

Original Article

Stone Clearance rate of Intracorporeal Pneumatic Lithotripsy for Mid Ureteric Stone of Size 1-2cm

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Ureteric stone, Stone size, Ureterorenoscopic lithotripsy, Stone clearance

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ABSTRACT

Background: Urolithiasis is a common urological disorder associated with significant morbidity and recurrence. Mid-ureteric stones frequently cause severe pain, obstruction, and impaired quality of life. Intracorporeal pneumatic lithotripsy is widely used for the management of ureteric stones because of its availability, affordability, and favorable clinical outcomes.

Objective: To determine the stone clearance rate of intracorporeal pneumatic lithotripsy for mid-ureteric stones measuring 1–2 cm in patients presenting to a tertiary care hospital.

Methodology: A prospective descriptive study was conducted at the Department of Urology, Lady Reading Hospital, Peshawar, from 30 January 2024 to 30 July 2024. A total of 183 patients aged 18–60 years with radiopaque mid-ureteric stones measuring 1–2 cm were included through non-probability consecutive sampling. Patients with coagulopathy, pregnancy, urinary tract infection, or previous ureteric intervention were excluded. All patients underwent ureterorenoscopic intracorporeal pneumatic lithotripsy using a semi-rigid ureteroscope and Swiss Pneumatic Lithoclast. Stone clearance was assessed by non-contrast CT KUB two weeks after the procedure. Data were analyzed using IBM SPSS version 25. A p-value ≤ 0.05 was considered statistically significant.

Results: The mean age of participants was 39.89 ± 12.38 years. Among the 183 patients, 103 (56.3%) were male and 80 (43.7%) were female. Stone clearance was achieved in 147 (80.3%) patients. Higher stone clearance rates were observed in patients aged 36–50 years, male gender, right-sided ureteric stones, lower body mass index, and shorter pain duration. Significant associations were observed between stone clearance and age, laterality, pain duration, and body mass index ($p < 0.05$).

Conclusion: Intracorporeal pneumatic lithotripsy demonstrated a high stone clearance rate for mid-ureteric stones measuring 1–2 cm and may be considered an effective treatment modality in selected patients.

INTRODUCTION

Urinary stone disease is one of the most common urological disorders worldwide and is associated with significant morbidity, recurrence, and healthcare burden.[1] Ureteric stones frequently require active intervention because of severe pain, urinary obstruction, infection, and impaired renal function.[2] The primary objective of treatment is complete stone clearance with minimal morbidity and preservation of renal function.[3] Several treatment modalities are available for ureteric stones, including shock wave lithotripsy (SWL), ureteroscopy (URS), percutaneous nephrolithotomy, laparoscopic ureterolithotomy, and open surgery.[4] The selection of treatment depends on multiple factors such as stone size, location, composition, anatomical considerations, equipment availability, and surgeon expertise.[5] According to the European Association of Urology guidelines, SWL and ureteroscopic lithotripsy are considered first-line treatment options for middle ureteric stones because of their minimally invasive nature and favorable clinical outcomes.[6] Although SWL is widely used because of its non-invasive approach and patient acceptability, ureteroscopic lithotripsy has demonstrated superior stone clearance rates, particularly for stones larger than 1 cm.[7] Recent advancements in ureteroscope technology, intracorporeal lithotripsy devices, and endoscopic instrumentation have considerably improved the success rate and safety profile of ureteroscopic management of ureteric stones.[8] Previous studies have reported high stone-free rates following ureteroscopic lithotripsy for middle ureteric calculi. Aboutaleb et al. reported a stone-free rate of 86.2% following ureteroscopic lithotripsy.[8] Similarly, Salem et al. demonstrated an 88.0% stone clearance rate in patients with ureteric stones measuring ≥ 1 cm.[9] Despite these advances, stone clearance rates may still be influenced by several factors including stone size, anatomical location, body mass index, duration of symptoms, and surgeon experience.[10] Intracorporeal pneumatic lithotripsy remains widely practiced in developing countries because of its affordability, availability, and satisfactory clinical outcomes.[11] However, local data regarding stone clearance rates following intracorporeal pneumatic lithotripsy for mid-ureteric stones remain limited in Pakistan.[12] Therefore, this study was conducted to determine the stone clearance rate of intracorporeal pneumatic lithotripsy for mid-ureteric stones measuring 1–2 cm in patients presenting to a tertiary care hospital.

