Original Article

A Prospective Comparative Study to Evaluate the Efficacy of Laser Vs Pneumatic Lithotripsy for Mid and Distal Ureteric Stones

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Abstract

Background: The aim is to prospectively compare the efficacy, operative outcomes, and complication rates of laser lithotripsy versus pneumatic lithotripsy in the management of mid and distal ureteric stones. **Material and Methods:** This prospective randomized comparative study was conducted in the Department of Urology, PGIMS, Rohtak, after approval from the Institutional Ethics Committee. A total of 60 patients aged >18 years with single mid or distal ureteric stones measuring 7–15 mm and normal renal function were enrolled and randomized equally into laser (n=30) and pneumatic (n=30) lithotripsy groups. Pre-operative evaluation included clinical assessment, routine laboratory investigations, ultrasonography, and NCCT KUB. **Results:** Baseline demographic and stone characteristics were comparable between groups except for a higher male predominance in the pneumatic group (p = 0.028). The stone-free rate was significantly higher in the laser group (93.3%) compared to the pneumatic group (80%) (p = 0.04). Stone migration occurred exclusively in the pneumatic arm (20% vs 0%, p = 0.024). The mean operative duration was significantly shorter in the laser group (22.43 ± 1.74 min) compared to the pneumatic group (31.17 ± 3.52 min) (p < 0.001). No late complications such as ureteric stricture or steinstrasse were observed in either group. **Conclusion:** Both pneumatic and laser lithotripsy are effective and safe modalities for treating mid and distal ureteric stones. However, laser lithotripsy offers distinct advantages, including a higher stone-free rate, lower retropulsion, and shorter operative duration, making it a superior choice in appropriately selected patients.

Keywords: Laser lithotripsy, Pneumatic lithotripsy, Ureteric stones, Ureteroscopy, Stone-free rate.

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Introduction

Urinary stone disease is a commonly encountered urological disorder, with a reported prevalence of approximately 2–3% in the general population. As the lifetime prevalence of stone disease is estimated to be around 15% and continues to rise, it has become increasingly important to formulate a clear and effective management strategy that is as minimally invasive as possible while ensuring a high stone-free rate.[1] Urolithiasis may occur due to urinary stasis, low urine volume, dietary factors (high oxalate, high sodium), urinary tract infections, and systemic acidosis. The most common cause is inadequate hydration and subsequent low urine volume. The four major types of renal calculi are calcium stones, which account for 95% of stones.[2] Uric acid stones are associated with acidic pH. Struvite stones are formed by gram-negative urease-positive organisms (Pseudomonas) that break down urea into ammonia, and cystine stones are formed due to an intrinsic metabolic defect causing cystinuria.[2] Urine is transported from the abdominal kidneys to the pelvic bladder via the ureter, a paired fibromuscular tube. The ureter comprises three sections and is roughly 25 to 30 cm long. The first component is the abdominal ureter, which runs from the pelvic brim to the renal pelvis. The second part is the Pelvic ureter, extending from the pelvic brim to the urinary bladder. The final component, located inside the bladder wall, is the intravenous or intramural ureter. Along the medial portion of the psoas muscle, the ureter starts its descend to the bladder. The ureter is located here anteriorly and slightly medial to the L2-L5 transverse process points. The ureter enters the pelvis at the pelvic brim, where the common iliac arteries split, anterior to the sacroiliac joint. It then travels down the lateral pelvic sidewall anterior to the internal iliac artery. It turns forward and medially at the level of the ischial spine to enter the bladder's posterolateral wall, where it travels an oblique 1-2 cm course before exiting at the internal ureteric orifice.[3] The distinctions between the male and female pelvic viscera and the both sides of the abdominal cavity make the ureter's relationships rather complicated. Although it is 3 mm in diameter, it contains

