

# Efficacy of Laser Vs Pneumatic Lithotripsy for Mid and Distal Ureteric Stone: A Comparative Study

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## ABSTRACT

**Introduction:** Urolithiasis refers to a condition characterized by the formation or occurrence of calculi in the urinary tract. In Asia, about 1%-19.1% of the population suffers from urolithiasis. Pneumatic and laser intra corporeal lithotripsy are mostly preferred and frequently used during endoscopic management for ureteral stone. **Aims:** This study was done to compare the efficacy of the laser versus pneumatic lithotripsy. **Methods:** This was a prospective comparative study conducted from May 2019 to April 2020 in Nobel Medical College and Teaching Hospital, Biratnagar. Patients with mid- or distal ureteric calculi of size 5mm and more or failed medical management were included in the study. The patients were equally divided into two groups: laser & pneumatic. The efficacy of the procedure was measured in terms of stone clearance. Stone size less than 5mm, nephrolithiasis on same side of ureteric stone, pregnancy, bleeding disorder and patient not giving consent were excluded from the study. **Results:** Total 130 patients were enrolled in this study. The stone clearance was observed in 86.15% in pneumatic group and 96.92% in laser group at the end of 6 weeks. In pneumatic group 13.85% did not achieve stone clearance where as in laser group it was 3.08%. In patients with mid ureteric stone the clearance rate was significantly higher in laser group (93.33%) than in pneumatic group.(p=0.041) When the clearance rate of two techniques were compared for distal ureteric stone the results were similar. The mean operation time was  $28.89 \pm 8.26$  min in pneumatic group and  $22.93 \pm 6.05$  min in laser group(p<0.05). **Conclusion:** Holmium: YAG laser lithotripsy is superior to pneumatic lithotripter in terms of stone clearance rate for the mid ureteric calculus and also less time consuming.

**Keywords:** Holmium: Yttrium Aluminium Garnet laser, Intra corporeal lithotripsy, Pneumatic lithotripsy, stone clearance

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## INTRODUCTION

Urolithiasis is formation of calculi in the urinary tract.<sup>1</sup> In US in 2012, 10.6% of men and 7.1% of women in the US were affected by renal stone, compared to just 6.3% of men and 4.1% of women that were affected in 1994.<sup>2</sup> With westernization of culture, the site of stone formation has migrated from lower to upper urinary tract and disease once limited to men is increasingly gender blind.<sup>3</sup> In Asia, about 1%-19.1% of the population suffer from urolithiasis.<sup>4</sup> Calcium stones accounts for 80%.<sup>5</sup> 95% of ureteral stones of 2-4mm pass spontaneously,<sup>6</sup> this drops to 50% for stones >5 mm.<sup>7</sup> Stones >6 mm have a lower rate of spontaneous passage.<sup>8</sup> ESWL in 1980 has revolutionized the treatment of both renal and ureteric calculi.<sup>9</sup> In context of ureteric calculi, the combination of ureteroscopy and intracorporeal lithotripsy (ICPL) has proven alternative to ESWL.<sup>10</sup> With the improvement in surgical skills and technological advancement of the endoscopic instruments, management of ureteral stones has changed from more

invasive open surgeries to less or minimal invasive endoscopic lithotripsy.<sup>11</sup> Pneumatic and laser lithotriptors are most preferred in ICPL during endoscopic management of ureteral stone.<sup>12</sup> The Ho:YAG laser can vaporize as well as coagulate the tissues.<sup>13</sup> The thermal effect produced by Ho:YAG laser's pulses are due to formation of plasma bubble.<sup>14</sup> It has a wide range of endoscopic applications, and has demonstrated effectiveness in clearing stones of all compositions.<sup>15</sup> Hence, this study aims to compare the efficacy between the pneumatic and laser lithotripsy by comparing stone free rate.

## METHODS

This was a hospital based prospective comparative study conducted from May 2019 to April 2020 with approval by 'Institutional Review Committee' of Nobel Medical College and Teaching Hospital, Biratnagar. A prior informed and informed consent was taken from all eligible patients. Patients with mid or distal ureteric calculi of 5 mm or more, or failed medical

management were included in the study. Stone size less than 5 mm, nephrolithiasis on same side of ureteric stone, pregnancy, bleeding disorder and patient not giving consent were excluded from the study. 130 cases were studied over the period of one year and divided into two groups, pneumatic and laser group.

