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Original Article
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Outcome of Lower Ureteric Stone Fragmentation by Laser in Comparison with Pneumatic Lithotripsy

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Abstract

Background: *Several different modalities are available for ureteral stone fragmentation. From them pneumatic and holmium: yttrium-aluminum-garnet (Ho: YAG) lithotripsy have supportive outcomes.*

Aims: *To see the outcome of lower ureteric stone fragmentation by laser in comparison with pneumatic lithotripsy.*

Methods: *The prospective clinical study was conducted during the period from July 2012 to June 2014 in Dhaka Medical College Hospital. From the patient admitted in Dhaka medical college hospital a total of 60 patient were selected using purposive sampling methods. Selected patients were numbered chronologically and odd number group as group A (laser lithotripsy) and even number group B (pneumatic lihtripsy). Cystoscopy followed by ureterescopy with the help of guide wire was done and stone fragmentation done by either laser lithotripsy (done in general operation theatre in Dhaka Medical College Hospital) or pneumatic lithotripsy (done in Urology operation theatre in Dhaka Medical College Hospital). Collected data were processed and analyzed using computer software SPSS (statistical package for social science), version-18. Un-pair t-test, chi-square test and Fishers Exact probability test were used to analyze the data. The findings of the study showed age and sex are almost identically distributed in both groups.*

Results: *The mean age of group A and group- B were 35.63±11.66 and 38.90±11.21 years respectively. A male predominance was observed in both groups with 70% male in group- A and 53.3% in group-B. Stone size was also observed identically in both groups. 43% of stone are larger than 10mm in group- A and 47% stone are larger than 10mm. None of other baseline variable found very between groups. Immediate stone clearance was much higher in group-A (96.7%) then that in group- B (80%). Although both the groups demonstrated 100% clearance after 1 month. Immediate complications were higher in group B then those of group- A. Ureteral perforation in group B was found 6.7% as opposed to none in group-A. Fever in group A (6.7%) was observed to be more than 3 times higher than in group- B (23.3%). Comparison of complications after 1 and 3 months shows some differences (higher in group-B) but that is not significant. Ureteral stricture developed in 3 patients in group- B compared to nil in group- A. More than 90% of patients of group-A were released from the hospital within 3 days after operation, in contrast about 40% in group-B left the hospital within 3 days.*

Conclusion: *So, laser lithotripsy is better option for the management of lower ureteric stone by using semi rigid ureteroscope, in term of stone migration, rate of stone fragmentation and clearance, operation time, hospital stay and complication.*

Keywords: Pneumatic lithotripsy; Laser lithotripsy; Ureteral stone; YAG laser

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Introduction

Stone formation in the kidney is one of the oldest and wide spread diseases known to human being. Calculi have been found in the pelvis, presumably in the bladder, of an Egyptian mummy estimated to be 4800 BC.[1] Reference to stone formation was made in early Sanskrit written in India in 6th century BC.[2]The history of stone disease implies that many diverse factors might be involved in its causation, heredity, environment, age, sex, urinary infection, metabolic disease changes and dietary excesses or deficiencies[1].

The prevalence of the urinary tract stone disease is estimated 2%-3%.[3]Male to female ratio is 3:1.[4]Stone formation requires super saturated urine followed by nucleation and crystal formation. Super saturation depends on urinary pH, ionic strength, solid concentration and complication. The role of solute concentration is clear. As ion concentration increases, their activity product reaches a specific point termed "solubility product" (Ksp). Concentration above this point is capable of initiating crystal growth. Super saturation level beyond this level is unstable and spontaneous nucleation may occur.[5]

Other factors play major roles in development of urinary calculi, including complication. So causes of stone formation may be divided into idiopathic, metabolic, and non-metabolic. Non metabolic causes include obstruction, infection, abnormal anatomy etc. Stone disease is also common in Bangladesh, more common in northern part of the country.[2] In the management of this problem, Past 20 years had witnessed revolutionary changes in this field. Treatment of stone disease moved dramatically from an open operative procedure to endoscopic, minimally invasive methods and non-invasive methods.[6]

Ureteral stone size less than 5mm usually pass spontaneously.[7] On the other hand stone more than 8mm size usually not passes spontaneously.[8]

Treatment of ureteral stone depends on stone size composition, position and degree of obstruction, pain, presence of infection single kidney and abnormal ureteral anatomy.[3]Surgical treatment option for ureteric stone includes Extra corporeal shock wave lithotripsy, ureteroscopy with lithotripsy have greatly improved the treatment of ureteral stone.[3]Success rates vary, and appear to be dependent upon device amongst other factors. Ureteroscopy is a common procedure done in Bangladesh, and most of the urologist use pneumatic lithotripsy. Laser lithotripsy is a new procedure in our country. Holmium:YAG laser is being used for different urological procedure in only few center in our country.

