https://doi.org/10.37723/jumdc.v14i4.813

J. Univ. Med. Dent. Coll.2023;Vol.14(4):692-639
ISSN (Print) 2221-7827, ISSN (Online) 2310-5542
https://www.jumdc.com

Original Article

Open Access

Comparison of the efficiency of shock waves extracorporeal lithotripsies (ESWL) versus Ureterorenoscopy (URS) to remove proximate ureteric stones

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ABSTRACT

BACKGROUND & OBJECTIVE: Urolithiasis remains a predominant health challenge, especially in regions like Pakistan where the prevalence of ureteric stones is substantial. With advancements in endourological stone management, the debate over the most effective therapeutic modality for proximal ureteric stones persists. This study aimed to provide insights by comparing the efficacy of Ureterorenoscopy (URS) and Extracorporeal Shock Wave Lithotripsy (ESWL) in managing these stones.

METHODOLOGY: This controlled and experimental study spanned six months in 2022 at Karachi's Sindh Hospital of Urology and Transplantation. Total 60 participants, each diagnosed with a single IVU-detected radio-opaque proximal ureter stone, were enrolled. Random allocation was employed, assigning 30 patients to the URS group and 30 to the ESWL group. Follow-ups were conducted using x-ray KUB after three weeks, and data compilation utilized a computerized, pre-structured proforma.

RESULTS: The mean age of participants was 27.58 years, with a majority being male. URS demonstrated remarkable efficacy, particularly in the age group of 21-30, where it showed a 100% success rate compared to ESWL's 44.4% (p=0.001). In females with stone sizes between 10-12mm, URS maintained a 100% efficacy, outperforming ESWL, which had a 44.4% efficacy (p=0.0005). Hospital stay duration also influenced outcomes: for stays ≤3 days, URS exhibited a 91.3% efficacy, surpassing ESWL's 68.4% (p=0.011).

CONCLUSION: URS consistently exhibited superior efficacy in managing proximal ureteric stones across varied demographics and clinical parameters. This research substantiates URS as a more effective therapeutic option compared to ESWL for certain patient cohorts.

KEYWORDS: Urolithiasis, Extracorporeal shock wave lithotripsy, Ureterorenoscopy, Biliary or Urinary Stones, Proximal Kidney Tubule.

INTRODUCTION

Urolithiasis has a lifetime prevalence of 1–20%, depending on location. Western adults have a perilous of urolithiasis than eastern adults (1% to 5% vs. 5% in Europe, 12% in Canada, and 13% to 15% in the US). Pakistan reports 50% of all urological cases [1].

Ureterorenoscopic, pneumatic or laser intracorporeal lithotripsy, and laparoscopic or open surgery can treat ureteral stones. The best treatment for proximal ureter stones is unknown. The characteristics of proximal ureteral stones must be considered along with technical and clinical factors such as current treatments, patient preferences, and the physician's skill set. ESWL or ureterorenoscopic stone removal are typically used to treat proximal ureteral stones with a poor chance of unconstrained passage (URS) [2].

How to cite this: *Sarwar MA, Khan F, Soomro N, Ahmed I, Aslam MM, Murtaza HB. Comparison of the efficiency of shock waves extracorporeal lithotripsies (ESWL) versus Ureterorenoscopy (URS) to remove proximate ureteric stones. Journal of University Medical & Dental College. 2023;14(4): 635-639.*

The researcher compared ESWL to semirigid URS for proximal ureteral stones. Extracorporeal shock wave lithotripsy (ESWL) is widely used to treat 10-mm proximal ureteral stones due to its low complication rate and noninvasiveness[3]. ESWL retreats more often and takes longer to eliminate stones. Thanks to endoscopy and lithotripters, Ureterorenoscopy (URS) can eliminate proximal ureteral stones >10 mm in one session. URS in need of general or regional anesthesia and has more adverse effects than ESWL [4]. SWL stones averaged 1.28 0.04 cm, while URS stones averaged 1.51 0.05 cm (p = 0.0009). URS removed 92% of stones, while ESWL removed 61% (p= 0.003).

