

COMPARATIVE STUDY BETWEEN HOLMIUM: YAG LASER AND PNEUMATIC LITHOTRIPSY IN THE MANAGEMENT OF UPPER URETERIC STONE

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Abstract

Background: Among various intracorporeal lithotripters, Pneumatic lithotripter has become the widely used tool for the treatment of ureteric stones. Recently the Holmium:YAG laser has been used with a wide range of potential urological applications, including intracorporeal lithotripsy of ureteric stones.

Objective: To compare the treatment of upper ureteric stone between laser and pneumatic lithotripsy.

Materials and methods: One hundred patients with upper ureteric stone who underwent ureteroscopic lithotripsy in the Department of Urology, CMH, Dhaka from October 2012 to September 2015 were enrolled in this study. Patients were divided into two groups. Group A (LL) were treated with holmium: YAG laser and Group B (PL) were treated with pneumatic lithotripsy. Two procedures were compared in term of stone fragmentation, stone clearance rate, duration of lithotripsy, complications and duration of post operative hospital stay. Patients were monitored as outpatients after one month and after three months with a kidney ureter and bladder radiograph and ultrasonograph. Patients with migrated fragments or incomplete clearance underwent an auxiliary procedure such as Extra Corporeal shock wave lithotripsy (ESWL).

Results: Mean stone size was 1.36 ± 0.36 cm in group A (LL) and 1.37 ± 0.36 cm in group B (PL). The immediate stone clearance rate was significantly higher in Group A (94.0%) than Group B (76.0%). Fragments proximal migration were 6.0% in LL group and 24.0% in PL group. Use of stone retrieval equipments (baskets, forceps) was 16.0% and 64.0% in LL and PL group respectively ($p < 0.05$) and stone fragments clearance requiring auxiliary procedures were 6% and 24% ($p < 0.05$) in LL and PL group respectively. The mean lithotripsy time 40.46 ± 19.25 min and 36.86 ± 14.83 min and mean period of post operative hospital stay was 2.32 ± 1.22 days and 2.44 ± 1.18 days in the LL and PL group respectively. Perioperative complications like hemorrhage, mucosal disruption/perforation were almost same in both groups.

Conclusion: In this study stone clearance and fragmentation of stone in Holmium:YAG assisted ureteroscopy was significantly higher than pneumatic lithotripsy group. The need for auxiliary procedure like ESWL for proximally migrated fragments was significantly less in Holmium:YAG assisted ureteroscopy compared with pneumatic lithotripsy.

Key words: Pneumatic Lithotripsy (PL), Laser Lithotripsy (LL), Extra Corporeal Shock Wave Lithotripsy (ESWL)

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Introduction:

Ureteral calculi may be associated with renal obstruction and care must be taken to prevent irreversible damage to the kidney. Patients with stone of 5 mm or less, conservative management may be considered. Whereas chance of spontaneous passage for larger stones and more proximal stones diminishes

considerably and thus intervention is required. Treatment decision of upper ureteric stones is based on several general aspects such as stone size and symptoms. Currently most ureteral stones are removed by minimally invasive endourological procedure. Small stones may be extracted but stones of >5mm in diameter require intracorporeal fragmentation before removing the resultant fragments. The advancement of ureteroscopy and related working elements to manipulate or fragment ureteral calculi has significantly increased treatment options for urologists.¹ For stone fragmentation, a variety of lithotriptors can be used, including ultrasonic, electro hydraulic, pneumatic and laser lithotriptors. Pneumatic lithotripsy and Holmium:YAG lithotripsy have reported favorable outcomes. A rather simple principle of the jackhammer has enabled Pneumatic lithotripsy to be a safe and effective method for stone treatment[2,3]. Thus, the lithoclast has become a widespread tool for fragmentation of urinary stones. However, it has some disadvantages. Semirigid probe requires a rigid or at least a semi rigid ureteroscope and there is a high possibility of undesired retrograde displacement of the calculus[4,5]. The holmium:YAG laser has excellent stone fragmenting properties and as a result, it is now a well-established modality for intracorporeal lithotripsy[6]. Holmium laser light can be transmitted through a thin, flexible fiber compared with instruments for mechanical stone fragmentation. Holmium:YAG lithotripsy depends on photothermal mechanism for stone fragmentation, thus the risk of retrograde stone propulsion could be minimized, but it may cause thermal injury to the ureter if used carelessly. Endoscopic treatment of ureteral stones should be evaluated from the standard points of efficacy and the ultimate success rate of the various procedures.

