

## Original Research Article

# Comparative evaluation of intracorporeal lithotripsy techniques during ureteroscopy: a clinical experience

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**Received:** 01 October 2020

**Revised:** 13 October 2020

**Accepted:** 14 October 2020

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### ABSTRACT

**Background:** The objective of the study was to compare pneumatic lithotripsy and laser lithotripsy techniques for safety, efficacy, and complications in the management of ureteric stone.

**Methods:** Patients underwent ureteroscopy for ureteral stones in a tertiary care teaching hospital were divided into 2 groups of 50 each. Group 1 patients underwent pneumatic lithotripsy and group 2 underwent holmium:yttrium-aluminium-garnet (Ho: YAG) laser lithotripsy. Both the groups were compared regarding demographic characteristics, stone dimensions, number of stones, operative time, stone migration rate, application of post-operative double J (DJ) stent, complications, and stone free rate.

**Results:** Mean age of the patients in the group 1, and group 2 were  $45.74 \pm 18.49$ , and  $44.5 \pm 14.33$  years, respectively ( $p=0.709$ ). There was no significant difference in male to female ratio in both groups. Total operative times were found  $29.12 \pm 10.83$  min, and  $28.44 \pm 7.49$  min in the group 1 and group 2, respectively which was statistically non-significant ( $p=0.716$ ). The stone free rate was 100% and 98% in group 1 and 2 respectively ( $p=0.130$ ). Stone migration was also found in 5 (10%) patients in the group 1 and 1 (2%) in group 2 which was found statistically significant ( $p=0.037$ ). Mucosal damage was found 3 (6%) in laser group as compared to 1 (2%) in pneumatic group. No significant difference between complications was seen in both the groups.

**Conclusions:** This study concluded that pneumatic lithotripsy and laser lithotripsy have similar efficacy in terms of operative time, success rate and hospital stay time. However, stone migration rate was significantly more in pneumatic lithotripsy.

**Keywords:** Ureteric stone, Pneumatic lithotripsy, Ho:YAG laser lithotripsy

### INTRODUCTION

Ureteral stones are one of the most common disorders of urology. There are different treatment methods for ureteral stones such as open surgery, extracorporeal shock wave lithotripsy (ESWL), laparoscopic ureterolithotomy and ureteroscopic procedures.<sup>1</sup> Ureteroscope could find the direct location of the ureteral stone which is much safer and efficacious.<sup>2</sup> There are various techniques available for stone fragmentation including electrohydraulic, ultrasonic, pneumatic and laser lithotripsy. Pneumatic

lithotripsy is commonly used due to its low cost, easy setup and high success rate but has high rate of proximal migration of stone.<sup>3,4</sup> Recently use of holmium:yttrium-aluminium-garnet (Ho: YAG) laser is increased due to its fewer complication and lower incidence of upward stone migration but it is more expensive and not available in most of the urologic centers.<sup>5,6</sup> There are some studies that have compared the efficacy of these two technique but found different results regarding operative time, stone free rate, migration rate, cost-benefit ratio and complications.<sup>7-9</sup>

On the basis of these finding this retrospective study was conducted with the aim to compare the efficacy and safety of pneumatic versus laser lithotripsy technique for treatment of ureteral stone in Indian population.

## METHODS

After obtaining approval from the institutional ethics committee, this retrospective study was conducted at tertiary care teaching hospital on 100 patients aged 18 to 70 years who had undergone elective semi rigid ureteroscopy (URS) for ureter stone from January 2018 to December 2019. All the patients during the study period were enrolled; means consecutive sampling was done. Patients were included in the study when they had ureteral stone failed to pass on medical expulsive therapy in 3 weeks, presence of hydronephrosis and stone size less than 1.5 cm. Patients with renal abnormality, uncontrolled coagulopathy, severe musculoskeletal deformity, respiratory or cardiovascular diseases, temperature  $>37^{\circ}\text{C}$  and pregnant female were excluded from the study. All the data of patients were separated into 2 groups (each 50 patients) according to the type of lithotripter used in stone fragmentation as pneumatic lithotripsy (PL-group 1) and Ho:YAG laser lithotripsy (LL-group 2). All patients were evaluated with preoperatively ultrasonography (USG), intravenous urography (IVP) or non-contrast computed tomography (NCCT). Stone number and size were evaluated with x-ray kidney, ureter and bladder (KUB) and USG in opaque stone and with NCCT in non-opaque stones. Sterile urine cultures were assured before surgery.