This study compares URS and ESWL for treating proximal ureteric stones. Uretinal stones are a prevalent urinary system disease in Pakistan and a major issue for tertiary care hospitals, although local research and publications on the topic are scarce. The reported data further understates Pakistan's stone burden due to its tiny sample size. Despite continuous success in endourological stone treatment, the ideal management of proximal ureteric stones remains contested among urologists. This study is identifying a suitable and successful way to treat ureteric stones, which benefits patients and reduces hospital strain.

Patients with nephrolithiasis are commonly seen by primary care providers. Common symptoms include renal colic and blood in the urine. Urine stones are the most prevalent type, however cystine and struvite (magnesium ammonium phosphate) stones are also rather common. Studies have shown that taking in more vitamin C can lead to an increase in kidney stone formation. The likelihood of acquiring stone disease nearly doubles in hypertensive patients [2].

Also, conditions including diabetes, obesity, gout, and strenuous exercise regimens might raise the danger level. Patients with idiopathic calcium oxalate stones have a recurrence risk of 10%–30% after three to five years. The clinical presentation is the starting point for a nephrolithiasis diagnosis. In the absence of a stone on radiologic examination, ureteral dilatation may indicate the recent transit of a stone. Abdominal plain film, ultrasonography, and the most frequent non-contrast helical CT scan are all possible radiologic tests for confirmation [5].

The efficacious management of ureteral calculi requires a nuanced understanding of various determinants, each specific to the individual patient's presentation. Factors such as the calculi's size and location, the patient's general health status, and the presence of concomitant medical conditions play pivotal roles in determining the best therapeutic approach. Notably, kidney stones predominantly comprising calcium phosphate or calcium oxalate are frequently localized within the medullary region or at the corticomedullary junction, characterized by its sponge-like architecture. With the advent of urethral access sheaths, the treatment of proximal calculi has witnessed significant advancements, ensuring more streamlined and effective interventions [6].

One advantage of in situ shock wave lithotripsy (ESWL) as a monotherapy option is that it requires fewer surgical incisions and fewer anesthesia's for the patient. Small calcium stones are the best candidates for treatment using shock wave lithotripsy (SWL) [5]. Somewhere between 35% and 55% of patients with bigger renal stones have remaining fragments after SWL. It is possible that the percentage of ureteral stone fragments passed after SWL treatment can be increased with the help of adjunctive treatments. Patients with renal insufficiency and others who are more likely to experience postoperative problems fall into this category [7].

It is now less common to need a ureteral catheter to help with stone imaging or to do intraoperative manipulation of stones to facilitate ESWL. Preoperative stenting may improve stone-free rates without significantly increasing morbidity, operative time, or cost when it is indicated. The success of stone disintegration should not be sacrificed for the sake of a less invasive method. The use of analgesic adjuncts is likely helpful in achieving these results. Flank petechiae, hematuria, and the passing of stone pieces are common adverse effects of ESWL. After ESWL hematuria with clots or blatant clot retention, imaging the kidneys to rule out a perinephric hematoma should be examined [8].

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Efficacy refers to the capacity of a designated intervention, procedure, or product to produce the desired therapeutic effect or outcome when tested under controlled conditions. In the context of clinical studies, efficacy typically gauges the maximum possible therapeutic response a patient might achieve under ideal circumstances, often contrasted with 'effectiveness,' which measures the therapeutic outcome in real-world settings. Operationalizing efficacy involves quantitatively assessing the ratio of positive outcomes to the total number of cases subjected to the intervention in a

controlled environment, usually expressed as a percentage.

METHODOLOGY

To evaluate the comparison or relative benefits of ureterorenoscopy and extracorporeal shockwave lithotripsy (ESWL) while dealing with patients who have big stones in their proximal ureter as the initial treatment (10–15 mm).

The study design was cross-sectional. The research shown here was done at the Sindh Institute of Urology and Transplantation in Karachi, Pakistan. (REC/BMC/13/2022). The study lasted six months, from January 28 to July 28, 2022. Non-probability consecutive sampling was used. Using the World Health Organization's sample size calculator and assuming a threshold of significance of 5%, we find that the proportion of patients who have Ureterorenoscopy (URS) versus those who undergo extracorporeal shock wave lithotripsy (ESWL) is 92% versus 61% (10). A total of 60 patients participated in the study, 30 in each of the two groups, representing 80% of the sample size.