The Holmium laser, in particular, provides a very powerful yet safe lithotripsy mechanism.[9] As commented by Winfield (1996), the intrinsic property of the Holmium laser had provided unsurpassed stone fragmentation including calcium oxalate monohydrate and cysteine stones which could be difficult even for the pulsed dye laser. These changes allow for rapid, safe and in most cases economic way of stone removal.[10]This is reflected by a number of recent reports of the highly successful Holmium laser lithotripsy.[11,12,13] It became clear that ureteroscopic lithotripsy should no longer be restricted to the distal ureter, as was the case in the late 70s when the technique was first introduced.

Laser lithotripsy is better option for the management of lower ureteric stone by using semi rigid ureteroscope, in term of stone migration, rate of stone fragmentation and clearance, operation time, hospital stay and complication also. So, comparison of the outcome of pneumatic lithotripsy and laser lithotripsy will guide us for most appropriate procedure for treatment of lower ureteric stone It has been shown that Holmium: YAG lithotripsy is better among other energy source in terms of safety and efficacy.

To my knowledge, no such study has been done in our country. Hence, this study has been designed to comparison of the efficacy and safety of pneumatic and laser lithotripsy for the management of lower ureteric stone.

Methods:

The study was a prospective study was conducted in the Department of Urology, Dhaka Medical College Hospital Dhaka from July 2012 to June 2014. Sixty patients who attended in the out patients department of urology, Dhaka Medical College Hospital, Dhaka with lower ureteric stone: those who are fulfill the inclusion and exclusion criteria were included for the study sample.

Purposive sampling methods were followed as per inclusion and exclusion criteria. After admission patients were again studied clinically and 60 patients, age ranging from 15-70 years were selected for this study as per selection criteria Incidence of ureteric stone is less in children and instruments for child is not available in our institute. On the other hand co-morbidity in elderly people is much more higher and

for these reasons, these group of patients are not included in our study. The cases were numbered chronologically and odd number grouped as Group A for laser lithotripsy and even number as Group B for pneumatic lithotripsy.

Selection criteria:

Inclusion criteria:

1. Patient with lower ureteric stone.
2. Patient between age ranges 15-70 years.
3. Consent from patient about treatment.

Exclusion criteria:

1. Stone present in upper part of the ureter.
2. Impacted Stone.
3. Patient in age below 15yr and above 70 yr.
4. Patient with abnormal ureteral anatomy (may interfere selective operative procedure.)
5. Pregnancy with ureteric stone.
6. Stone with documented urinary infection
7. Radiolucent stone
8. Renal failure
9. Solitary functioning kidney
10. Patients with co-morbidity like Diabetic, HTN, CVD.

Procedure:

Informed consent was taken from all patients. A detail data sheet was completed and this included particulars of the patient history, results of physical examinations and relevant baseline investigations Urinalysis (R/E,M/E and C/S) was advised.

Transabdominal USG was done by the sonologist of Radiology Department, DMCH to detect any hydronephrotic change or any other pathology.

IVU was done to see the size and location of stone, renal function any hydronephrotic changes and any abnormal anatomy. Following General or spinal anesthesia, all patient placed in lithotomy position. In the present study ureteroscopy followed by pneumatic or laser lithotripsy done. Both the procedure are similar in initial part.

Cystoscopy was done for identification of ureteric orifice. Then guide wire was passed within ureteric orifice under visual and fluoroscopic monitoring.

Then Ureteroscope is advanced commonly next to the guide wire. At time a tortuous portion of ureter is encountered, posing a challenge for the passage of the scope. In such cases, a second guide wire may be helpful.

Patient released within 3 days of operation. During operation procedure, all patient were followed properly for all outcome variables (Stone clearance, Ureteral injury, haematuria, Ureteral perforation.).

Stone clearance was checked by ureteroscopy and fluoroscopy at the end of procedure. Any ureteral injury, bleeding, ureteral perforation were immediately noticed and managed accordingly.

