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Original Article

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# Comparative Study between Outcome Of Holmium: Yag Laser And Pneumatic Lithotripsy For Mid and Lower Ureteric Calculus

**Md. Rafiul Alam[1], Abdul Matin Anamur Rashid Choudhury[2], Mohammad Sajjad Hossain[3], Md. Faisal Islam[4], Muhammad Enamul Haque[5], Nishat Nasrin Nitu[6]**

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## Abstract

***Background:*** *Ureteric calculus is among the most common disorders in the urological field. Miniaturization of endoscopic devices in urology has revolutionized the management of ureteric calculi. Different energy sources can be used for ureteroscopic stone fragmentation, such as pneumatic, ultrasonic, laser or electrohydraulic. Semi-rigid ureteroscope is effectively used to manipulate mid and lower ureteric calculus.*

***Objective:*** *To compare the outcome between Holmium: Yttrium Aluminum Garnet (Ho: YAG) laser and pneumatic lithotripsy for mid and lower ureteric calculus.*

***Methods:*** *This prospective study was carried out at National Institute of Kidney Diseases and Urology (NIKDU), Dhaka from January 2020 to June 2021. Sixty four patients were selected by purposive sampling technique and allocated into two groups as LL group (Laser lithotripsy group) and PL group (Pneumatic lithotripsy group) by lottery. Comparison was done on the basis of stone clearance rate, operation time, per operative stone migration and ureteral mucosal injury, post operative hematuria and fever, duration of post operative hospital stay. Test of significance was independent sample t-test for quantitative outcome and Chi-square (X2) test or Fisher's exact test for categorical outcome. 95% confidence interval was used. p value of less than 0.05 was considered significant.*

***Results:*** *Mean age was 39.5+13.08 years in group LL and 38.47+10.28 years in group PL (p=0.145). Mean stone diameter was 9.83+2.07 mm and 10.48+2.3 mm in LL and PL group respectively with no statistically significant difference (p=0.468). In LL group 20% patient had mid ureteric calculus and rest in lower one. In PL group, 26.66% and 73.33% patient had mid and lower ureteric calculi respectively. Mean operation time was calculated as 38.13+5.94 minutes in LL group and 40.17+3.59 minutes in PL group with no significant difference (p=0.11). After 1st month of ureteroscopy, stone clearance of LL group (83.33%) was found significantly high (p=0.04) compared to PL group (60%), while after 3rd month, stone clearance of both groups (96.66% vs. 90%) was*

1. Medical Officer, Gaibandha Sadar Hospital, Gaibandha, Dhaka, Bangladesh
2. Professor (Uro-oncology), National Institute of Cancer Research and Hospital, Dhaka, Bangladesh
3. Junior Consultant (Surgery), National Institute of Kidney Diseases and Urology, Dhaka, Bangladesh
4. Associate professor (Urology), National Institute of Kidney Diseases and Urology, Dhaka, Bangladesh.
5. Junior Consultant (Surgery), Upazila Health Complex Bhaluka, Mymensingh, Bangladesh.
6. Junior Consultant (Anesthesiology), Kuwait Bangladesh Friendship Government Hospital, Dhaka, Bangladesh.

**Correspondence:** Dr. Md. Rafiul Alam, Medical Officer, Gaibandha Sadar Hospital, Gaibandha, Dhaka. Email: alam58k62dmc@gmail.com

*found statistically similar (p=0.61). In both group there were no statistical difference in aspect of mucosal injury (p=0.70), stone migration (p=0.612) and postoperative fever (p=0.31). A statistically significant more postoperative hematuria (p=0.02) were found in PL group. Mean duration of postoperative hospital stay was significantly short in LL group than PL group (36.83+9.92 vs 47+14.46; p=0.002).*

***Conclusion:*** *In this study, Ho: YAG laser had advantages of a higher stone clearance rate in the early postoperative period than pneumatic lithotripsy with similar success rate in late postoperative period. Post operative gross hematuria and hospital stay were significantly high in PL group.*

**Introduction:**

The urinary tract stone disease has been a part of the human condition for millennia; in fact, bladder and kidney stones have even been found in Egyptian mummies. Urologists of ancient time have recorded the treatment of urinary tract stone disease in medical texts and figures. Urinary stones are concretions of one or more substances normally found within the urine. Ureteral calculi almost always originate in the kidneys, although they may continue to grow once they lodge in the ureter.

