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OUTCOME OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL) OF LOWER URETERIC STONES

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ABSTRACT

Urolithiasis is a prevailing urological condition, with ureteric stones affecting around 22% of cases, mostly causing severe pain and other complications. Surveillance, medical therapy, and interventions including non-invasive and invasive are various treatment options. However, extracorporeal shockwave lithotripsy (ESWL) is one of commonly used primary non-invasive technique in treatment for kidney and ureteric stones due to its success rate and cost-effectiveness. Thus, its effectiveness for lower ureteric stones is arguable due to anatomical and technical challenges. Factors such as stone size, density, and patient BMI influence ESWL success. This study aims to evaluate ESWL outcomes for lower ureteric stones, providing insights to refine treatment strategies and improve patient care.To determine the outcomes of extracorporeal shock wave lithotripsy for lower ureteric stones and evaluate the factors influencing these outcomes.This cross-sectional study was conducted at the Institute of Kidney Diseases, Peshawar, from September 2024 to February 2025, enrolling 171 patients with lower ureteric stones. Subject underwent evaluation, including ultrasound, X-ray KUB, BMI calculation, and investigations before ESWL treatment using an electromagnetic lithotripter. Patients received maximum up to three sessions of ESWL, with success defined as stone-free status as stone <4mm on ultrasound. These outcomes were assessed after two weeks. Data were analyzed using SPSS 23, with statistical tests applied to identify predictors of treatment success.The study consisted of 113 males (66.1%) and 58 females (33.9%), with a mean age of 37.3 years. The stones averaged 9.8 mm in size. Extracorporeal shockwave lithotripsy (ESWL) was successful in 83.6% of cases, while 16.4% required auxiliary procedures. The mean number of sessions needed to achieve stone-free status was 1.5. The successful outcomes were 92.6% in stones less than 10 mm, and 72.4% in stones more than 10mm (p-value 0.001). Moreover, successful outcomes was 71.1% in BMI more than 30 kg/m2, and more than 80% in BMI < 30 kg/m2 (p-value 0.02).Extracorporeal shock wave lithotripsy (ESWL) maintains its role as a safe, non-invasive treatment for well-selected lower ureteric stones. The major predictors of positive outcomes included stones stone size and body mass index (BMI). These findings support existing evidence on prognostic factors for ESWL efficacy, offering perceptions to improve patient selection for successful outcomes and reduced unnecessary interventions. In future, the studies should aim to develop protocols that incorporate variables such as stone density, impaction duration, and anatomical factors.

INTRODUCTION

Urolithiasis is one of a common disease in urology where crystal particles are produced and passed through urinary tract. This diseases is prevalent world widely ranging from 1 to 20%. As an escalating issue, urolithiasis is posing a substantial health problem across all age groups and emphasizing the crucial need for public health initiatives to address this matter. (1) About 22% of urolithiasis cases occur in the ureters that causes severe pain, infection, and hematuria and sometimes may lead to irreversible kidney damage. Several options are available for the treatment of ureteric stones including surveillance, medical expulsion therapy (MET), noninvasive techniques such as extracorporeal shockwave lithotripsy (ESWL), minimally invasive procedures such as ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL), and laparoscopic and open surgeries. The treatment choice to treat an individual depends on the stone characteristics and patient factors. Therefore, to design a course of management, a complete medical history, clinical examination, and laboratory and radiographic investigations are compulsory. (2)

These stones are mineral formations, usually consisting of calcium oxalate, calcium phosphate, uric acid can vary significantly in size, ranging from small crystals to huge stones that impede the flow of urine. The exact cause of such condition is intricate and multifactorial, including dehydration, eating habits, metabolic abnormalities, and genetic predispositions. Ureteric stones present with a range of symptoms, such as intense pain on affected side, hematuria, difficulty urinating, and urgency. (3, 4)

A study was performed to explore the composition of renal stones, revealing calcium oxalate stones were the most common (80.1%), followed by uric acid stones (13.5%), mixed stones (3.3%), calcium appetite (2.3%), struvite (5%), hydroxy appetite (1%) and cysteine stones (2%). Male predominance was also recorded in people with renal stones (79.5%). (3)

