ORIGINAL ARTICLE

Efficacy and Safety of Holmium: Yag Laser in Comparison with Pneumatic Lithoclast for Ureteric Calculi

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ABSTRACT

Background: Ureterorenoscopy is considered the standard treatment in the management of urolithiasis with pneumatic lithotripter and holmium: YAG (Ho: YAG) laser.
Aim: To assess efficacy and safety of holmium: YAG (Ho: YAG) laser lithotripsy in comparison with pneumatic lithoclast during retrograde ureteroscopy for the management of ureteric calculi of different sizes.
Methodology: Data was collected by recruiting 100 patients of ureteric stone disease admitted in urology department Shaikh Zayed Hospital Lahore, from 25-02-16 to 15-08-16. All ureteric stone patients of both genders included in this study were in the age range of 18 to 60 years having stone size upto 1.5cm.
Results: Stone free rate in Ho: YAG laser group was 94% whereas it was 72% in pneumatic lithoclast group. The difference in the stone free rate was more marked for stones greater than 10 mm of size (80% versus 47.4%, P = 0.07). Overall complication rate was 7.9% (Clavien II and IIIb). There was no complication found with Holmium: YAG laser. The complication rates were not dependent on the size of stone.
Conclusion: The use of the Ho: YAG laser in ureteroscopy appears to be a better tool to disintegrate ureteral calculi independent of stone size.
Key Words: Ureterorenoscopy, Urolithiasis, Holmium:YAG Laser, Ureteric Calculi

INTRODUCTION

Urolithiasis can lead to obstruction of the ureter depending on the stone size, edema in the wall of ureter and the duration of impaction. This may lead to the emergency surgical management of the patient. Mostly patients with stone disease present with colicky pain. Although some time patients remain asymptomatic and are diagnosed on routine screening.[1,2] From the last 30 years, the management of ureteric calculi has changed from the open ureterolithotomy to extracorporeal shockwave lithotripsy (ESWL), ureteroscopy (URS) and endoscopic lithotripsy. Ureteroscopy has become gold standard owing to high stone free rate and low complication rate.[3] Holmium: YAG laser and pneumatic lithotripter both are effective mode of treatment in the management of ureteral stones. Ho: YAG LASER is effective in the fragmentation of the stone and can achieve high stone free rate but there are more chances of postoperative stricture formation. Holmium: YAG laser decreases the operation time and hospital stay in comparison with pneumatic lithotripter.[4,5] The use of Ho: YAG laser seems to be a better tool for disintegration of ureteral calculi independent of primary location[6] but pneumatic lithotripter is preferred by many urologists because of lower cost and easy installation.[7]

In a study conducted by Gurocak et al., both instruments were found to have almost same efficacy with 6 (16%) and 4 (16.7%) patients having clinically significant residual stones at 4 weeks following pneumatic and laser techniques respectively (p=0.83).[8] In another study conducted by Akdeniz and colleagues the pneumatic lithotripsies has higher (p<0.79) stone free rate (89.9%) than laser lithotripsies (87.9%).[9] In another study conducted by Razzaghi and colleagues stone free rate was 82.1% and 100% with pneumatic and laser techniques respectively (p 0.001).[10] The rationale of the present study is to compare the relative efficacy of pneumatic lithotripters and holmium laser for management of stones in the ureter. Currently both modalities (pneumatic and laser) are recommended for ureteral stones. As controversy exists in the above-mentioned studies, the result from this study may prove helpful in deciding the better treatment option for the population.

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MATERIALS AND METHODS

After taking permission from the ethical board of hospital, ureteric stone patients reporting in the department of urology Shaikh Zayed Hospital, Lahore who fulfill the inclusion criteria were included in this study. Merits and demerits of the treatment options were explained to the patients and written informed consents were taken. A or B group were allocated to the patient by using the lottery method. Group A was managed with pneumatic lithotripsy while group B was treated with holmium: YAG laser. Both groups were admitted and surgery was done.URS was performed with semi rigid 9.8-8 Fr. Karlzstore ureteroscope. The calculus was broken by pneumatic lithoclast in group A and holmium: YAG laser in group B. Ureteric stent was left at the discretion of the surgeon. Prophylactic antibiotics were given to all the patients. Patients in each of the two groups were followed up to compare the efficacy of both procedures. Efficacy was assessed on X-ray and ultrasound KUB at four weeks follow up. The research follows a prospective randomized controlled trial design and was set in department of Urology, Shaikh Zayed Hospital, Lahore which is a public sector hospital. The duration of the study was six months. Non-probability consecutive sampling technique was used. 100 cases (50

in each group) were calculated using 80% power of test with 5% level of significance while taking expected percentage of clearance (in terms of no residual stone) in groups as 100% in holmium: YAG laser group and 82.1%[10] in pneumatic lithotripter group for ureteric stones.