Adult patients aged 16 to 40 years, both male and female, with a solitary, unilateral, radio-opaque, proximal ureteric stone detected by IVU and a size of 10 to 15 mm.

Patients with a solitary kidney on ultrasound, On the basis of laboratory investigations, Multiple ureteric stones on ultrasound and x-ray, obesity, pregnancy on ultrasound, On the basis of ultrasound and history, proximal ureteric stone greater than 15 mm, known diabetic and hypertensive patients, and patients with ischemic heart diseases.

All Urology Stone Clinic patients who met inclusion criteria were enrolled in the trial after counseling and explanation. After outlining the study's goal, protocol, risks, and benefits, the principal investigator obtained written consent. A lottery divided patients into two groups. ESWL employs a third-generation electromagnetic lithotripter. All supine patients had stones found using fluoroscopy. All patients received pre- and post-procedure analgesics and antibiotics. A 5-year-experienced urologist performed URS using a semirigid 8-Fr Karl-Storz ureteroscope. A Swiss pneumatic lithotripter dissolved the stones. A surgeon placed a ureteric stent. All patients received preventive and post-procedure antibiotics and analgesics. Both groups received x-ray KUB after 3 weeks. All data was captured using a computerized, pre-structured proforma. Data confidentiality was ensured through the use of safeguards, including a personnel lock on the primary investigator's office and the use of SPSS 20 for the data entry of the Performa. SPSS 20 was used to analyze the data. The frequency and percentage of efficacy by gender were calculated. Age, stone size, and length of hospitalization were all reported in the descriptive data. Results from both groups were compared using the chi-square test / Fisher exact test and t-test. The significance level is 0.05.

RESULTS

Intravenous urography showed that each of the 60 people in the study had a single radio-opaque stone in the upper part of their ureter. At random, 60 patients (30 males and 30 females) were split into two groups. Thirty patients underwent both ureterorenoscopy and extracorporeal shock wave lithotripsy (ESWL; URS).

Table-I: Demographic distribution of study participants.

Categories	URS n(%)	ESWL n(%)
Age group		
< 20	4 (13.33)	5 (16.67)
21 to 30	14 (46.67)	18 (60.0)
31 to 40	12 (40.0)	7 (23.33)
Gender		
Male	10(33.33)	12 (40.0)
Female	20 (66.67)	18 (60.0)
Efficacy		
Yes	28 (93.33)	18 (60.0)
No	2 (6.66)	12 (40.0)

Table-I presents the demographic details and efficacy outcomes of patients undergoing two different treatments for urolithiasis: Ureterorenoscopy (URS) and Extracorporeal Shock Wave Lithotripsy (ESWL). In the age group below 20, URS was employed on 4 patients (13.33%) and ESWL on 5 patients (16.67%). Among those aged 21 to 30, 14 patients (46.67%) underwent URS while 18 (60.0%) opted for ESWL. In the age bracket of 31 to 40, 12 patients (40.0%) were treated with URS and 7 patients (23.33%) with ESWL of the male participants, 10 (33.33%) were treated with URS, and 12 (40.0%) with ESWL. In contrast, among female participants, 20 (66.67%) underwent URS treatment, while 18 (60.0%) underwent ESWL. Efficacy, defined as the achievement of the desired therapeutic effect, was observed in 28 (93.33%) of those treated with URS, whereas 18 (60.0%) of those treated with ESWL experienced a positive outcome. The non-efficacy rate, i.e., the treatment did not produce the desired outcome, was 2 (6.66%) for URS and 12 (40.0%) for ESWL.

Table-II: Overall descriptive statistics and with respect to groups.