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three constrictions, which are the most typical locations for renal calculus obstruction in the ureter: at the ureter-renal pelvis pelviureteric junction (PUJ). The ureter enters the pelvis and passes through the bifurcation of the common iliac artery. The ureter obliquely penetrates the bladder wall at the vesicoureteric junction (VUJ). Ureters are made up of three layers: the innermost mucosa, which is lined by transitional epithelium epithelium, giving it a waterproof property. Muscularis is made up of longitudinal and circular smooth muscle layers; responsible for the peristaltic motion of the ureter to move the urine from the kidneys to the bladder, and the outermost layer is the adventitia, made up of dense collagen and elastic fibres.[3]

For decades, intravenous urography (IVU) and retrograde urography were the mainstays of ureteral imaging. Typically, a ureter exits each renal pelvis at approximately L2 to L3 and parallels the spine overlying the transverse processes. As the ureters enter the pelvis, they course first laterally, and then curve toward the bladder trigone, entering at an angle that is variable but often approximates 45 degrees. The ureters are usually divided into proximal, middle, and distal segments when describing any abnormalities. The proximal ureter refers to the segment from the ureteropelvic junction (UPJ) to the superior margin of the sacrum. The mid-ureter is the segment that overlies the sacrum (also referred to as the sacral ureter), and the distal ureter is the short segment between the inferior margin of the sacrum and the ureteral orifice. The ureter begins at the ureteropelvic junction of the kidneys, which lies posterior to the renal vein and artery in the hilum. The ureter travels inferiorly inside the abdominal cavity. Then it passes over anterior to the psoas muscle and enters the urinary bladder on the posterior aspect of the bladder in the trigone. The area along the path of the ureter that is clinically significant for renal stone lodging the ureteropelvic junction, the crossover of the common iliac artery and the ureterovesical junction.[3] A ureteric stone in the ureter may or may not have originated in the kidneys and travelled down into the ureter. If small enough, less than 5mm, it can pass through the ureter and out of the body unnoticed. If it is too large, it may lodge in the ureter, obstruct the flow, and become extremely painful, accompanied by cramps in the lower abdomen, which may later spread to the groin. As the body attempts to expel the stone, hematuria occurs. Urination may be more frequent, painful, and leads to a burning sensation, associated with fever and chills, indicating the presence of infection. If left untreated, it may also lead to chronic kidney disease followed by end-stage kidney disease due to obstructive stone in bilateral cases. Selection of appropriate treatment strategy depends upon several factors including stone size, stone composition, presence of obstruction as well as patient’s anatomy and surgeon’s experience. Endoscopic stone removal is the treatment of choice worldwide due to miniaturisation of equipment and availability of a wide array of Intracorporeal lithotripters like electrohydraulic, ultrasonic, pneumatic and laser lithotripters. Most common lithotripters currently in use are pneumatic and laser lithotripters.[4] Pneumatic Lithotripter converts kinetic impact energy to mechanical stress, which is passed through the probe to the stone and the stone breaks by ballistic energy. In previous studies it has been found pneumatic lithotripsy provides good stone-free rate (SFR), less likely to lead to ureteral strictures and lower treatment costs. However, there is considerable incidence of stone migration, a lower stone free rate and longer operating time.[5] It is a pulsed mode modality with 2100 nm wavelength and approximately 0.5 mm tissue penetration characteristics.It is most effective, safest, and most adaptable lithotripter. Further benefits of holmium laser are its significantly smaller post lithotripsy particles compared to other lithotripters. Although it is associated with milder injury to ureter mucosa because of superficial penetration depth, but the local heat generated by the Holmium laser can still cause thermal damage to ureteral mucosa and submucosa, which may lead to ureteral strictures post operatively. It also has a longer learning curve, limited availability, and high price.[6,7]

Materials and Methods

After the approval from Institutional Ethical Committee, this prospective, randomized comparative study was conducted in the Department of Urology, Post Graduate Institute of Medical Sciences, Rohtak, Haryana, a tertiary care hospital, a center of excellence for urological surgery in Haryana. The study protocol was approved by the Institutional Ethics Committee (EC/NEW/INST/2022/HR/0189) before enrollment of the patients. After obtaining written and informed consent from each patient, 60 patients were randomly assigned to undergo either Laser or Pneumatic lithotripsy for mid and distal ureteric stone of size 7 mm–15 mm during the study period.

