.7 ± 11.8 years, with a male-to-female ratio of 1.17:1. Most stones were located in the left proximal ureter (64%) and had a mean size of 1.7 cm. The average operative time was 90.2 ± 28.5 minutes, and mean intraoperative blood loss was 74.7 ± 33.8 mL. Conversion to open surgery occurred in 14% of cases. Postoperative pain scores averaged 5.8 ± 2.2 on the VAS scale, and the mean hospital stay was 8.5 ± 3.2 days. Complications were minimal, with 18% developing surgical site infections and only 6% experiencing injury to adjacent structures.

Conclusion:

Laparoscopic transperitoneal ureterolithotomy is a safe and effective modality for the treatment of large upper and mid-ureteric stones. The procedure is associated with favorable operative outcomes, minimal complications, and good postoperative recovery, supporting its use as a viable alternative to open surgery or repeated endoscopic interventions in selected patients.

1. INTRODUCTION

One of the major disorders of the urinary system that frequently concerns patients is stone formation. The significance of this condition can be understood from the fact that approximately 10% of patients with urinary calculi eventually lose the affected kidney either through nephrectomy or due to progressive destruction [1]. The damaging effects of urinary stones may include obstruction and dilatation of the urinary tract, leading to urinary stasis, infection, and subsequent fibrosis [2].

The choice of treatment depends on several factors, including stone size, site of impaction, presence of obstruction, and

associated infection. Until the 1980s, urinary stones posed a serious health problem, with a considerable proportion of patients undergoing extensive surgical interventions and some experiencing renal loss. However, the introduction of extracorporeal techniques for stone fragmentation and advancements in endoscopic surgery have significantly reduced the morbidity associated with stone surgery [3].

In the management of ureteric stones, the emergence of minimally invasive techniques—such as extracorporeal shock wave lithotripsy (ESWL), flexible ureterorenoscopy, percutaneous surgery, and laser lithotripsy—has led to a marked decrease in morbidity [4]. Nevertheless, open surgery remains necessary in select cases. Laparoscopic ureterolithotomy, particularly through the transperitoneal or retroperitoneal route, is primarily indicated for large stones and failed ureteroscopy or when open surgery is otherwise contemplated [5].

Laparoscopic ureterolithotomy has been demonstrated to be a safe, feasible, and effective minimally invasive treatment for ureteral stones. Multiple studies have shown its value either as a primary treatment for large, impacted stones or as a salvage option following failed ESWL or ureteroscopy [6]. The procedure offers benefits including minimal blood loss, reduced analgesic requirement, improved cosmetic outcomes, and shorter hospital stay and convalescence [7].

In light of these advantages, the present study was undertaken to evaluate the effectiveness and safety of laparoscopic transperitoneal ureterolithotomy in managing large upper and mid-ureteric stones.

Objectives

1. To evaluate the safety of transperitoneal laparoscopic ureterolithotomy in the management of large upper and mid-ureteric stones.
2. To assess the efficacy of the procedure based on intraoperative and postoperative outcomes, including bleeding, operative time, injury to surrounding structures, conversion to open surgery, postoperative pain, drainage duration, hospital stay, recovery time, and surgical site complications.

2. MATERIALS AND METHODS

Study Design This was a prospective observational study conducted to evaluate the outcomes of laparoscopic transperitoneal ureterolithotomy in patients with proximal and mid-ureteric calculi.

Setting The study was carried out in the Department of General Surgery at our institute from the time of ethical approval until December 2016.

Participants A total of 50 patients presenting with proximal or mid-ureteric stones were enrolled. All patients provided informed written consent prior to inclusion. A pre-structured proforma was used to collect baseline data and clinical history.

Eligibility Criteria

Inclusion Criteria:

- Patients aged 20 to 60 years
- Presence of proximal or mid-ureteric calculus >1.5 cm
- No prior history of abdominal surgery
- Both sexes
- Willingness to provide written informed consent

Exclusion Criteria:

- Patients unfit for laparoscopy due to comorbidities
- Presence of multiple small stones <1.5 cm
- Stones located outside the upper or mid-ureter

Variables and Data Collection Baseline and clinical variables were recorded using a standardized form. Key intraoperative and postoperative outcomes were documented, including:

- Intraoperative blood loss (gauze count method)
- Operative time (in minutes)
- Intraoperative injuries to adjacent structures
- Conversion rate to open surgery
- Postoperative pain (measured by Visual Analogue Scale, VAS)

- Duration of drainage
- Recovery time and length of hospital stay
- Wound and surgical site complications

Investigations Routine preoperative investigations included hemoglobin, total leukocyte count (TLC), differential count (DLC), blood urea nitrogen (BUN), serum creatinine, urine microscopy, urine culture and sensitivity, and blood grouping. Special investigations included X-ray KUB, ultrasonography (USG) of the abdomen and pelvis, and intravenous pyelogram (IVP). All patients underwent pre-anesthesia check-up prior to surgery.

