E-ISSN 2250-0944
ISSN 2250-1150

doi:10.48047/ijprt/15.02.54

Article type: Original Article

ASSESS THE COMPLICATIONS AND OPERATING TIME TAKEN BY HOLMIUM LASER AND PNEUMATIC LITHOTRIPSY USING SEMIRIGID SCOPE IN MANAGING URETERIC CALCULUS

Mohit Kumar Patel[1], Tushar Dani [2], Dipak Purohit[3], Sanscriti Tripathi[4*]

[1]Associate Professor, , [2,3]Assistant Professor, [4]Senior resident, Department of General surgery, Raipur Institute of Medical Science, India

***Corresponding Author and reprint request to: Dr. Tushar Dani, Assistant Professor, Department of General Surgery, Raipur Institute of Medical Science, India**

Toshu2705@gmail.com

Received date: 05-July-2025, Accepted date: 13-July-2025, Date of Publication: 14-July-2025.

ABSTRACT

Background: Technology has made it possible to successfully access and treat virtually any stone within the ureter in a relatively atraumatic fashion. Different lithotriptors can be used for intracorporeal lithotripsy including electrohydraulic (EHL), ballistic (pneumatic), ultrasonic (US), laser (Ho: YAG). In the last few years lasers have been increasingly replacing others for intracorporeal lithotripsy.

Objective: To assess the complications i.e. Up migration rates, mucosal injuries and perforation caused by both techniques and to assess the operating time taken by both techniques in managing ureteric calculus**.**

METHODS: In the present study, we have analyzed and compared two most commonly used energy sources for lithotripsy i.e. Pneumatic and Ho-YAG laser in terms of - stone free rates (immediate & overall), complications & operating time ,over a period of two years from July 2015 to June 2017. On analysis of our data with various studies in the literature, we came across the following findings.

RESULTS: Most common age group of presentation was 31-40 years of age group with male preponderance as compared to women as male work outdoors in the hot and humid climate as is in south western coastal India, which could be one of the contributing factor. Most common location of stone in our study was in upper ureter. Most frequently encountered stone size was 11-15 mm range. Majority of stones were radioopaque. Intraoperative complications such as ureteral perforation was encountered in only one patient who underwent pneumatic lithotripsy. Other complications, such as mucosal injury, postoperative fever and hematuria were comparable in both groups.

CONCLUSION: Although the various endoscopic modalities for fragmenting stones have their advantages and disadvantages the holmium laser and pneumatic lithotripters are most widely used for management of ureteric stones. Operating time was higher with laser as compared to pneumolithotripsy because of longer contact time for fragmentations. In term of complications, such as, upmigration, mucosal injury, ureteral perforation and postoperative hematuia & fever, there was no statistically significance difference between the two groups.

KEYWORDS: Complications and Operating Time, Laser lithotripsy, Pneumatic lithotripsiy, Ureterorenoscopy

INTRODUCTION

The *Charak Samhitā* contains sufficient but scattered matter pertaining to anatomy, physiology and pathology of urinary calculi (*Mutravaha aşhmari*) as well as the diagnosis and treatment of its disorders. The *Sushruta Samhitā* is the pioneer text in surgery and it contains more descriptive explanations as far as the anatomy and physiology of *Mutravaha aşhmari* is concerned[1]. Urolithiasis is the existence of stones in the urinary system characterized by the symptomatic manifestations of many metabolic turbulences that are due to the pathological parameters and their interactions. Two most common lithotripters used in urologic fields are pneumatic and Ho:YAG laser. Pneumatic lithotripsy is more popular among the urologists because of its low cost, easy setup, and high success rate.[20]Nevertheless, proximal migration of calculi may be a limiting factor of this method[2].Ho:YAG laser is a reliable method for the treatment of ureteric stones especially in proximal and impacted ureteric stones, but it is expensive and not available

in most of the urologic centers[3].The Swiss Lithoclast (a pneumatic lithotripter), originally developed at the University Teaching Hospital in Lausanne,Switzerland, is based on a jackhammer principle.[4]

A projectile in the hand piece is propelled by compressed air through the probe. The compressed air originates from a small generator that is connected to a dry, clean air supply. The ballistic energy produced is conveyed to the probe base at a rate of 12 Hz.[5] Continued impaction of the probe tip against the stone results in stone breakage once the tensile forces of the calculus are overcome. *Laser* is an acronym for light amplification by *s*timulated emission of radiation, The Holmium: Yttrium, Aluminum, Garnet laser (holmium:YAG laser) was developed in early 1990s.[6] The holmium: YAG laser is transmittable via flexible fibers. The thermal effect produced by holmium: YAG laser's pulses are due to formation of plasma bubble.[7] Holmium laser lithotripsy occurs primarily through a photo thermal mechanism that causes stone vaporization.[8]