Inclusion Criteria

- Patients giving consent for the procedure
- Patients with Mid or Distal ureteric calculus of size 7 mm–15 mm
- Patients with normal renal function tests
- Patients age more than 18 years

Exclusion Criteria

- Stone sizes less than 7 mm
- Stone sizes more than 15 mm
- Nephrolithiasis on same side of ureteric stone
- Pregnancy

Methodology

Written and informed consent were obtained from all the patients. All of the included patients' histories of the onset, course, and progression of different symptoms were thoroughly examined and recorded. Demographic information, family history, work history, and prior history were collected. A thorough physical examination was performed. Haematological and radiological evaluations were done in every case.

Pre-Operative Workup

Upon admission, all the patients were thoroughly evaluated with routine blood investigations, renal function tests, ultrasonography abdomen, NCCT KUB. CT urography and DTPA scan were done if indicated. Patients were randomly allocated using computer generated sequence number to undergo either Laser or Pneumatic lithotripsy. For both the groups, surgery was performed under spinal anesthesia as per institutional protocol. All patients were given antibiotics prophylaxis, Inj. Ceftriaxone 1 gram stat I/V just before induction of anaesthesia.

Pneumatic Lithotripsy Technique

After the induction of spinal anesthesia, patients were placed in the lithotomy position. Cystourethroscopy was performed using 20 Fr sheath/30-degree scope. A 0.035-inch floppy tip hydrophilic guidewire was introduced through 6 Fr ureteric catheter, which was passed through the cystoscope, under fluoroscopy guidance, till it reached the pelvis. Ureteroscopy was done and the stone was located. We used a 6/7.5 Fr semi-rigid ureteroscope with a 3.5 Fr working channel (Olympus). Lithoclast probe of size 1.2 mm was introduced through the straight working channel and brought into contact with the stone, and the stone was fragmented into small pieces. Small fragments of the stone were removed using 3 Fr Bipronge U-handle forceps. In all patients 5 Fr Double-J stent (DJS) was placed under fluoroscopic guidance and Foley's catheter was placed.

Laser Lithotripsy Technique

After the induction of spinal anesthesia, patients were placed in the lithotomy position. Cystourethroscopy was performed using 20 Fr sheath/30-degree scope. A 0.035-inch floppy tip hydrophilic guidewire was introduced through 6 Fr ureteric catheter, which was passed through the cystoscope, under fluoroscopy guidance, till it reached the pelvis. Ureteroscopy was done and the stone was located. We used a 6/7.5 Fr semi-rigid ureteroscope with a 3.5 Fr working channel. Holmium laser lithotripsy was performed using the laser setting of 0.6–1.0 J/sec and frequency of 8–12 Hz of 30 Watt (Quanta laser system). In all patients 5 Fr Double-J stent (DJS) was placed under fluoroscopic guidance and Foley's catheter was placed.

Postoperatively

All patients were given antibiotics as per institutional protocol. Foley's catheter was removed on postoperative day 1 (POD 1). Double-J stent was removed after 2–3 weeks. All patients underwent NCCT KUB at the 4th week post-URSL. Stent position was confirmed by fluoroscopy. Stone clearance was confirmed by NCCT KUB. A follow-up was done at the 4th week. Patients were considered stone-free when no stone or stone <4 mm was visualized.

Statistical Analysis

All statistical analyses were performed by using SPSS 22.0 software package (SPSS Inc., Chicago, IL, USA). All data were summarized as mean ± SD for continuous variables, and numbers and percentages for categorical variables. The variables were assessed for normality using the Kolmogorov–Smirnov test. A $p < 0.05$ was accepted as statistically significant.

