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Comparison of Ureteroscopic Lithotripsy and Laparoscopic Ureterolithotomy for the Treatment of Unilateral Upper Ureteral Stone: A Randomized Controlled Trial at a Tertiary Care Hospital in Pakistan

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ABSTRACT

Objective: To compare the efficacy and perioperative outcomes of laparoscopic ureterolithotomy (LU) and ureteroscopic lithotripsy (URL) in patients with proximal ureteral stones measuring 10–20 mm. **Methods:** This study was designed as a prospective, randomised, controlled trial and conducted in the Department of Urology at Lahore General Hospital over three months i.e from 1st April, 2025 to 30th June, 2025. A total of fifty-six adult patients diagnosed with a solitary unilateral proximal ureteric stone were enrolled and randomly allocated into two equal treatment groups: laparoscopic ureterolithotomy (LU, n = 28) and ureteroscopic lithotripsy (URL, n = 28). The primary objectives of the study included operative duration, postoperative hospitalisation, and stone-free rate (SFR). Secondary endpoints comprised perioperative adverse events, categorised according to the Clavien–Dindo classification, and the need for additional or auxiliary interventions. Postoperative assessment of stone clearance was confirmed using plain X-ray KUB, and/or non-contrast CT KUB. A p-value of < 0.05 was considered statistical significance. **Results:** The two intervention groups were similar with respect to baseline demographic variables. The average stone diameter was greater among patients managed with LU (1.71 ± 0.29 cm) than those treated with URL (1.29 ± 0.31 cm), and this difference was statistically significant ($p < 0.001$). The mean operative time was longer in the laparoscopic ureterolithotomy group (101.2 ± 11.4 minutes) compared with the ureteroscopic lithotripsy group (40.9 ± 5.9 minutes), with this difference reaching statistical significance ($p < 0.001$).Postoperative hospitalisation was also prolonged in the LU group (2.5 ± 0.3 days) compared with the URL group (1.0 ± 0.3 days; $p < 0.001$). Stone clearance was complete in all patients undergoing LU, whereas the stone-free rate following URL was 78.6%, ($p = 0.01$). In the URL arm, 6 patients (21.4%) required additional treatment with PCNL, whereas none in the LU group required auxiliary intervention ($p = 0.02$). The majority of recorded complications were of low grade. **Conclusion:** Single-session laparoscopic ureterolithotomy is a better option than retreatment because it provides superior stone clearance and is unlikely to recur over time. Lithotripsy using the ureteroscopic approach is not as invasive and has faster healing, but has increased chances of leaving behind stones.

INTRODUCTION

Urolithiasis is a growing worldwide health issue and recent epidemiological research determined that its lifetime prevalence was about 1015 percent all over the world (1). This burden is very high in those countries found in the so-called stone belt such as Pakistan where prevalence rates are reported to be between 1216 percent due to a combination of environmental, dietary and genetic factors (2). Proximal ureteric calculi are among the most difficult to treat subgroups within the different presentations of stone disease. They are usually hard to reach and do not respond to conservative treatment, like medical expulsive therapy or extracorporeal shock-wave lithotripsy (ESWL) and eventually require surgical management (3-5).

Several surgical procedures are available for treating proximal ureteral stones, the most common being ureteroscopic lithotripsy (URL), laparoscopic ureterolithotomy (LU), and percutaneous nephrolithotomy (PCNL). The URLs have become widely accepted due to their less invasive nature and broad coverage. Nevertheless, the patients with big or infiltrated proximal ureteral stones still show mixed results. The reported rates of being stone-free differ and are usually

tampered by stone retropulsion, residual fragments and technical restrictions of semirigid ureteroscopes to reach the upper ureter (6).

Conversely, LU provides direct contact with the stone, prevents retropulsion, and exhibits high stone-free rates in randomised and observational studies (79). In addition to these benefits, LU is associated with prolonged operative time, increased invasiveness, and the need for a high level of laparoscopic skills, which determine its implementation in practice.

In South Asian and resource-limited environments, the problem of clinical decision-making is further complicated by the fact that access to flexible ureteroscopes, high-power laser systems, and trained laparoscopic surgeons differs significantly among institutions. Despite the prevalence of proximal ureteric stones in these areas, randomised controlled trials comparing URL and LU have not been conducted adequately.