For many years, the therapeutic options for the ureteral stones advance from open ureterolithotomy to least invasive methods like extracorporeal shock wave lithotripsy, laparoscopic lithotomy and ureteroscopic lithotripsy.[9] Of them, ureteroscopic lithotripsy has less number of contraindications and this procedure can be done in most of cases barring those with serious constriction of the ureters that can hinder the advancement of scope.[10] On account of good success rate in the removal of stones and less risk, ureteroscopic procedures are preferred in the treatment of ureteric calculi suggested by various studies.

Various lithotripters like ultrasonic, laser, electrohydraulic, and pneumatic can be used for ureteroscopic lithotripsy procedures. Among them, pneumatic lithotripsy (PL) and Ho-YAG laser lithotripsy (LL) are the preferable methods.[11] The LL is more desirable on the merits of flexibility and fragmentation.[12]But, some scholars believed that PL was as good as LL in breaking the calculi effectively together with the benefits of being easily installable and cost-effective.[13] For the past 10 years, the information available in order to assess the safety and efficiency of LL and PL are indecisive.[12,13] However in the year 2013, a meta-analysis done by Yin et al[14] on 4 trials and 295 patients until the year 2012, established that LL yielded a better success rate in the stone clearance and less migration in comparison with PL.

Even though numerous studies have carried out the research in terms of using pneumatic and Ho:YAG laser, however, they did not give any clear evidence on superiority of one over other in terms of efficacy and safety.[15,16] There are few studies to compare these two techniques and previous studies comparing these two methods were done in smaller population and number of surgeons operating was not specified which can lead to operator bias depending on operator's comfort and experience. Hence the present study aimed to evaluate the results of Lithotripsy with these two methods according to their stone-free rates, operating time and complications in a larger population and with a single operator to eliminate operator bias.

MATERIALS AND METHODS

This prospective randomized comparative study was carried out at Kasturba Medical College Hospital, Dr. B. R Ambedkar Circle, Mangalore, Karnataka. The study population included the patients admitted with diagnosis of single, unilateral ureteric calculus in the department of urology at the study site mentioned above. The study was carried out over a period of two years from July 2015 to June 2017. Ethical clearance was obtained from the institutional ethical committee for the present study. A total sample size of 120 patients was taken {60 in each arm, PL arm (pneumatic lithotripsy) and LL arm (laser lithotripsy)}.

Inclusion criteria:

- All patients with single ureteric calculus of size 7 mm to 20 mm were included in the study

Exclusion criteria:

- Patient's with infected Hydroureteronephrosis
- Patient's with associated UTI and Sepsis
- Patient's with ureteric stricture
- Patient's with associated renal stones

METHODOLOGY

The patients diagnosed with single, unilateral ureteric calculus disease with appropriate imaging studies (X-ray KUB/USG KUB and NCCT /CECT Urogram) were included into the study after informed consent. A detailed history was obtained.

All patients underwent URSL (ureterorenocopic lithotripsy) with DJ stenting by one designated surgeon, well versed with both the techniques, either by Pneumatic lithotripsy or Laser lithotripsy (PL group and LL group).

A retrograde pyelogram was performed, and a safety guide wire was placed into the renal pelvis. The lower ureter was dilated with a 6/12F Nottingham dilator under fluoroscopic control**.** Under appropriate anaesthesia in lithotomy position, Ureterorenoscopic lithotripsy was performed in a standard fashion with a 8/9.5F semirigid ureteroscope (Karl Storz). The ureteroscope was advanced up the ureter, and the ureteral lumen was inspected for location of stone, appearance of stone,stone impaction, inflammatory polyps and for any other abnormal findings. Swiss Pneumatic lithoclast with 1mm probe was used to fragment the stone with either single or continuous pulses and pressure was set at 2 bars in PL group. In LL group stone was fragmented using LISA Sphinx (LISA laser, Germany) holmium laser (100 watts). The laser fiber used was 272/420 *u*m, Laser energy was generally applied at an initial setting of 0.6 to 0.8 joules (J) energy at a frequency of 8 to 10 hertz (Hz) and increased incrementally by 0.2 J as necessary. We started with the low-power setting and then increased according to stone hardness. To prevent stone up migration during fragmentation a zero-tip nitinol stone basket (Boston Scientific) was used in both groups as deemed necessary. An attempt was made to retrieve all stone fragments using a grasper or basket**.** In order to maintain a clear ureteroscopic view, irrigation was pumped manually and intermittently during the procedure. After stone fragmentation, final ureteroscopy was performed to detect any residual stone (approximate assement of size was done with tip of lithoclast probe or laser fibre accordingly) or injury to the ureter (mucosal injuries, perforation). Operating time was calculated from first hit to last hit. 11 A 5 Fr. Double J stent was indwelled in all patients at the end of the procedure. On table fluoroscopy was performed for reassessing any residual fragments or up migration in immediate