Results

[Table 1] Demographic Characteristics Between the Two Groups

The demographic comparison between the laser and pneumatic groups demonstrated that the two cohorts were largely comparable in terms of age distribution. The mean age in the laser group was 38.17 ± 14.33 years, whereas in the pneumatic group it was slightly higher at 40.13 ± 11.90 years. This difference was not statistically significant ($t = -0.578$, $p = 0.565$), indicating that age did not confound the comparison of treatment outcomes. The median age also followed a similar pattern, with the laser group showing a median of 35 years (IQR: 24.5–50.25) compared to 42 years (IQR: 29.5–48.75) in the pneumatic group. The age ranges were broadly comparable between both groups (21–68 years in laser vs 20–64 years in pneumatic).Gender distribution, however, showed a significant difference between the groups ($\chi^2 = 4.800$, $p = 0.028$).

[Table 2] Stone and Procedural Characteristics Between the Two Groups

Comparison of laterality showed no statistically significant difference between the two groups ($\chi^2 = 3.590$, $p = 0.058$). Right-sided URSL was performed in 53.3% of patients in the laser group and 76.7% in the pneumatic group, while left-sided procedures were more evenly distributed, with 46.7% in the laser and 23.3% in the pneumatic group. The predominance of right-sided stones was noted overall (65%).The grade of hydronephrosis on USG (HDuN) was also comparable. In the laser group, grades I, II, and III were seen in 53.3%, 43.3%, and 3.3% of patients respectively, whereas in the pneumatic group, these grades were 33.3%, 53.3%, and 13.3%. Although grade III hydronephrosis was slightly more frequent in the pneumatic group, the overall difference was statistically insignificant ($\chi^2 = 3.495$, $p = 0.176$).Stone size on NCCT KUB was nearly identical in both groups.

[Table 3] Intraoperative Complications Between the Two Groups

Intraoperative bleeding occurred at an equal rate in both groups (6.7% each), and the difference was statistically insignificant ($\chi^2 = 0.000$, $p = 1.000$). The majority of patients (93.3%) in each group experienced no bleeding, indicating similar safety profiles with respect to mucosal trauma.Perforation was rare, encountered only in one patient (3.3%) in the laser group and none in the pneumatic group. This difference was also statistically insignificant ($\chi^2 = 1.017$, $p = 1.000$).A major difference was found in stone migration. While no cases (0%) of upward stone migration occurred in the laser group, six cases (20%) occurred in the pneumatic group, making this difference statistically significant ($\chi^2 = 6.667$, $p = 0.024$). This confirms a well-recognized disadvantage of pneumatic lithotripsy associated with greater retropulsion.Formation of false passage occurred in two patients (6.7%) in the pneumatic group but in none from the laser group. Although clinically relevant, this difference did not reach statistical significance ($\chi^2 = 2.069$, $p = 0.492$).

[Table 4] Operative Duration Between the Two Groups

Operative time differed significantly between the two treatment modalities. The laser group had a much shorter mean operative duration of 22.43 ± 1.74 minutes compared to 31.17 ± 3.52 minutes in the pneumatic group. This difference was highly statistically significant ($W = 0.000$, $p < 0.001$).

[Table 5] Stone-free Rate and Early Postoperative Complications

Stone-free rate at follow-up was higher in the laser group, where 93.3% achieved complete clearance compared to 80% in the pneumatic group. The difference was statistically significant ($\chi^2 = 2.308$, $p = 0.04$). Residual stones occurred in 6 patients (20%) in the pneumatic arm and 2 patients (6.7%) in the laser arm. These findings reaffirm the superior fragmentation and dusting efficiency of laser lithotripsy.Postoperative hematuria occurred equally in both groups (6.7%), and the difference was statistically insignificant ($\chi^2 = 0.000$, $p = 1.000$). Most patients (93.3% in

each group) did not develop hematuria, suggesting comparable postoperative mucosal healing.Similarly, postoperative UTI/urosepsis occurred in 16.7% of laser patients and 23.3% of pneumatic patients. The difference was not statistically significant ($\chi^2 = 0.417$, $p = 0.519$).

