

COMPARISON OF HO:YAG LASER AND PNEUMATIC LITHOTRIPSY IN THE TREATMENT OF PROXIMAL URETERAL STONES

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ABSTRACT

Objective: To evaluate the effectiveness and safety of treatment for proximal ureteral stones with pneumatic lithotripsy compared to holmium: yttrium-aluminum-garnet (HO: YAG) laser therapy.

Study Design: Randomized control study.

Place and Duration of Study: Armed Forces Institute of Urology, Rawalpindi from Sep 2014 to Mar 2015

Material and Methods: This randomized control trial was conducted at Armed Forces institute of Urology Rawalpindi. A total of 73 patients who underwent treatment between Sep 2014 and Mar 2015 were included in the study. Of the patients, 37 had pneumatic lithotripsy (PL group) and 36 had ureteroscopic HO: YAG laser lithotripsy (LL group) using rigid 8 Fr-ureteroscope for the fragmentation of the ureteric stones. Patients were evaluated for stone clearance after 3 weeks, with X-ray KUB, ultrasound and plan CT KUB (where indicated). All the data were recorded in a proforma and analyzed in SPSS version 11.

Results: There was a difference between the two groups according to overall stone clearance rate 83.8% for PL group vs. 86.5% for LL group. Proximal stone migration was seen in 16.2% of cases in PL group while in only 5.5% of cases in LL group. The overall complication rate was 35.1% in PL group while 30.5% in LL group. The mean procedure time was 28.8 ± 4.5 minutes for PL group while it was 35.5 ± 8.6 minutes for LL group.

Conclusion: The pneumatic and holmium: yttrium-aluminum-garnet laser lithotripsy both are established choices for treatment of ureteral stone but in terms of stone clearance rate and decrease incidence of proximal stone migration HO: YAG lithotripsy is better than pneumatic lithotripsy.

Keywords: Proximal ureteral stone, Laser lithotripsy, Pneumatic lithotripsy, Uretero-rensoscopy.

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INTRODUCTION

Renal stone disease constitutes a major burden of both outdoor and operative urology workload. It is the third most common affliction of urinary tract with a lifetime prevalence rates of 1% to 15%¹. Unfortunately Pakistan falls amongst the geographical stone belt where ureteric calculi are common².

Management of ureteral calculi ranges from medical expulsive therapy to extracorporeal shock wave lithotripsy (ESWL) to endoscopic interventions³. Historically ESWL was the preferred treatment for patients with proximal ureteral calculi. In this modern era where a

variety of endoscopic urological interventions are available medical management of ureteral stones should not delay prompt definitive cure of ureteral calculi. Two most common lithotripters that are used via rigid Uretero-rensoscopy are pneumatic and Ho: YAG laser. Pneumatic lithotripsy though more popular among the urologists because of its low cost, easy setup, and high success rate^{4,5} has its limitation while treating proximal ureteral calculi⁶. Ho: YAG laser on the other hand is a reliable method for the treatment of ureteral stones especially in proximal and impacted ureteral stones, but it is expensive and not available in most of the urologic centers⁷. Review of the literature reveals many studies comparing pneumatic lithotripsy with laser lithotripsy though some of them show similarities⁸⁻¹¹ some report laser lithotripsy to be better in terms of efficacy and safety profile¹²⁻¹⁴.

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Pneumatic lithoclast lithotripter functions in a similar manner as pneumatic jackhammer¹⁵. Compressed air pushes a small projectile which in turn makes the probe oscillate at the frequency of 12 cycles per second. Fragmentation occurs as a result of the repetitive impact of probe tip against the stone. The energy transmitted thus can result in proximal migration of stones¹⁶. HO: YAG laser lithotripsy works according to photothermal mechanism¹⁷. Stones are cratered and fragmented with a power setting of 10 W, as the depth of thermal injury is 0.5-1 mm the tip of laser probe should be more than 1 mm away from ureteral mucosa or the guide wire¹⁸. The

YAG laser lithotripsy as a goldstandard procedure for ureteroscopic intracorporeal lithotripsy¹³.