post operative period. Endoscopic and fluoroscopic scrutiny was done to asses immediate clearance rate..

Ultrasound abdomen and pelvis and X ray KUB was done prior to scheduled time of DJ stent removal after 2 weeks, to check for the clearance of calculus or any residual fragments.

Statistical analysis: A statistical package for social science (SPSS) vers.20.0 was used to analyze the data. Additionally, descriptive statistics was carried out to describe the negative or positive result of the patients and ANOVA was determined from each gender. The continuous data were expressed as mean ± SD, while the categorical data were expressed as percentage. P value of <0.05 was considered as significant.

RESULTS

Our study included 120 patients of sinlge, unilateral ureteric calculus who were treated in Kasturba Medical College and allied Hospitals, over a period of two years from July 2015 to June 2017.

Of the 120 patients in our study population 94 (78.3%) were males and 26(21.7%) were females. The male to female ration was 3.6: 1.

Table 1: Age Distribution

Age Group (years)	No. of cases n (%)	Mean±SD
≤ 20	3 (2.5%)	**46.38±14.037**
21-30	15(12.5%)	
31-40	28(23.3%)	
41-50	25(20.8%)	
51-60	27(22.5%)	
61-70	18(15%)	
≥70	4(3.3%)	
Total	**120(100%)**	

Table 2: Comparison of Mean Stone size with energy source used for fragmentation

	Age **Mean±SD** **(years)**
Laser Lithotripsy Group (n=60)	48.45±13.95
Pneumatic Lithotripsy Group (n=60)	44.32±13.93

Of the total 120 cases, majority 23.3% (38) of the cases belonged to 31-40 years of age group followed by, 22.5%(27) of cases were in 51-60 years age group. Least frequent group was ≤ 20 years age group with 2.5 % (3) incidence. Mean age distribution was 46.38 ± 14.037 years , with eldest and youngest patients being 79 and 19 years old respectively.

Table 1: Presenting complaints

	No. of cases **n (%)**	
	Yes	**No**
Loin pain	118 (98.33%)	2 (1,66%)
Fever	7 (5.8%)	113 (94.2%)
Hematuria	6 (5.0%)	114 (95.0%)
Nausea	7 (5.8%)	113 (94.2%)
Scalding voiding	8 (6.7%)	112 (93.3%)
Vomiting	5 (4.2%)	115 (95.8%)
Poor urinary stream	1 (0.8%)	119 (99.2%)
Diffuse pain	1 (0.8%)	119 (99.2%)

Most common presenting complaints in our study population was loin pain in 98.33 % (118) cases, followed by Scalding voiding and Fever in 6.7%(8) & 5.8%(7) patients respectively

Table 2: Preoperative Imaging modality used prior to intervention

	No. of cases n (%)
X-ray KUB+USG	97(80.8%)
X-ray KUB & USG + IVU	1(0.8%)
X-ray KUB+USG+CT KUB	22(18.3%)

In our study ,Combination of X ray KUB & USG was used as the most common imaging modality in 80.8%(97) patients. CT KUB was added imaging in 18.3% (22) patients while IVU was used in one of our patient.

In our study 43.33 % (52) patients had upper ureteric calculus while least common location of stone was mid ureteric in 18.33% (22) patients.

Table 5: Distribution of stone based on size

Size of stone	**No. of cases n (%)**
7 - 10mm	50(41.7%)
11 - 15mm	62(51.7%)
16 - 20mm	8(6.7%)
Total	120(100%)

As an indication of intervention stones of size more than 7 mm were considered, which was also inclusion criteria of our study .50 (41.7%) patients had stone of size range 7 - 10 mm, while 62 (51.7%) had stone of size range 11 to 15 mm. Stone of size range 16-20 mm was found in 8 (6.7%) patients. Patients with stone size > 20 mm were excluded from study.