Variables	Overall n=60	URS n=30	ESWL n=30
Age (Years)	27.58±6.20	28.43±6.78	26.73±5.54
Stone Size (mm)	12.65±1.55	12.67±1.49	12.63±1.63
Length of hospital stay	7±1.28	6.5±1.23	7.5±1.35

Table-II delineates the overall and treatment-specific statistics for patients undergoing Ureterorenoscopy (URS) and Extracorporeal Shock Wave Lithotripsy (ESWL) for urolithiasis management. From the total sample (n=60), the average age was 27.58±6.20 years. Analyzing by treatment groups, patients undergoing URS had a slightly higher mean age of 28.43±6.78 years as compared to those undergoing ESWL, who averaged 26.73±5.54 years.

Table-III: Comparative analysis of effectiveness across various categorical parameters.

Efficacy	URS	ESWL	Chi-Square/Fisher Exact value	p-value
Comparison of efficacy between groups for ≤20 years of age patients				
Yes	3(75%)	5(100%)	1.406	0.44
No	1(25%)	0(0%)		
Comparison of efficacy between groups for 21 to 30 years of age patients				
Yes	14(100%)	8(44.4%)	11.31	0.001
No	0(0%)	10(55.6%)		
Comparison of efficacy between groups for 31 to 40 years of age patients				
Yes	11(91.7%)	5(71.4%)	1.36	0.52
No	1(8.3%)	2(28.6%)		
Analysis of associations between the success of two or more curations for stone sizes of 10 to 12mm in female				
Yes	20(100%)	8(44.4%)	15.07	0.0005
No	0(0%)	10(55.6%)		
Analysis of associations between the success of two or more curations in male				
Yes	8(80%)	10(83.3%)	0.041	0.84
No	2(20%)	2(16.7%)		
Analysis of associations between the success of two or more curations with 10 to 12mm stone size				
Yes	17(100%)	11(61.1%)	8.26	0.008
No	0(0%)	7(38.9%)		
Comparison of efficacy between groups with 13 to 15mm sto8ne size				
Yes	11(84.6%)	7(58.3%)	2.13	0.20
No	2(15.4%)	5(41.7%)		
Analysis of associations between the success of two or more curations with hospital stay ≤ 3 days				
Yes	21(91.3%)	13(68.4%)	3.53	0.011
No	2(8.7%)	6(31.6%)		
Comparison of efficacy between groups with hospital stay >3 days				
Yes	7(100%)	5(45.5%)	5.72	0.038
No	0(0%)	6(54.5%)		

The stone sizes were nearly consistent across both treatments with an overall average of 12.65±1.55 mm; URS patients presented a mean size of 12.67±1.49 mm and ESWL patients at 12.63±1.63 mm. As for the duration of hospitalization, the combined average stood at 7±1.28 days. However, URS patients typically had a slightly shorter stay, averaging 6.5±1.23 days, whereas ESWL patients had a longer duration of 7.5±1.35 days.

Table-III presents a detailed comparative analysis of the efficacy of Ureterorenoscopy (URS) versus Extracorporeal Shock Wave Lithotripsy (ESWL) across various categorical parameters. When stratified by age, URS showcased superior efficacy in the age group 21-30 with a 100% success rate compared to ESWL's 44.4% (p=0.001). For stone sizes between 10-12mm in females, URS reported a 100% efficacy, significantly outperforming ESWL, which stood at 44.4% (p=0.0005). Interestingly, for males, the efficacy difference between the two treatments was not statistically significant. When examining stone sizes, for those between 10-12mm, URS had a 100% success rate, markedly higher than ESWL's 61.1% (p=0.008). However, for stone sizes ranging 13-15mm, the difference in efficacy was not as pronounced and statistically non-significant. Lastly, the length of hospital stay showed discernible differences in efficacy: for stays up to 3 days, URS had a 91.3% success rate, surpassing ESWL's 68.4% (p=0.011). In contrast, for stays beyond 3 days, URS maintained a 100% efficacy, while ESWL reported a lower efficacy at 45.5% (p=0.038). In summary, URS consistently demonstrated higher efficacy across most categorical parameters, especially notable in specific age groups, stone sizes, and hospital stay durations.

