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Original Research Article

A Hospital Based Prospective Comparative Assessment of the Efficacy of Laser vs Pneumatic Lithotripsy for Mid and Distal Ureteric Stone: A Comparative Study

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Abstract

Aim: The aim of the study was to compare the efficacy of the laser versus pneumatic lithotripsy.

Methods: This was a hospital based prospective comparative study conducted in department of Urology, Igims, Patna, Bihar, India for the period of one year. A prior informed and informed consent was taken from all eligible patients. Patients with mid or distal ureteric calculi of 5 mm or more, or failed medical management were included in the study. Stone size less than 5 mm, nephrolithiasis on same side of ureteric stone, pregnancy, bleeding disorder and patient not giving consent were excluded from the study. 100 cases were studied over the period of one year and divided into two groups, pneumatic and laser group.

Results: There was no significant difference in male to female ratio in both groups (60% male in group 1 vs 70% male in group 2). The stone clearance at 6 weeks was seen in more patients in laser group (96%) than in the pneumatic group (84%). When both the groups were compared, the result was statistically significant (p= 0.022). When two techniques were compared for the stone clearance for mid ureteric stone, it was found that 92% in laser group had complete stone clearance in contrast to 80% in pneumatic group and the difference was statistically significant. Similarly when stone clearance rate was compared for distal stone, 100% patients in laser group and 90% in pneumatic group achieved the stone clearance at 6 weeks follow up however it was statistically not significant.

Conclusion: In conclusion, according to our results, by using both techniques, acceptable results were achieved. However, in the pneumatic group, the duration of operation was shorter and the cost was less than LL. There was no major complication with any statistically significant differences between the 2 groups.

Keywords: Holmium: Yttrium Aluminium Garnet laser, Intra corporeal lithotripsy, Pneumatic lithotripsy, stone clearance

Introduction

The main objective of stone treatment is to achieve the highest stone-free rate (SFR) with minimal morbidity. In a market of highly sophisticated materials and equipment, the costs incurred to achieve a stone-free status must be taken into consideration. This is particularly true in developing countries, where healthcare systems are subsidised by governments. In the absence of a national healthcare insurance system, patients may be expected to contribute financially to their care. [1] Management of large ureteric stones (>10 mm) represents a treatment challenge for physicians. The selection of an appropriate treatment strategy depends upon several factors including stone size, stone composition, the presence of obstruction, as well as patient anatomy and surgeon experience. The availability of materials and financial factors also have to be considered. [2,3] Open and laparoscopic surgical removals are considered highly morbid in relation to minimally invasive procedures; yet, in cases with associated anatomical abnormalities or in presence of ureteric strictures, conventional surgery is a valid option. Shockwave lithotripsy (SWL) produces excellent results in terms of SFR for proximal ureteric stones, yet in mid and distal stones SWL is hindered by overlying viscera and underlying bony structures. [3-5]

Miniaturization of endoscopic devices in urology and extracorporeal shock wave lithotripsy (ESWL) has revolutionized the management of ureteral stones. Lithotripsy techniques such as holmium: yttrium-aluminum-garnet (Ho: YAG) laser lithotripsy (LL) and pneumatic lithotripsy (PL) have been introduced as the newest treatment methods, improving the success rate while decreasing complications. Ho: YAG laser is a modality used for the treatment of urinary and biliary stones which can work with frequencies of up to 50 Hz and can be used with very fine fibers of up to 200 microns. [6] Recently, there has been an increase in the use of the Ho: YAG laser for TUL due to its fewer complications and lower incidence of stone upward migration. [7] With the improvement in surgical skills and technological advancement of the endoscopic instruments, management of ureteral stones has changed from more invasive open surgeries to less or minimal invasive endoscopic lithotripsy. [8] Pneumatic and laser lithotriptors are most preferred in ICPL during endoscopic management of ureteral stone. [9] The Ho:YAG laser can vaporize as well as coagulate the tissues. [10] The thermal effect produced by Ho:YAG laser's pulses are due to formation of plasma bubble. [11] It has a wide range of endoscopic applications, and has demonstrated effectiveness in clearing stones of all compositions. [12]

The aim of the study was to compare the efficacy of the laser versus pneumatic lithotripsy.

