**ORIGINAL ARTICLE**

# Comparison of Proximal Ureteric Stones (10-20mm) Clearance between Holmium: Yag Laser and Pneumatic Lithotripsy

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## ABSTRACT

**Background:** Pakistan lies in the Afro-Asia stone belt with significant urinary disease burden on healthcare facilities. The implication of laser technology in the development of lithotripter fibers has revolutionized intra-corporeal lithotripsy.
**Aim:** To compare proximal ureteric stone clearance between holmium: YAG Laser and pneumatic lithotripsy
**Study design:** Randomized controlled trial.\
**Setting:** Urology Department, KEMU/Mayo Hospital, Lahore.
**Duration of study:** 06 months after the approval of synopsis (27/05/2017- 26/11/2017)
**Methodology:** 92 patients with proximal ureteric stone of 10-20 mm size seen on CT scan were included. Stone clearance was accessed on follow-up after 4 weeks of laser treatment, with radiological investigations
**Results:** In our study group ratio of male gender with female gender was 2.2:1. Stone size varied from 10 to 20 mm with a mean of 13.32±3.03mm. 66.3% patients had stone size 10-14 mm while 33.7% patients with≥15mm; in right ureter (46.7%) and left ureter (53.3%). No statistically significant difference in terms of mean age (p=0.884), mean stone size (p=0.707), age (p=0.788), gender (p=0.822), stone size (p=0.825) and anatomical side (p=0.834) group was seen. The frequency of stone clearance was significantly higher in patients treated with holmium YAG laser versus pneumatic lithotripsy (93.5% vs. 76.1%; p=0.020).
**Conclusion:** Stone clearance is better with holmium YAG laser lithotripsy as compared to pneumatic lithotripsy in proximal ureteric stone patients, this advocate preferred use of holmium YAG laser in future urologic practice.
**Keywords:** Intracorporeal lithotripsy, pneumatic lithotripsy, ureteric stone, Holmium: YAG Laser

## INTRODUCTION

As our country, Pakistan, is lies in the Afro-Asian belt where stone formation, urolithiasis, in the body occur in more than 10% of the population[1]. Ureteric stones occur in about 2/3rd of all the renal system calculi with incidence of 17% at proximal part of the ureter, 11% at the middle part and 72% in lower part.[2] The proximal ureter is the part of ureter starting from the pelvic cavity of the kidney till the outer margin of sacrum, middle part is from the end of proximal part till the lower margin of sacrum, and rest of the ureter till the bladder is the lower part[3].

For smaller ureteric stones in the upper part (less than 10 mm), resistant to watchful waiting and failed medical expulsive therapy, extra corporal shock wave lithotripsy (ESWL) has shown higher stone clearance rate than ureteroscopy (90% versus 80%, respectively), however, for stones more than >10 mm), ureteroscopic stone free rate has shown better results (79% versus 68%, respectively)[4]. Currently ureteroscopy (URS) accompanied by stone fragmentation is the gold standard endoscopic intervention for larger proximal ureteral stone[5].

The stone clearance rate, defined as residual stone fragment of <2mm as measured by Non contrast CT KUB, reaches 74% for proximal urteric stones. The spectrum of lithotripters used for stone fragmentation includes: Ultrasonic lithotripter, electrohydrolic lithotripter, pneumatic lithotripter and laser lithotripters. Amongst all these Pneumatic and holmium: YAG laser lithotripters used very often in all the major urology centers.[6] Regarding proximal ureteral stone clearance of Holmium: YAG laser lithotripsy and pneumatic lithotripsy, studies done in the past have shown that Holmiun: YAG laser has high success rate for proximal ureteric stone clearance as compared to pneumatic lithotripsy, 86.4% for laser lithotripsy versus 33.3% for pneumatic lithotripsy[6], 100% for laser lithotripsy versus 42.9% [7], 100% for laser lithotripsy versus 85.7% for pneumatic lithotripsy[8]. Another study showed no significant statistical difference in terms of stone clearance rate of Holmium: YAG laser lithotripsy and pneumatic lithotripsy for upper ureteric stone, 80.5% for laser lithotripsy and 78.7% for pneumatic lithotripsy.[9] Since consensus cannot be made on the superiority of one treatment modality over the other in terms of stone clearance, therefore the rationale of the study is to compare the stone clearance rate between Holmium: YAG laser and pneumatic lithotripsy in proximal ureteric stone of 10-20mm size with appropriate sample size.