Against this background, the present randomised controlled trial was conducted to compare LU and URL for the treatment of proximal ureteric calculi measuring 10–20 mm. The study evaluates stone-free rate, operative parameters, perioperative complications, and the need for auxiliary procedures to guide evidence-based decision-making in environments with variable resources and technological availability.

MATERIALS AND METHODS

Study Design and Setting

A prospective, randomised, controlled design was employed for this study, which was done in the Urology Department of Lahore General Hospital over three months i.e from 1st April, 2025 to 30th June, 2025. Ethical approval was granted by the Institutional Ethical Review Committee of PGMI/LGH. The trial (**NCT07197385**) was conducted in accordance with CONSORT recommendations. Informed written consent was taken from all enrolled participants prior to inclusion.

Sample Size

The sample size was determined using OpenEpi based on operative time data reported by Fang et al. (10), who documented a mean operative time of 49.0 ± 10.7 minutes for laparoscopic ureterolithotomy (LU) and 41.8 ± 8.0 minutes for ureteroscopic lithotripsy (URL). Using these values, with a 95% confidence level and 80% power, the necessary sample size was determined to be 28 patients per group**.**

Patient Selection

The target population consisted of adult patients presenting to the Department of Urology at LGH with proximal ureteric stones. Stone size was confirmed on X-ray, KUB, and CT KUB.

Inclusion Criteria

- Age ≥18 years
- Single proximal ureteral stone 10–20 mm
- Normal contralateral kidney
- Informed consent

Exclusion Criteria

- Solitary functioning kidney
- Active UTI
- Previous ipsilateral ureteric/renal surgery
- Congenital/anatomical abnormalities
- Significant systemic illness contraindicating surgery

Randomization

Patients were randomized 1:1 to LU or URL using sealed, opaque envelopes prepared by an independent staff member. Allocation concealment was maintained until surgery.

Surgical Techniques

Laparoscopic Ureterolithotomy (LU)

A transperitoneal approach was used. After identifying the ureter, a longitudinal ureterotomy was made, the stone retrieved intact, and the ureter closed with interrupted absorbable sutures. A DJ stent was placed at surgeon discretion.

Ureteroscopic Lithotripsy (URL)

Semirigid ureteroscopy with pneumatic lithotripsy was performed. Stone fragments were removed with baskets or graspers. A DJ stent was placed when indicated.

All surgeries were done under general anesthesia by experienced consultants.

All patients were followed at 4 weeks.

Outcome Measures

Primary outcomes

1. Operative time
2. Length of hospital stay
3. Stone-free rate (SFR), defined as the absence of residual fragments >3 mm on postoperative X-ray KUB or CT KUB

Secondary outcomes

- Perioperative complications (Clavien–Dindo classification)
- Requirement for auxiliary procedures (e.g., PCNL)

Statistical Analysis

Data evaluation was carried out using SPSS version 26. Quantitative data following a normal distribution were presented as mean ± SD and analysed by the independent-samples t-test, while variables with non-normal distributions were expressed as median ± interquartile range and compared using the Mann–Whitney U test. Qualitative variables were presented as numbers and percentages and analysed using the chi-square or Fisher's exact test when indicated. Statistical significance was defined as $p < 0.05$.

RESULTS

Fifty-six patients were included in the analysis, with 28 assigned to the LU group and 28 to the URL class. No patient was missed in follow-up. Baseline characteristics—including age, sex, BMI, and stone side—were equal between the two groups (Table 1). Although the mean stone size was larger in the LU group, this reflected routine clinical practice and did not affect the comparative assessment of outcomes.