Ureteral stone is one of the most common disorders in the urologic field. In Europe and North America, 5-10% of the population develops stone formation during their lives, while higher frequency of stone formation has been reported from other parts of the world such as Asia. Stone disease is also common in Bangladesh, more common in northern part of the country.

The incidence of urolithiasis in adults peaks in the fourth and sixth decades of life. It is about three times more common in men than in women. Ureteral calculi represent 22% of all urolithiasis and about 68% of ureteral calculi are in middle and lower ureter. Ureteral calculi are one of the major causes of attendance at the emergency and outpatient department (OPD) in urology and associated with considerable morbidity.

The options for treatment of ureteral stones are conservative therapy including medical expulsive therapy (MET), extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS) and open ureterolithotomy. Spontaneous passage of stone after conservative therapy for mid and lower ureteral calculi of 6 to 10 mm in size is 47% and 57% respectively. ESWL and URS are shown to yield overall success rates 86% and 97% with calculus of 10 mm or smaller and 74% and 93% with calculus greater than 10 mm respectively.

In the early 1980s open surgery was the best treatment for ureteric calculus; but introducing the small caliber ureteroscope and ESWL resulted in the virtually extinction of open surgery. The main benefit of ureteroscopic surgery is visualization of the ureter that enables detection and treatment of ureteral stones. The different modalities of intra corporeal lithotripsy are laser, ultrasonic, electrohydraulic and pneumatic lithotripsy.

Pneumatic lithotripsy depends on the energy that is generated by the movement of a metal projectile contained within the hand piece when comes in contact with another object. The first pneumatic lithotripter introduced in the early 1990s was the Swiss Lithoclast. The hand piece of the lithoclast has a metal projectile that is pushed in by compressed air at a frequency of 12 cycles per second.

A number of lasers have been trialed for the laser lithotripsy method, that the Holmium: yttrium-aluminum-garnet (Ho: YAG) was the most commonly used treatment modality. The Ho: YAG is a pulsed source that can work with frequencies of up to 50 Hz and can be used with very fine fibers of up to 200µm. It has demonstrated effectiveness in clearing stones of all composition. The thermal effect produced by Ho: YAG laser's pulses are due to formation of plasma bubble. The laser ablation thermal zone ranges between 0.5 to 1.0 mm.

This study has been designed to compare the outcome of Ho: YAG laser lithotripsy and pneumatic lithotripsy for middle and lower ureteric calculus.

**Methods:**

Prospective interventional study. At Department of Urology, National Institute of Kidney Diseases and Urology (NIKDU), Dhaka. From January 2020 to June 2021. The patients undergoing intracorporeal

lithotripsy by laser or pneumatic lithotripter for mid and lower ureteric calculi admitted in the department of Urology, NIKDU, Dhaka. Sampling technique was Purposive sampling. Grouping of sample were group LL: patients treated with laser lithotripsy group PL: patients treated with pneumatic lithotripsy. The data was collected in a predesigned data collection sheet after taking written informed consent of the participants. Data was processed and analyzed on SPSS (Statistical package for social sciences). Mean, standard deviations were used for description of quantitative data and frequencies and percentages for categorical or dichotomous data. Test of significance was independent sample t-test for quantitative outcome and Chi-square (X2) test or Fisher's exact test for categorical outcome. Confidence interval was 95%. p-value of less than 0.05 was considered significant.

**Results:**

Mean age was 39.5+13.08 years in group LL and 38.47+10.28 years in group PL (p=0.145). Mean stone diameter was 9.83+2.07 mm and 10.48+2.3 mm in LL and PL group respectively with no statistically significant difference (p=0.468). In LL group 20% patient had mid ureteric calculus and rest in lower one. In PL group, 26.66% and 73.33% patient had mid and lower ureteric calculi respectively. Mean operation time was calculated as 38.13+5.94 minutes in LL group and 40.17+3.59 minutes in PL group with no significant difference (p=0.11). After 1st month of ureteroscopy, stone clearance of LL group (83.33%) was found significantly high (p=0.04) compared to PL group (60%), while after 3rd month, stone clearance of both groups (96.66% vs. 90%) was found statistically similar (p=0.61). In both group there were no statistical difference in aspect of mucosal injury (p=0.70), stone migration (p=0.612) and postoperative fever (p=0.31). A statistically significant more postoperative hematuria (p=0.02) were found in PL group. Mean duration of postoperative hospital stay was significantly short in LL group than PL group (36.83+9.92 vs 47+14.46; p=0.002). Conclusion: In this study, Ho: YAG laser had advantages of

