European Journal of Clinical Pharmacy

Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Original Research Article

Extracorporeal shockwave lithotripsy versus ureteroscopy for distal ureteric calculi: efficacy and patient satisfaction

Article History:

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Received: 12-08-2025
Revised: 05-09-2025
Accepted: 20-10-2025
Published: 04-12-2025

Abstract: ***Introduction:*** Distal ureteric calculi are a frequent cause of acute urological symptoms. Extracorporeal shockwave lithotripsy (ESWL) and ureteroscopy (URS) are the main treatment options, yet differences in efficacy and patient outcomes remain clinically relevant. ***Objective:*** To compare the efficacy, complications, postoperative pain, and patient satisfaction between ESWL and URS. ***Methodology:*** This comparative prospective study was conducted at Institute of Kidney diseases Hayatabad Peshawar for a period of six months from January 2025 to June 2025. A total of 106 patients with single distal ureteric stones (5–15 mm) were enrolled and divided into ESWL (n=53) and URS (n=53) groups. Outcomes included stone-free rate (SFR), complications, pain scores, and satisfaction. Statistical tests applied were Chi-square, independent t-tests, and multivariate logistic regression. ***Results:*** The SFR was significantly higher in the URS group 48 (90.6%) than in the ESWL group 36 (67.9%) ($p = 0.0035$). Complications were more frequent in ESWL 15 (28.3%) compared with URS 7 (13.2%) ($p = 0.046$). Pain scores were lower in ESWL (4.9 ± 1.6) than in URS (5.8 ± 1.9; $p = 0.008$). Satisfaction was higher in URS (4.3 ± 0.7) than in ESWL (3.6 ± 0.8; $p < 0.001$). URS remained the strongest predictor of stone clearance on multivariate analysis (OR = 4.21, $p = 0.005$). ***Conclusion:*** URS provided higher stone clearance and satisfaction than ESWL, supporting its use as the more effective treatment for distal ureteric calculi, while ESWL offers a non-invasive alternative with lower postoperative pain.

Keywords: Ureteroscopy, Lithotripsy, Extracorporeal Shock Wave, Ureteral Calculi, Patient Satisfaction, Urolithiasis.

INTRODUCTION

Urinary stone disease is a widespread urological issue, and distal ureteric calculi often develop renal colic, hematuria, and hydronephrosis [1]. Early and good intervention is very essential to avoid complications and save renal performance [2]. Open surgery has been nearly eliminated by minimally invasive surgery, such as Extracorporeal Shockwave Lithotripsy (ESWL) and Ureteroscopy (URS) which provide same-day recovery and reduced patient discomfort [3]. ESWL is not invasive and can be done on an inpatient basis in many instances and does not need general anesthesia although it might be necessary to have several procedures to ensure the stones have been cleared [4].

URS, by offering progress in semi-rigid and flexible scopes and laser lithotripsy offers greater clearance of the stones immediately and permits direct extraction of fragments [5]. It has been demonstrated that in case of distal ureteral stones, URS has better stone free rates over ESWL and less retreatment [6]. But ESWL

can have some benefits in terms of hospital stay and less invasive procedure in terms of invasiveness [7]. Clinical outcome is not the sole contributor to patient satisfaction, but the treatment experience, pain, recovery time, and repeat procedure requirement are also included [8].

The choice of treatment depends on various factors which may include stone size, composition, anatomical position and co-morbidity of the patient [9]. Also, the availability of resources, expertise of surgeons, and cost-efficiency are significant factors especially in the third world [10]. Knowledge of these factors and efficacy and patient satisfaction is critical to streamline treatment plans [11]. According to the recent research, personalized decision-making could enhance the clinical outcomes and patient-centered care [12].

Although global evidence on URS usage with distal stones of the ureter is in favor of the method, local data in resource-constrained areas are scarce. Efficacy and patient-centered outcomes must be assessed in order to influence practice in regional settings. This study aims to compare ESWL and URS in terms of stone-free rates and patient satisfaction for distal ureteric calculi.

MATERIALS AND METHODS

Study design and setting: This comparative prospective study was conducted at Institute of Kidney diseases Hayatabad Peshawar for a period of six months from January 2025 to June 2025**.**

Study Population: Patients aged 18–65 years who presented with a single distal ureteric calculus measuring 5–15 mm, confirmed by non-contrast computed tomography (NCCT) or ultrasound, were included in the study. Patients with multiple ureteric stones, bilateral stones, and anatomical abnormalities of the urinary tract, pregnancy, coagulopathy, or active urinary tract infection were excluded.