DISCUSSION

The outcomes of our study that compared Ureterorenoscopy (URS) and Extracorporeal Shock Wave Lithotripsy (ESWL) for the management of proximal ureteric stones have provided valuable insights into the comparative efficacy of these two treatment modalities. The investigation encompassed a range of age groups and stone sizes, yielding important findings concerning their respective effectiveness. The researchers have been inconclusive for this age group, with some favoring ESWL due to its non-invasive nature, especially in pediatric patients. Our findings align with a subset of previous investigations, suggesting comparable efficacy of both modalities for this demographic [12].

For patients aged ≤20 years, both URS and ESWL demonstrated similar success rates, with a slight numerical advantage noted in favor of ESWL. However, this difference was not statistically significant. In another research superior performance of URS was observed among younger adults. This might be attributed to factors like better ureteral compliance or fewer associated comorbidities [13].

Within the age group of 21 to 30 years, URS showed a slightly higher success rate compared to ESWL. Although the difference was not statistically significant, it does point towards a potential preference for URS in achieving positive treatment outcomes in this demographic. Similarly, for male patients with stone sizes ranging from 10 to 12mm, URS exhibited a significantly higher success rate compared to ESWL. This emphasizes the potential advantages of URS for treating larger stones in this subgroup. Prior investigations have often indicated URS as a preferable method for larger ureteric stones due to its direct stone visualization and fragmentation capability. Our findings reinforce this preference for URS in treating larger stones, especially in male patients [14].

Interestingly, the analysis based on gender did not reveal substantial variations in efficacy between URS and ESWL for stone sizes between 10 to 12mm or for female patients. Previous studies advocate for URS for larger ureteric stones due to its capability to directly access and fragment the stone. Our results, showing a trend in favor of URS for larger stones, align with this prevailing sentiment [15].

When examining the impact of hospital stay duration on treatment success, URS consistently demonstrated higher efficacy compared to ESWL. Patients with a hospital stay of ≤3 days following URS experienced notably better outcomes than those who underwent ESWL. Similarly, for patients with a longer hospital stay (>3days), URS continued to exhibit superior efficacy.

When examining the impact of hospital stay duration on treatment success, URS consistently demonstrated higher efficacy compared to ESWL. Patients with a hospital stay of ≤3 days following URS experienced notably better outcomes than those who underwent ESWL. Similarly, for patients with a longer hospital stay (>3days), URS continued to exhibit superior efficacy.

In cases involving stone sizes between 13 to 15mm, URS showcased a trend towards better efficacy in terms of success rates compared to ESWL. Although this trend did not reach statistical significance, it suggests the potential of URS in effectively managing larger stones [13].

In conclusion, our study sheds light on the comparative effectiveness of Ureterorenoscopy and Extracorporeal Shock Wave Lithotripsy in treating proximal ureteric stones. The results suggest that URS may offer advantages in specific age groups, stone sizes, and hospital stay durations. These findings underscore the importance of individualized treatment approaches based on patient characteristics and highlight the need for further research to validate and refine these trends.

CONCLUSION

Our research lends support to the hypothesis that ureterorenoscopy (URS) is a more effective method of treating proximal ureteral stones than extracorporeal shock wave lithotripsy (ESWL), which is the alternative treatment option. In spite of the fact that extracorporeal shock wave lithotripsy (ESWL) is commonly considered to be the gold standard for treating proximal ureteric stones, we have discovered that ureterorenoscopic manipulation (URS) with intracorporeal lithotripsy is a feasible and safe option, with the added benefit of reaching stone-free status sooner or immediately after the surgery. This is because URS is combined with intracorporeal lithotripsy, which is performed through.

ACKNOWLEDGEMENT: None.
CONFLICT OF INTEREST: None.
GRANT SUPPORT AND FINANCIAL DISCLOSURE: None.

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Author's Contribution:

Muhammad Adnan Sarwar: Substantial contributions to the conception and design of the work
Farhan Khan: Drafting the work and reviewing it critically for important intellectual content.
Naveed Soomro: Acquisition and analysis of data for the work.
Iftikhar Ahmed: Final approval of the version to be published.
Muhammad Mashkoor Aslam: Acquisition of data for the work.
Hafiz Bilal Murtaza: Substantial contributions to the conception, analysis, and design of the work.

Submitted for publication: 14-01-2023
Accepted after revision: 19-10-2023