Each of the patients was followed up at one month (1st visit) and 3 months (2nd visit). All the cases were follow up after 1 month (1st visit) of ureteroscopy (pneumatic or laser lithotripsy) with history, urine examination (R/E, M/E and C/S) to detect presence of any urinary tract infection, plain x-ray KUB region to see stone clearance. After 3 month (2nd visit), each patient was evaluated by history, Urine examination (R/E, M/E and C/S) to detect presence of any urinary tract infection, IVU to exclude late complications like ureteric stenosis and stricture. Improvement was assessed on the changes from base line symptoms and findings from investigations.

Ethical issue:

Ethical clearance for this study will be taken from the Ethical Review Committee of Department of Urology, Dhaka Medical College Hospital Dhaka. The participants were explained the purpose of the study and the importance of such study. The study was conducted with signed informed consent of all the participants with the right to withdraw himself/herself from the study at any time during the study period. Interest of the patient was given highest priority and confidentiality was maintained with safe guard of the right and health of the participants.

Results

Table-1: Comparison of age between groups.

Age (yrs)	Group		p-value
	Group-A (n = 30)	Group-B (n = 30)	
15- 19	2(6.7)	1(3.3)	
20 – 29	9(30.0)	7(23.3)	
30 – 39	5(16.7)	7(23.3)	0.273
40 – 49	9(30.0)	8(26.7)	
≥50 (up to 70)	5(16.7)	7(23.3)	
Mean ± SD	35.63 ±11.66	38.90 ± 11.21	

Table-1 demonstrates that highest frequency of ureteral stone was observed in age category 40 – 49 years (30.0% in Group-A and 26.7% in Group-B) and the least frequency in between 15 – 19 years (6.7% in Group-A and 3.3% in Group-B). The lowest and highest ages in Group-A were 15 and 70 years respectively and those in Group-B were 15 and 70 years respectively.

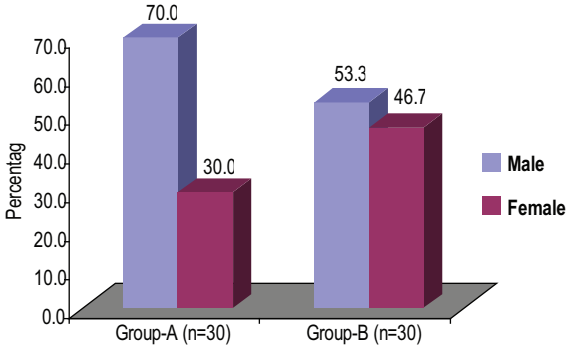

Fig.-1: *Sex distribution of the patients in two groups.*

Over half (70.0%) of Group-A and 53.3% of Group-B were males.

Table-II : *Comparison of pertinent baseline variables between groups.*

Baseline variables	Group		p-values
	Group-A (n = 30)	Group-B (n = 30)	
Stone impaction#	6 (20%)	9(30%)	0.371
Stone size ## (Mean ± SD)	10.83 ± 2.52	10.30 ± 2.04	0.374
Associated UTI#	10(33.3%)	1(3.3%)	0.002
IVU excretion delayed#	18(60%)	8(26.7%)	0.009
IVU (P-C) system dilated#	16(53.3%)	17(56.7%)	0.795

value reached from Chi-square test
p value reached from Unpaired student t-test

Table-II demonstrates the comparison of baseline variables that might be influence on the outcome of intervention. The variables chosen were stone impaction, stone size, associated UTI, IVU excretion and IVU (P-C) system.

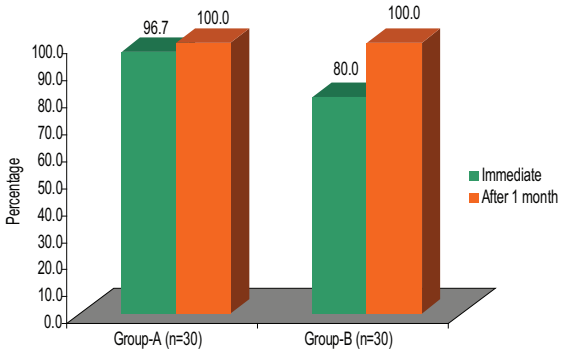

Fig.-2: *Comparison of stone clearance*

Figure shows that immediate stone clearance was much higher in Group-A (96.7%) than that in Group-B (80%), although both the groups demonstrated 100% clearance after 1 month.