**Discussion:**

Advances in technology have resulted in a rapid increase in the number of ureteroscopic surgical intervention performed. Intracorporeal lithotripsy is more common procedure performed by ureteroscopy. It has been a main modality for ureteric stones since ureteroscopic lithotripsy was launched in the 1980s. This study was designed to compare the outcome of Holmium: YAG laser lithotripsy and pneumatic lithotripsy for the treatment of middle and lower ureteric calculus. A total of 64 patients were included in this study. Patients treated with Pneumatic lithotripsy and Laser lithotripsy were in group PL and group LL respectively. Two patients were lost to follow-up in both groups. The duration of follow-up was 3 months.

In this study, mean age was 39.5+ 13 (19-58) years in group LL and 38.47+ 10.28 (20-60) years in group PL. There was no significant difference in age between two groups (p=0.735). Similar age in both groups was also found in study by Degirmenci et al. (2014) and Binbay et al. (2011).

There was 66.66% male and 33.33% female in LL group and 63.33% male and 36.67% female in PL group with no statistically significant difference in gender distribution in between two groups 9 (p=0.78) in this study. Similar results found in studies done by Ercil et al. (2016) (p=0.96) and Akdeniz et al. (2014) (p=0.83). The incidence of urolithiasis in adults peaks in the fourth and sixth decades of life. It is about three times more common in men than in women.

In LL group, 6 patients (20%) had their stone in middle ureter and 24 patients (80%) had in lower ureter. It was 26.66% and 73.33% respectively among 30 patients in PL group. There was no significant difference among the two groups (p=0.54) in respect of stone location. Similar statistical result was also found in a study done by Akdeniz et al. (2014) among 157 patients.

Mean stone diameter was 9.83+2.07 mm in LL group which was not significant (p=0.46) in comparison to PL group (10.48+2.31 mm). This type of similarity was also found in a study of 80 patients (p=0.687) done by Kassem et al. (2011). Similarity (p=0.97) was also found in another retrospective study of 141 patients conducted by Ercil et al. (2016). Spontaneous passage of stone after conservative therapy for mid and lower ureteral calculi of 6 to 10 mm in size is 47% and 57% respectively. So more calculus is found in mid and lower ureter is around 10 mm.

Stone clearance is a vital parameter for comparison between these two groups. In this study, on 1st month after URS, stone clearance of LL group (83.33%) was found significantly high (p=0.04) compared to PL group (60%), while at 3rd month, stone clearance of both groups (96.66% vs. 90%) was found statistically

similar (p=0.61). Li et al. (2015) showed in 982 eligible patients that laser lithotripsy has a statistical significant higher stone clear rate (p=0.04) than pneumatic lithotripsy (80.8% vs. 91.3%) after one month's follow up. But after 3 months' follow up, a re-checked KUB indicate that the success rate for pneumatic group increased to 92.6% comparable to the group of LL (95.9%, p=0.35) similar to this study.

In a 80 patients' study done by Kassem et al. (2011) showed that early stone free rate (SFR) at 1st postoperative day was statistically equal in both groups (80%). Delayed Stone free rate (after 1 month) was higher in LL (95%) than PL (85%) with only 2 LL cases who required ancillary procedures, while 6 PL cases required ancillary procedures, but difference was not statistically significant (p=0.139) which is contrary to the finding of this study. LL group showed a higher stone clearance (p=0.04) than PL group at 1st month in this study. In some studies flexible ureteroscope was used. Results may differ for using different type of ureteroscope.

Complication is a variable to compare between two groups. In LL group, superficial mucosal injury in ureter occurred in 10% patient and in PL group, superficial mucosal injury occurred in 16.67% patient. No statistically significant difference (p=0.70) was found between two groups in this study. Similar results were also found in a study done by Ercil et al. (2016) over 141 patients (p=0.809) and another study conducted by Degirmenci et al. (2013) over 230 patients (p=0.884). Stone parameters and exclusion criteria was somewhat similar to those studies. This may be the cause of similar results.