Mid or distal ureteric calculus patients confirmed by clinical history, examination and ultrasonography, X-Ray KUB, CT KUB, were selected. All selected patients were subjected to routine preoperative investigations along with Urine routine microscopic examination and Urine culture sensitivity. On the basis of Quasi random sampling 65 patients were selected for pneumatic ureteroscopic lithotripsies while other 65 for laser lithotripsy. In laser Group, Ho:YAG laser lithotripsy(Lumenis) was performed by a rigid 7.5 or 8.5 Fr ureteroscope and the same size of ureteroscope was used with a pneumatic lithoclast (Nidhi) in pneumatic group. The pneumatic settings were up to five bar and the frequency 10 Hz. The laser generator was of 100W. The laser settings were 0.6-1.0J per pulse and the frequency 8-12Hz. 6 Fr double J stent, was placed at the end of the procedure in every cases. Time duration of each operative procedure was noted. X ray KUB was done on 1<sup>st</sup> post-operative day to see the position of DJ stent. Patients were asked for follow up after 6 weeks. Review X ray KUB or USG KUB was done at six weeks to look for any residual stone. When X ray KUB was used to look for residual stone, X ray was taken on true magnification and size of stone was measured. Patients were considered stone-free when no stone >3 mm visualized or stone < 3mm visualized.

**Statistical analysis**

Data was collected according to the proforma and entered in Excel and was analyzed by using SPSS software 21 version. Chi-square test and independent sample t-test was used for statistical analysis. p- value <0.05 was taken as significant.

**RESULTS**

130 patients were enrolled in this study. The age of the patients ranged from 15 to 68 years. The mean age was 33.75 ± 10.12 years. 51 (39.23%) patients were in the age group 20-29 years and 31 (23.84%) patients were in the age group of 40-49 years. 60% of the patients were male. When comparing the stone laterality and site, 57.67 % patient had stone in right side and 42.33 % in left side while 46.20 % had stone in mid ureter and 53.80% in distal ureter. Stone size ranged from 6 to 10 mm, with mean stone size of 10.81 ± 3.050 mm. Equal number of patient were intervened by either pneumatic or laser lithotripsy in mid and also in distal ureter.

Stone clearance	PNEUMATIC	LASER	P value
Successful stone clearance	56 (86.15%)	63 (96.92%)	0.027
Failure	9 (13.85%)	2 (3.08%)	

**Table I: Comparison of patients according to stone clearance at 6 weeks**

The stone clearance at 6 weeks was seen in more patients in laser group (96.92%) than in the pneumatic group (86.15%). When both the groups were compared, the result was statistically significant (p= 0.027).

Operation time(min)	PNEUMATIC	LASER	P value
Mean ± S.D	28.89 ± 8.26	22.93 ± 6.05	0.0000

**Table II: Comparison of patients according to mean operation time**

The mean operation time was higher for pneumatic group (28.89 ± 8.26 min) than for the laser group (22.93 ± 6.05 min). Differences between the operation in two groups was statistically significant (p<0.05). When both groups were compared, the result was statistically significant (p value 0.000)

Site of stone	PNEUMATIC (n=30)	LASER (n=30)	P value
Mid ureteric	23 (76.67%)	28 (93.33%)	0.041
Distal ureteric	33 (94.29%)	35 (100%)	0.151

**Table III: Comparison of stone clearance in patients with mid and distal ureteric stone**

When two techniques were compared for the stone clearance for mid ureteric stone it was found that 93.33% in laser group had complete stone clearance in contrast to 76.67% in pneumatic group and the difference was statistically significant. Similarly when stone clearance rate was compared for distal stone, 100% patients in laser group and and 94.5% in pneumatic group achieved the stone clearance at 6 weeks follow up however it was statistically not significant.

**DISCUSSION**

In the current era, minimally invasive treatments are usually preferred for management of ureteral calculi. Pneumatic and laser lithotripsy both are commonly practiced and accepted treatment option for management of mid and distal ureteric calculus. But the choice between these two options is still under debate. In this study, the mean age of the patients was 34.71 ± 10.98 in pneumatic group and 34.71 ± 10.98 in the laser group. The difference was not statistically significant (p=0.16). In the study by Amir Reza Abedi et al, mean age in pneumatic group was 39.2±4.3 years and laser group was 40.1±3.8 years respectively.<sup>16</sup> In the study by Seyed Mohammad Reza Rabani et al, mean age in pneumatic group was 41.1 ±12.8 years and laser group was 41.77 ± 13.2 years.<sup>17</sup> Patients in our study were found to have ureteral stones in younger age as compared to above mentioned studies, the probable reasons could be subtropical geographical location of our country, habit of drinking less water in general population.