Materials and Methods

This was a hospital based prospective comparative study conducted in department of Urology, Igims, Patna, Bihar, India for the period of one year. A prior informed and informed consent was taken from all eligible patients. Patients with mid or distal ureteric calculi of 5 mm or more, or failed medical management were included in the study. Stone size less than 5 mm, nephrolithiasis on same side of ureteric stone, pregnancy, bleeding disorder and patient not giving consent were excluded from the study. 100 cases were studied over the period of one year and divided into two groups, pneumatic and laser group.

Mid or distal ureteric calculus patients confirmed by clinical history, examination and ultrasonography, X-Ray KUB, CT KUB, were selected. All selected patients were subjected to routine preoperative investigations along with Urine routine

microscopic examination and Urine culture sensitivity. On the basis of Quasi random sampling 65 patients were selected for pneumatic ureteroscopic lithotripsies while other 65 for laser lithotripsy. In laser Group, Ho: YAG laser lithotripsy(Lumenis) was performed by a rigid 7.5 or 8.5 Fr ureteroscope and the same size of ureteroscope was used with a pneumatic lithoclast in pneumatic group. The pneumatic settings were up to five bar and the frequency 10 Hz. The laser generater was of 100W. The laser settings were 0.6-1.0J per pulse and the frequency 8-12Hz. 6 Fr double J stent, was placed at the end of the procedure in every cases. Time duration of each operative procedure was noted. X ray KUB was done on 1st post-operative day to see the position of DJ stent. Patients were asked for follow up after 6 weeks. Review X ray KUB or USG KUB was done at six weeks to look for any residual stone. When X ray KUB was used to look for residual stone, X ray was taken on true magnification and size of stone was measured. Patients were considered stone-free when no stone >3 mm visualized or stone < 3mm visualized.

Statistical Analysis

Data was collected according to the proforma and entered in Excel and was analyzed by using SPSS software 21 version. Chi-square test and independent sample t-test was used for statistical analysis. p- value <0.05 was taken as significant.

Results

Table 1: Demographic and Clinical Characteristics of Patients

Group	**Laser**	**Pneumatic**	***P* Value**
Mean age ± SD, y	42.48 (± 14.2)	41.39 (±12.8)	0.75
Male, n (%)	30 (60%)	35 (70%)	0.425
Stone clearance			
Successful stone clearance	48 (96%)	42 (84%)	0.022
Failure	2 (4%)	8 (16%)	
Site of stone			
Mid ureteric	46 (92%)	40 (80%)	0.041
Distal ureteric	50 (100%)	45 (90%)	0.151

There was no significant difference in male to female ratio in both groups (60% male in group 1 vs 70% male in group 2). The stone clearance at 6 weeks was seen in more patients in laser group (96%) than in the pneumatic group (84%). When both the groups were compared, the result was statistically significant (p= 0.022). When two techniques were compared for the stone clearance for mid ureteric stone, it was found that 92% in laser group had complete stone clearance in contrast to 80% in pneumatic group and the difference was statistically significant. Similarly when stone clearance rate was compared for distal stone, 100% patients in laser group and 90% in pneumatic group achieved the stone clearance at 6 weeks follow up however it was statistically not significant

Table 2: Preoperative Stone Data in Patients in Both Groups

Group	Laser	Pneumatic	*P* Value
Mean stones size (mm)	9.31 (± 4.6)	9.41 (± 4.8)	0.42
Stone lateralityRight side Left side	20 30	22 28	0.40
Stone location Proximal Middle Distal	 15 7 28	 16 6 28	0.85
Stone numbers One Two More than two	 44 2 4	 46 3 1	0.82
Stone diameter <7 mm 7-10 mm > 10mm	 5 38 7	 5 36 9	0.50
Duration of stoneimpaction <7 days 7-21 days >21 days	 10 38 2	 7 40 3	 0.80

Various characteristics of ureteral stone were compared in both groups including stones' size, laterality, location, quantities, diameter and duration of stone compactions. These stone's characteristics achieve no significant difference in both groups (all P values were more than 0.05).