As far as the inclusion and exclusion criteria are concerned, those included were patients of age18 to 60 years, patients of both genders (male and female), and patients having ureteric stone (radio opaque shadow on CTU) size less than or equal to 15mm that would require pneumatic lithotripsyor holmium: YAG laser as the primary treatment modality. Those excluded from the study included patients refusing to participate in the study, patients with history of kidney transplant and ureteric implantation (URS not possible due to difficult approach or increase risk of complications), patients with severe musculoskeletal deformities found on general physical examination (difficult positioning), patients having urinary tract infections (cfu/hpf>100000) diagnosed on urine culture and sensitivity(i.e. those having the risk of sepsis) and patients with uncontrolled coagulopathy with INR>1.5 (risk of hemorrhage).

RESULTS

There were total 100 cases of mean age of 38.61±9.37 years (Table 1). When they were evaluated for stone size mean size of stone was 9.42±2.23mm of which the mean stone size of pneumatic lithotripsy was 9.70±2.27 and in the Ho: YAG laser group was 9.14±2.17 (Table 2). On comparison, it was noted that pneumatic lithotripsy was effective in 38 (72%) and Ho: YAG laser in 47 (94%) with a statistically significant difference (p< 0.06) (Table 3). On stratification, it was noted that there is no significant impact of age on the efficacy of the treatment. Ho: YAG laser was effective in 9 (90%) in age group <30 and showed the same results38 (95%) in >40 year of age (Table 4).

But there was significant difference for the size of stone in the treatment groups as lithotripsy was effective in 27 (87%) in stone size of 6-10mm while in 9(47%) in stone size of >10mm with a p-value of <0.05 as significant (Table 5).

Table 1: Distribution of Mean Age in the study participants

	Group of treatment	n	Mean	Std. Deviation
Age of patients	Pneumatic Lithotripsy	50	36.3800	9.67827
	Holmium YAG Laser	50	40.8400	8.57942

Table 2: Distribution of Size of stone in the study participants

	Group of treatment	N	Mean	Std. Deviation
Stone size	Pneumatic lithotripsy	50	9.7000	2.27004
	Holmium YAG laser	50	9.1400	2.17603

Table 3: Comparison of efficacy of treatment in the both groups

		Efficacy of the treatment		
		Achieved	Not achieved	Total
Group of treatment	Pneumatic lithotripsy	36 72.0%	14 28.0%	50 100%
	Holmium YAG laser	47 94.0%	3 6.0%	50 100%

Table 4: Stratification of age of treatment for the ureteric stone

Age group	Group of treatment	Efficacy of the treatment			P value
		Achieved	Not achieved	Total	
18- 30 years	Pneumatic lithotripsy	14 73.7%	5 26.3%	19 100%	0.63
	Holmium YAG laser	9 90.0%	1 10.0%	10 100%	
>30 years	Pneumatic lithotripsy	22 71.0%	9 29.0%	31 100%	
	Holmium YAG laser	38 95.0%	2 5.0%	40 100%	

Table 5: Stratification of stone size of treatment for the ureteric stone

Size of stone	Group of treatment	Efficacy of the treatment		Total	P value
		Achieved	Not achieved		
6-10mm	Pneumatic lithotripsy	27 87.1%	4 12.9%	31 100%	0.04
	Holmium YAG laser	35 100.0%	0 .0%	35 100%	
>10mm	Pneumatic lithotripsy	9 47.4%	10 52.6%	19 100%	0.07
	Holmium YAG laser	12 80.0%	3 20.0%	15 100%	

DISCUSSION

In the management of urolithiasis ESWL has a significant role and also considered the first line of treatment but this treatment is associated with the need to repeat the sessions of ESWL again and again. These patients need frequent hospital admissions. Patients with congenital urinary tract abnormalities are also not good candidates for this mode of treatment. In multiple studies, stone free rate in three months after ESWL was 78% whereas 22% of patients needed reoperations. Certain factors like

inheritance, diet, geographic location and socioeconomic status also affect the stone formation. In endemic areas like South East Asia metabolic factor such as hypocitraturea and hyperuricosurea are also important risk factors for calculus formation. The initial aim of the treatment should be the identification and reduction of these risk factors.[11-14] PCNL (percutaneous nephro-lithotomy), URS (ureterorenoscopy), RIRS (retrograde intra-renal surgery), ESWL (Extracorporeal shock-wave lithotripsy) and their various modifications are the modern management options for the urinary stone patients.