Sample size calculation: A sample size calculation was performed to compare the stone-free rates between ureteroscopy (URS) and extracorporeal shockwave lithotripsy (ESWL). The WHO recommended formula for comparing two independent proportions was used [13]:

$$n = \frac{[Z_{1-\alpha/2}\sqrt{2\bar{p}(1-\bar{p})} + Z_{1-\beta}\sqrt{p1(1-p1)+p2(1-p2)}]^2}{(p1-p2)^2}$$

Where p_1 and p_2 represent the expected stone-free rates for URS and ESWL respectively. Using previously published rates of 90% for URS and 68% for ESWL [2], with a two-sided $\alpha = 0.05$ and power $(1-\beta) = 0.80$, the minimum required sample size was calculated as 53 patients per group, yielding a total of 106 participants. The calculated value was rounded up to ensure adequate statistical power.

Patient Allocation and Grouping: The eligible patients were divided into two groups according to the treatment modality. Group A comprised of patients who received extracorporeal shockwave lithotripsy (ESWL) and Group B involved patients that received ureteroscopy (URS). The assignment to either category was done based on the patient choice and clinical appropriateness following the proper counseling on the advantages, risks, and nature of the procedures of the two treatments.

Procedure Protocols: Group A patients had ESWL in line with the EAU Guidelines on Urolithiasis and AUA Kidney Stone Guidelines [14] [15]. Surgery was done under a sedated or local anesthesia and shockwaves were administered at a frequency of 60 to 90impulses per minute. Fragments of stones were observed through the way of fluoroscopy or ultrasound. The patients were educated on hydration, analgesia and fragmental passage after the procedure. Imaging follow-up was done at 2 and 4 weeks to determine stone clearance. Group B patients received semi-rigid ureteroscopy with general or spinal anesthesia, according to the EAU and AUA procedures recommendations [14] [15]. A guide wire was placed to assist in the progression of the ureteroscope and the calculus was then directly viewed. Where necessary, stones were broken with a holmium laser lithotripsy or excised with retrieval equipment. Ureteral stents were put in where necessary and taken out 1-2 weeks later. At week 2 and week 4, imaging was used to confirm the status of the stones as being stone-free.

Outcome Measures: The stone-free rate (SFR) which was full clearance of the stone but without further intervention, measured by NCCT or ultrasound at 2-4 weeks after the procedure was the main outcome [14]. The procedure related complications, postoperative pain, and satisfaction among the patients were taken as secondary outcomes. The patient satisfaction was assessed based on a self-developed, 10-item questionnaire that dealt with procedures experience, perceived

pain, comfort, and overall satisfaction. The score of each was on a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied) [16]. The questionnaire was also piloted on 10 patients to test its lucidity and practicability before data collection.

Data Analysis: SPSS version 25 was used in analyzing data. Continuous variables were given in terms of mean ± standard deviation and categorical variables were provided in form of frequencies and percentages. The Chi-square test was employed in the comparison of categorical variables, whereas the independent t-test was involved in the comparison of continuous variables. Multivariate logistic regression analysis was conducted to adapt all the possible confounding variables e.g. age, sex, stone size, and comorbidities on the primary, as well as, secondary outcomes. The p-value of < 0.05 was taken as statistically significant.

Ethical considerations: Before the study was commenced, the study received ethical approval in the Institutional Review Board of LRH. All the participants were given informed consent by clearly stating the aims of the study, the methods that would be used, the possible positive and negative impacts, and the risks.

RESULTS

Baseline characteristics were comparable between the ESWL and URS groups as shown in Table 1, the ESWL group included 29 (54.7%) males and 24 (45.3%) females, while the URS group had 33 (62.3%) males and 20 (37.7%) females (χ^2=0.37, p=0.54). Mean age was similar between ESWL (41.2 ± 12.1 years) and URS (42.4 ± 11.2 years) (t=0.56, p=0.58). Stone size (9.2 ± 2.4 mm vs. 9.5 ± 2.1 mm, t=0.70, p=0.48) and BMI (26.3 ± 3.1 vs. 25.9 ± 2.8, t=0.73, p=0.47) also showed no significant difference. Comorbidities, including diabetes (8 (15.1%) vs. 7 (13.2%), χ^2=0.08, p=0.78) and hypertension (10 (18.9%) vs. 9 (17.0%), χ^2=0.06, p=0.80), were similarly distributed. Prior renal stones were reported in 5 (9.4%) ESWL patients and 6 (11.3%) URS patients (χ^2=0.10, p=0.75).