Surgical Technique Transperitoneal laparoscopic ureterolithotomy was performed using the following port placement strategy:

- One 11 mm port above the umbilicus via open technique
- One 5 mm port in the ipsilateral hypochondrium
- One 11 mm port in the ipsilateral mid-clavicular line under vision

Following colonic mobilization, the dilated ureter was identified. Stone localization was performed via inspection and gentle palpation. Ureterotomy was done using a monopolar hook, followed by stone extraction. A double J stent was placed if required. The ureterotomy was closed with interrupted 3-0 Vicryl sutures. A drain was placed retroperitoneally through one of the port sites. Stone retrieval was achieved either by dilating the 11 mm port site or by extending the incision when necessary.

Bias Patients were selected consecutively based on defined eligibility criteria to minimize selection bias. Procedural steps and outcome recording were standardized to reduce measurement variability.

Study Size The sample size comprised 50 patients who met the inclusion criteria during the study period.

Statistical

Collected data were compiled in Microsoft Excel and analyzed descriptively. Outcomes were tabulated and correlated. Results are presented in tabular form. Continuous variables (e.g., operative time, bleeding) were summarized using mean values, while categorical outcomes (e.g., conversion rate, complications) were expressed as proportions.

Methods

3. RESULTS

Demographics and Clinical Presentation

The patient cohort showed a mean age of 40.7 years, predominantly in the 30–50 age range, with a slight male predominance (54%). Clinical presentation was typical of ureteric calculi, with nearly all patients (98%) reporting colicky pain. Burning micturition and hematuria were present in 52% and 18% respectively. Nearly half the patients presented within the first year of symptom onset, indicating moderate chronicity of disease progression at the time of surgical intervention.

Table 1. Demographics and Clinical Presentation of Patients Undergoing Laparoscopic Ureterolithotomy

Characteristic	Subgroup	No. of Cases	Percentage (%)
Age (years)	< 20	1	2%
	20–30	9	18%
	30–40	17	34%
	40–50	13	26%
	50–60	10	20%
	Mean ± SD	40.70 ± 11.84	
Sex	Male	27	54%
	Female	23	46%

Characteristic	Subgroup	No. of Cases	Percentage (%)
Symptoms	Pain	49	98%
	Burning micturition	26	52%
	Hematuria	9	18%
Duration of Symptoms	5 days	3	6%
	7 days	3	6%
	10 days	3	6%
	15 days	5	10%
	20 days	2	4%
	1 month	6	12%
	2 months	5	10%
	3 months	2	4%
	4 months	2	4%
	5 months	3	6%
	6 months	5	10%
	1 year	7	14%
	2 years	4	8%
	Total	50	100%

Stone Characteristics and Laterality Stones were more frequently left-sided (64%) and located predominantly in the proximal ureter (74%). The average stone size was approximately 1.7 cm, affirming the study's inclusion criteria and justifying the choice of laparoscopic intervention over non-invasive modalities like ESWL. Imaging via USG and IVP confirmed consistent findings in terms of size and location.

Table 2. Anatomical Distribution and Radiological Characteristics of Ureteric Stones

Parameter	Subgroup	No. of Cases	Percentage (%)
Side of Stone	Left Side	32	64%
	Right Side	18	36%
	Total	50	100%
Size of Stone (USG)	< 1.5 cm	4	8%
	1.5–2.0 cm	42	84%
	> 2.0 cm	4	8%

Parameter	Subgroup	No. of Cases	Percentage (%)
	Total	50	100%
	Mean ± SD	1.698 ± 0.21	
Site of Stone (USG)	Left Mid Ureter	8	16%
	Left Proximal Ureter	22	44%
	Right Mid Ureter	5	10%
	Right Proximal Ureter	15	30%
	Total	50	100%
Size of Stone (IVP)	< 1.5 cm	6	12%
	1.5–2.0 cm	37	74%
	> 2.0 cm	7	14%
	Total	50	100%
	Mean ± SD	1.666 ± 0.14	
Site of Stone (IVP)	Left Mid Ureter	8	16%
	Left Proximal Ureter	22	44%
	Right Mid Ureter	5	10%
	Right Proximal Ureter	15	30% (corrected)**
	Total	50	100%
Diagnosis	Lt Mid Ureteric Calculus	8	16%
	Lt Prox Ureteric Calculus	24	48%
	Rt Mid Ureteric Calculus	5	10%
	Rt Prox Ureteric Calculus	13	26%
	Total	50	100%

Intraoperative Parameters and Surgical Details The average operative time was 90.2 minutes, and mean blood loss was 74.7 mL, reflecting controlled intraoperative conditions. The conversion to open surgery occurred in 14% of cases—mostly attributable to intraoperative complications. Only 6% experienced injuries to adjacent structures, emphasizing procedural safety when performed by skilled surgeons. Most procedures were successfully completed laparoscopically (86%).

