

COMPARISON OF SUCCESS OF EXTRACORPOREAL LITHOTRIPSY (ESWL) AND LASER URETERORENOSCOPY IN PROXIMAL URETERIC STONES

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Abstract: Managing ureteral stones to achieve complete stone clearance with minimal patient morbidity involves several therapeutic approaches. The commonly used methods include extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS), percutaneous nephrolithotripsy, laparoscopic ureterolithotomy, and open ureterolithotomy. However, definitive evidence-based options for managing large proximal ureteral stones are lacking. **Objective:** To compare extracorporeal shock wave lithotripsy (ESWL) and laser ureterorenoscopy (URS) success rates in treating proximal ureteric stones. **Methods:** This randomized controlled trial was conducted in the Department of Urology & Renal Transplantation at Bahawal Victoria Hospital, Bahawalpur, from January 1, 2020, to May 31, 2021. One hundred four patients, aged 20 to 60, with single proximal ureteric stones measuring 8-15 mm, were included. Patients with pyelonephrosis, sepsis, bleeding disorders, solitary kidney, previous open ureterolithotomy, chronic renal failure, proteinuria, recurrent urinary tract infections, congenital urinary tract obstruction, bladder outflow obstruction, chronic liver disease, or a history of chronic drug usage were excluded. Patients were randomized into two groups: Group A underwent URS lithotripsy with DJ stent placement, while Group B underwent ESWL with DJ stent placement. A single surgeon performed all procedures. Pre-operative antibiotics and analgesics were administered to all patients. Stone clearance was assessed two weeks post-procedure. Statistical analysis was performed using appropriate methods, with a p-value ≤ 0.05 considered significant. **Results:** The mean age of patients in Group A was 37.52 ± 11.20 years, and in Group B was 36.73 ± 10.57 years. Most patients (75, 72.12%) were between 20 and 40. Out of the 104 patients, 63 (60.58%) were male, and 41 (39.42%) were female, with a male-to-female ratio of 1.7:1. Complete stone clearance was achieved in 44 (84.62%) patients in Group A (URS group) and 30 (57.69%) patients in Group B (ESWL group), with a statistically significant p-value of 0.002. The study concluded that the stone clearance rate after laser ureterorenoscopy (URS) is significantly higher than extracorporeal shock wave lithotripsy (ESWL) for proximal ureteric stones.

Keywords: Extracorporeal Shock Wave Lithotripsy, Laser Ureterorenoscopy, Proximal Ureteric Stone, Stone Clearance, Ureteroscopy.

Introduction

Urinary stone diseases require active treatment due to their high prevalence, high recurrence rates, and various complications. The increased risk of dehydration coupled with a diet compared to Western diets accounts for the higher risk. In the Middle East, uric acid stones are more common than calcium-containing stones. The prevalence rate of urolithiasis in Pakistan is approximately 12%, with recurrence rates up to 50%. (1) Spontaneous expulsion occurs in only 22% of proximal ureteric calculi; hence, most cases require intervention.

There are many therapeutic approaches for the treatment that are complete ureteral stone clearance with minimal patient morbidity. The most commonly used methods include extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS), percutaneous nephrolithotripsy, laparoscopic ureterolithotomy, and open ureterolithotomy. However, there is a lack of definite evidence-based options for managing large proximal ureteral stones. (2)

Minimally invasive techniques have revolutionized the urological practice over the past few decades. Semi-rigid ureteroscopy and ESWL are the most commonly used minimally invasive techniques for managing proximal ureteric calculi. (3) According to the European and

American Urological Association guidelines, ureteroscopy, or ESWL, is regarded as the first-line treatment modality for managing proximal ureteric stones. However, the choice of procedure remains a dilemma. (4)