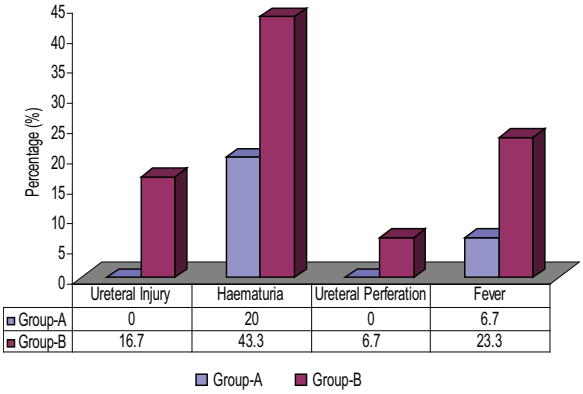

Fig.-3: *Comparison of immediate complications*

Out of 30 cases, 5(16.7%) cases had ureteral injury in group-B compared to none in Group-A. Haematuria observed in 6(20%) cases of group-A compared to 13(43.3%) cases in group-B. 2(6.7%) cases had ureteral perforation in group-b compared to none in Group-A. Fever observed in 2(6.7%) cases of group-A compared to 11(23.3%) cases in group-B.

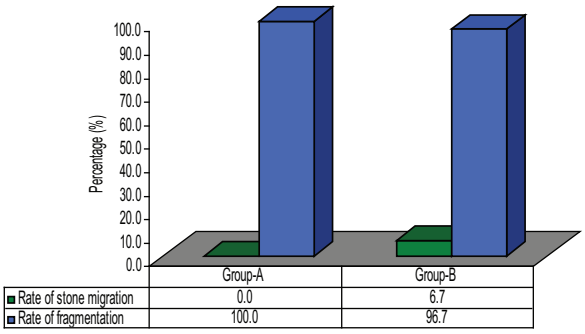

Fig.-4: *Rate of stone migration and fragmentation*

Figure-4 demonstrate the rate of stone migration in Group B (pneumatic lithotripsy) 6.7% and none in Group A (Laser lithotripsy). Stone fragmentation rate in Group A 100.0% and 96.7% in Group B.

Table-III: Comparison of complications after 1 month between groups.

Complication after 1 month	Group	
	Group-A (n =30)	Group-B (n = 30)
Pain in the loin	1 (3.3%)	3 (10%)

All the cases were evaluated after 1 month (1st visit) of ureteroscopy with pneumatic or laser lithotripsy. All patients were followed up with history, urine examination (R/E and C/S) to detect presence of any urinary tract infection, plane X-ray KUB region to see stone clearance. Table demonstrates that 1(3.3%) patients in Group-A,3(10.0%) patient in Group-B suffered from pain, while none of the patients of either Group-A and Group-B developed infection.

Table-IV : *Comparison of complications after 3 months between groups.*

Complication after 3 months	Group	
	Group-A (n =30)	Group-B (n = 30)
Ureteral Stricture	0.0	3 (10.0%)

Table-4shows that 3(10%) patients of Group-B developed ureteral stricture, where as none of Group-A developed the same. While none of the patients of either Group-A or Group-B developed infection. After 3 month (2nd visit), each patient was evaluated by history, urine examination (R/E, M/E and C/S) to detect presence of any urinary tract infection. IVU was done in 2nd visit to see any ureteral stricture.

Table-5: *Comparison of total outcome between groups*

Baseline variables	Group		p-values
	Group-A (n = 30)	Group-B (n = 30)	
Stone clearance#	29(96.7%)	24(80%)	0.04
Complication rate#	4(13.33%)	11(36.66%)	0.03
Mean operation time (minutes)##	42.17 ± 8.97	68.33 ± 11.77	< 0.001
Mean hospital stay (days)##	2.37 ± 0.72	4.27 ± 1.39	< 0.001

value reached from Chi-square test
##p value reached from Unpaired student t-test

Table-5 compares the outcome of the two groups. The outcome variables were stone clearance, complication rate, operation time and hospitals stay. Stone clearance was significantly lower in Group-B 24(80.0%) than that in Group-A 29(96.7%). Likewise the complication rate was much higher in the former group B (36.66%) than that in the latter group A (13.33%). The mean operation time and mean hospital stay were also much higher in the former group-B than those in the latter group-A suggesting that laser lithotripsy is the better intervention choice than pneumatic lithotripsy for clearance of lower ureteral stone.

Discussion

Comparison of patient's baseline variables also had done, which might have influence of the outcome of intervention. The variable chosen was stone impaction, stone size, associated urinary tract infection, renal function and condition of the pelvicalyceal system. None of this variable was found to vary between two groups. So, it is obviously seen that both group are almost identical with the consideration age, sex, stone impaction, stone size, associated urinary tract infection, renal function and condition of the pelvicalyceal. So, it is likely to give us more perfect idea of safety and efficacy of intervention (laser lithotripsy or pneumatic lithotripsy) for the management of the lower ureteric stone.