[Table 6] Late Complications Between the Two Groups

Long-term complications such as ureteric stricture and steinstrasse were not observed in any patient from either group. All patients (100%) were free of both complications throughout the follow-up period.This indicates excellent procedural safety for both modalities when using proper technique and stenting protocols.

Table 1: Demographic characteristics between the two groups

Parameter	Category / Statistic	LASER	Pneumatic	Total	t / χ2	p value
Age (Years)	Mean (SD)	38.17 (14.33)	40.13 (11.90)	—	-0.578	0.565
	Median (IQR)	35 (24.5–50.25)	42 (29.5–48.75)	—	—	—
	Min – Max	21–68	20–64	—	—	—
Gender	Male	16 (53.3%)	24 (80.0%)	40 (66.7%)	4.800	0.028
	Female	14 (46.7%)	6 (20.0%)	20 (33.3%)	—	—
	Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—

Table 2: Stone and procedural characteristics between the two groups

Parameter / Category	LASER	Pneumatic	Total	t / χ2	p value
Laterality of Procedure					
Rt URSL	16 (53.3%)	23 (76.7%)	39 (65.0%)	3.590	0.058
Lt URSL	14 (46.7%)	7 (23.3%)	21 (35.0%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
Grade of HDuN on USG					
I	16 (53.3%)	10 (33.3%)	26 (43.3%)	3.495	0.176
II	13 (43.3%)	16 (53.3%)	29 (48.3%)	—	—
III	1 (3.3%)	4 (13.3%)	5 (8.3%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
Size of Stone on NCCT KUB (mm)					
Mean (SD)	10.89 (1.86)	10.48 (1.82)	—	0.878	0.384
Median (IQR)	10.8 (9.85–12)	10 (9–12)	—	—	—
Min – Max	7.7–15	7–14	—	—	—
Location of Stone					
Distal Ureter	21 (70.0%)	25 (83.3%)	46 (76.7%)	1.491	0.222
Mid Ureter	9 (30.0%)	5 (16.7%)	14 (23.3%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—

Table 3: Intraoperative complications between the two groups

Parameter / Category	LASER	Pneumatic	Total	χ2	P Value
Bleeding					
Yes	2 (6.7%)	2 (6.7%)	4 (6.7%)	0.000	1.000
No	28 (93.3%)	28 (93.3%)	56 (93.3%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
Perforation					
Yes	1 (3.3%)	0 (0.0%)	1 (1.7%)	1.017	1.000
No	29 (96.7%)	30 (100.0%)	59 (98.3%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
Stone Migration					
Yes	0 (0.0%)	6 (20.0%)	6 (10.0%)	6.667	0.024
No	30 (100.0%)	24 (80.0%)	54 (90.0%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
False Passage					
Yes	0 (0.0%)	2 (6.7%)	2 (3.3%)	2.069	0.492
No	30 (100.0%)	28 (93.3%)	58 (96.7%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—

Table 4: Operative duration between the two groups

Operative Duration (Mintues)	LASER	Pneumatic	W	p value
Mean (SD)	22.43 (1.74)	31.17 (3.52)	0.000	<0.001
Median (IQR)	22.5 (21-24)	30 (28-35)		
Min - Max	20 - 25	26 - 36		

Table 5: Stone free rate and early postoperative complications

Parameter / Category	LASER	Pneumatic	Total	χ2	P Value
Stone Free Rate					
Yes	28 (93.3%)	24 (80.0%)	52 (86.7%)	2.308	0.04
No	2 (6.7%)	6 (20.0%)	8 (13.3%)	—	—

Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
Hematuria					
Yes	2 (6.7%)	2 (6.7%)	4 (6.7%)	0.000	1.000
No	28 (93.3%)	28 (93.3%)	56 (93.3%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—
UTI/Urosepsis					
Yes	5 (16.7%)	7 (23.3%)	12 (20.0%)	0.417	0.519
No	25 (83.3%)	23 (76.7%)	48 (80.0%)	—	—
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	—	—

Table 6: Late complications between the two groups

Parameter / Category	LASER	Pneumatic	Total
Sticture			
No	30 (100.0%)	30 (100.0%)	60 (100.0%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)
Steinstrasse			
No	30 (100.0%)	30 (100.0%)	60 (100.0%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)

Discussion

The present study provides a comprehensive comparison of laser and pneumatic ureteroscopic lithotripsy, and our demographic profile is broadly consistent with published series. The mean age in our cohort was 38.17 years in the laser group and 40.13 years in the pneumatic group, with no statistically significant difference (p = 0.565). Patients in our setting thus present with ureteric stones in the late third to early fourth decade, slightly younger than many Western series. This is comparable to the observations of Rabani et al, who reported mean ages of 41.77 and 41.12 years in the laser and pneumatic groups, respectively, with no significant difference, supporting the notion that energy modality selection is not age-dependent (p = 0.746).[8]

In contrast, the gender distribution in our study showed a statistically significant difference between the two arms. Overall, 40 of 60 patients were male and 20 were female; the pneumatic group included 24 males and 6 females, whereas the laser group included 16 males and 14 females (p = 0.028). This male predominance reflects the known higher incidence of urolithiasis in men, but the imbalance between groups may also have contributed to longer operative times in the pneumatic arm, given that larger body habitus and higher stone burden are more frequent in male patients. Abedi et al reported a similar overall male predominance (73 males and 42 females in the pneumatic arm vs 91 males and 44 females in the laser arm), but without significant intergroup difference, indicating that randomisation generally balances sex distribution in larger series.[9]

Laterality of ureteroscopic access was well balanced in our cohort and did not differ significantly between groups (p = 0.058). Right-sided URSL was performed in 23 pneumatic and 16 laser cases, whereas left-sided URSL was done in 7 pneumatic and 14 laser cases, reflecting a slight predominance of right-sided disease overall. This pattern aligns with the findings of Kumar et al, who also reported comparable distributions of right and left URSL between laser and pneumatic groups (22 vs 28 on the right and left in the pneumatic group, and 20 vs 30 in the laser group), with no statistically significant difference, suggesting that laterality does not influence the choice of fragmentation modality.[10]

The grades of hydronephrosis on ultrasonography were similarly distributed between the two treatment arms in our study, with no significant difference (p = 0.176). In the laser group, most patients had grade I or II HDN (16 and 13 patients, respectively), with only 1 patient showing grade III changes; the pneumatic arm showed a similar pattern (10, 16, and 4 patients with grades I, II, and III, respectively). This suggests that both groups had comparable degrees of chronic obstruction at baseline, reducing the risk of confounding. Nour et al also reported no significant difference in preoperative hydronephrosis grade between laser and pneumatic groups, reinforcing that baseline upper tract dilatation tends to be comparable when patient allocation is balanced.[11]