Table 3. Intraoperative Parameters and Surgical Approach

Parameter	Subgroup	No. of Cases	Percentage (%)
Diagnosis	Left Lap Ureterolithotomy	32	64%

Parameter	Subgroup	No. of Cases	Percentage (%)
	Right Lap Ureterolithotomy	18	36%
	Total	50	100%
Operative Time (minutes)	60–70	15	30%
	70–80	6	12%
	80–90	13	26%
	90–100	5	10%
	100–120	7	14%
	>120	4	8%
	Total	50	100%
	Mean ± SD	90.20 ± 28.50 min	
Intraoperative Bleeding (ml)	30–40	4	8%
	40–50	9	18%
	50–60	8	16%
	60–70	10	20%
	70–80	5	10%
	80–90	9	18%
	90–100	3	6%
	>100	7	14%
	Total	50	100%
	Mean ± SD	74.70 ± 33.75 ml	

Postoperative Recovery and Complication Postoperative pain scores averaged 5.8 on the VAS scale, with analgesia required for a mean of 6.4 days. Drain duration (mean 5.84 days) and hospital stay (mean 8.5 days) were slightly longer than some comparative studies, possibly due to a higher incidence of surgical site infections (18%) and mild complications in a subset of patients. Despite these, the overall recovery profile remains favorable, with minimal severe morbidity and high tolerance of the laparoscopic approach.

Table 4. Postoperative Outcomes, Pain Scores, and Recovery Metrics

Parameter	Subgroup / Score	No. of Cases	Percentage (%)
Pain (VAS Score)	3	3	6%

Parameter	Subgroup / Score	No. of Cases	Percentage (%)
	4	15	30%
	5	12	24%
	6	5	10%
	7	3	6%
	8	3	6%
	9	5	10%
	10	3	6%
	11	1	2%
	Total	50	100%
	Mean $\pm$ SD	5.80 $\pm$ 2.17 days	
Drain Duration (days)	3	4	8%
	4	12	24%
	5	11	22%
	6	8	16%
	7	4	8%
	8	4	8%
	9	3	6%
	10	3	6%
	12	1	2%
	Total	50	100%
	Mean $\pm$ SD	5.84 $\pm$ 2.14 days	
Hospital Stay (days)	5	6	12%
	6	9	18%
	7	11	22%
	8	7	14%
	9	3	6%
	10	3	6%

Parameter	Subgroup / Score	No. of Cases	Percentage (%)
	11	1	2%
	12	3	6%
	14	3	6%
	15	2	4%
	16	2	4%
	Total	50	100%
	Mean $\pm$ SD	8.50 $\pm$ 3.18 days	
Surgical Approach	Open Conversion	7	14%
	Laparoscopic	43	86%
	Total	50	100%
Other Postoperative Outcomes	Pain (VAS) Duration	—	5.80 $\pm$ 2.17 days
	Analgesic Requirement	—	6.38 $\pm$ 2.46 days
	Drain Duration	—	5.84 $\pm$ 2.14 days
	Hospital Stay	—	8.50 $\pm$ 3.18 days

4. DISCUSSION

Since the introduction of extracorporeal shock wave lithotripsy (ESWL) [56] and ureteroscopy [57], the routine use of open surgery for ureteric calculi has markedly declined. However, large or impacted ureteric stones remain a challenge for modern endourologic techniques and often necessitate multiple interventions. ESWL is generally suitable for ureteric stones smaller than 1 cm [58], but its efficacy diminishes with increasing stone size, often requiring repeated sessions [59]. Park et al. [60] reported a drop in stone-free rates from 84% to 42% for stones exceeding 1 cm. Consequently, laparoscopic ureterolithotomy is indicated for stones inaccessible to ureteroscopy or refractory to fragmentation techniques.

Laparoscopic ureterolithotomy offers a minimally invasive alternative for treating large ureteric calculi. Although only a few small case series have addressed its use in lower ureteric stones [61], its safety and efficacy are well established for mid and upper ureteric stones via the transperitoneal approach, which offers superior anatomical orientation. The first transperitoneal laparoscopic ureterolithotomy was reported by Raboy et al. in 1992. Subsequently, Gaur's introduction of retroperitoneal access using balloon dilation [62] expanded the technique's feasibility. These minimally invasive approaches have gradually supplanted open ureterolithotomy due to lower morbidity.