Received on 10-06-2018
Accepted on 13-12-2018

## MATERIAL AND METHODS

This randomized controlled research was done at the Urology department MAYO hospital, Lahore 6 months after approval in the hospital research review meeting. All the patients of both genders ranging 18 to 50 years in age with a stone size of 10-20mm having unilateral proximal ureteric were enrolled. Stone size measurement was done by

measuring largest dimension of stone on non-contrast computerized tomography KUB. Stone clearance was defined as complete disappearance of stone or residual fragments of <2 mm as confirmed on Non contrast CT KUB at 4 week follow up[6]. Patients with stone with any congenital urinary system abnormality, patients with previous ureteric surgery, patients who have bilateral ureteric stones, patients who have ureteric stricture, solitary functioning obstructed kidney ,urinary tract infection, pregnancy and bleeding disorder were excluded from the study. Sample size of 92 patients was calculated using the WHO sample size calculator (46 in one group) taking 5% level of significance and 90% power of test taking success rate using ureteroscopic holmium: YAG laser lithotripsy 80% and 62%[6] with pneumatic lithotripsy by using hypothesis test for two population proportions. Sampling technique was non-probability consecutive sampling. After explaining the objective and taking informed consent, data was collected by obtaining detailed history, examination, investigations like blood count, serum urea, serum creatinine and urinalysis was done on all patients. Urine culture was performed if urinalysis indicates infection and appropriate antibiotics were given. Ultrasonography KUB and non-enhanced CT KUB was performed to determine location and size of stone. Patients were asked to sign an informed consent that outlined alternative treatment options consequences and complications of various treatment options. Patients were randomly divided into groups with each containing 46 patients. Each patient was allotted respective group before research. All patients were treated under anesthesia (spinal / general) in lithotomy position. After all aseptic measures standard technique employed for ureteroscopic treatment of ureteric calculi including a cystoscopy along with placement of a 0.038-inch floppy tip guide wire across the stone or a glide wire when and where required. Ureteroscopy was carried out by a 9F semi-rigid ureteroscope (wolf).

Ureteroscope with guide wire was taken inside the orifice along with irrigation for clear vision. Stone was disintegrated using either Holmium: YAG laser or Pneumatic lithotripsy. At the end of procedure a 6Fr double-J stent was placed. X-ray KUB and ultrasound KUB was done on first post-operative day in all patients to check for any residual stone fragment, stone pushed back in kidneys and position of double J stent. This was removed on 4 week follow-up visit under local anesthesia when no residual stone fragment was seen on non-contrast CT KUB performed at 4 week. Any residual stone detected at 04 week follow up in the ureter or in the kidney due to push back that requires any other secondary intervention like extracorporeal shock wave lithotripsy, redo ureterorenoscopy or open ureterolithotomy or pyelolithotomy was considered as treatment failure.