Stone burden and location were also comparable between the two groups in our study. The mean stone size was 10.89 mm in the laser group and 10.48 mm in the pneumatic group, with no statistically significant difference (p = 0.878), and the majority of stones in both arms were located in the distal ureter (21 distal vs 9 mid in the laser group; 25 distal vs 5 mid in the pneumatic group, p = 0.222). These findings mirror those of Shah et al, who reported similar mean stone sizes between pneumatic and laser groups (10.48 vs 10.81 mm) and a predominance of distal ureteric calculi (approximately 54% distal and 46% mid), ensuring that comparisons of fragmentation efficacy and complications are not biased by differences in stone size or location.[12] With respect to intraoperative complications, bleeding and perforation were infrequent and did not differ significantly between groups in our series. Only two patients in each arm experienced minor bleeding, and a single minor perforation occurred in the laser group; both events were managed conservatively and did not require conversion or open surgery (p = 1.000 for both parameters). These low rates reflect atraumatic technique and careful instrumentation. Almusafer et al similarly documented low rates of intraoperative bleeding (~1.8%) and false passage or perforation (~2–3%) during ureteroscopic lithotripsy, predominantly in patients with long-standing impacted stones and significant mucosal edema, confirming that such complications are uncommon but closely related to stone chronicity and mucosal fragility rather than the energy source itself.[13] Stone migration, however, showed a clear difference between modalities in our study. No patient in the laser group experienced proximal stone migration, whereas six

patients (20%) in the pneumatic group did, particularly when stone size exceeded 9 mm (p = 0.024). This underscores the jackhammer-like action of pneumatic lithotripsy, which generates significant retropulsive forces. Chen et al reported similar findings, with 62.7% of stones larger than 10 mm being pushed back into the kidney during pneumatic lithotripsy compared with only 37% in the laser group (p = 0.011), highlighting the mechanistic advantage of laser photothermal fragmentation in minimising retropulsion and improving intraoperative control of stone fragments.[14] Operative duration in our cohort clearly favoured the laser arm. The mean operative time was 22.43 minutes for laser URSL compared with 31.17 minutes for pneumatic URSL, a difference that was both clinically and statistically significant (p < 0.001). This likely reflects more efficient dusting and reduced need for basket extraction of large fragments with Ho:YAG laser. Islam et al also reported significantly shorter mean operative times with laser lithotripsy (46.12 ± 26.3 minutes) compared with pneumatic lithotripsy (58.32 ± 34.12 minutes, p = 0.003), supporting the notion that laser facilitates faster fragmentation and clearance, particularly in the presence of larger stone burden or complex anatomy.[15] The stone-free rate (SFR) at 6 weeks in our study was higher in the laser group (93.3%) than in the pneumatic group (80.0%), with 2 and 6 patients, respectively, having residual stones (p = 0.04). This difference reflects the finer fragmentation and "dusting" effect of laser, which enhances spontaneous clearance. Jhadav et al similarly demonstrated the superiority of Holmium:YAG laser, reporting SFRs of 94% in the laser arm versus 72% in the pneumatic arm, a statistically significant advantage that they attributed to smaller residual fragment size and reduced need for auxiliary procedures.[16]

Postoperative complications were generally mild and comparable between groups in our series. Hematuria occurred in two patients in each arm and was self-limiting (p = 1.000), while UTI/urosepsis was observed in 5 patients in the laser group and 7 in the pneumatic group (p = 0.519). Importantly, no patient developed ureteric stricture or steinstrasse on follow-up, despite the use of both energy modalities. Li et al reported a higher stricture rate after Ho:YAG laser lithotripsy (4.9% vs 1% in laser and pneumatic groups), suggesting that, in some settings, laser energy and thermal spread may contribute to late mucosal injury; however, our absence of strictures and steinstrasse indicates that with appropriate settings, careful technique, and adequate postoperative surveillance, both modalities can be used safely without increasing long-term ureteric morbidity.[17]

Conclusion

In conclusion, we found that both the pneumatic and the laser lithotripsy approaches were effective and safe for ureteral stones, but the laser method had advantages over the pneumatic lithotripsy, especially in the stone-free rate. Another advantage of the laser method was safe stone fragmentation due to a lower retropulsion rate in comparison to the pneumatic group, also reducing the operative duration of the laser procedure. There was no major complication seen with any statistically significant differences between the two groups.

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Conflicts of interest

There are no conflicts of interest.

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