MATERIALS AND METHODS

Study Design and Setting

This prospective descriptive study was conducted at the Department of Urology, Lady Reading Hospital (LRH), Peshawar, from 30 January 2024 to 30 July 2024.

Sample Size

The sample size was calculated using the WHO sample size calculator by taking an anticipated stone clearance rate of 86.2%, margin of error of 5%, and confidence level of 95%. The calculated sample size was 183 patients.

Sampling Technique

Participants were recruited using non-probability consecutive sampling technique.

Inclusion Criteria

- Patients aged 18–60 years
- Both genders
- Mid-ureteric stones measuring 1–2 cm
- Radiopaque ureteric stones

Exclusion Criteria

- History of previous intervention on the corresponding ureter
- Coagulopathy
- Pregnant females
- Urinary tract infection

Operational Definition

Stone clearance was defined as complete absence of residual ureteric stone fragments on non-contrast CT KUB performed two weeks after ureterorenoscopic intracorporeal pneumatic lithotripsy.

Data Collection Procedure

After obtaining approval from the Ethical Review Committee of the hospital (Ref No: 1049/LRH/MTI), eligible patients fulfilling the inclusion criteria were enrolled from the Department of Urology. Written informed consent was obtained from all participants prior to inclusion in the study. Baseline demographic and clinical information including age, gender, height, weight, and body mass index (BMI) was recorded. Detailed

clinical history, physical examination, laboratory investigations, X-ray KUB, ultrasonography KUB, and non-contrast CT KUB were performed preoperatively. All procedures were performed under general or spinal anesthesia using a semi-rigid ureteroscope (6/8.9 Fr). A 0.035-inch floppy tip guidewire was passed beyond the stone to maintain ureteric access and provide safety guidance. Swiss Pneumatic Lithoclast was used for intracorporeal pneumatic lithotripsy. Continuous low-pressure irrigation and intermittent manual irrigation were used to maintain adequate visualization during the procedure. Dormia baskets were used to prevent stone migration and retrieve significant stone fragments. All patients were managed on a day-care basis unless complications occurred. Double J ureteric stents (6 Fr) were inserted selectively in cases of excessive manipulation, mucosal edema, ureteric injury, or residual stone fragments. Stents were removed after confirmation of complete stone clearance. Patients were followed up after two weeks, and stone clearance was confirmed using non-contrast CT KUB. Data were recorded on a structured proforma by the principal investigator.

DATA ANALYSIS PROCEDURE

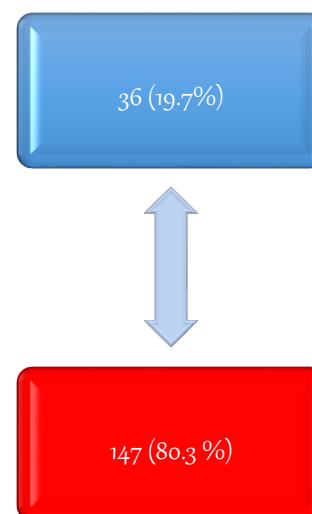
Data were analyzed using IBM SPSS version 25. Quantitative variables including age, body mass index, stone size, and duration of pain were presented as mean $\pm$ standard deviation. Categorical variables including gender, ureteric laterality, and stone clearance were

presented as frequencies and percentages. Stone clearance was stratified according to age, gender, body mass index, ureteric laterality, and duration of pain. Post-stratification chi-square test was applied to assess associations between categorical variables. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