The optimal treatments for ureteral stones are yet controversial. However, ureteral stones fragment less effectively than renal stones, shockwave lithotripsy (ESWL). However, the advances in the design of ureteroscopes have significantly impacted the management of ureteric stones. (4, 5) In a study, the stone-free rate after a single procedure was 62.5% for ESWL and 84% for the URS group ($p=0.001$). (6) Another study has shown ESWL as the better option than URS due to a statistically significant difference in stone clearance rate compared to ESWL (73.33%) and URS group (66.7%). (7) Mostafa MM et al., in their study, have shown that complete stone clearance occurred in 66.7% of the 30 patients undergoing ESWL and in 80% of the 30 patients undergoing URS, indicating no significant difference in overall stone clearance between both groups (8) The rationale of this study was that the choice of procedure for the management of proximal ureteric stones remains controversial, and previous studies have shown variable results. There is a lack of data comparing ureteroscopy and ESWL in managing

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proximal ureteric stones in Pakistan. Therefore, the results of my study determine a better treatment modality and help manage proximal ureteric stones in our population. Thus, the study's objective was to compare the success of extracorporeal shock wave lithotripsy (ESWL) and laser ureterorenoscopy (URS) in proximal ureteric stones.

Methodology

This randomized controlled trial was conducted in the Department of Urology & Renal Transplantation at Bahawal Victoria Hospital, Bahawalpur, from January 1, 2020, to May 31, 2021. The calculated sample size was 104 patients, with 52 in each group, determined at a 5% level of significance and 80% power, based on the expected stone clearance rates of 62.5% for ESWL and 84.0% for URS. A non-probability consecutive sampling technique was used to select patients. The inclusion criteria encompassed patients aged 20-60 years of either gender with a single proximal ureteric stone measuring 8-15 mm and a duration of stone presence greater than one month. Patients with pregnancy, a solitary functioning kidney, bleeding disorders (INR >1.2), pyonephrosis, sepsis, claustrophobia, co-existing ureteral pathologies such as tumors or strictures, history of previous open ureterolithotomy, and any chronic diseases including chronic renal failure, recurrent urinary tract infections, congenital urinary tract obstructions, and bladder outflow obstructions were excluded from the study. After obtaining permission from the institutional ethical review committee, 104 patients presenting to the outpatient Department of Urology at Bahawal Victoria Hospital who met the inclusion criteria were selected. Informed written consent was obtained from all participants. Patients were then randomly divided into two equal groups, A and B, using the lottery method. Group A underwent URS laser lithotripsy with DJ stent placement, while Group B received

extracorporeal shock wave lithotripsy (ESWL) with DJ stent placement. A single surgeon performed all procedures, and patients were given pre-operative antibiotics and analgesics. Post-operatively, patients were followed regularly, and stone clearance was assessed two weeks after the procedure.

Statistical analysis was performed using SPSS version 25.0. Continuous variables such as age, height, weight, BMI, disease duration, and stone size were presented as mean and standard deviation. In contrast, categorical variables such as gender, place of living (rural/urban), recurrent stone (yes/no), and success (yes/no) were presented as frequency and percentage. The success rates of the two groups were compared using the Chi-square test, with a p-value of ≤0.05 considered statistically significant. Effect modifiers, including age, gender, BMI, duration of disease, place of living, recurrent stone, and stone size, were controlled through stratification. Post-stratification, the Chi-square test was applied to assess their effect on success, with a p-value of ≤0.05 considered significant.

Results

The age range in this study was from 20 to 60 years, with a mean age of 37.13 ± 10.89 years. The mean age of patients in group A was 37.52 ± 11.20 years, and in group B was 36.73 ± 10.57 years. The majority of the patients, 75 (72.12%), were between 20-40 years of age. Of these 104 patients, 63 (60.58%) were male, and 41 (39.42%) were females, with a ratio of 1.7:1. Mean duration of disease was 3.56 ± 1.20 months. The mean size of the stone was 11.86 ± 1.49 mm. The mean BMI was 28.31 ± 3.28 kg/m². The distribution of patients according to place of living and recurrent stone is shown in Tables 1 & 2, respectively.

Table 1: Distribution of patients according to place of living.