### Surgical technique

All patients were administered a single dose prophylactic intravenous antibiotic before surgery. Spinal anaesthesia was given in all patients and surgery was performed in lithotomy position. The ureteroscopic procedures were done using a 6/7.5 Fr (Wolf Inc., Germany) semirigid ureteroscope and ureters were accessed via 0.035 inch guide wires. In the group 1 the 0.8 mm to 1.2 mm lithoclast-probe was used and the tip of the probe was rested on the stone surface and the probe was activated under 2.5 atmospheric pressure and frequency of 4 on Nidhilith (NMS Co.) Pneumatic lithotripter. For the group 2 Ho: YAG laser lithotripter (30 W Quanta, Italy) was used with 1-1.5 J energy and 8-12 Hz frequency. The stones were broken to particles less than 2-3 mm and removed with stone forceps. Double J (DJ) stent of 5 Fr was routinely placed after the procedure and the stent was removed after 3-4 weeks when stone free status was achieved. Operative time was defined as the duration between introducing the ureteroscope into the urethra and the placement of the DJ stent and removing the ureteroscope from the urethra at the end of the procedure. All the patients were evaluated for residual stones on post-operative day 1, after 1 and 3 month. X-ray KUB and USG were used to assess the existence of residual fragments.

Success was defined as a stone free rate (SFR) in the first month after operation. The data of both the groups were compared regarding demographic characteristics, stone dimensions, number of stones, operative time, application of DJ stent, complications, SFR on post-operative day 1, duration of hospitalization and post-operative 1 and 3 month SFR.

### Statistical analysis

Statistical analysis was performed using the statistical package for social sciences (SPSS) 22 software (IBM SPSS Statistics, IBM Corporation, Chicago, IL). Quantitative variables were presented as mean and standard deviation while qualitative variables as frequency and percentage. The independent samples t-test was used for comparisons of quantitative variables while chi-square tests were used for comparisons of qualitative variables and p value  $<0.05$  was considered as significant.

## RESULTS

A total of 50 patients in group 1 and 50 patients in group 2 were compared in present study. Mean age of the patients in the group 1, and group 2 were  $45.74\pm 18.49$ , and  $44.5\pm 14.33$  years, respectively ( $p=0.709$ ). Male/female ratio was 1.63 in group 1 and 1.38 in group 2 ( $p=0.838$ ). The stones were located in the right ureter in 24 patients in group 1 and 22 patients in group 2. Mean stone size was  $8.77\pm 1.88$  mm, and  $8.30\pm 1.00$  mm respectively in group 1 and group 2. The present study found proximal (4%), midureteral (24%) and distal (72%) ureter stones in group 1 while it was proximal (4%), midureteral (32%) and distal (64%) ureter stones in group 2 which was found statistically non-significant (Table 1).

**Table 1: Patients' characteristics in both the groups.**

Characteristics	Group 1 (pneumatic lithotripsy)	Group 2 (Ho:YAG laser lithotripsy)	P value
Mean age (years)	45.74±18.49	44.5±14.33	0.709
Male/female ratio	31/19	29/21	0.838
Mean size of stone (mm)	8.77±1.88	8.30±1.00	0.122
No. of stone in right/left ureter	24/26	22/28	0.841
Stone location (%)			
Proximal	2 (4)	2 (4)	0.668
Middle	12 (24)	16 (32)	
Distal	36 (72)	32 (64)	

Stone free rate immediately after surgery was found 100 and 96% in the group 1 and group 2, respectively.

Difference between two groups was found non-significant (p=0.130). Total operative times were found 29.12±10.83 min, and 28.44±7.49 min in the group 1 and group 2, respectively which was statistically non-significant (p=0.716). Post-operative DJ or ureteral stent was also placed in group 1 patients (n=44; 88%), and group 2 (n=47; 94%) respectively. Lengths of the hospital stay were 2.0±0.49, and 1.82±0.52 days in group 1, and group 2, respectively which was also found non-significant (p=0.078).

In both groups hematuria and fever were found in 6 (12%), and 1 (2%) respectively, but mucosal damage was 1 (2%) in group 1 as compared to 3 (6%) in group 2. Other complications such as perforation, stricture, and ureteral avulsion were not found in any patient in both the groups. Stone migration was also found in 5 (10%) patients in the group 1 and 1 (2%) in group 2 which was found statistically significant (p=0.037) (Table 2).