In this study we aim to present our experience of HO: YAG laser lithotripsy specifically in the treatment of proximal ureteral stones and compare it with pneumatic lithotripsy in terms of efficacy and safety profile. It is the first study on the treatment modality in our setup.

MATERIAL AND METHODS

This randomized control study was conducted at Armed Forces Institute of Urology Rawalpindi from Sep 2014 to Mar 2015 after

Table-I: Pre and Post-operative comparison of pneumatic lithotripsy and laser lithotripsy groups.

Variables	Pneumatic lithotripsy group	Laser lithotripsy group	p-values
Stone size mean (mm)	12.16 ± 5.8	11.7± 6.2	0.7443
Laterality			
Right	25 (67.6%)	20 (54.1%)	0.29
Left	12 (32.4%)	16 (43.2%)	
Double J stenting	12 (32.43%)	10 (27.8%)	0.66
Re-procedure	6 (16.2%)	4 (11.1%)	0.73

Table-II: Comparison between different studies.

Study	Stone free rates (%)		Operative time Mean (min)		JJ stenting(%)		Stone migration (%)		Reprocedure (%)	
	PL	LL	PL	LL	PL	LL	PL	LL	PL	LL
Akdenizeetal ¹¹	75%	74.2%	30.31 ± 15.03	34.30 ± 19.70	94.5	87.9	9.1	6.5	2.7	2.8
Tipu et al ²⁰	71.4 %	90.9%	37.21 ± 13	39.6 ± 11.9	13	5	10	4	14	4
Razzaghi etal ²¹	42.9 %	100%	7.9±4.2*	13.7±12.6*	NA	NA	17.4	0	NA	NA
Present study	83.8	86.5	28.8 ± 4.5	35.5 ± 8.6	32.43	27.8	16.2	5.5	16.2	11.1

* lithotripsy time only

Table-III: Comparison of complications seen in different studies.

Study	Complications							
	Hematuria %		Fever/sepsis %		Mucosal damage		Ureteral perforation	
	PL	LL	PL	LL	PL	LL	PL	LL
Akdenize et al ¹¹	1.5	0.5	2	0.5	0	0	0	0
Tipu et al ²⁰								
Razzaghi etal ²¹	0	9	3.6	1.8	0	0	1.8	3.6
Present study	8.1	2.7	5.4	5.5	5.4	5.4	0	2.7

main advantage of this technique is that it is effective against all types of stones also due to its local effects it reduces stone migration. European Association of Urology (EAU) recommends Ho:

approval of hospital ethical committee. Patients with proximal ureteric stones greater than 6 mm and less than 20 mm who failed to respond to medical expulsion therapy even after two weeks,

patients with hydronephrosis were included in study. Patients with renal insufficiency, ipsilateral ureteric stricture, active urinary tract infection and obesity (BMI ≥ 29), pregnancy, coagulopathy, stones more than 20 mm or congenital ureteral abnormality were excluded from the study. A total of 73 cases were selected by non-probability consecutive sampling technique after fulfilling the inclusion exclusion criteria. Out of these 73 cases pneumatic lithotripsy was employed in 37 cases (assigned as PL group) while HO: YAG lithotripsy was employed in 36 cases (assigned as LL group) randomly by lottery method. Complete History, clinical examination, relevant investigations like urine culture, X-ray kidney ureter bladder (KUB), ultrasound KUB and plain CT KUB/excretory urography were performed. Stone areas were estimated based on their longest diameters measured on KUB scout film for opaque, and on plain CT KUB for non-opaque stones.