Place of living	Group A (n=52)		Group B (n=52)		Total (n=104)	
	Frequency	%age	Frequency	%age	Frequency	%age
Rural	22	42.31	23	44.23	45	43.27
Urban	30	57.69	29	55.77	59	56.73

Table II: Distribution of patients according to recurrent stone

Recurrent stone	Group A (n=52)		Group B (n=52)		Total (n=104)	
	Frequency	%age	Frequency	%age	Frequency	%age
Yes	17	32.69	15	28.85	32	30.77
No	35	67.31%	37	71.15	72	69.23

Table 3 provides a detailed comparison of the success rates (defined as 100% stone clearance) between Group A (URS group) and Group B (ESWL group) based on various patient factors. The success rates are stratified by age, gender,

duration of disease, stone size, BMI, place of living, and recurrence of stones. The p-values indicate the statistical significance of differences observed between the groups.

Table 3: Stratification of Success concerning Various Patient Factors

Factor	Category	Group A (n=52)	Group B (n=52)	p-value
Age	20-40	Yes: 33, No: 5	Yes: 21, No: 16	0.004
	41-60	Yes: 11, No: 3	Yes: 9, No: 6	0.280
Gender	Male	Yes: 25, No: 8	Yes: 16, No: 14	0.062
	Female	Yes: 19, No: 0	Yes: 14, No: 8	0.003
Duration	≤3 months	Yes: 23, No: 4	Yes: 15, No: 13	0.011

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	>3 months	Yes: 21, No: 4	Yes: 15, No: 9	0.088
Stone Size	8-12 mm	Yes: 28, No: 6	Yes: 17, No: 16	0.007
	13-15 mm	Yes: 16, No: 2	Yes: 13, No: 6	0.131
BMI	≤27	Yes: 19, No: 2	Yes: 13, No: 9	0.018
	>27	Yes: 25, No: 6	Yes: 17, No: 13	0.043
Place of Living	Rural	Yes: 17, No: 5	Yes: 15, No: 8	0.372
	Urban	Yes: 27, No: 3	Yes: 15, No: 14	0.001
Recurrent Stone	Yes	Yes: 13, No: 4	Yes: 4, No: 11	0.005
	No	Yes: 31, No: 4	Yes: 26, No: 11	0.056

The table compares success rates for achieving 100% stone clearance between the URS group (Group A) and the ESWL group (Group B), stratified by various patient factors. In the age stratification, patients aged 20-40 showed significantly higher success in Group A compared to Group B (p=0.004), while no significant difference was observed in the 41-60 age group (p=0.280). Gender-wise, female patients had significantly higher success rates in Group A than in Group B (p=0.003), whereas the difference for male patients was insignificant (p=0.062). For the duration of disease, patients with a disease duration of 3 months or less had higher success in Group A (p=0.011), but no significant difference was found for durations longer than three months (p=0.088). Regarding stone size, those with stones measuring 8-12 mm had higher success in Group A (p=0.007), while for stones measuring 13-15 mm, the difference was not significant (p=0.131).

BMI stratification revealed that patients with a BMI of 27 or less had higher success in Group A (p=0.018), and those with a BMI greater than 27 also showed significant differences (p=0.043). The place of living stratification indicated that urban patients had significantly higher success rates in Group A compared to Group B (p=0.001), while the difference for rural patients was insignificant (p=0.372). Lastly, for patients with recurrent stones, Group A showed significantly higher success than Group B (p=0.005), whereas for patients without recurrent rocks, the difference was insignificant (p=0.056). This comparison highlights the effectiveness of URS over ESWL across various patient demographics and clinical factors, providing valuable insights into the treatment outcomes for proximal ureteric stones.