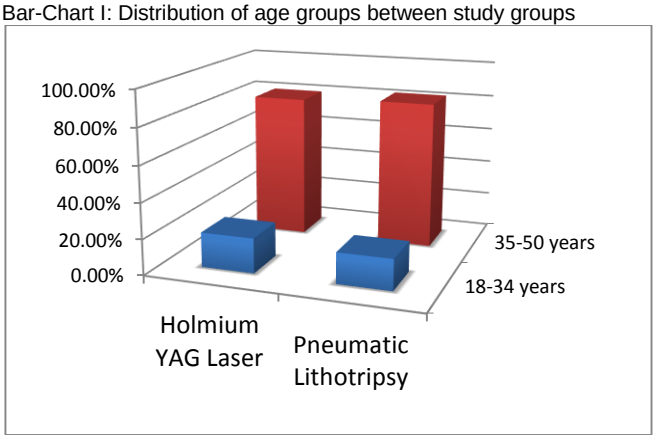
All the collected data was entered and analyzed through SPSS version 22, numerical variables; age and stone size have been presented by mean ±SD. Categorical variable i-e gender, anatomical side and stone clearance have been presented by frequency and percentage. For comparison of frequency of stone clearance in two groups, (holmium: YAG laser Lithotripsy and pneumatic lithotripsy). Post-stratification chi-square test has been applied taking p value ≤0.05 as statistically significant.

## RESULTS

Age of patients ranged from 18 years to 50 years with a mean of 42.48±8.50 years. Majority of the patients were aged between 35-50 years (81.5%) followed by 18-34 years (18.5%). There were 63 (68.5%) male and 29 (31.5%) female patients in the study group with a male to female ratio of 2.2:1. Stone size ranged from 10mm to 20mm with a mean of 13.32±3.03mm. 61 (66.3%) patients had stone size in the range of 10-14 mm, while 31(33.7%) patients had stone with size of 15mm or more. It was in right ureter in 43(46.7%) and left ureter in 49(53.3%) patients. Various demographic features of study participants have been summarized in Table-1.

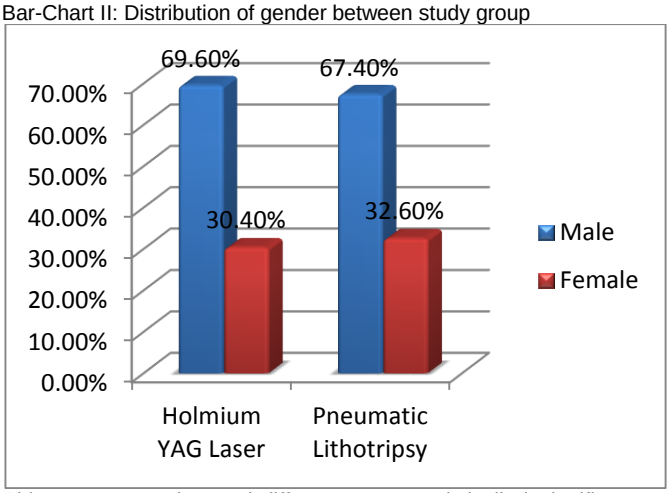
Independent sample t-test and chi-square test, observed difference was statistically insignificant. No statistical significant difference was seen between the two groups in terms of mean age (p=0.884), mean stone size (p=0.707) and age (p=0.788), gender (p=0.822), stone size (p=0.825) and anatomical side (p=0.834) groups distribution. The frequency of stone clearance was significantly higher in patients treated with holmium YAG laser (93.5% vs. 76.1%; p=0.020) as compared to pneumatic lithotripsy.

Bar-Chart I: Distribution of age groups between study groups



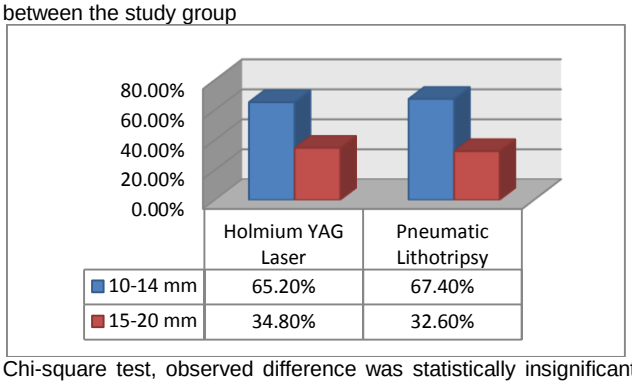

Chi-square test, observed difference was statistically insignificant (p=0.788)