The aim of this study is to evaluate and compare the outcome of the treatment of upper ureteric stone between laser and pneumatic lithotripsy.

Methods:

This hospital based comparative study was carried out in the Department of Urology, CMH, Dhaka from October 2012 to September 2015. One hundred patients with upper ureteric stone who underwent ureteroscopic lithotripsy at above institution from October 2012 to September 2015 were included in this study. Patients were divided into two groups. In Group A Holmium:YAG laser was used on 50 patients and in group B pneumatic lithotripsy was performed on

another 50 patients. Two procedures were compared in term of stone fragmentation, stone clearance rate, duration of lithotripsy, complications and duration of post-operative hospital stay. Patients were monitored as outpatients after one month and after three months with a kidney ureter and bladder radiograph and ultrasonograph. Patients with migrated fragments or incomplete clearance underwent an auxiliary procedure such as ESWL.

Results:

Table- I
Age distribution of the patients

Age (years)	Group A	Group B	p value
≤30	9 (18.0)	13 (26.0)	0.521
31 – 40	16 (32.0)	10 (20.0)	
41 – 50	12 (24.0)	12 (24.0)	
>50	13 (26.0)	15 (30.0)	
Mean±SD	41.90±10.97	41.32±12.3	0.804ns
Min-max	22 – 60	20 - 60	

The mean age was 41.90±10.97 years and 41.32±12.33 years in group A and group B respectively. Only nine patient (18%) in group-A and 13 patient (26%) in group-B were below 30 years of age. There was no significant difference in age between two groups.

Table II
Gender distribution of the patients

Gender	Group A	Group B	p value
Male	36 (72.0)	31 (62.0)	0.288
Female	14 (28.0)	19 (38.0)	

Males were predominant in both groups. There was no significant difference in gender between two groups.

Table III
Side involved of the patients

Side of involvement	Group A	Group B	p value
Right	20 (40.0)	22 (44.0)	0.685
Left	30 (60.0)	26 (56.0)	

Involvement of the left side was more than right side. There was no significant difference in side of involvement between two groups.

Table-IV
Size of the stones

Size of the stones	Group A	Group B	p value
0.5 – 1.0	15 (30.0)	15 (30.0)	1.000
1.1 – 1.5	23 (46.0)	23 (46.0)	
1.5 – 2.0	12 (24.0)	12 (24.0)	
Mean±SD	1.36±0.36	1.37±0.36	0.934ns
Min – max	0.80 – 2.00	0.80 – 2.00	

The mean stone size was 1.36±0.36 cm in Group- A and 1.37±0.36 cm in Group- B. The range of the stone size was 0.8cm to 2 cm in both groups.

Table-V
Density of the stones

Density of the stones	Group A	Group B	p value
525 – 575	5 (10.0)	5 (10.0)	1.000
576 – 625	7 (14.0)	7 (14.0)	
626 – 725	21 (42.0)	22 (44.0)	
726 – 775	9 (18.0)	8 (16.0)	
776 – 825	4 (8.0)	4 (8.0)	
>825	4 (8.0)	4 (8.0)	
Mean±SD	697 ± 88	695 ± 89	0.943ns
Min – max	540 – 910	530 – 900	

The Mean density (HU) of stone was 696.66±87.89 in Group-A and 695.40±89.42 in Group- B. The density of large number of stones (21 in group-A and 22 in group-B) were in between 626 HU to 725 HU. Only in 8 patients (four in each group) stone density were above 825 HU.

Table-VI
Time required for lithotripsy

Time (minutes)	Group A	Group B	p value
= 30	24 (48.0)	18 (36.0)	0.173
31 – 60	20 (40.0)	29 (58.0)	
>60	06 (12.0)	03 (6.0)	
Mean±SD	697 ± 88	695 ± 89	0.297ns
Min – max	540 – 910	530 – 900	

The Mean duration (min) of lithotripsy was 40.46±19.25 in Group-A and 36.86±14.83 in Group-B. In majority of the cases stone were broken within an hour in both groups. Only in 12.0% patient's lithotripsy time was

more than 60 min in laser group and only in 6.0% patients lithotripsy time was more than 60 min in pneumatic lithotripsy group.