Discussion

A few decades back, ureteral stones were managed by open ureterolithotomy. Then with time, there was a refinement of semi-rigid ureteroscopes, shock wave lithotripsy (SWL) machines, laparoscopic procedures, and flexible ureterorenoscopy (URS), resulting in enormous change in the management of ureteral stones. Each of these modalities has high efficacy when used for the appropriate indication in adults and children.(9)(2)

For treating proximal ureteral stones, ESWL is a minimally invasive procedure and can be performed as an outdoor patient procedure. However, it also has disadvantages, such as a high retreatment rate, prolonged treatment time, and poor patient compliance.(13, 14) Within the last few years, ureterorenoscopy treatment of ureteral stones has gained widespread popularity among surgeons. URS has been strongly advised for patients with distal ureteral calculi,

yielding high stone-free rates of more than 95%.(14) some surgeons are very cautious in using semi-rigid URS for proximal ureteral stones, especially in male patients, because of the longer working distance compared to female patients.(15, 16)

I have conducted this study to compare the success of extracorporeal shock wave lithotripsy (ESWL) and laser ureterorenoscopy (URS) in proximal ureteric stones. Success (100% clearance of stone) was seen in 44 (84.62%) patients in group A (URS group) and 30 (57.69%) patients in group B (ESWL group) with a p-value of 0.002.

In a study, the stone-free rate after a single procedure was 62.5% for ESWL and 84% for the URS group (p=0.001).(6) Another study has shown ESWL as the better option compared to URS. The difference in stone clearance rate was statistically significant compared to ESWL (73.33%) and URS group (66.7%).(7) Mostafa MM et al. in their study, has shown that complete stone clearance occurred in 66.7% of the 30 patients undergoing ESWL and 80% of the 30 patients undergoing URS, indicating no significant difference in overall stone clearance between both groups.(8)

In 2015, Kumar et al. found the mean operative time in the ESWL group was ± 1.7 minutes, and it was 39.1 ±1.5 minutes in the URS group (p=0.31). The modified efficiency quotient was 46.4% and 83.4%, respectively, which was statistically significant (p=0.01). The stone-free rate was 78.4% and 85.4% in the two groups, respectively (p=0.34).(17) Manzoor et al. in 2013 found that the stone-free rate was 49.2% for ESWL and 57.8% for URS (p=0.088) however, it was statistically significant with URS than in ESWL for stones greater than 12 mm (p=0.019).(18)

It is pertinent here that besides the influence of stone size and position, the efficiency of the URS procedure also depends on the experience and skill of the operating urologist.(19) Fong et al. experienced an overall stone-free rate of 50% in ESWL and 80% in URS.(20) Tawfik achieved a 92% stone-free rate with ureteroscopic lithotripsy of proximal ureteric stone, and the initial stone-free rate for in situ SWL was 58%.(21) Saleem achieved a stone-free rate of 88% with URS and 60% with ESWL for a stone size greater than or equal to 1 cm size.(21)

A meta-analysis published by the AUA Nephrolithiasis Guideline Panel in 1997 documented the overall stone-free rate of ESWL for proximal ureteral stones as 83% (78 studies, 17,742 patients), and the panel recommended ESWL as the initial choice for stones smaller than 1 cm, and either ESWL or ureteroscopy

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for larger (>1 cm) calculi in the proximal ureter. On the other hand, they reported stone-free results of ESWL for proximal ureteral stones as 82%, with surprisingly little difference in stone-free rates concerning stone size (93% for stones <10 mm and 87% for stones >10 mm). Flexible ureteroscopy methods were primarily associated with improved access to the proximal ureter, providing superior stone-free rates with the use of flexible URS (87%), compared with rigid or semirigid URS (77%) and comparable to those achieved with ESWL.(22)

Conclusion

This study concluded that the stone clearance rate after laser ureterorenoscopy (URS) is higher than that after extracorporeal shock wave lithotripsy (ESWL). Therefore, we recommend that laser ureterorenoscopy (URS) be preferred over extracorporeal shock wave lithotripsy for proximal ureteric stone to improve the outcome of these patients.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department Concerned. (IRB/BVHB-0323)

Consent for publication

Approved

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The authors declared an absence of conflict of interest.

Authors Contribution

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