Table 1: Baseline Demographic and Clinical Characteristics of Patients (N = 106)

Variable	ESWL (n=53)	URS (n=53)	Test Used	Test Value	p-value
Age (years, mean ± SD)	41.2 ± 12.1	42.4 ± 11.2	Independent t-test	t = 0.56	0.58
Male gender, n (%)	29 (54.7%)	33 (62.3%)	Chi-square	χ^2 = 0.37	0.54
Female gender, n (%)	24 (45.3%)	20 (37.7%)	Chi-square	χ^2 = 0.37	0.54
Stone size (mm, mean ± SD)	9.2 ± 2.4	9.5 ± 2.1	Independent t-test	t = 0.70	0.48
BMI (kg/m², mean ± SD)	26.3 ± 3.1	25.9 ± 2.8	Independent t-test	t = 0.73	0.47
Diabetes mellitus, n (%)	8 (15.1%)	7 (13.2%)	Chi-square	χ^2 = 0.08	0.78
Hypertension, n (%)	10 (18.9%)	9 (17.0%)	Chi-square	χ^2 = 0.06	0.80
Previous renal stones, n (%)	5 (9.4%)	6 (11.3%)	Chi-square	χ^2 = 0.10	0.75

Legend: Independent t-test was used for continuous variables (t-values ranged from 0.56 to 0.73, all p > 0.47), and Chi-square test was used for categorical variables (χ^2-values ranged from 0.06 to 0.37, all p > 0.54). No statistically significant differences were found between the groups.

As illustrated in Figure 1, the stone-free rate was significantly higher in the URS group, where 48 (90.6%) patients achieved stone clearance compared with 36 (67.9%) in the ESWL group. Conversely, residual stones were present in 17 (32.1%) ESWL patients and 5 (9.4%) URS patients at 2–4 weeks. The difference in stone-free rates between the two modalities was statistically significant, as confirmed by the Chi-square test (χ^2 = 8.52, p = 0.0035), indicating superior efficacy of URS over ESWL.

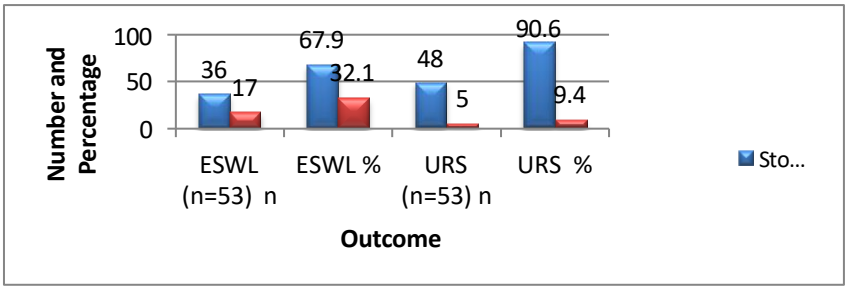

Figure 1: Primary Outcome: StoneFree Rate at 2–4 Weeks

Legend: The Chi-square test was used to compare the results of Stone-free in the groups. A high difference was found and URS reported high rates in stone-free rates compared to ESWL (χ^2 = 8.52, p = 0.0035).

Procedure-related complications were also more common in the ESWL group as shown in Figure 2, 15 (28.3) patients suffered complications in comparison to 7 (13.2) patients in URS group (χ^2 = 3.98, p = 0.046). Hematuria in 9 (17.0%)

ESWL patients and 3 patients (5.7%) URS patients (χ^2 = 3.23, p = 0.07, and χ^2 = 1.37, p = 0.24) and dysuria in 5 (9.4) ESWL patients and 2 (3.8) URS patients (χ^2 = 1.37, p = 0.24 and χ^2 = 3.23, p = 0.07 The incidence of fever was rare 1 (1.9) in ESWL patient and 2 (3.8) in URS patient (χ^2 = 0.34, p = 0.56). The ESWL group did not show Ureteral mucosal injury, but URS patients had 2 (3.8) cases of the mucosal injury (χ^2 = 2.78, p = 0.15). Generally, ESWL showed more complication rates but most of the variations were not statistically significant except on the overall number of complication.