Bar-Chart II: Distribution of gender between study group



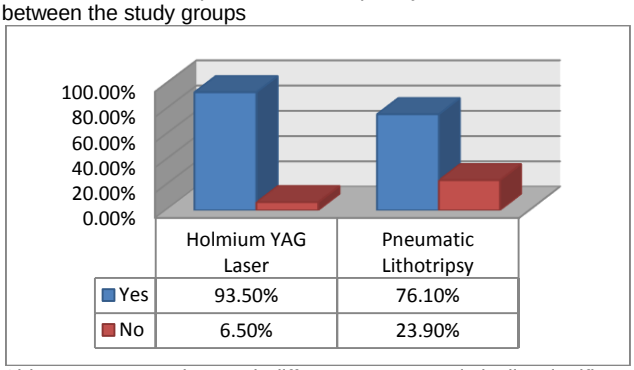

Chi-square test, observed difference was statistically insignificant (p=0.822)

Bar-Chart III: Distribution of various groups based on stone size between the study group




Chi-square test, observed difference was statistically insignificant (p=0.825)

Bar-Chart IV: Comparison of Frequency of stone clearance between the study groups




Chi-square test, observed difference was statistically significant (p<0.020)

Table 1: Various characteristics of Patients

| Characteristics | Holmium YAG Laser (n=46) | Pneumatic Lithotripsy (n=46) | P value |
|---|---|---|---|
| **Age (years)** | 42.35±8.75 | 42.61±8.33 | 0.884 |
| 18-35 years | 9 (19.6%) | 8 (17.4%) | 0.788 |
| 35-50 years | 37 (80.4%) | 38 (82.6%) | |
| **Gender** | | | |
| Male | 32 (69.6%) | 31 (67.4%) | 0.822 |
| Female | 14 (30.4%) | 15 (32.6%) | |
| **Stone Size (mm)** | 13.20±2.97 | 13.43±3.12 | 0.707 |
| 10-14 mm | 30 (65.2%) | 31 (67.4%) | 0.825 |
| 15-20 mm | 16 (34.8%) | 15 (32.6%) | |
| **Anatomical Side** | 13.20±2.97 | 13.43±3.12 | 0.707 |
| Right | 21 (45.7%) | 22 (47.8%) | 0.834 |
| Left | 25 (54.3%) | 24 (52.2%) | |

## DISCUSSION

Stone formation in the Urinary system is a common condition seen in the tertiary care hospitals in our country[10]. Prevalence of these calculi is almost 20% in our country[11]. The management of ureteral calculi represents one of the complex problem in urological practice. Urological treatment of urinary calculi has changed much in the past 20 years[12]. Among the management options for proximal ureteric stones include ESWL, uretero-renoscopy, laparoscopic ureterolithotomy and open surgery[13]. Using Ho:YAG laser, which is the latest laser technique when compared to ultrasonic, pneumatic and other laser devices ureteric stones can be removed[14].

Tipu et al[15] reported after his research that Holmium: YAG laser lithotripsy is better than pneumatic lithoclast when compared for rate of stone clearance and other complications encountered. The objective of this study was to compare proximal ureteric stone (10-20mm size) clearance between holmium: YAG Laser and pneumatic lithotripsy.

In the present study, mean age was 42.68±8.08.15±11.19 years. Cai et al (2014) reported similar mean age of 42.83±9.24 years in their study. A relatively higher mean age of 43.4±14.5 years has been reported by Cui et al. (2014[17] while Yon et al. (2014)[18] reported it to be 40.6±9.8 3years, and Fan et al. (2007)[19] reported it to be 43.5±8.82 years. It is also comparable with studies carried out by Yin et al. in 2014 (43.9±6.2)[20], He and Bao in 2015 (43.2±2.7)[21], Hendrikx et al. in 1999 (40.5±4.6)[22] and Manzoor et al. 2015 (42.54±14.07)[23] found in Pakistani patients.

