Section A-Research paper
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HOLMIUM: YAG LASER VERSUS PNEUMATIC LITHOCLAST FOR TREATMENT OF UPPER AND MID URETERIC CALCULI: A RETROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Introduction: The upper and mid ureteric stones are the most difficult to treat stones. Because of their chances of drifting back into the renal pelvis during fragmentation. In the present study, we compared the results of holmium laser lithotripsy with the pneumatic lithotripsy in terms of effectiveness, need of ancillary procedure, re-treatment rates and complications.

Material and Methods: This retrospective study was done in two institutes over a period of two years. Group 1 included 80 Ho:YAG laser lithotripsy patients and group 2 included 80 pneumatic lithotripsy patients. The stone clearance was confirmed at 4 weeks and presence of fragments ≤ 2mm were considered as free of stone. Statistical analyses were done by using the Student t-test and Chi-square test.

Results: The mean age of the patients in group 1 was 45.82 years and 46.42 years in the group 2. The stone clearance was higher in the group of Ho:YAG laser ($p = 0.038$). The ancillary procedures were fewer in the Ho:YAG laser group ($p = 0.542$). There was statistically significant difference in the mean fragmentation time and the duration of the procedure in both the groups. There was severe retropulsion in ten patients in the pneumatic lithoclast group.

Conclusion: Holmium:YAG laser lithotripsy and lithotripsy with pneumatic lithoclast are safe procedures for upper/mid ureteric stones. Laser lithotripsy is better and recommended for larger stones as compared to the pneumatic lithotripsy because of lesser stone migration. Both have comparable complication rate.

Keywords: Laser Lithotripsy, Pneumatic lithotripsy, upper ureteric stone, mid ureteric stone, ureteric calculi, urolithiasis

INTRODUCTION:

The incidence of stone disease ranges from 2% and 20%, varying with the socio-economic and geographic conditions [1]. The endoscopic treatment of urinary stones is changing rapidly. Among these, the ureteric calculi, located at any place from the vesico-ureteric junction to the uretero-pelvic junction, have a wide variety treatment options like medical

expulsion therapy, ureteroscopic lithotripsy with pneumatic energy, ultrasonic energy, electrohydraulic energy, holmium and thulium laser energy, push back and PCNL (percutaneous nephrolithotomy), ESWL (extracorporeal shock wave lithotripsy), laproscopic/robotic ureterolithotomy and open ureterolithotomy. None of the above procedure is ideal when the parameters like complete clearance, least invasive, minimal complications – intra-operative and post-operative, duration of stay in the hospital and co-morbidities are taken into consideration. Among the ureteric stones, the upper and mid ureteric stones are the one most difficult to treat. The reason has been their chances of drifting back into the renal pelvis during fragmentation. In the recent times, the success rate of stone fragmentation has been improved by the introduction of holmium and thulium lasers. Both the lasers have comparable success rates. In the present study, we compared the results of holmium laser lithotripsy with the pneumatic lithotripsy in terms of effectiveness, need of ancillary procedure, re-treatment rates and complications.

MATERIAL AND METHODS:

This study was done in two tertiary care institutes situated in Maharashtra – SMBT IMS & RC, Nashik and Medicover Hospital Sangamner, over a period of two years from July 2020 to June 2022. All patients who underwent ureteroscopic lithotripsy for upper/mid ureteric calculi by holmium:yttrium-aluminium-garnet (Ho:YAG) laser (Allenger – Blaze – 30 watt), group 1 and pneumatic lithoclast (Sigma, India), group 2 were included and reviewed retrospectively in the study.