Procedures were performed under general/spinal anesthesia with patients in dorsal lithotomy position. Uretero-renaloscopic procedures were done with rigid uretero-renaloscopes (diameter 8 Fr). This started with identification of the ureteral orifice and its cannulation with 0.038-inch hydrophilic guide wire over which the uretero-renaloscope was introduced in the ureter. In PL group pneumatic lithotripsy was performed with 2 Fr pneumatic probe, while in LL group laser lithotripsy Ho: YAG Laser (Karl Storz) with 550 μm fiber probe, pulse frequency: 8-10 Hz, and power supply: 9.6-16 W were used. Ureteric manipulations were aiming to direct laser shock impulses to the middle of stones and their fragments under direct vision to allow fragmentation without ureteric injuries preferably less than 1 mm in size. Fragments > 2 mm in size were removed with forceps after laser fragmentation to achieve samples for stone composition analysis whereas smaller ones were left for spontaneous passage. Irrigation during ureteroscopy was provided with an irrigation pressure pump. Staged therapy was considered in case of bad visibility limiting

further access to residual fragments or when remaining stone burden seemed too large to be removed at the same session. Bad visibility was mainly due to hematuria as well as stone dust leading to turbidity of fluid media and obscuring vision.

At the end of the procedure, double-J catheter was left in place in cases where stone size was large, ureteric narrowing, mucosal tears or hematuria and perforation to ensure post operative drainage and to prevent obstruction secondary to ureteral edema, depending on the surgeon's preference. A double-J stent was removed after 3-4 weeks according to the surgeon's decision. Operation time was defined as the time period between the insertion of the ureteroscope into the urethra and placement of the urethral catheter at the end of the procedure. On the 1st post operative day stone-free state was checked with KUB films, and ultrasonograms. The patients who failed to pass their stones spontaneously, received medical expulsive treatment, and their stone-free state was assessed at weekly KUB films or ultrasonograms. The patients were followed up for 3 weeks postoperatively. All the data were recorded on a predefined proforma.

The data were analyzed with the SPSS version 11.0 (SPSS Inc, Chicago, IL, USA). The Student t test was used for comparison of the normally distributed variables between the two groups. Proportions of patient characteristics, complication rates, and operative data of the two groups were compared using the Chi-square test and Fishers' exact test. A p value of < 0.05 was considered to be significant.

Quantitative variables like age, stone size, duration of surgery were represented by mean \pm SD. For qualitative variables like gender frequencies and percentages were used.

RESULTS

A total of 73 patients who underwent uretero-renaloscopy for proximal ureteral stones from Sept 2014 till Mar 2015 were included in the study. Group wise 37 patients were in PL group

while 36 patients were in LL group. The gender distribution in PL group was 25 (67.6%) male and 12 (32.4%) females while in LL group 23 (63.9%) were male while 13 (36.1%) were female with *p*-value= 0.740. The mean age in PL group was 26.7 ± 12.6 and 28.4 ± 13.2 years with *p*-value= 0.792. Overall stone size range from 07 mm to 18mm. The difference in some other variables between PL and LL group are shown in table-I.

Stone clearance was complete in 83.8% cases of PL group while in case of LL group it was 86.5% with *p*-value= 0.777. On the other hand the mean time to complete the procedure from introduction of uretero-roscope till the end of procedure was 28.8 ± 4.5 minutes for PL group while it was 35.5 ± 8.6 minutes for LL group with *p*-value <0.001. The rate of complications observed in both groups is given in fig-1. Proximal stone migration was seen in 16.2% cases of PL group. Medical expulsive treatment was given to patients post operatively for clearance of

evolution of endoscopic procedures for treatment of ureteral calculi is an interesting one. Young¹⁸ in 1912 was the first to perform ureteroscopy when he introduced a cystoscope into the dilated ureter of a child with posterior urethral valve. Since then ureterorenoscopy has evolved into an established treatment especially due to advancements in endourology in past three decades¹⁹. Various power sources used for intracorporeal lithotripsy include electrohydraulic, ultrasonic, pneumatic and laser.