Diagnostic modalities consist of several imaging techniques, such as plain computed tomography (CT) scans, ultrasonography, and intravenous pyelography. These techniques seek to precisely visualize the stones and evaluate any related problems. (5) When deciding on an intervention, it is important to consider the effectiveness, level of invasiveness, and possible consequences. (6) Furthermore, implementing preventive measures such as making dietary adjustments, ensuring sufficient hydration, and utilizing medication, are crucial in decreasing the odds of stone recurrence. (7)

Since the beginning in 1984, extracorporeal shockwave lithotripsy (ESWL) has been the primary treatment for kidney and ureteric stones. Although ureterorenoscopy (URS) is a preferred method in treatment of ureteric stones nowadays, ESWL is still widely used by urologists due to its minimal intrusive nature, low cost and positive results in terms of efficacy. Various factors influence the effectiveness of this intervention such as the stone location within urinary tract, stone density and size, skin-to-stone distance, and body mass index. (8) Lower ureteric stones are a frequently encountered and difficult urological ailment, often causing substantial health problems and requiring expensive medical therapy.

ESWL is commonly used to treat ureteric stones, although its efficiency in treating lower ureteric stones has to be specifically studied because of anatomical factors and possible technical restrictions. As there is no such literature available on this subject locally, the goal of this study is to conclude the outcome of ESWL of lower ureteric stones at our health setup. The findings of this study will helpful for our medical professionals to provide valuable insights regarding the optimal management strategies for lower ureteric stones, informing clinical decision-making and improving patient care.

OBJECTIVE

To determine the outcomes of extracorporeal shock wave lithotripsy for lower ureteric stones and evaluate the factors influencing these outcomes.

METHODOLOGY

This cross-sectional study was conducted at the Department of Urology, Institute of Kidney Diseases, Peshawar, from September 2024 to February 2025 following approval from ethical board. A sample size of 171 participants was calculated using the WHO sample size calculator including subjects aged 18–70 years, diagnosed with lower ureteric stones (defined as stones below the pelvic brim and presented with complaints of flank pain, hematuria, dysuria, and confirmed by ultrasound findings of hypoechoic areas, ureteral dilatation, and hyperechoic foci), were enrolled via non-probability consecutive sampling. Exclusion criteria include pregnancy, uncorrectable coagulopathy, active urinary tract infections, and solitary kidney.

After a detailed history and examination to patients presenting in OPD, were investigated with ultrasound and X-ray KUB, which confirmed a diagnosed of lower ureteric stones. The history included all the relevant information needed such as gender, duration of symptoms and co-morbidities. Afterwards height and weight of the subjects were measured to calculated body mass index (BMI) by using formula weight (kg)/height $(m)^2$. The investigations showed stone size upto 15mm and location and informed consent for the procedure was taken. Furthermore, renal function tests (RFTs), coagulation profile and urine culture and sensitivity tests were also performed.

After evaluation, subjects underwent session of extracorporeal shockwave lithotripsy (ESWL) by electromagnetic lithotripter machine. They were positioned in a supine posture for the procedure. Stone was targeted with the help of fluoroscopy and a ultrasound used with a preset shock wave frequency at approximately 90 shocks per minute. Initially, 500 shocks at energy level 2 were delivered, followed by a gradual increase to energy levels 3 and 4 for the subsequent 2000–2500 shocks. Intravenous tramadol (100 mg) was administered if patients experienced pain during the procedure. (9) Patients were be re-evaluated after two weeks to assess treatment success. If treatment was not successful another session of ESWL was planned next week, which a maximum of 3 sessions. The successful outcome was defined in terms of stone free rate following completion of the ESWL procedure as no stone fragments visualized on ultrasound, typically < 4 millimeters in size. Data analysis in SPSS 23 was performed and displayed in figures and tables. The continuous variables were presented in terms of mean ± standard deviation, categorical variables in form of frequencies and percentages. The p- value was calculated using Chi-square test to identify associations between variables and treatment success. P-value less than 0.05 was labelled as significant. A multivariate regression test was also applied to predict the success of procedure.