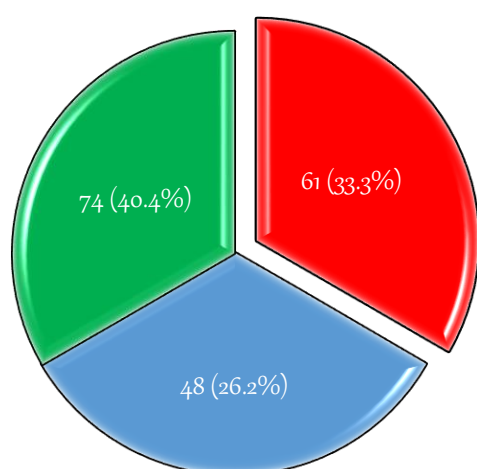
A total of 183 patients were included in the study. The mean age of participants was 39.89 ± 12.38 years, while the mean stone size was 1.57 ± 0.30 cm. The mean body mass index was 25.59 ± 2.44 kg/m², and the mean duration of pain was 5.26 ± 1.96 days (Table 1). Among the participants, 103 (56.3%) were male and 80 (43.7%) were female. The age distribution of the study population is presented in Figure 1. Stone clearance was achieved in 147 (80.3%) patients, whereas 36 (19.7%) patients had residual stones after the procedure (Figure 2). Statistically significant associations were observed between stone clearance and age, ureteric laterality, duration of pain, and body mass index ($p < 0.05$). Higher stone clearance rates were observed among middle-aged patients, patients with right-sided ureteric stones, lower body mass index, and shorter duration of symptoms. Male patients demonstrated relatively higher stone clearance compared with female patients; however, this difference did not reach statistical significance. Detailed stratification analysis is presented in Table 2.

Figure 2. Stone Clearance Following Intracorporeal Pneumatic Lithotripsy (n=183)



Proportion of patients achieving complete stone clearance and those with residual stones following ureterorenoscopic intracorporeal pneumatic lithotripsy.

Figure 1: Age Distribution of Study Participants (n = 183)



This figure Shows the distribution of study participants according to age groups. The majority of patients were within the middle-aged category, reflecting the common age range affected by ureteric stone disease in the study population.

Table 1. Baseline Clinical Characteristics of Study Participants (n = 183)

Variable	Mean ± SD
Age (years)	39.89 ± 12.38
Pain Duration (days)	5.26 ± 1.96
Stone Size (cm)	1.57 ± 0.30
Body Mass Index (kg/m²)	25.59 ± 2.44

Data are presented as mean ± standard deviation (SD).

Table 2. Association of Stone Clearance with Demographic and Clinical Variables

Variable	Stone Cleared n (%)	Residual Stone n (%)	P-value
Age Group (years)			0.047
18–35	48 (75.0)	16 (25.0)	
36–50	71 (86.6)	11 (13.4)	
>50	28 (75.7)	9 (24.3)	
Gender			0.051
Male	86 (83.5)	17 (16.5)	
Female	61 (76.3)	19 (23.7)	
Stone Laterality			0.039
Right	82 (85.4)	14 (14.6)	
Left	65 (74.7)	22 (25.3)	
Pain Duration (days)			0.019
≤5 Days	92 (85.2)	16 (14.8)	
>5 Days	55 (73.3)	20 (26.7)	
BMI (kg/m²)			0.008
<25	79 (88.8)	10 (11.2)	
≥25	68 (72.3)	26 (27.7)	

Data are presented as frequency and percentage. P-values were calculated using the Chi-square test. A p-value ≤0.05 was considered statistically significant.