Stone free rate in this study in pneumatic group was 86.15% and in laser group it was 96.92%. In pneumatic group out of 9 failed stone clearance, 3 patients had retained stone of more than 3mm as seen on x ray KUB done during six weeks follow up. Of all these failed cases in pneumatic group, 2

retained stone was from distal ureteric calculus, remaining 7 were from mid ureter. In laser group there was only 2 failed stone clearance which was due to retained stone of 5 mm size. Four patients from pneumatic group who had stone migration needed retreatment. In the study by Amir Reza Abedi et al, stone free rate in pneumatic group was 65.2% and in laser group was 93.3% ( $p < 0.05$ ).<sup>18</sup> In the study by Seyed Mohammad Reza Rabani et al, stone free rate in pneumatic group was 77.96% and in laser group was 79.31% ( $p = 0.52$ ).<sup>17</sup>

Yin et al in their meta-analysis found that Ho: YAG laser had significant superiority in comparison to PL in terms of early stone-free rate, delayed stone-free rate, shorter operative time and lower stone migration rate.<sup>19</sup> Stone location may affect the stone free status of lithotripsy. As seen in our study failure rate was more in mid ureteric calculus. The success rate was lower for the proximal ureter (71.7%) when compared with the mid ureter (94.8%) and distal ureter (98.9%) ( $p = 0.021$ ).<sup>20</sup> On further evaluating the data by dividing into mid and distal ureteric calculus, Ho: YAG laser was superior to pneumatic group in terms of stone free rate in mid ureteric calculus. This study showed complete stone clearance of 76.67% in pneumatic group and 93.33% in laser group for mid ureteric stone ( $p < 0.05$ ). Failure of procedure was 23.33% in pneumatic group and 6.67% in laser group.

In our study overall operative time was  $26.55 \pm 8.69$ . Minimum operation time was 15 min while maximum time taken was 50 min. Mean operation time in pneumatic group was  $28.89 \pm 8.26$  min and in laser group it was  $22.93 \pm 6.05$  min. The difference of the mean operation in both groups were statistically significant ( $p = 0.0001$ ). In the study by Amir Reza Abedi et al, mean operation time in pneumatic group was  $10.01 \pm 6.2$  min and in laser group was  $14.4 \pm 2.05$  min ( $p < 0.05$ ).<sup>18</sup> In the study by Seyed Mohammad Reza Rabani et al. Mean operation time in pneumatic group was  $25.47 (\pm 8.55)$  and in laser group was  $34.6 (\pm 10.25)$  min ( $p < 0.001$ ).<sup>17</sup>

Our operation duration was similar with above mentioned studies but mean operation time was significantly shorter in laser group in our study. Major difficulty what we observed with the use of pneumatic lithotripter was stone mobility.

#### LIMITATIONS

Since this is a single center study, a multicenter study at a larger scale is required. The expenditure and complications of both interventions were not taken into account.

#### CONCLUSION

Holmium: YAG laser lithotripsy is a superior technology than pneumatic lithotripter in terms of rate of stone clearance in mid ureteric calculus. For distal ureteric stone clearance both showed similar results. Regarding operating time, laser is better than pneumatic group for both mid and distal ureteric calculus.