Post operative variable, stone clearance observed in the present study. Out of 30 cases in Group-A shows immediate stone clearance in 29(96.7%) cases, whereas Group-B shows immediate stone clearance in 24(80.0%) cases, which is lower. Though both groups demonstrated 100% clearance after one month. In a study in China, 285 patients underwent endoscopic removal of ureteric stone with either pneumatic lithotripsy (145 patients) or by laser lithotripsy (140 patients). In one single session, the overall successful stone fragmentation rate of laser lithotripsy was higher than that of pneumatic lithotripsy (95.7% vs. 69.7%; P<0.01).[14]

Ureteroscopic holmium: YAG laser lithotripsy was used in 168 patients of ureteral calculi (mostly lower ureteric stone 108). The stone free rate was 94%(102/108) of lower ureteric stone. The complication rate was 5%(8 cases). They concluded ureteroscopic Holmium: YAG laser lithotripsy is a highly effective and safe treatment modalities.[15] Larizgoitia[16] systematically reviewed the current evidence on the use of Holmium: YAG laser in different area of urology. They treated 160 patients of urinary stone, among them Holmium:

YAG laser causes 97% clearance, on the other hand electrohydrolic lithotripsy causes 65% clearance.

Forty seven (47) ureteroscopic laser lithotripsy were performed in 44 patients (three bilateral stones), out of them 37 patients had stone in the lower ureter. The success rate was 9l%.[17]All these study is shown that Group-A is higher comparable then Group-B, in case of outcome in form of immediate stone clearance. Some of the immediate complication found in study considerably higher in Group-B then those of Group-A. Ureteral injury in Group-B was 16.7% compared to zero percent in Group-A. Out of 30 cases 5 cases had ureteral injury in Group-B compared to nil in Group-A. In the present study, haematuria observed in 6 cases of group-A compared to 13 cases in Group-B. Haematuria in Group-A (20.0%) was more than double then that in Group-B (43.7%). 2 cases had ureterat perforation in Group-B compared to nil in Group A. Ureteral perforation in Group-B was found 6.7% compared to zero percent in Group-A. Fever is also observed 3 times more in Group-A (6.7%) then Group-B (23.3%). The rate of stone migration in Group B (pneumatic lithotripsy) 6.7% and none in Group A (Laser lithotripsy). Stone fragmentation rate in Group A 100.0% and 96.7% in Group B. Li XC et al.[18], in a study showed 3 perforation occurred in pneumatic lithotripsy group (n=201), compare to nil in laser lithotripsy group (n=214).In a study in China, 285 patients underwent endoscopic removal of ureteric stone with either pneumatic lithotripsy (145 patients) or by laser lithotripsy (140 patients), where shown 5 perforations in-group where pneumatic lithotripsy was done (n=145) compare to none in laser lithotripsy group (n=140)and the average time to stone-free status was shorter for laser lithotripsy then for pneumatic lithotripsy (18 days VS 31 days, p<0.001).[14]

Comparison of complication after one month and three months shows some complication in Group-B (ureteral stricture in 3 patients) compare to nil in Group-A. However difference between complications is not significant (p= 0.119). Duration of hospital stay was considered in this study. Mean hospital stay was 2.37 days in group-A and mean hospital stay was 4.27 days in Group-B. More than 90% of patients of Group-A were released from the hospital within 3 days after operation. In contrast only 40% of the patients in Group-B left hospital within 3 days. Longer hospital stay in Group-B occurred because more complication. In a study shows that average post operative hospital stay 2.5±1.7 days in case of pneumatic lithotripsy and 1.0±.05 in case of laser lithotripsy, which is almost comparable to this stud.[19]

As outcome is considered it seen that both study group experienced a favorable outcome. So, laser lithotripsy is better option for the management of lower ureteric stone by using semi rigid ureteroscope, in term of stone migration, rate of stone fragmentation and clearance, operation time, hospital stay and complication.

Conclusion

Laser lithotripsy is better option for the management of lower ureteric stone by using semi rigid ureteroscope, in term of stone migration, rate of stone fragmentation and clearance, operation time, hospital stay and complication also. So, urologist of our country may use laser lithotripsy as energy source for lower ureteral stone management.

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