Table 6: Comparison of Mean Stone size with energy source used for fragmentation

Energy Source Used	**Stone size** **Mean±SD** **(mm)**
Laser Lithotripsy Group (n=60)	11.42±2.59
Pneumatic Lithotripsy Group (n=60)	11.18±2.75

p value 0.633

In our study mean stone size was Table 6 shows the difference in mean stone size between energy source used. There was no significant difference in the mean stone size between energy source used.

Out of 120 patients in our study, 99 (82.5%) had radioopaque stones while 11(17.5%) had radiolucent stones.49 of 60 (81.7%) patients randomized to laser lithotripsy group had radioopaque stones while 50 of 60 (83.33%) patients in pneumatic lithotripsy group had radioopaque stones.

Table 7: Comparison of Operating time (min) with the Energy Source Used in fragmentation

Operating time (min)	**Energy Source Used**		**Total n (%)**
	Laser Lithotripsy group n(%)	**Pneumatic Lithotripsy group n(%)**	
≤10 min	13(21.7%)	48(80%)	61(50.8%)
10-20 min	45(75%)	11(18.3%)	56(46.6%)
21-30 min	2(3.3%)	1(1.7%)	4(2.5%)

In our study 48 of 60 patients (80%) in the pneumatic lithotripsy group had operating time range of ≤10 min, while it was noted only in 13 of 60 patients (21.7%) in laser lithotripsy group. In the

Laser lithotripsy group majority of patients (45/60,70 %) had an operating time range of 10-20 min, which was noted only in 11 of 60 (18.3%) patients of pneumatic lithotripsy group.> 20 min operating time was required in 2 & 1 patient in laser and pneumatic lithotripsy groups respectively.

In our study Laser Lithotripsy group had a higher mean operative time (12.45±5.17 min) while Pneumatic Lithotripsy group had a lower mean operative time (7.08±4.93 min).On statistical analysis p value was found to be <0.01, which was statistically significant in our study.

It was observed that 86.4% and 91.7% of the patients in Laser Lithotripsy and Pneumatic Lithotripsy group respectively did not have any significant difficulty in visibility due to bleeding or stone dust (snow storm effect) during fragmentation. Numerically laser arm had more visibility issues (9 cases) as compared to pneumatic lithotripsy arm (5 cases), however on calculating p value, the difference was not statistically significant between 2 arms.

Table 8: Comparison of Intra Operative Complications - Up migration/Mucosal injury/Perforation and energy source used

Intra Operative Complications - Up migration/Mucosal injury/Perforation	**Energy Source Used**		**Total**	**p value**
	Laser Lithotripsy group (n=60)	**Pneumatic Lithotripsy group (n=60)**		
Nil	48 (80.0%)	49 (81.7%)	97 (80.8%)	0.440 (N.S)
Up migration	3 (5.0%)	6 (10.0%)	9 (7.5%)	
Perforation	1 (1.7%)	0 (0.0%)	1 (0.8%)	
Mucosal Injury	8 (13.3%)	5 (8.3%)	13 (10.8%)	
Total	**60 (100.0%)**	**60 (100.0)**	**120 (100.0%)**	

In our study we analyzed the Intra Operative Complications - Up migration/Mucosal injury/Perforation with energy source used & it was observed that 80.8 % of the patients did not have any significant Intra Operative Complications in both the arms. However 10 % cases in

Pneumatic lithotripsy arm and 5 % cases in Laser arm had up migration of stone (p value 0.298). In 13.3 % in LL and 8.3 % in PL group mucosal injury was observed (p value 0.378) while in one case in LL arm had perforation p value 0.317).Overall there was no statistical significant association between Intra Operative Complications - energy source used in our study.

Table 9: Comparison of Post operative Complication – Hematuria with energy source used

Post operative Complications - Hematuria	**Energy Source Used**		**Total**	**p value**
	Laser Lithotripsy group (n=60)	**Pneumatic Lithotripsy group (n=60)**		
No	57 (95.0%)	56 (93.3%)	113 (94.2%)	0.697 (N.S)
Yes	3 (5.0%)	4 (6.7%)	7 (5.8%)	
Total	**60 (100.0%)**	**60 (100.0%)**	**120 (100.0%)**	

In our study we analyzed the Post operative complication – hematuria with energy source used. It was observed that 94.2% of the patients did not have hematuria in Post operative period. 5 % patients in laser group and 6.7 % patients in pneumatic lithotripsy group had postoperative hematuria, which was not statistically significant.