Operative Time and Postoperative Hospitalisation

The LU group had a significantly longer operative time (101.2 ± 11.4 minutes) compared with the URL group (40.9 ± 5.9 minutes; p<0.001). Hospital stay followed a similar trend, with LU patients staying longer (2.5 ± 0.3 vs 1.0 ± 0.3 days; p < 0.001). Table 2 and Figure 1 summarise these outcomes

Stone-Free Rate & Auxiliary Procedures

LU achieved a 100% stone-free rate, with all patients confirmed stone-free on postoperative imaging. In contrast, the URL group achieved a stone-free rate of 78.6% (22/28) (p=0.01). Six URL patients (21.4%) required an auxiliary PCNL for residual or migrated fragments, whereas no LU patients required further intervention (p=0.02). The findings are depicted in Table 2 and Figure 1

Complications

Overall complications were more frequent with LU (25%) than URL (10.7%). Most were minor (Clavien I–II), including postoperative pain, fever, or urinary infection. Three Grade IIIa complications were reported (two LU; one URL), all managed with minimally invasive measures. No Grade IIIb, IV, or ureteral strictures occurred during the three-month follow-up period (Table 3).

Table 1

Baseline Characteristics

Variable	LU Group (n=28)	URL Group (n=28)	p-value
Age (years, mean ± SD)	41.5 ± 10.2	39.8 ± 11.1	0.56
Sex (M/F)	18/10	17/11	0.79
BMI (kg/m^2)	24.2 ± 2.8	23.9 ± 3.1	0.72
Stone size (cm)	1.71 ± 0.29	1.29 ± 0.31	<0.001
Stone laterality (R/L)	12/16	13/15	0.79

Table 2

Operative and Postoperative Outcomes

Variable	LU Group	URL Group	p-value
Operative time (min)	101.2 ± 11.4	40.9 ± 5.9	<0.001
Hospital stay (days)	2.5 ± 0.3	1.0 ± 0.3	<0.001
Stone-free rate (%)	100	78.6	0.01
Need for auxiliary procedure (%)	0	21.4	0.02

Table 3

Complications According to Clavien–Dindo Classification

Complication Grade	LU Group (n=28)	URL Group (n=28)
Grade I (Fever, pain)	2	1
Grade II (UTI, transfusion)	3	1
Grade IIIa (urine leak, stent issues)	2	1
Grade IIIb (re-operation)	0	0
Overall complication rate (%)	25%	10.7%

Figure 1

Comparison of operative time, length of hospital stay, stone-free rate, and overall complication rate between laparoscopic ureterolithotomy (LU) and ureteroscopic lithotripsy (URL).

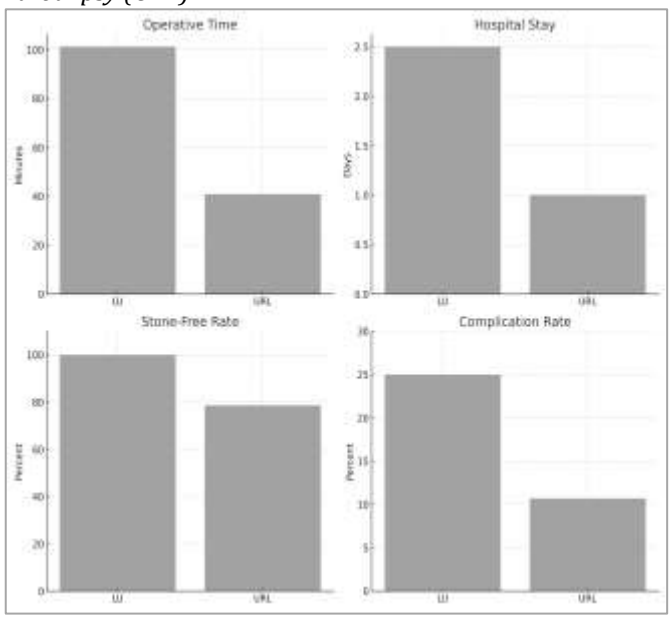
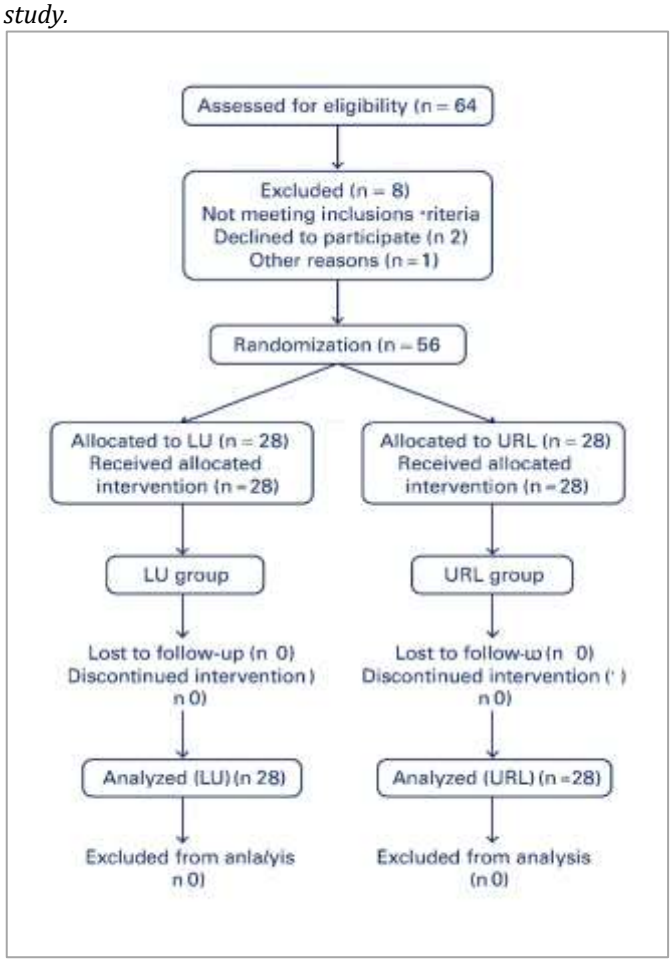