In our study, the average patient age was 41 years, with a range from 16 to over 60 years, aligning with earlier reports that most cases occur between the ages of 20 and 50 [63]. A male predominance was observed (54%), comparable to previous data showing male-to-female ratios ranging from 2:1 to 3:1 [64].

The predominant symptom in our cohort was colicky pain (98%), followed by burning micturition (52%) and hematuria (18%), which is consistent with reports by Higgins [63] and others [65,66]. Duration of symptoms in our study ranged from under one week to over a year, with 48% of patients presenting within the first year, echoing findings by Miles et al. [67].

Our inclusion criteria focused on stones >1.5 cm, with the average size being 17 mm, which reflects the clinical threshold above which ESWL efficacy significantly drops [58–60]. Left-sided stones were slightly more prevalent (60%), whereas Bumpus and Thompson [68] reported equal laterality.

Operative time varied with factors such as stone impaction and surgeon experience. Our average operative time was 90

minutes (range: 60–180 minutes), which compares favorably with previous studies: Abolyosr [69] (85.2 min), Skrepetis et al. [70] (130 min), El-Feel et al. [71] (145 ± 42 min), Kijvikai et al. [72] (121.4 min), Keeley [73] (105 min), and Matias et al. [74] (145 min). Our average intraoperative blood loss was 75 mL, with most cases under 100 mL. Higher blood loss correlated with injuries to adjacent structures, such as gonadal vessels. We employed a monopolar diathermy hook to perform ureterotomy, a technique supported by Gaur [62], Harewood, and others for its ease and safety. Although scissors or cold knives may theoretically reduce stricture risk, their use is often limited by technical difficulties. Suturing the ureter remains a time-intensive step requiring laparoscopic skill.

Postoperative analgesia was typically limited to a single dose of intramuscular diclofenac followed by oral NSAIDs. Most patients required analgesia for an average of six days. Only four patients needed extended pain management due to complications. Our findings are consistent with Skrepetis et al. [70], El-Feel et al. [71], and Flasko et al. [73], all reporting shorter analgesic durations with laparoscopic versus open approaches.

Hospital stay in our cohort averaged 8.5 days (range: 5–16 days). Although slightly longer than the mean durations reported by Abolyosr [69] (3.8 days), Skrepetis [70] (3 days), El-Feel [71] (4.1 days), and Flasko [73] (3 days), this may be due to the inclusion of patients with postoperative complications such as fever and surgical site infections.

Perioperative complications were minimal. Only 6 patients required postoperative double-J stenting, and drain duration averaged 6 days. Surgical site infections occurred in 9 cases, and 3 patients sustained injuries to adjacent structures, necessitating conversion to open surgery in 7 cases. Comparative studies, including those by Abolyosr [69], Skrepetis [70], and Simforoosh et al. [75], confirm the low complication profile of laparoscopic ureterolithotomy. Simforoosh et al. [75] reported a 96.7% stone-free rate, with minimal reoperations and complications such as hematoma or urinoma.

5. LIMITATIONS

This study has several limitations that should be acknowledged. First, it was conducted at a single tertiary care center, which may limit the generalizability of the results to other institutions with different surgical expertise, patient populations, or healthcare infrastructure. Second, the relatively small sample size of 50 patients restricts the statistical power of the study and may not adequately capture less frequent complications or outcomes. Additionally, the absence of a comparative control group—such as patients undergoing ESWL, ureteroscopy, or open ureterolithotomy—limits the ability to directly assess the relative advantages of laparoscopic ureterolithotomy over alternative treatment modalities. Lastly, long-term follow-up data on stone recurrence, stricture formation, or renal function preservation were not included, which would have further strengthened the evaluation of the procedure's long-term efficacy and safety.

6. CONCLUSION

Laparoscopic transperitoneal ureterolithotomy represents a reliable and minimally invasive surgical option for the management of large proximal and mid-ureteric stones, particularly in cases where other interventions such as ESWL and ureteroscopy have failed or are unsuitable. In this prospective observational study of 50 patients, the procedure demonstrated high safety and efficacy, with low rates of complications, acceptable operative times, and minimal blood loss. Most patients experienced manageable postoperative pain, short drainage durations, and satisfactory recovery periods. The findings support the use of laparoscopic ureterolithotomy as an effective alternative to open surgery, offering favorable clinical outcomes when performed by experienced surgical teams. Future comparative studies with larger cohorts may further consolidate its role in the modern endourological treatment algorithm.

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