Table VII
The use of forceps/Dormia basket for stone retrieval

Fragments retrieval	Group A	Group B	p value
Yes	8 (16.0)	32 (64.0)	0.0001
No	42 (84.0)	18 (36.0)	

Forceps/Dormia baskets were required for retrieval of stone fragments in 8 (16%) cases in Group-A and in 32 (64%) cases in Group-B and in rest of the cases stone fragments were washed out spontaneously.

Table VIII
Stone clearance after Laser and Pneumatic of lithotripsy

Outcome	Group A	Group B	p value
Success	47 (94.0)	38 (76.0)	0.0001
Failure	3 (6.0)	12 (24.0)	

Complete stone clearance was significantly higher in Group A (94.0%) than Group B (76.0%).

TableIX
Peri procedural complications

Complications	Group A	Group B	p value
Nil	42 (84.0)	25 (50.0)	0.002
Hemorrhage	1 (2.0)	8 (16.0)	
Mucosal disruption/ perforation	4 (8.0)	5 (10.0)	
Stone migration	3 (6.0)	12 (24.0)	

Post operative haematuria occurred in 2% patients in Group A and in 16.0% patients in group-B. Mucosal abrasion/ disruption was occurred in 8.0% patients in group-A and 10.0% patients in group-B. In 6.0% cases stone fragments were migrated proximally in group-A and in 24.0% cases stone fragments were migrated proximally in group-B. Complication rate was significantly higher in PL group than LL group (p value 0.002).

Table X
Duration of post operative hospital stay

Hospital stay (days)	Group A	Group B	p value
= 2	34 (64.0)	19 (38.0)	0.165
3 – 4	11 (22.0)	29 (58.0)	
>4	05 (10.0)	02 (4.0)	
Mean±SD	2.32±1.22	2.44±1.18	0.628ns
Min – max	1 – 6	1 – 5	

The Mean duration (days) of hospital stay was 2.32±1.22 in group A and 2.44±1.18 in Group B.

Discussion:

The goal of the surgical treatment of patients suffering from ure-teral calculi is to achieve complete stone clearance with minimal complication. A variety of lithotriptors can be used through an ureteroscope. Although there are some advantages and disadvantages,⁷the Holmium laser and pneumatic lithotripters are most widely used in different centers for the management of upper ureteral stones[8].

The present study was designed to compare laser lithotripsy with pneumatic lithotripsy in treatment of upper ureteric stone. One hundred patients were included in this study. The patients were divided into 2 groups. In group-A (LL), 50 patients underwent laser lithotripsy and in group-B (PL), another 50 patients underwent pneumatic lithotripsy. Two procedures were compared in term of fragmentation time, stone free rate, size and proximal migration of the fragments, requirement of the use of forceps/baskets for stone retrieval and complications.

In this study, mean age of patients was 41.90 ± 10.97 years in LL group and 41.32 ± 12.33 years in PL group. There was no significant difference in the ages between two groups. This is general agreement with other reports in the literature[9,10].

In the present series, twenty right upper ureteric and thirty left upper ureteric stones were operated in group-A and twenty-two right upper ureteric and twenty-six left upper ureteric stones were operated in group-B.

In the present series, size of the stones ranges from 0.8 cm to 2 cm. The mean size of stone was 1.36±0.36 cm and 1.37±0.36 cm in group-A and group-B respectively. No significant difference in the size of stones was observed between the two groups. In the study of Sun et al.¹¹, mean stone size was 11 ±2.5 mm in PL group and 12 ±2.3 mm in LL group. Mean stone

size was 11.5 mm in LL group and 12.3 mm in PL group in the study of Bapat et al[12]. In other studies, mean size of stone ranges from 9 to 16 mm[6,9].

In this study, density of stones ranges from 530HU to 900 HU. The mean density of stones was 696.66±87.89 HU in group-A and 695.40±89.42 HU in group-B. No significant difference was found between the two groups. EAU guideline suggested that density of the stone is an important variable to decide the method of stone removal[13].