URS using Ho: YAG laser or pneumatic lithotripter is considered as the first-line management option in urinary stone patients.[15,16] According to the emerging guideline in Asian and European countries: the mechanism of action of pneumatic lithotripter is that a metal rod is hit by a metallic ball (using pressurized air)on one end while it pushes the stone on the other end whereas light amplification with stimulated emission of radiation (laser) is the main mechanism of Ho: YAG Laser.[14] Many comparative studies have been done to assess the differences in clinical efficacy between ESWL and URS. Vorreuther et al., studied adult patients with ureteric stones who had undergone ESWL at least once in their life and noted no significant difference among various lithotripsy techniques in terms of complete stone disintegration and residual stones.[14] Menezes et al., also mentioned similar observations in adult patients with ureteric calculi resistant to ESWL.[17] Eden et al., studied differences in stone clearance between various lithotripsy techniques for distal ureteric stones in adults and recommended intracorporeal lithotripsy for smaller (<8mm) while ureteroscopy with lithoclast fragmentation for larger (>8mm) calculi in distal ureter[18]. Due to the poor efficacy of ESWL in fragmenting ureteric stones in one session depicted by low stone-free rates, most of the time patients require a second and often a third session for complete disintegration and clearence.[19] On the basis of these, URS is recommended as the initial urological intervention for appropriate uretericcalculi. In this study, we compared Ho: YAG lithotripter versus pneumatic lithotripter for ureteric stones.

Endourology hasrevolutionized the management of urolithiasis and ureteric endoscopic management is the standard procedure now-a-days. The miniaturization of the ureteroscope, lithotripsy devices has made open surgical interventions mostlyobsolete. Different types of lithotripters are compatible for use with newer ureterorenoscope. Ho: YAG laser and pneumatic lithoclasts are the most frequently used devices during ureteroscopy for stone management throughout the world.[20]

In the current study, the stone free rates of Holmium:YAG laser were much better than that of pneumatic lithoclast (94% and 72%) respectively. These observations are quite similar to the findings of Jeon et al. in 2005 and Tipu et al. in 2007 where they mentioned stone free rates of 96% for laser while 71% for pneumatic lithoclast. Similar results were published by Noori.[20,21,22] In contrast, Bhandri & Basnet in 2011 mentioned stone free rates of 92% and 94% for laser versus pneumatic lithoclast.[23] The superiority of laser lithotripters over pneumatic lithoclasts in terms of stone clearance can be explained by the different nature of fragmentation achieved. The pneumatic lithoclast fragments the stone by physical force which results in varying sizes of fragments with each stroke whereas laser breaks down the stone using heat into much smaller fragments and often results in minute dust-like particles which easily pass in the urine. Similar to the findings of Bhandri & Basnet in 2011 and Grasso et al. in 1996, another paper mentioned stone free rate of 98% (49 patients) in laser group while 94% (47 patients) in pneumatic group. But this result was not statistically significant (p=0.07).[24]

EAU (European Association of Urology) has recommended Ho: YAG laser as the gold-standard intervention for endourological stone fragmentation. This recommendation is based on the evidence of high efficacy of this laser for breakdown and clearance of stones of varying compositions and also because of significantly lower rate of retropulsion when compared with pneumatic lithoclast.[25,26] During the last two decades, the increasing availability of modern flexible ureteroscopes as well as the Ho: YAG laser has revolutionized the management of urinary stones. Pneumatic lithoclast is also an effective technique with good stone clearance and minimal complications.[27]

Ho: YAG laser generates localized heat and therefore is capable of fragmenting almost all stones of any composition or size. With the advent of small diameter flexible fibers, it is able to reach anywhere in the entire urinary tract as it can be used with rigid, semi-rigid or flexible ureteroscopes.[28]Among the intracorporeal lithotripters; Ho: YAG laser breaks the stone into smallest particle size which appear dust-like and may even reach size smaller than 1mm. This evolution in endourology has modified traditional practices for example, routine stenting following URS in patients with complete stone fragmentation achieved using laser is no longer recommended.[29] Although this study may be limited by its smaller sample size, each group however was homogenous with respect to age of patient and size of stone and constituted from consecutive sampling of patients. Therefore, both groups are comparable and the results of efficacy of intervention in each group are true representation of that group. However, the results still need to be validated by a randomized prospective trial on a larger scale.

CONCLUSION

In conclusion, Ho: YAG laser lithotripsy has the advantage over the pneumatic lithoclast in terms of clearance of ureteric stones of size less than 15mm,so we can choose the Ho: YAG lithotripsy as a priority procedure for the removal of ureteric stones.

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