DISCUSSION

In the present study, intracorporeal pneumatic lithotripsy achieved a stone clearance rate of 80.3% in patients with mid-ureteric stones measuring 1–2 cm. This finding demonstrates that pneumatic lithotripsy remains an effective treatment modality for ureteric calculi, particularly in resource-limited settings where laser lithotripsy may not be readily available [13,14]. The observed stone clearance rate is comparable to previously reported outcomes. Mustafa et al. reported successful stone clearance rates exceeding 80%, supporting the effectiveness of pneumatic lithotripsy in routine clinical practice [15,16]. Stone size is an important determinant of procedural success. The mean stone size in our study was 1.57 ± 0.30 cm, and previous studies have demonstrated that increasing stone size is associated with lower stone-free rates and a greater likelihood of secondary interventions [17,18]. The slightly lower clearance rate observed in our study compared with some international reports may be attributable to differences in stone burden, patient characteristics, and institutional practices. We observed significantly higher stone clearance rates among patients with right-sided ureteric stones, lower body mass index, and shorter duration of symptoms [19]. Similar findings have been reported by Seike et al., who identified lower body mass index as a predictor of favorable ureteroscopic outcomes [19]. Likewise, Ulvik et al. and Yildiz et al. demonstrated that patient-related and stone-related factors significantly influence treatment success following ureteroscopic lithotripsy [20]. These findings highlight the importance of patient selection and preoperative assessment in optimizing treatment outcomes. Several procedural and anatomical factors may influence treatment success. Previous studies have shown that ureteral anatomy, stone characteristics, perioperative infections, and operative techniques can

STRENGTHS

The strengths of this study include prospective data collection, standardized operative technique, objective assessment of stone clearance using CT KUB, and inclusion of a relatively large sample of patients with mid-ureteric stones.

CONCLUSION

Intracorporeal pneumatic lithotripsy demonstrated a satisfactory stone clearance rate of 80.3% in patients with mid-ureteric stones measuring 1–2 cm. Stone clearance was significantly associated with age, body mass index, duration of symptoms, and stone laterality. The procedure remains a safe, effective, and cost-efficient treatment option in resource-limited settings.

affect ureteroscopic outcomes and postoperative complications [21,22]. Furthermore, advances in endoscopic technology and improvements in ureteroscopic instrumentation have contributed to enhanced visualization, improved maneuverability, and better stone-free rates in contemporary practice [23]. The clinical significance of this study lies in demonstrating that intracorporeal pneumatic lithotripsy continues to provide satisfactory outcomes despite the increasing availability of advanced laser technologies. Comparative studies evaluating laser lithotripsy have reported excellent outcomes; however, pneumatic lithotripsy remains a practical and cost-effective alternative in many healthcare settings [24]. Given its lower cost, widespread availability, and acceptable stone clearance rates, pneumatic lithotripsy remains particularly valuable in developing countries. Overall, the findings of the present study reinforce existing evidence that intracorporeal pneumatic lithotripsy is an effective treatment modality for mid-ureteric stones measuring 1–2 cm, achieving satisfactory stone clearance rates with favorable clinical outcomes.

LIMITATIONS

This study had several limitations. It was conducted at a single tertiary care center with a relatively limited sample size, which may restrict the generalizability of the findings. Long-term follow-up for stone recurrence and postoperative complications was not performed. In addition, stone composition analysis was not evaluated, which may influence fragmentation efficiency and treatment outcomes. Further multicenter studies with larger sample sizes and longer follow-up duration are recommended.

Ethical Approval Statement

Ethical approval for this study was obtained from the Ethical Review Committee of Lady Reading Hospital, Peshawar (Ref No:MTI/LRH/ERB/ 1049/14/06/2023).

Informed Consent

Written informed consent was obtained from all participants prior to enrollment in the study.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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The authors received no external funding for this study.

Data Availability Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

AI-Assisted Technology Disclosure

During the preparation of this manuscript, the authors used artificial intelligence (AI)-assisted tools to improve language quality, grammar, and manuscript organization. The authors critically reviewed and edited all AI-generated content and assume full responsibility for the final version of the manuscript. AI tools were not used to generate study data, perform statistical analyses, interpret findings, or formulate scientific conclusions.

Authors' Contributions

Concept and Study Design

AAmir Zeb Khan

Data Collection

Hamza Khan

Data Analysis and Interpretation

Muhammad Usman

Manuscript Drafting

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Critical Review and Final Approval: All authors

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