Graph 1: Graphical representation of Comparison of Post operative Complication - Hematuria with energy source used

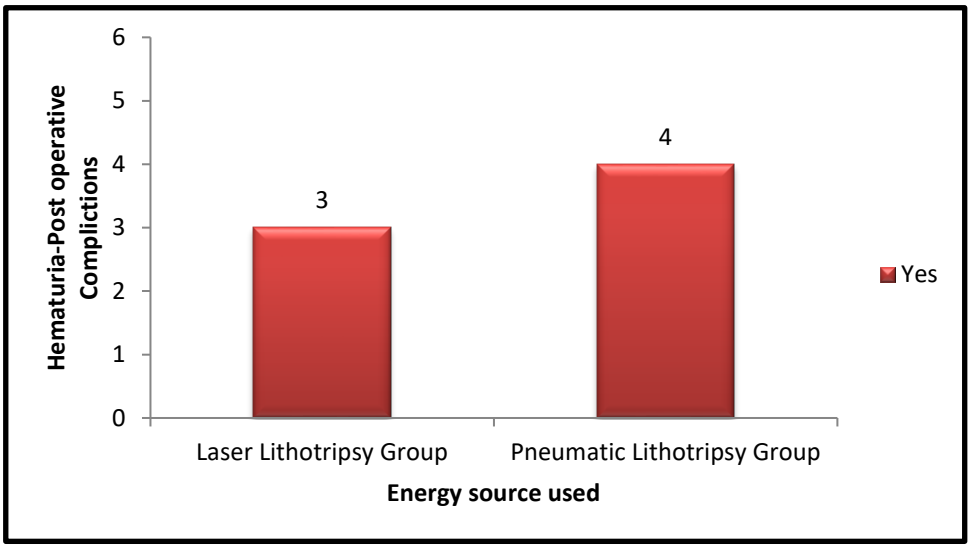

Table 10: Comparison of Post Operative Fever with energy source used

Fever	Energy Source Used		Total	p value
	Laser Lithotripsy group (n=60)	Pneumatic Lithotripsy group (n=60)		
No	57 (95.0%)	55 (91.7%)	112 (93.3%)	0.464 (N.S)
Yes	3 (5.0%)	5 (8.3%)	8 (6.7%)	
Total	**60 (100.0%)**	**60 (100.0%)**	**120 (100.0%)**	

In our study we analyzed the Post operative complication – fever with energy source used. It was observed that 93.3% of the patients did not have fever in Post operative period. 5 % patients in laser group and 8.3 % patients in pneumatic lithotripsy group had postoperative fever, which was not statistically significant.

In our study we observed that overall 69.2% of the patients were stone free during immediate scrutiny (by fluoroscopy and endoscopy) including 75.0% in Laser Lithotripsy group and 63.3% Pneumatic Lithotripsy group. Since p value was 0.166, hence we could not establish any statistical significance in immediate stone clearance rates between these 2 energy sources.

In our study we observed that overall 92.5% of the patients were Stone free after 2 weeks. Further 96.7% and 88.3% of the patients in Laser Lithotripsy and Pneumatic Lithotripsy group respectively were Stone free after 2 weeks. In our study there was no statistically significant difference between 2 energy sources in terms of destoning however 7 (11.7%) cases in Pneumatic Lithotripsy group and 2 (3.3%) cases in Laser Lithotripsy group had clinically significant residual fragments.

In our study we observed that in Laser Lithotripsy Group, out of 2 patients with clinically significant residual fragment one underwent surgical intervention while other was managed with medical expulsive therapy and in Pneumatic Lithotripsy group out of 7 patients 3 patients needed surgical intervention,2 were managed with medical expulsive therapy while remaining 2 patients preferred observation.

DISCUSSION

The mean age of presentation in our study was 44.32 in PL group and 48.45 in LL group with 31-40 years of age group having higher number of patients (23.3%). Mohammad Reza Razzaghi et al[11] reported mean age incidence as 36.4 & 35.9 years in PL and LL groups respectively in their study, which was slightly lower than our study.

In the present study, there was a male preponderance with a male to female ratio of 3.6:1. There were 26 females and 94 males in our study of 120 patients.