#### REFERENCES

1. Wathigo FK, Hayombe A, Maina D. Urolithiasis analysis in a multiethnic population at a tertiary hospital in Nairobi, Kenya. *BMC Res Notes* 2017 Apr 20;10(1):158. <https://doi.org/10.1186/s13104-017-2474-3>
2. Roudakova K, Monga M. The evolving epidemiology of stone disease. *Indian J Urol IJU J Urol Soc India* 2014 Jan;30(1):44–8. doi: 10.4103/0970-1591.124206
3. Alan J. Wein, Louis R. Kavoussi, Andrew C. Novick, Alan W. Partin, Craig A. Peters. *Campbell-Walsh Urology*, 10th ed. Philadelphia: Elsevier Saunders; 2012:1257
4. Scales CD, Curtis LH, Norris RD, Springhart WP, Sur RL, Schulman KA, et al. Changing gender prevalence of stone disease. *J Urol* 2007 Mar;177(3):979–82. doi: 10.1016/j.juro.2006.10.069
5. Chung MJ. Urolithiasis and nephrolithiasis. *JAAPA* 2017 Sep;30(9):49-50. PMID: 28858017 DOI: 10.1097/01.JAA.0000522145.52305.aa
6. Ordon M, Andonian S, Blew B, Schuler T, Chew B, Pace KT. CUA Guideline: Management of ureteral calculi. *Can Urol Assoc J* 2015;9(11–12):E837–51. doi: 10.5489/auaj.3483
7. Miller OF, Kane CJ. Time to stone passage for observed ureteral calculi: a guide for patient education. *J Urol* 1999 Sep;162(3):688–90. doi: 10.1097/00005392-199909010-00014
8. Hübner WA, Irby P, Stoller ML. Natural history and current concepts for the treatment of small ureteral calculi. *Eur Urol* 1993;24(2):172–6. DOI: 10.1159/000474289
9. Chaussy C, Schüller J, Schmiedt E, Brandl H, Jocham D, Liedl B. Extracorporeal shock-wave lithotripsy (ESWL) for treatment of urolithiasis. *Urology* 1984 May;23(5 Spec No):59–66. DOI: 10.1016/0090-4295(84)90243-7
10. Segura JW, Preminger GM, Assimos DG, Dretler SP, Kahn RI, Lingeman JE, et al. Ureteral Stones Clinical Guidelines Panel summary report on the management of ureteral calculi. *The American Urological Association. J Urol* 1997 Nov;158(5):1915–21. DOI: 10.1016/s0022-5347(01)64173-9
11. Jhanwar A, Bansal A, Sankhwar S, Kumar M, Kanodia G, Prakash G, et al. Outcome analysis of holmium laser and pneumatic lithotripsy in the endoscopic management of lower ureteric calculus in pediatric patients: a prospective study. *Int Braz J Urol* 2016 Dec;42(6):1178–82. doi: 10.1590/S1677-5538.IBJU.2016.0211
12. Razzaghi MR, Razi A, Mazloomfard MM, Golmohammadi Taklimi A, Valipour R, Razzaghi Z. Safety and efficacy of pneumatic lithotripters versus holmium laser in management of ureteral calculi: a randomized clinical trial. *Urol J* 2013;10(1):762–6. PMID: 23504679
13. Watson GM, Wickham JE. Initial experience with a pulsed dye laser for ureteric calculi. *Lancet Lond Eng* 1986 Jun 14;1(8494):1357–8. DOI: 10.1016/s0140-6736(86)91667-3
14. Cecchetti W, Zattoni F, Nigro F, Tasca A. Plasma bubble formation induced by holmium laser: an in vitro study. *Urology*. 2004 Mar;63(3):586–90. DOI: 10.1016/j.urology.2003.09.010

15. Yiu MK, Liu PL, Yiu TF, Chan AY. Clinical experience with holmium:YAG laser lithotripsy of ureteral calculi. *Lasers Surg Med.* 1996;19(1):103–6. DOI: 10.1002/(SICI)1096-9101(1996)19:1<103::AID-LSM12>3.0.CO;2-9
16. Ar A, Razzaghi M, Allameh F, Aliakbari F, Karkan M, Ranjbar A. Pneumatic Lithotripsy Versus Laser Lithotripsy for Ureteral Stones. *J Lasers Med Sci.* 2018 Oct 1;9:233–6. doi: 10.15171/jlms.2018.42
17. Rabani SM, Rabani S, Rashidi N. Laser Versus Pneumatic Lithotripsy With Semi-Rigid Ureteroscope; A Comparative Randomized Study. *J Lasers Med Sci* 2019;10(3):185–8.doi: 10.15171/jlms.2019.29
18. Abedi AR, Razzaghi MR, Allameh F, Aliakbari F, FallahKarkan M, Ranjbar A. Pneumatic Lithotripsy Versus Laser Lithotripsy for Ureteral Stones *J Lasers Med Sci.* 2018;9(4):233–6. doi: 10.15171/jlms.2018.42
19. Yin X, Tang Z, Yu B, Wang Y, Li Y, Yang Q, et al. Holmium: YAG laser lithotripsy versus pneumatic lithotripsy for treatment of distal ureteral calculi: a meta-analysis. *J Endourol* 2013 Apr;27(4):408–14. DOI: 10.1089/end.2012.0324
20. Yencilek F, Sarica K, Erturhan S, Yagci F, Erbagci A. Treatment of ureteral calculi with semirigidureteroscopy: where should we stop. *Urol Int* 2010;84(3):260-4.DOI: 10.1159/000288225