Figure 2

CONSORT flow diagram showing patient inclusion, randomization, allocation, follow-up, and analysis in the study.



DISCUSSION

Although laparoscopic ureterolithotomy (LU) achieved a 100% stone-free rate, ureteroscopic lithotripsy (URL) had a lower clearance rate, and auxiliary procedures were necessary in a significant percentage of patients in this randomised study. It is also noteworthy that the LU group had marginally larger stones at baseline yet still achieved full clearance, supporting LU as a convenient single-session intervention for large or impacted proximal ureteral stones. These findings have been similar in earlier comparative studies. A significantly higher immediate clearance was also reported by Choi et al. using LU, in which flexible ureteroscopy or semirigid URL tended to require additional procedures. (8,13–15).

These trends are reflected in our results. LU stayed in the hospital longer but avoided numerous problems with URL, including retropulsion, incomplete fragmentation, and fragmentation pieces. The retreatment rate in the URL arm is consistent with prior evidence that semirigid ureteroscopy often does not achieve optimal outcomes for large, impacted proximal stones — particularly in an environment without regular access to flexible scopes or a high-power laser. (16–18).

Recent evidence indicates that flexible ureteroscopy can narrow the performance gap to some extent, although it is currently not as effective as LU at clearing initial stones. Torricelli et al. (11) found that complication rates were similar, but primary stone-free rates were lower in LU than in flexible URS for large impacted stones>15 mm. A prospective three-arm randomized trial by Zoeir et al. (12) also reported that LU was the only modality with 100% clearance in large impacted stones (15 mm or larger).

Although these are the benefits, LU remains technically more challenging and requires laparoscopic skills, limiting its uniform application. In most low-resource settings, such as some South Asian centres, access to flexible endoscopes, lasers, and trained endourologists is quite limited. In this case, LU is not a bad choice, especially when retreatment reduction is necessary and a single conclusive procedure is paramount.

The strengths of the research include a randomised design, a standardised operative method, and full follow-up. The weaknesses, however, are the one-centre location, small sample size, insufficient use of flexible ureteroscopy, and limited follow-up, which may lead to the overlooking of late ureteral complications such as ureteral stricture. Despite these limitations, the results advocate the use of LU as a highly efficient approach for large or impacted proximal ureteric stones and in areas where endourological facilities remain insufficient. (19,20).

CONCLUSION

Laparoscopic ureterolithotomy has a higher stone-free rate, and no second surgery is necessary, which is why it is a safe choice of single surgery in case of large or impacted proximal ureteral stones. Even though ureteroscopic lithotripsy had a shorter duration of operation and shorter recovery, it had a high risk of leftover fragments and retreatment. Individualised procedure selection is to be determined by stone features, a surgeon's skills, and the availability of state-of-the-art endoscopic technology.

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