In T Manohar et al[17], the ratio is 2.5:1, in Mohammad Reza Razzaghi et al[11] series it was 3:1, in Garg et al[18] it was 1.2:1.

The mean stone size in our study was 11.18±2.75 mm in PL group and 11.42±2.59 mm in LL group which were similar with the study of Garg et al[18], Cimino et al[19] and other studies mentioned above.

There is no statistically significant superiority of one over other could be established (though percent wise Laser group had better immediate stone free rates), which was inconsistent with results reported in studies by Mohammad Reza Razzaghi et al[11], While this result was in agreement with a study conducted by Bhandri et al[20] in which figures of (92% vs 94% ,p 0.696)

for laser and pneumatic lithotripsy respectively was reported. Interestingly Naqvi et al[21] reported significantly higher immediate stone free rates with pneumatic lithotripsy group however there was significant difference in sample size between two groups in their study, which could have been the cause for their results.

The Overall Stone free rates after 2 weeks in our study was 92.5 % (111/120) and were 88.3% (53/60) and 96.7% (58/60), respectively in PL and LL groups (p=0.083). Our success rates were similar to those reported by Sarwar Noori Mahmood et al[22], Akdeniz et while were inconsistent with results reported by Robab Maghsoudi et al[23] who found higher clearance rates with laser lithotripsy.Both energies were found to be effective in fragmenting stones in our study.

In our study laser lithotripsy had higher mean in operating time than pneumatic lithotripsy group with statistically significant difference (7.08±4.93 in PL group Vs 12.45±5.17 in LL group p <0.01),which was similar with studies done by Sarwar Noori Mahmood et al[22], and T Manohar et al[17].

In the present study,stone up migartion rates of holmium:YAG laser lithotripsy and pneumatic lithotripsy group were 5 % and 10 % with p value of 0.298 respectively, which was not statistically significant(though percent wise Laser group had lower up migration rates), which was inconsistent with results reported by Garg et al[18],Cimino et al[19] etc.

Proximal migration is related to dilatation of proximal ureter, size ,hardness of stone, severity of stone impaction and pressure of irrigation fluid, and is considered as major disadvantage in the pneumatic lithotripsy and has been reported to be 2 – 17% in various literatures. Long holmium:YAG pulse duration produces an elongated cavitation bubble that generates only a weak shockwave to explain the low rate of stone retropulsion with laser lithotripsy as mentioned in various studies..

In this study we observed one case of perforation in laser group (1/60, 1.7 % ,p 0.317) which was in accordance to the study by Garg et al[18],while in other studies they found slightly higher rates of perforation in pneumatic lithotripsy group,though none of them were statistically significant.

In our study, Post operative hematuria was found in 4/60 (6.7%) and 3/60 (5%) patients in Pneumatic and Laser lithotripsy group respectively (Clavien-Dindo Grade 1) which is in line with the most of studies except study done by T Manohar et al[24]

In our study post operative fever (Clavien-Dindo Grade 1) was seen in 5/60 (8.35) and 3/60(5 %) cases of pneumatic and laser lithotripsy respectively with no statistically significant difference between two groups and was in concurrence with most of the studies. [25]

In our study, the mucosal injuries were 5 /60(8.3%) and 8/60 (13.3%) with Pneumatic and Laser lithotripsy group respectively, which was in accordance to most of the studies.

Mucosal injuries were slightly more common with laser lithotripsy group. Holmium laser can cause mucosal injuries when in contact with the mucosa. An important point of technique is that the tip must be 1 mm away from the urothelium or the guide wire during activation of the laser pulses, as the depth of thermal injury is 0.5-1 mm.

Since during the pneumatic lithotripsy procedure little heat is produced, the mucosal injury chances were less than laser group.

In the study by *de la Rosette* et al ,Postoperative fever was most frequent complication of Ureteroscopy.[26] Various causes of fever after lithotripsy has been described in literature like, ,bacteremia, mucosal injuries ,long operating time, infected system ,associated risk factors (Diabetes Mellitus,Obesity) and irrigation fluid related infections.