Many studies are present in the literature comparing pneumatic lithotripsy with HO: YAG laser lithotripsy in terms of efficacy and complications. Akdeniz et al¹¹ found pneumatic lithotripsy as efficacious as laser lithotripsy and can be used safely in the endoscopic management of ureteral stone. He also found out that there were no difference as to operative time, success of operation and the time to removal of the catheter, however, hospitalization period was shorter in

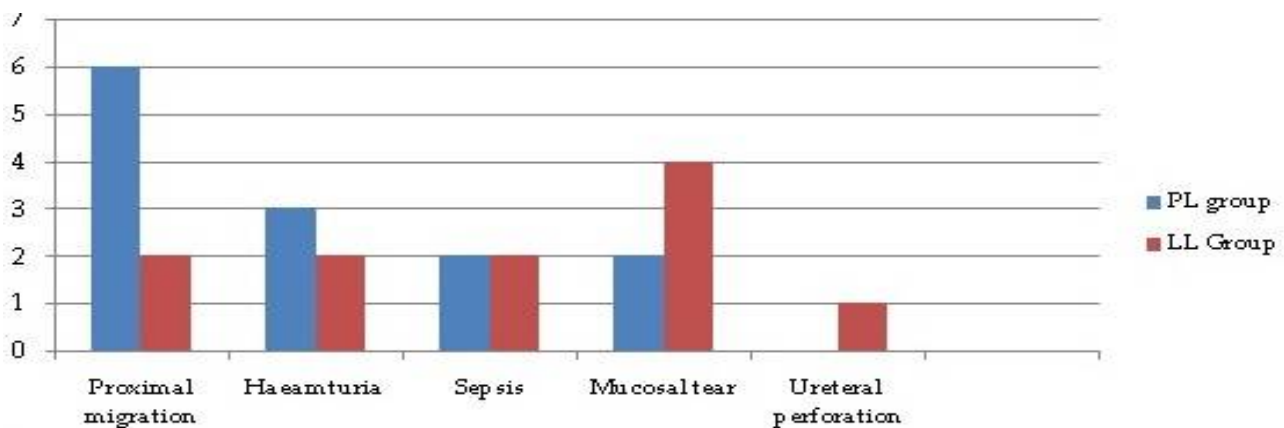


Figure-1: Comparison of complications observed in each group.

stone fragments. All cases were reviewed at the end of three weeks with X Ray KUB or plain CT KUB (where indicated). Table-II gives a comparison of different studies. Table-III gives a comparison of various complications.

DISCUSSION

Various treatment options available for the management of proximal ureteral calculi include ESWL, uretero-rensoscopy, laparoscopic ureterolithotomy and open surgery³. History of

laser lithotripsy group. Tipu et al²⁰ in a local study found Holmium: YAG laser lithotripsy to be superior to pneumatic lithoclast in terms of rate of stone clearance and complications, especially in proximal ureteral stones. Whereas in another local study Naqvi et al¹⁵ concluded that both modalities of treatment are effective and safe in treatment of small ureteral stones while pneumatic lithotripsy being more effective against larger stones.

In our study we found laser lithotripsy to be better than pneumatic lithotripsy in terms of stone clearance (86.5% vs 83.8%), stone migration (5.5% vs 16.2%), re procedure (11.1 % vs 16.2%) and overall complications (35.1% vs 30.5%). On the contrary pneumatic lithotripsy took less time to complete the procedure as compared to laser lithotripsy (28.8 ± 4.5vs 35.5 ± 8.6). Table-II and Table-III show the comparison between present study and studies conducted in the past both locally and internationally. All these studies show that laser lithotripsy is better than pneumatic lithotripsy in terms of stone clearance and complications^{11,20,21}. On the other hand pneumatic lithotripsy is better in terms of time duration 4.5 easy installation and is cost effectiveness^{11,20,21}. Laser lithotripsy though costlier than pneumatic lithotripsy is efficacious in terms of stone clearance and less chances of proximal stone migration especially in proximal ureteric calculi. The limitation of our study is small sample size but as we installed the laser lithotripter in our institute just six months back we will follow our study in this regard with a longer duration and sample size.

CONCLUSION

The pneumatic and holmium: yttrium-aluminum-garnet laser lithotripsy both are established choices for treatment of ureteral stone but in terms of greater stone clearance rate and decrease incidence of proximal stone migration HO: YAG lithotripsy is better than pneumatic lithotripsy. On the other hand laser lithotripsy is costlier and takes more time to fragment larger stones. This disadvantages over shadows its effectiveness in treatment of proximal ureteral stones.

CONFLICT OF INTEREST

This study has no conflict of interest to

declare by any author.

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