RESULTS

Among total 171 subjects with lower ureteric stones, 66.1% (n=113) were males whereas 33.9% (n=58) were females, who underwent lithotripsy. The mean age observed was 37.3 ± 12.4 years ranging from 18 to 70 years. Regarding laterality, the right side was more affected (50.9%, n=87) compared to the left side which was affected by 49.1% (n=84). Moreover, comorbidities were noted among subjects i.e. 24.6% (n=42) had hypertension and 7% (n=12) had diabetes mellitus. The mean body mass index observed in the subjects was 27.42 ± 4.38 kg/m^2.

The average stone size seen in the study was 9.8 ± 2.5 mm ranging from 6.1 to 15.0 mm, displayed in figure 1. In terms of experiencing symptoms such as pain, LUTS or dysuria, 57.3% (n=98) had duration of 14 days of less; however, 42.7% (n=73) had duration more than 14 days. The successful outcomes of extracorporeal shockwave lithotripsy (ESWL) was 83.6% (n=143), though 16.4% (n=28)

needed auxiliary procedures such as ureteroscopy or ureterolithotomy. The mean sessions required to achieve stone-free status was 1.5 from 1 to 3 sessions per stone. Table 1 showing categorical variables in predicting ESWL failure for lower ureteric stones. Table 2 showing multivariate analysis for variables predicting ESWL failure.

Variable		Frequency (n)	Successful Outcomes (n) (%)	p-value
Gender	Male	113	97 (85.8)	0.28
	Female	58	46 (79.3)	
Laterality	Right	87	74 (85.1)	0.68
	Left	84	69 (82.1)	
BMI (kg/m²)	<25	59	53 (89.8)	*0.02*
	25-30	67	58 (86.6)	
	≥ 30	45	32 (71.1)	
Stone size (in mm)	<10	95	88 (92.6)	*0.01*
	≥ 10	76	55 (72.4)	

Table 1: Categorical variables in predicting ESWL failure for lower ureteric stones *(p-value by Chi-square test)*

Variable		B	SE	Exp (B)	p-value
BMI (kg/m²)	<25	0		1	0.03
	25-30	-1.27	0.54	0.27	0.01
	≥ 30	-0.96	0.48	0.38	0.04
Stone size (in mm)	<10	-0.96	0.25	0.38	0.001
	≥ 10	-1.56	0.46	0.20	

Table 2: Multivariate analysis (logistic regression) for variables predicting ESWL failure in lower ureteric stones
(Exp(B) represents the probability of failure increasing due to a one-unit rise in the predictor value relative to its original probability. B, regression coefficient.)

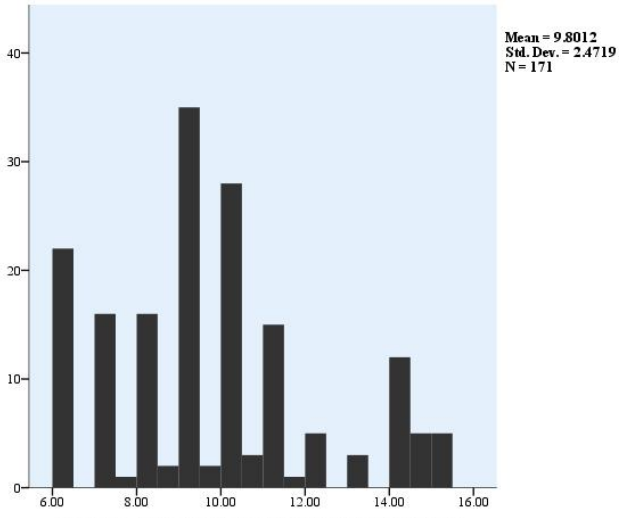

Figure 1: Average stone size (in mm) in lower ureteric stones underwent ESWL

DISCUSSION

Our study on extracorporeal shock wave lithotripsy (ESWL) for lower ureteric stones provides positive understandings of treatment outcomes and predictive factors for success in a considerable population of 171 patients. The overall success rate of 83.6% demonstrates that ESWL remains an effective first-line treatment option for appropriately selected lower ureteric stones. However, stone size less than 10 mm, particular stone composition and density less than 1000, lower body mass index and absence of ureteric edema have significant impacts on success of procedure. Though, sufficient amount of shockwaves and target is also important, poor technique and stone obscured with gut or improper positioning lessens its effectiveness.