Koji Mistuzuka et al concluded that preoperative pyuria was significant risk factor for post operative fever after ureteroscopy.[27] The European Association of Urology Guidelines recommend the use of cephalosporin or fluoroquinolone as prophylactic antibiotics prior to diagnostic ureteroscope and ureteroscopic lithotripsy.[28] *Mcaleer* reported that infectious stones contain an average endotoxin level of 12223 ng/g, as compared to the 340.3 ng/g of endotoxin in non infectious stones.[29]

When perfusion fluid accumulates to a certain extent, the high pressure may cause pyelovenous backflow; consequently, bacteria and bacterial endotoxins can enter the bloodstream along with perfusion fluid absorption, and cause postoperative fever, bacteremia, or even sepsis.[30] However

renal pelvic pressure was not assesed in the present study, and were hence unable to assess these risk factors, However maintenance of low pressure in the renal pelvis may help reduce the intra operative absorption of fluid and the incidence of postoperative fever and bacteremia

Limitations of study were being a single centre study and short term follow up periods therefore, we recommend comparing of the two aforesaid methods with more cases under additional assessment over a longer time scale

CONCLUSION

Although the various endoscopic modalities for fragmenting stones have their advantages and disadvantages the holmium laser and pneumatic lithotripters are most widely used for management of ureteric stones. Operating time was higher with laser as compared to pneumolithotripsy because of longer contact time for fragmentations. In term of complications, such as, upmigration, mucosal injury, ureteral perforation and postoperative hematuia & fever, there was no statistically significance difference between the two groups. Though higher stone up migration rates have been reported with pneumatic lithotripsy, they were not statistically significant in our study, and up migartion can be minimized by judicious use of anti retropulsion devises and other maneuvers as discussed in our study. The Ho:YAG laser and the Pneumatic lithotripsy are equally efficient in the management of ureteric stones. They have comparable immediate and overall stone clearance rates. The ultimate success of these procedures depend on feasibility of the procedure, number of the sessions required to be the patient stone-free, complication rates, and the requirements to achieve the stone-free status. The size and location of ureteric stones, technological efficiency of the instruments, and endoscopic experience all had a role in the success or failure of ureteroscopic lithotripsy. Both energies are safe and effective and if they are used judiciously, then the chances of major complications are minimal.

REFERENCES

1. K. K. Bhishagratna (Editor) *"An English Translation of the Sushruta Samhita"*Calcutta (1911)
2. Kispe HH, Klein R, Heicappell R, Miller K. Pneumatic lithotripsy applied through deflected working channel of miniureteroscope: Results in 143 patients. J Endourology 1998; 12:513-5

3. Yiu MK, Liu PL,Yiu TF, Chan AY. Clinical experience with holmium: YAG laser lithotripsy of ureteral calculi. Laser Surg Med 1996; 19: 103-6.
4. Denstedt JD, Eberwein PM, Singh RR. The Swiss Lithoclast: a new device for intracorporeal lithotripsy. J Urology 1992; 148: 1088-90.
5. Teh CL, Zhong P, Preminger GM. Laboratory and clinical assessment of pneumatically driven intracorporeal lithotripsy. J Endourology 1998*;* 12: 163-9.
6. Cecchetti W, Zattoni F, Nigro F, Tasca A. Plasma bubble formation induced by Hol: yag laser: An in-vitro study. Urology 2004; 63:586-90
7. Breda A, Ogunyemi O, Leppert JT, et al: Flexible ureteroscopy and laser lithotripsy for single intrarenal stones 2 cm or greater is this the new frontier J Urology 2008;179:981-84.
8. Vassar GJ, Chan KF, Teichman JM, et al: Holmium:YAG lithotripsy: photothermal mechanism. J Endourology 1999; 13:181-90
9. Khaladkar, S., Modi, J., Bhansali, M., Dobhada, S. & Patankar, S. ,Which is the best option to treat large (>1.5 cm) midureteric calculi. *Journal of laparoendoscopic & advanced surgical techniques. Part A*.2009. 19 (4). pp. 501–4.
10. Wright, A.E. Ureteroscopy and stones: Current status and future expectations. *World Journal of Nephrology*. .2014, 3 (4). p.p. 243.
11. Razzaghi, M.R., Razi, A., Mazloomfard, M.M., Golmohammadi Taklimi, A., Valipour, R. & Razzaghi, Z., Safety and efficacy of pneumatic lithotripters versus holmium laser in management of ureteral calculi: a randomized clinical trial. *Urology journal,*2013,10(1).pp.762–6.
12. Lee, J. & Gianduzzo, T.R.J.,Advances in Laser Technology in Urology. *Urologic Clinics of North America*. 2009,36 (2) pp. 189–198.
13. Akdeniz, E., İrkılata, L., Demirel, H.C., Saylık, A., Bolat, M.S., Şahinkaya, N., Zengin, M. & Atilla, M.K., A comparison of efficacies of holmium YAG laser, and pneumatic lithotripsy in the endoscopic treatment of ureteral stones. *Turkish journal of urology*,2014,40 (3). pp. 138–143.