**Table 2: Comparison of patients’ intraoperative and postoperative parameters including complications.**

Parameters	Group 1 (pneumatic lithotripsy)	Group 2 (Ho:YAG laser lithotripsy)	P value
Mean operative time (minutes)	29.12±10.83	28.44±7.49	0.716
Mean hospital stay time (days)	2.0±0.49	1.82±0.52	0.078
Stone migration (%)	5 (10)	1 (2)	0.037*
Stone free rate (success rate) (%)	50 (100)	49 (98)	0.130
Post-operative DJ stent (%)	44 (88)	47(94)	0.217
<b>Complications</b>			
Ureteral perforation	0	0	-
Hematuria (%)	6 (12)	6 (12)	0.828
Fever (%)	1 (2)	1 (2)	0.614
Mucosal damage (%)	1 (2)	3 (6)	0.279
Ureteral stricture	0	0	-
Avulsion	0	0	-

\*significant

**DISCUSSION**

Among the minimally invasive procedure, ureteroscopic lithotripsy has a good acceptance for the ureteral stone patients because of minimal complications and early recovery. Both Ho:YAG laser and pneumatic are the commonly used energy sources during ureteroscopic surgery for the treatment of ureteral stones now a days.<sup>9</sup> Still different studies have variable conclusions for these best available methods so this retrospective study was planned to compare both the procedures.

In present study both the groups were demographically similar. Mean age of the patients were found similar in both the groups and in both the groups ureteric stone were found more in male patients. Many studies have also reported that ureteric stones are more common in male as compared to female and its incidence has been reported 2.2 to 3.4 times in male.<sup>10</sup> There were also statistically non-significant differences in stone size, laterality, and number of stone in both groups.

Operative time in both the groups was found similar. Similar results were found in other studies.<sup>11,12</sup> Nour et al study has reported significantly longer time in pneumatic lithotripsy that was due to the need for retrieval of relatively larger stone fragments in comparison to laser where this time is reduced due to combined fragmentation-dusting technique.<sup>6</sup> The mean hospital stay was also

similar in the pneumatic and laser lithotripsy group which was similar to other studies.<sup>13</sup>

Post-operative stenting after surgery is recommended to reduce postoperative complications. Post-operative DJ stents were used in most of the patients in present study, with no difference in the rate of stenting between both the groups. Similar results of putting stents in both the groups were also found in other studies.<sup>6</sup> Many researcher have already shown earlier in their studies that post-operative obstruction and other complications can be minimized by using these stents, that was the reason of putting these stents in most the patients in our study and has also been used in other studies.<sup>14-16</sup>

Stone migration rate in present study was found significantly more in pneumatic group. This was similar to the fact that it is the common complication in pneumatic lithotripsy as compared to laser lithotripsy.<sup>17</sup> This occurred only in one patients of laser lithotripsy in our study. That may be the reason of preference of using laser lithotripsy by many urologists.

SFR were found 100% in pneumatic and 98% in laser groups and the difference between two was found insignificant. Many other studies have also reported similar SFR in both groups.<sup>6,18</sup> Studies done Bapat et al and Maghsoudi et al have reported Ho:YAG lithotripsy as superior to pneumatic lithotripsy when comparing stone-free rate (95-98.6% versus 80-86%).<sup>19,20</sup>

In our present study, mucosal damage was found 6% in laser group as compared to 2% in pneumatic group. There was no statically significant difference in complications between the two groups. Similar results were also seen in other studies.<sup>6,7,21</sup> This shows that pneumatic or laser energy has no significant role in the occurrence of complications.

In present study ureteric perforation was not found in any of the group but hematuria and fever were found in both the group but was insignificant. Chin et al meta-analysis had shown non-significant difference between both the groups for fever, hematuria and perforation. Ureteral perforation, stricture and avulsion are the most devastating complications of ureteroscopic surgery, were not found in any of the group of our patients. Over all decreased incidence of complications in both groups may be due to the use of smaller calibre ureteroscopes and increased experience of the surgeon.<sup>13</sup> A meta-analysis done in 2016 by Chin et al showed that holmium laser lithotripsy for ureteral stones can achieve shorter mean operative time, better early and delayed SFR, but present study showed early and delayed stone free rate which were similar in both groups but there was no significant difference between operative time in both the methods.<sup>22</sup>

### Limitations

As this study was retrospective which has its own limitations so more prospective randomized studies from different places with large sample size as well as long follow up are required to confirm these results.

### CONCLUSION

This study concluded that pneumatic lithotripsy and laser lithotripsy have similar efficacy in terms of operative time, success rate and hospital stay time. However, stone migration rate was significantly more in pneumatic lithotripsy.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Trivedi P. Comparative evaluation of intracorporeal lithotripsy techniques during ureteroscopy: a clinical experience. *Int Surg J* 2020;7:3581-5.