Exclusion criteria:

1. Active urinary tract infection
2. Acute renal failure
3. Coagulation abnormality
4. Stone in pregnancy
5. Skeletal deformities leading to difficulty in positioning
6. Ureteric stricture
7. Paediatric patients
8. Not willing to participate in the study

Operative technique

We used semirigid 7 Fr Storz ureteroscope (Storz, Tuttlingen, Germany) and 6/7.5 wolf ureteroscope (Wolf, Knittlingen, Germany). All patients were operated in reverse Trendelenburg position. Peri-operative intravenous antibiotics were given to all patients. The anaesthetist was asked to give injection furosemide 20 mg at the start of the procedure in all cases. The pressure of the saline was decreased by decreasing the height of the saline bottle. After lithotripsy was done, the bigger fragments were removed and the smaller ones were left for spontaneous passage. A 5/26 Fr double J stent was inserted at the end of the procedure. The stone clearance was confirmed at 4 weeks and presence of fragments $\leq$ 2mm were considered as free of stone.

Statistical analyses

Statistical analyses were done by using the Student t-test and Chi-square test. A p value of <0.05 was considered as statistically significant.

RESULTS:

A total of 160 patients, 80 in each group of Ho:YAG laser (group 1) and the pneumatic lithotripsy (group 2), were included in the study. The mean age of the patients in group 1 of

Ho:YAG laser was 45.82 years and 46.42 years in the group 2 of pneumatic lithotripsy. The stone burden and the stone size in both the groups were not statistically significant. Double J stent was inserted in all the patients. The stone clearance was higher in the group of Ho:YAG laser (95% vs 85%, p = 0.038). The ancillary procedures were fewer in the Ho:YAG laser group (10% vs 22.5%, p = 0.542), though not statistically significant. The mean stone size was 12.18 mm and 11.89 mm in the Ho:YAG laser and the pneumatic lithoclast groups respectively. There was statistically significant difference in the mean fragmentation time and the duration of the procedure in both the groups (Table 1). There was only mild retropulsion of the stone during fragmentation in the Ho:YAG laser group in six patients while there was severe retropulsion in ten patients in the pneumatic lithoclast group (Table 2). The overall number of complications were more in the pneumatic lithotripsy but these were not statistically significant (Table 1).

Table 1: Demographic data of patients in both holmium laser lithotripsy group and pneumatic lithotripsy group.

Characteristics		**Holmium**	**Pneumatic**	**p-value**
Age in years	Mean ± SD	45.82 ± 13.10	46.42 ± 11.23	0.42
	Range	18-94	18-89	
Sex, n (%)				0.684
Male		62(77.5)	68(85)	
Female		18(22.5)	12(15)	
Side, n (%)				0.810
Left		48(60)	54(67.5)	
Right		32(40)	26(32.5)	
Stone location, n (%)				0.712
Upper ureter		66(82.5)	62(77.5)	
Mid ureter		14(17.5)	18(22.5)	
Size of stone (mm) (Mean ± SD)		12.18±11.12	11.89±13.12	0.892
Stone density HU(Mean ± SD)		1083±258.02	1026±201.04	
Mean fragmentation time (minutes) (Mean ± SD)		8.24±3.21	15.18±4.82	0.041
Duration of procedure (Mean ± SD) in minutes		23.5 ± 5.8	31.6 ± 6.3	0.043
Ancillary procedure		8(10)	18(22.5)	0.542
PCNL		2(2.5)	12(15)	
URS		6(7.5)	6(7.5)	
Complication n (%)	Early(Clavien grade I, II,)	4 (5)	10 (12.5)	0.631
	Late (Ureteric Stricture)	1 (1.25)	1 (1.25)	
Stone clearance at 4 weeks		76(95)	68(85)	0.038

Table 2 Comparison of degree of retropulsion of stone in both the groups

Group	Likert scale for grading of stone retropulsion		
	0 No retropulsion	1 Mild retropulsion but allowed fragmentation	2 Severe retropulsion which made fragmentation difficult
Ho:YAG laser, n (%)	74 (92.5)	6 (7.5)	
Pneumatic lithoclast, n (%)	48 (60)	22 (27.5)	10 (12.5)

DISCUSSION:

Improvements in the instrument design and the miniaturization has changed our focus from the era of ESWL (extra corporeal shock wave lithotripsy) as the first choice for the upper/mid ureteric calculus to semi-rigid ureteroscopy with stone fragmentation as the first choice for the upper/mid ureteric stone. Currently, there are only two modalities to deal with the stone during ureteroscopy in India – laser lithotripsy and pneumatic lithotripsy. Pneumatic lithotripsy act by the jack hammer effect, where the pneumatic force causes the stone to fragment alongwith the higher chances of upward migration of the stone [2]. On the other hand, Ho:YAG laser causes the stone disintegration by photothermal mechanism which acts locally on the stone, where the force is very less to propel the stone upward. Therefore, very less chances of drifting the stone upward [2]. The Ho:YAG laser is a solid state laser system that can fragment stone of any composition [3]. These characteristics of Ho:YAG laser leads to better stone treatment results [4,5,6]. We also have the similar results. We had very good stone clearance at four weeks, although our criteria for stone-free was stone fragment <2mm. This was, infact, better than A R Abedi et al [7] and similar to other studies [3,8,9]. We used 550µm fibre with energy setting at 1.0 Joule at a frequency of 12-15 Hertz. This could explain our better performance as larger laser fibre and higher energy settings cause more stone migration [10]. Different authors have used different settings for good results [3,7,8].
The upward stone migration was higher in the pneumatic lithotripsy group similar to Li Chen Chen et al [11]. The rate of retropulsion in our study was 27.5% for mild retropulsion where we were able to fragment the stone completely. This happened because we used minimum pulse energy which was more helpful in stone fragmentation and decreasing the retropulsion. Galeti E H et al used swiss lithoclast in their study and had a retropulsion rate of 12 % and 8% in the pneumatic and laser lithotripsy groups respectively which needed ancillary procedure [3]. The retropulsion was severe in 12.5% cases in our study which needed an ancillary procedure. We used all the ways to prevent stone retropulsion like use of 0.8mm probe for pneumatic lithoclast, pressure of 2 bars, decreasing irrigation water pressure, reverse Trendelenburg position and use of basket and trapping devices, etc.

We stented all our patients as most of our patients had long duration obstructed stones with ureteral oedema, few had mild renal insufficiency and, in few cases, sizeable fragments were left. This also brought uniformity to all the patients in addition to ordered healing. These indications were among the various indications mentioned by different authors to keep the double J stent post-operatively [12]. Noor H H et al and Pankaj Trivedi also stented all patients routinely in their study [8,13].

Rahul Jaggi et al [14] in his study proved laser lithotripsy better than the lithoclast for stone clearance with lesser complications. We also got the similar results.

Li Chen Chen et al [11] had a statistically significant difference in the secondary intervention rate among the laser and the pneumatic lithotripsy groups for stones more than 10mm. We had a greater number of ancillary procedures in the pneumatic lithotripsy group as compared to the laser lithotripsy group but it was not statistically significant in our study.

Except Li et al [15] whose study had higher stricture rate, other studies suggested similar stricture rate with the laser lithotripsy group [16]. We also found no significant difference in the ureteric stricture rate during the one year follow up.

Regarding complications in both the groups, we had more number in the pneumatic lithoclast, the difference was not statistically significant, 5% and 12.5% in the laser and the pneumatic lithotripsy groups, respectively. All were Clavien grade I and II. S M Rabani et al and Chunlin et al also had no significant difference in the complication in both the groups [16,17].

Overall, the success rate was good in the laser lithotripsy group with good safety and efficacy as mentioned in the meta-analysis review by Shulian Chen et al [18] but was comparable in the pneumatic lithotripsy group.

The limitations of our study are mainly the retrospective nature, only two centres included, wide age range and the shorter follow-up. Prospective randomised and controlled trials may further add to this.

CONCLUSION:

Holmium:YAG laser lithotripsy and lithotripsy with pneumatic lithoclast are safe procedures for upper and mid ureteric stones. Laser lithotripsy is better and recommended for larger stones (12.18 mm) as compared to the pneumatic lithotripsy (11.89mm) because of lesser stone migration, otherwise pneumatic lithotripsy is a good, cheap and safe option where laser machine is not available. Both have comparable complication rate. Laser is considered as an expensive source of energy due to the initial cost of the equipment while pneumatic lithotripsy is durable and pocket friendly.

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Conflicts of interest:- None

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