Majority cases were of 35-50 years (81.5%) followed by 18-34 years (16.7%). There were 63(68.5%) male and 29(31.5%) female patients in the study group with a male to female ratio of 2.2:1. Our results match with those of Khoso et al. (2016)[24] who reported similar male to female ratio of 2.1:1. While cui et al. (2014) [18] reported it to be 2.3:1. Cai et al (2014)[16] reported relatively higher male to female ratio 1.8:1, Yin et al. (2014)[20] also reported higher ratio 1.8:1, Iqbal et al. (2016)[25] reported it to be 2.1:1 and Rajpar et al. (2012)[26] reported it to be 2.1:1 in Pakistani population.

Stone size ranged from 10mm to 20mm with a mean of 13.32±3.03mm. 61(66.3%) patients were having calculi of 10-14 mm while 31(33.7%) patients had stone with size of 15mm or more. Our mean stone size was comparable with Khoso et al. (12.16±5.8mm)[24], Khalil et al. (13.2±2.9mm)[27], Cui et al. (9.8±3.5mm)[18], Khoder et al. (10.7±0.7mm)[28], Iqbal et al. (10.01±6.024mm)[25] and Rajpar et al. (11.44±1.41mm)[26].

Stone was in right ureter in 43(46.7%) and left ureter in 49(53.3%) patients. A similar right to left ureter percentage has been observed by Khoso et al. (right ureter 76.6% and left ureter 32.4%)[24], Khalil et al. (right ureter 54.1% and left ureter 45.9%)[27], Degirmenci et al. (right ureter 64.95% and left ureter 35.05%)[29], Cui et al. (right ureter 47.5% and left ureter 52.5%)[18] and Rajpar et al. (right ureter 47.8% and left ureter 52.2%)[26] in Pakistani population. There was no statistically significant difference between the groups in terms of mean age (p=0.884), mean stone size (p=0.707) and age (p=0.788), gender (p=0.822), stone size (p=0.825) and anatomical side (p=0.834) groups distribution.

The frequency of stone clearance was significantly higher in patients treated with holmium YAG laser (93.5% vs. 76.1%; p=0.020) as compared to pneumatic lithotripsy. Our observation is in line with that of Degirmenci et al[29] who reported similar stone clearance frequency (94.4% vs. 67.9%) in patients. Cui et al[18] (2014) also reported similar frequency (97.5% vs. 77.5%) of stone clearance in patients. A similar frequency of stone clearance (92.67% vs. 80.67%) has been reported by He and Bao et al[21] (2015) among patients. Cai et al[16] (2014) also observed similar frequency (94% vs. 80%) of stone clearance. Hendrikx et al[22] also reported similar frequency (94.85% vs. 92.70%) stone clearance among. Honecket al[30] (2006)

reported higher frequency (96.77% vs. 88.87%) of stone clearance in Germany. Lam et al[31] in 2002 (96.77% vs. 80%). Lin et al[32] in 2015 reported frequency (90% vs. 70%) of stone clearance. Yin et al.[20] (2014) reported similar frequency (94% vs. 76%) of stone clearance among such patients in China.

In present study, it was confirmed that the pneumatic and holmium YAG laser lithotripsy can both be used for the management of proximal stone but when comparing the more efficient and the one with a better stone clearance rate and lesser chances of stone migration HO: YAG lithotripsy is far more superior than pneumatic lithotripsy.

## CONCLUSION

The stone clearance was significantly higher with holmium YAG laser as compared to pneumatic lithotripsy in patients with proximal ureteric stones which establish the supremacy of YAG laser and advocate its preferred use in future urologic practice.

**Limitation of study:** The limitation of our study is that small number of cases was taken when comparing the two procedures we are trying to collect more data from our institute.

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