The stone-free rate observed in our study aligns with findings from a study (10), which reported a stone-free rate ranging from 68% to 83 for lower ureteric stones after undergoing ESWL. The success rate is particularly notable in stone with mean size of 9.8 mm, which is at the upper range of stone sizes typically considered suitable for ESWL. The average number of sessions required (1.5 sessions) further supports ESWL as an efficient treatment, possibly offering advantages in terms of less morbidity compared to more invasive techniques.

Stone size, an important predictor in success of treatment, where stones less than size of 10mm showed higher success rate i.e. 92.6%. However, stone having size more than 10 mm were resilient to ESWL with a success rate of 72.4%. This finding is supported by studies (10, 11). Similar to study from Middle East (12), we found falling success rates with increasing stone size, proposing that alternative approaches such as ureteroscopy to large calculi in lower ureter.

Our study demonstrates a significant correlation between BMI and ESWL outcomes ($p=0.02$), with success rates declining as BMI increases: 89.8% for BMI <25 kg/m², 86.6% for BMI 25-30 kg/m², and 71.1% for BMI ≥30 kg/m². This finding is consistent with a study (13), who reported that increased BMI negatively impacts ESWL success rates. This occurs because of a reason that more the skin-to-stone distance hinders the shockwave to the targeted stone lowering the effect of lithotripter. This is a considerable point in planning surgery with higher BMI and advising obese patients about the outcomes of ESWL. Moreoever, discussing other options with them.

Our study shows a male predominance, as living in male dominant region. So far, gender implies no distinguished impact on the success of ESWL. The laterality in our study showed no significant different in success of ESWL; however, right sided had slightly higher stone-free rate. The factors discussed in study showed that right ureter is shorter and straight and left ureter is tortuous and long due to anatomical relationship with sigmoid making it less mobile, causing difficulty in passage of stone after fragmentation (14). The presence of comorbidities such as hypertension and diabetes mellitus in our study reflects the typical patient population presenting with urolithiasis. A research has suggested that metabolic factors may influence stone composition and fragility, interfering in the success of treatment. (15)

The duration of symptoms had been recorded, whereas 14 days is taken as a cut-off point because of reason that mostly stones pass on its own in said period. Though factors such as impaction of stone and duration of the stone is also one of the reason to failure of the procedure given in a study. (16)

The study suggests a subtle approach to selecting patients for ESWL in treating lower ureteric stones. ESWL is highly effective for stones <10 mm in patients with a BMI <30 kg/m² and should be the preferred a considerable treatment. Developing predictive models incorporating stone size and BMI could enhance patient selection (15), improving treatment efficiency and reducing healthcare finances by reducing auxiliary procedures as needed in 16.4% of our cases.

LIMITATIONS

Our study had several limitations including single-center experience, and operator variability. It did not include stone density as described in many studies to be an influential predictor of ESWL success. Furthermore, our study did not evaluate duration of stone impaction or obstruction and its impact

on treatment outcomes. Additionally, longer follow-up would better characterize late complications and recurrence rates.

CONCLUSION

Extracorporeal shock wave lithotripsy (ESWL) maintains its role as a safe, non-invasive treatment for well-selected lower ureteric stones. The major predictors of positive outcomes included stones smaller than 10 mm and a body mass index (BMI) below 30 kg/m². These findings reinforce existing evidence on prognostic factors for ESWL efficacy, offering insights to improve patient selection for good success rates and reduced unnecessary interventions. In future, the studies should aim to develop such protocols that incorporate variables such as stone density, impaction duration, and anatomical factors to better guide clinical decision-making and boost therapeutic outcomes. Such advancements could further streamline treatment pathways and personalize care for patients with ureteric calculi.

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