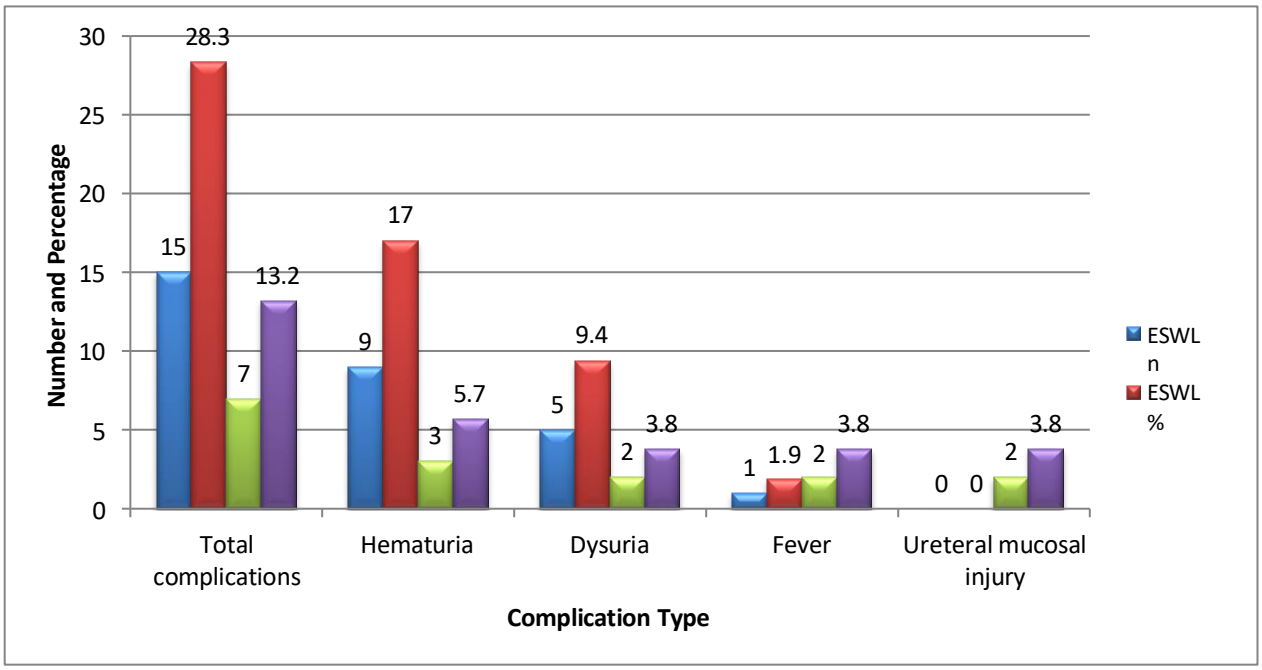

Figure 2: Procedure-Related Complications

Legend: All complications were compared between groups using Chi-square tests. A significant difference was found for total complications (χ^2 = 3.98, p = 0.046). Hematuria (χ^2 = 3.23, p = 0.07), dysuria (χ^2 = 1.37, p = 0.24), fever (χ^2 = 0.34, p = 0.56), and ureteral mucosal injury (χ^2 = 2.78, p = 0.15) showed no statistically significant differences.

Postoperative results, as presented in Table 2 indicated that the pain scores were much lower In the ESWL group, where the mean of the pain score was 4.9 ± 1.6, and on the URS group, the mean of the pain score was 5.8 ± 1.9. (t = 2.69, p = 0.008). Conversely, URS patients had more satisfaction with their patients, who reported that the mean score in the ESWL group was 4.3 ± 0.7 as compared to 3.6 ± 0.8 (t = 4.67, p < 0.001). These results suggest that despite the fact that ESWL was related to reduce postoperative pain, URS led to a much higher overall satisfaction.

Table 2: Postoperative Pain and Patient Satisfaction Scores

Parameter	ESWL (n=53)	URS (n=53)	Test Used	Test Statistic	p-value
Pain score (mean ± SD)	4.9 ± 1.6	5.8 ± 1.9	Independent t-test	t = 2.69	0.008
Satisfaction score (mean ± SD)	3.6 ± 0.8	4.3 ± 0.7	Independent t-test	t = 4.67	<0.001

Legend: Mean pain and satisfaction scores between ESWL and URS were compared using independent t-tests. Pain scores showed a significant difference (t = 2.69, p = 0.008), while satisfaction scores demonstrated a highly significant difference favoring URS (t = 4.67, p < 0.001).