14. Yin, X., Tang, Z., Yu, B., Wang, Y., Li, Y., Yang, Q. & Tang, W., Holmium: YAG Laser Lithotripsy Versus Pneumatic Lithotripsy for Treatment of Distal Ureteral Calculi: A Meta-Analysis. *Journal of Endourology*.,2013 27 (4). pp. 408–414.
15. Mahmood, S.N. & Bajalan, D.H.., Ureteroscopic Management of Ureteral Calculi: Pneumatic versus Holmium: YAG Laser Lithotripsy. *Open Journal of Urology*.,2016,6(3).pp.36–42.
16. Jhanwar, A., Bansal, A., Sankhwar, S., Kumar, M., Kanodia, G. & Prakash, G., Outcome analysis of holmium laser and pneumatic lithotripsy in the endoscopic management of lower ureteric calculus in pediatric patients: a prospective study. *International braz j urol*.,2016,42 (6). pp. 1178–1182.
17. Manohar, T., Ganpule, A. & Desai, M. ,Comparative evaluation of Swiss LithoClast 2 and holmium:YAG laser lithotripsy for impacted upper-ureteral stones. *Journal of endourology*.2008,22 (3). pp. 443–6.
18. Garg S, Mandal AK, Singh SK, Naveen A,Ravimohan M, Aggarwal M, Mete UK, Santosh K: Ureteroscopic laser lithotripsy versus ballistic lithotripsy for treatment of uretericstones: a prospective comparative study.Urol Int 2009; 82: 341–345.
19. Cimino S, Favilla V, Russo GI, Saita A, Sortino G, Castelli T, Veroux M, Madonia M,Morgia G: Pneumatic lithotripsy versus holmium:YAG laser lithotripsy for the treatment of single ureteral stones: a prospective, single-blinded study. Urol Int 2014; 92: 468– 472.
20. Bhandari BB,Basnet RB, Comparison of Holmium Laser and Pneumatic Lithotripsy in Treatment of Ureteral Stones JGPEMN,Jan-June, 2011,17-20
21. Naqvi S, Khaliq M, Zafar M, Rizivi S. Treatment of ureteric stones, comparison of laser and pneumatic lithotripsy. BJU 1994;77:694-8.
22. Mahmood, S.N. and Bajalan, D.H., Ureteroscopic Management of Ureteral Calculi: Pneumatic versus Holmium: YAG Laser Lithotripsy. *Open Journal of Urology*,2016, 6, 36-42.
23. Maghsoudi R, Amjadi M, Norizadeh D, Hassanzadeh H. Treatment of ureteral stones. A prospective randomized controlled trial on comparison of Ho:YAG laser and pneumatic lithotripsy. Indian J Urol 2008;24:352-354

24. Young Kwon Hong and Dong Soo Park : Ureteroscopic Lithotripsy Using Swiss Lithoclast for Treatment of Ureteral Calculi,12-Years Experience ,J Korean Med Sci 2009; 24*:* 690-4.
25. Aridogan A, Zeren S, Bayazit Y. Complications of pneumatic ureterolithotripsy in the early postoperative period. J Endourology 2005; 19:50-3
26. de la Rosette J, Denstedt J, Geavlete P et al,The clinical research office of the endourological society ureteroscopy global study: indications, complications, and outcomes in 11,885 patients. J Endourol,2014, 28:131–139
27. Koji Mistuzuka et al Identification of factors associated with postoperative febrile urinary tract infection after ureteroscopy for urinary stones,Urolithiasis,June 2016,Volume44,Issue 3,257-262
28. Yoon HN. Preoperative antibiotic prophylaxis in urologic field: EAU guideline. Korean J Urogenital Tract Infect Inflamm. 2010;5:110–117
29. Flannigan R, Choy WH, Chew B, Lange D. Renal struvite stones-pathogenesis, microbiology and management strategies. Nat Rev Urol. 2014;11:333–341.
30. Gu SP, Huang YT, You ZY, Zhou X, Lu YJ, He CH, Qi J. Clinical effectiveness of the PolyScope™ endoscope system combined with holmium laser lithotripsy in the treatment of upper urinary calculi with a diameter of less than 2 cm. Exp Ther Med. 2013;6:591–595