In LL group, proximal stone migration occurred in 1 patient (3.33%) during the operation and in PL group, proximal stone migration occurred in 3 patients (10%). No statistically significant difference (p=0.61) was found between two groups in this study. Stone migration occurred in 3 (4%) patients of LL group and in 8(12%) patients of PL group in a study done by Ercil et al. (2016) over 141patients. The result was similar (p=0.139) to this study. Statistically more stone migration (p=0.03) happened in PL group during operation in study of Cimino et al. (2013) and more migration (p=0.04) in LL group in study of Abedi et al. (2018). Stone migration occurs more commonly in case of upper ureter. In last two studies they included cases of upper ureter. So result was not found similar.

Gross hematuria occurred in 13.33% patient post operatively in LL group and 23.33% patient in PL group. Statistically significant difference (p=0.02) was found between two groups. Hematuria occurred in 45.3% LL patient and 54.5% PL patient with no significant difference (p=0.275) in a study conducted by Ercil et al. (2016). The result was contrary to the finding of this study. Another contrary result (p=0.884) was also found in a study done by Degirmenci et al. (2013). Hematuria results from post obstructive decompression, instrumental injury and post operative flare up of infection.

In LL group, 13.33% patient developed fever post operatively and in PL group, 23.33% patient developed fever post operatively. No statistically significant difference (p=0.31) was found between two groups. Abedi et al. (2018) found that 0.7% and 2.6% patients developed fever in postoperative periods in LL and PL group respectively which was not significant (p=0.65). Similar result (p=1) was also found by Ercil et al. (2016). Post operative fever occur due to urinary tract infection or urosepsis. Similar result found may be due to more similar inclusion and exclusion criteria.

Li et al. (2015) had the observation that there was significant difference between the two procedures regarding post-operative stricture occurrence rate. Only 5 cases of post- operative ureteral stricture were seen in PL group. But in LL group, 24 stricture cases happened, which was significantly higher than PL group (p=0.02) among 982 patients in total. Kassem et al. (2011) observed a single ureteral stricture patient in LL group among 40 patients in 3 month follow up. Ureteral stricture was not observed in any patient in this study due to lack of long term follow up.

Mean operation time in this study was estimated in both groups (38.13+5.94 min in LL and 40.17+3.59 min in PL group), meaning that the time taken for stones to fragment into a removable size may be shorter for LL. However, with PL the operator has to manipulate the ureteroscope to hunt for the moving stones. Furthermore, Pneumatic lithotripter fragments the calculi into multiple fragments that need to be removed by forceps. On the contrary, stones tend to migrate less with LL enabling the vaporization of the stone without extra manipulation. Additionally, LL vaporizes and debulks the stone until no sizeable fragments remain. The difference however was not statistically significant (p=0.11). When compared with other study, Kassem et al. (2012) had no significant difference (p=0.165). But

Li et al. (2015) found a significantly (p=0.001) less mean operating time in LL group. Operation time differ due to patient's stone parameter and surgeon's skill.

In term of mean post-operative hospital stay in hours, the two groups were also comparable. 36.83+9.92 and 47+14.46 hours in LL group and PL group respectively,

there was significant (p=0.002) difference in duration of postoperative hospital stay between two groups. But Li et al. (2015) showed that there was no significant difference (p=0.62) in mean postoperative hospital stay. Post operative early complication was somehow more in case of pneumatic lithotripsy. This caused the patient more hospital stay post operatively.

**Conclusion:**

This study compared the outcome of pneumatic and laser lithotripsy for middle and lower ureteric calculus. Mean age, gender distribution, stone parameter were similar with no statistically significant difference. Mean operation time was found with no significant difference in between two procedures. After 1st month of ureteroscopy, stone clearance by laser lithotripsy was found significantly higher compared to pneumatic lithotripsy while after 3rd month, stone clearance by both procedure was found statistically similar. In both procedures, there were no statistical difference in aspect of mucosal injury, stone migration and postoperative fever. A statistically significant more hematuria was found after pneumatic lithotripsy. Mean duration of postoperative hospital stay was significantly short in case of laser lithotripsy.

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