As shown in Table 3, multivariate logistic regression identified ureteroscopy (URS) as the strongest predictor of achieving stone-free status, with an adjusted odds ratio of 4.21 (95% CI: 1.53–11.61; Wald = 7.77, p = 0.005). Stone size did not significantly influence stone clearance (OR = 0.91 per mm, 95% CI: 0.78–1.06; Wald = 1.43, p = 0.23). Similarly, age (OR = 0.99, p = 0.72), male sex (OR = 1.12, p = 0.77), and the presence of comorbidities (OR = 0.88, p = 0.78) were not significant predictors. These results support the idea that URS alone offers better clearance rates irrespective of demographics and stone properties.

Table 3: Multivariate Logistic Regression for Predictors of Stone-Free Status

Variable	Adjusted OR	95% CI	Wald Statistic	p-value
URS vs. ESWL	**4.21**	1.53–11.61	Wald = 7.77	0.005
Stone size (per mm)	0.91	0.78–1.06	Wald = 1.43	0.23
Age (per year)	0.99	0.96–1.03	Wald = 0.13	0.72

Male sex	1.12	0.51–2.47	Wald = 0.08	0.77
Comorbidity (any)	0.88	0.37–2.11	Wald = 0.08	0.78

Legend: Multivariate logistic regression was performed using the Wald test to assess predictors of stone-free status. URS was a significant independent predictor of stone clearance (Wald = 7.77, p = 0.005). Stone size (Wald = 1.43, p = 0.23), age (Wald = 0.13, p = 0.72), male sex (Wald = 0.08, p = 0.77), and comorbidity status (Wald = 0.08, p = 0.78) showed no statistically significant associations.

DISCUSSION

The findings of this study demonstrated that ureteroscopy (URS) was far much better than extracorporeal shockwave lithotripsy (ESWL) in the treatment of distal ureteric calculi. Despite the increased postoperative pain being linked with URS, there was more patient satisfaction, reduced complications, and overall improved treatment outcomes. ESWL though a less invasive method demonstrated a reduced clearance rate with a higher risk of need of adjunctive interventions. The multivariate analysis also proved that URS is the most significant independent predictor of successful stone clearance despite the comorbidities like age, sex, stone size, and comorbidities.

The superior stone-free rate obtained with URS in the study is consistent with international data of always good high clearance rates of distal ureteric stones, generally more than 85-90% [17]. The literature on ESWL has a range of outcomes between 60-75% which is agreeable with the 67.9% clearance in this case [18]. The trends of complications were also in line with the existing data with URS reporting fewer yet marginally more invasive complications, whereas ESWL reported a higher rate of mild and self-limiting complications like hematuria and dysuria [19]. This was anticipated to result in pain that was greater following URS because of manipulation and stent insertion in the ureters, and ESWL generated moderate but less severe pain [20]. Nevertheless, the level of patient satisfaction was still higher in URS, as the value of effective and immediate stone clearance is higher [21]. In general, the results of the study closely reflect the findings on the topic in the world that URS is more reliable as a modality, and ESWL is the less invasive option but less predictable [22].

Limitations and Future Recommendations: There are also certain limitations in this study such as the design of the study that is single center and that patients were not randomly allocated, thereby exposing them to selection bias. Late complications or recurrences could have eluded the short follow-up period. The self-constructed satisfaction survey could be a limiting factor in comparing results with other studies and the use of ultrasound in some follow up scans could over look residual fragments of stones. Further studies ought to incorporate multicentered randomized studies on a larger scale to enhance external validity. The follow-up should be longer to evaluate the recurrence and the long-term outcomes. Patient satisfaction standard and validated instruments are to be involved and additional analysis according to stone density, composition, and anatomical differences is suggested to promote the better customization of treatment.

CONCLUSION

This study demonstrated that ureteroscopy has much higher rates of stone-free rates, low rates of complications and patient satisfaction than extra-corporal shockwave lithotripsy as a therapeutic option in the treatment of distal ureteric calculi. Despite the fact that URS was linked to greater postoperative pain, its better efficacy and reliability makes it the more effective form of treatment in general. ESWL is also an option that has an inferior and less predictable clearance but is a useful, non-invasive option. These results promote personalized choice of courses of treatment depending on the priorities of the patient, clinical assessment, and the availability of resources.

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