Table 3: Patients' Intraoperative and Postoperative Data

Group	Laser	Pneumatic	*P* Value
Mean operation time (min)	35.5 (± 10.30)	26.44(±8.42)	<0.001
Complications			
Mucosal damage	1	2	0.2
Residual or escaped stones	8	8	0.7
Mean hospital stay (day)			0.60
Out patient	18	20	
One	24	24	
More than one	8	6	

The significant difference was observed between the mean operation time of 2 groups (35.5 (± 10.30) minutes in group 1 vs 26.44(±8.42) minutes in group 2, P value was <0.001). Mean hospital stay was the same in both groups (1.2 days). No significant differences were seen in intra- and postoperative complications between 2 groups.

Discussion

The management of stone disease has been revolutionized. The miniaturization of scopes and sophistication of medical instrumentation is driving urological practice into a high-technological performance with its economic impact, particularly in developing countries. [13] URS with lithotripsy is the benchmark treatment for large mid-ureteric stones.

Despite the availability of several energy sources, pneumatic and laser energy are favoured for their high SFRs (>90%) [14] and lower morbidity rates. [13,15]

There was no significant difference in male to female ratio in both groups (60% male in group 1 vs 70% male in group 2). The stone clearance at 6 weeks was seen in more patients in laser group (96%) than in the pneumatic group (84%). When both the groups were compared, the result was statistically significant (p= 0.022). When two techniques were compared for the stone clearance for mid ureteric stone, it was found that 92% in laser group had complete stone clearance in contrast to 80% in pneumatic group and the difference was statistically significant. Similarly when stone clearance rate was compared for distal stone, 100% patients in laser group and 90% in pneumatic group achieved the stone clearance at 6 weeks follow up however it was statistically not significant. Operative time was significantly longer when pneumatic lithotripsy was used, which is discordant with most published literature. [16,17] This difference is related to the combined fragmentation/ dusting technique used with the laser, this results in smaller fragments, thus reducing the need for fragment retrieval in comparison to pneumatic lithotripsy in which additional time is needed for retrieval of relatively larger stone fragments. Due to the small laser fibre size compared with the pneumatic probe, better irrigation and consequently vision can be achieved.

According to some studies, PL used for TUL requires a wider straight working channel, and upward migration of the stones is a major drawback, especially for upper ureteral calculi [18]; therefore, it can be used only within a rigid probe. There is no electricity and little heat energy is produced which cause no adverse thermal damage to ureteral mucosal layer. [19] Dolowy et al in their study concluded that this therapeutic technique was a versatile tool in all field of urology. Due to its viability, by reducing its cost, laser equipment will become a mandatory and indispensable asset in all urology wards. [20] Fallah Karkan et al in their study about the clinical potency of the Ho: YAG laser on ureteral stones, based on its fiber caliber, concluded that all 3 types of laser caliber (200 Mm, 365 Mm, and 500 Mm fibers) had great efficacy in stone fragmentation, however; by increasing the laser caliber, the stone-free rate would significantly increase. [21]

Various characteristics of ureteral stone were compared in both groups including stones' size, laterality, location, quantities, diameter and duration of stone compactions. These stone's characteristics achieve no significant difference in both groups (all P values were more than 0.05). The significant difference was observed between the mean operation time of 2 groups (35.5 (± 10.30) minutes in group 1 vs 26.44(±8.42) minutes in group 2, P value was <0.001). Mean hospital stay was the same in both groups (1.2 days). No significant differences were seen in intra- and postoperative complications between 2 groups. Maghsoudi et al showed that Ho: YAG laser had more advantages over PL due to a higher efficacy of stone free rate and a lower rate of upward displacement of ureteral stones, while their complications were the same and very rare. [22] Razzaghi et al conducted a review of the literature on laser application in Iran and revealed that this technology has not yet found its position in Iran, especially in the field of urology, it might be due to problems in accessibility of laser devices and inadequacy of knowledge about this technology. [23]

Conclusion

In conclusion, according to our results, by using both techniques, acceptable results were achieved. However, in the pneumatic group, the duration of operation was shorter and the cost was less than LL. There was no major complication with any statistically

significant differences between the 2 groups.

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