In our study, mean operation time was 40.46±19.25 minutes and 36.86±14.83 minutes in group-A and group-B respectively. No significant difference between the groups was found. In the study of Bapat et al.¹² mean operation time was 38.85± 8.99 min for PL group and 45.61±11.30 min for the LL group. They also found no significant difference in operation time between two groups which was similar to our study. But Sun et al.¹¹ in their study found significant difference in operation time in favour of laser lithotripsy. Operation time for laser lithotripsy was 49.8±26.4 min and 76.9±48.3 min in PL group.

Forceps/Dormia baskets were required for retrieval of stone fragments significantly lower in LL group (16.0%) than PL group (64.0%). Sun et al.¹¹ reported that the stone should be fragmented into pieces <3 mm to pass spontaneously. Jeon et al¹, in their study found that the Hol:YAG laser virtually vaporizing the stone and the stone is fragmented into very small sizes, ranging from 1 to 2 mm which is also supported by another study by Vassar et al[14]. Teichman et al[15]. showed that fragments of e"4mm are produced by all types of endoscopic lithotripters, with the exception of the Hol:YAG laser. In the present study fragments of stones were very small and which was confirmed by direct vision and fluoroscopy.

In this study, complete stone clearance was significantly higher in group-A (94.0%) than in group-B (76.0%). Whereas proximal migration of fragments was occurred significantly lower in Group-A (6.0%) than Group-B (24.0%). In one study, Maghsoudiet al[16]. revealed that stone fragmentation was 90.2% in LL group and 73.2% in PL group (P < 0.05). They concluded that the overall stone free rate in Hol:YAG laser lithotripsy was better than pneumatic lithotripsy. Sun et al.¹¹ reported stone free rate 95.7% in LL group and 69.7% in PL group. Bapat et al.[12] found complete clearance of stone in 166(86.1%) patient out of 193 patients in PL group, whereas in LL group they noticed complete stone clearance in 195 (97.01%) out of 201 patients.

In this study, proximal migration of fragments was occurred in three (6%) cases in group-A and twelve (24%) cases in group-B. Proximal stone migration is the most disadvantage of the pneumatic lithotripsy and reported in the 2-17% of cases in the study of Fong et al.¹⁷ Jeon and associates¹ reported that the main cause of failure in ureteroscopic lithotripsy was the proximally migrated stone/ fragments. They found upward migration of stone fragments occurred in 19.2% in the Pneumatic lithotripsy group while in 4.0% in the LL group.

Stone fragments migrated into the kidney with Pneumatic lithotripsy was 13.9% in one study by Bapat et al.¹² whereas stone fragments migrated proximally in only 1.9% patients in laser group. Dasgupta¹⁵ also reported that the proximal migration of stone fragments is the main drawback to ballistic lithotripsy. Sun et al.¹¹ found proximal migration of stone fragments in 19.1% cases in PL group. It was significantly higher than laser group.

Post-operative haematuria was occurred in one (2.0%) patient in Group A and in 8 (16.0%) patient in group-B. Mucosal abrasion/disruption was occurred in 4 (8%) patients in group-A and 5 (10%) patients in group-B. Uro sepsis was not occurred in either group probably due to use of antibiotics in peri operative period. In Bapat¹² study, Ureteral perforation, which were mucosal, occurred in 2.9% patients in LL group and 4.6% patients sustained ureteral perforation in PL group. In one study Sun et al^[11]. reported 5 ureteral perforation out of 141 patients. In another study, Monohoret al^[18]. found no significant difference of mucosal perforation/disruption between laser and pneumatic lithotripsy.

In this study, hospital stay ranged from one day to 6 days with a mean of 2.32 days \pm 1.22 in the laser group and ranged from one to five days with a mean of 2.44 days \pm 1.18 in the lithoclast group. In one study, Sun et al^[11]. reported that shorter post operative hospital stay was in LL group. In their study post operative hospital stay was 3.2 days in PL group and 2.5 days in LL group which was significant ($p < 0.01$). In another study, Jeon et al.¹ reported longer post operative hospital stay in PL group than LL group.

Conclusion:

This study revealed that Hol:YAG laser lithotripsy is safe and more effective than pneumatic lithotripsy in respect of lower proximal migration rate of stone

fragments, higher stone free rate and less requirement of forceps/baskets. The need for auxiliary procedure after Hol:YAG laser assisted URS is significantly less in comparison with pneumatic lithoclast.

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