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Research Article

COMPARISON OF LASER AND PNEUMATIC LITHOTRIPSY FOR MID AND LOWER URETERAL STONES: "AN ANALYTICAL REVIEW" AT TERTIARY CARE CENTER

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ABSTRACT

Objectives: Management of large lower and mid ureteric stones represents a treatment challenge. The main objective of stone treatment is to achieve the highest stone-free rate with minimal morbidity. Available modalities are medical therapy, open surgery, laparoscopic surgery, endoluminal surgery and extracorporeal shock wave lithotripsy (ESWL). After the invention of uretero-renoscopy (URS) and ESWL in 1980s, there has been a paradigm shift in the treatment modality of ureteric calculus from open surgery to endoluminal and non-invasive method. There are various modalities for stone fragmentation in URS – electrohydrolic lithotripsy, pneumatic. Ultrasonic, laser and dual energy source (Ultrasound+Pneumatic) Lithotripsy. Both laser lithotripsy (LL) and pneumatic lithotripsy (PL) have favourable outcomes The aim of this study was to compare efficacy of pneumatic versus laser lithotripters for Mid and lower ureteric calculi in regional population at KIMS, Hubballi.

Methods: This was a prospective comparative study done in 116 cases of mid and lower ureteric calculi (58 in PL and 58 in LL) at karnataka institute of medical sciences, Huballi from May 2022 to November 2022. Patients were randomly divided into two groups: Group 1 had PL, while Group 2 had lithotripsy using a laser energy source. For PL group, 0.8 and 1 mm probe was passed through working channel of URS. LL was performed using a 100-W holmium:yttriumaluminium-garnet (YAG)-pulsed laser machine, with 365 µm fibres. Complications were graded according to the Clavien-Dindo Grading System.

Results: In all, 116 patients (78 male and 38 female) with a mean age of 36.21 years were included in the study, Varying from 18 to 75 years. In group one 58 patients under went PL out of which 41 were males and 17 were females. In group two 58 patients under went LL out of which 37 were males and 21 were females. In group one (PL) mean operative with SD was 42.10±(10.16) min, and in group two (LL). Mean operative with SD was 46.78±(9.36) min, with p=0.011, which was statistically significant. Mean hospital stay ±SD (days) in PL group was 2.69±(0.730) days, and in group two LL mean hospital stay ±SD (days) was 2.40±(0.591) with p=0.019, which was statistically significant. In group one out of 58 patients, 11 patients had stone migration with % of an 18.96% and in group two out of 58 patients 2 patient had stone migration of, with % of 3.44%, with p=0.008, which is statistically very significant. Post operatively 7 patients in group one needed auxillary procedures, 3 patients needed ESWL, 3 patients needed. Re URSL and one patient needed bladder clot evacuation with DJ stenting, In all these patients stone size was larger than 15 mm, In Group 2 no patient needed Auxillary procedure, with p=0.003 which is statistically significant.

Conclusion: Both pneumatic and LL are standard and safe techniques for the management of lower and mid ureteric calculi. Our study showed LL had less stone migration, and no need for reintervention.

Keywords: Ureteric calculi, Laser lithotripsy, Pneumatic lithotripsy, Stone migration, Fragmentation, Stone free rate.

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INTRODUCTION

The treatment challenge involves how to manage large lower and mid ureteric stones.

The selection of an acceptable treatment method and plan is influenced by a number of variables, including the patient's anatomy, the surgeon's experience, the stone's size, composition, and obstruction, if any. It is also necessary to take into consideration financial and material availability [1,2].

The main objective of stone management is to obtain the maximum stone-free rate (SFR) with the least amount of morbidity. Medical treatment, open surgeries, laparoscopic surgery, endoluminal surgery, and extracorporeal shock wave lithotripsy are the current available techniques [3].

In comparison to minimally invasive techniques, open and laparoscopic surgical removals are regarded as highly morbid. There has been paradigm shift in the treatment plans of ureteric calculus from open surgery to endoluminal and non-invasive approach since the emergence of uretero-renoscopy (URS) and extracorporeal shockwave lithotripsy (ESWL) in the 1980s.

Fragmentation under direct vision is URS' principal benefit.

Stone fragmentation techniques used in URS include electrohydraulic lithotripsy (EHL), pneumatic lithotripsy (PL), ultrasonic lithotripsy, laser lithotripsy (LL), and dual energy source (Ultrasound plus Pneumatic) lithotripsy [4].

Both PL and LL provide successful results [5].

It works on a ballistic force of very compressed air, whereas Ho: yttriumaluminium-garnet (YAG) works by producing minute vaporization bubbles that are quickly ejected from the fiber's tip to produce a shock wave that triggers stone disintegration.

Only few published studies compare the various lithotripter modalities for mid- and lower-ureteric calculus in the local community.

This study compared the effectiveness of laser lithotripters with PL for treating mid and lower ureteric calculi in the local population at KIMS, Hubballi.

METHODS

A prospective comparative analysis was conducted in 116 patients of mid and lower ureteric calculi (58 in PL and 58 in LL) treated at the Karnataka Institute of Medical Sciences in Hubballi from May 2022 to November 2022. The Institutional Review Committee granted ethical approval.

Criteria for inclusion

- Patient with lower and mid ureteric calculi with patient age >18 years
- A willing participant in the study
- Calculi larger than 7 mm in size
- No prior history of laparoscopic or open stone surgery at the stone site.

Criteria for exclusion

- Patient not willing to give consent for study
- Active urinary tract infection
- Coagulopathy
- Spinal deformity
- Pregnant patients.

Two groups of patients were randomly assigned, Group 1 underwent PL and Group 2 received lithotripsy utilizing a laser energy source.

A simplistic randomization approach was used to achieve randomization.

Based on earlier studies that evaluated the results of treating ureteric stones using various fragmentation techniques, the sample size was estimated by comparing the SFR proportion between pneumatic and holmium LL using standard method [6].

Thirty minutes before surgery, a single intravenous (IV) antibiotic dose was administered as per urine culture report.

Experienced urologists working at the Department of Urology, KIMS-Hubballi, performed URS on all patients after administering spinal anesthesia and positioning in the lithotomy position.

URS was done with 7.5 and 6.5 Fr (Olympus make) semi-rigid URS scope under direct vision with 0.032 Fr guidewire placement.

For PL group, 0.8 and 1 mm probe was inserted through working channel of URS.

The tip of the probe was brought to surface of the stone and probe was activated. Pressure was set in the range from 2.5 to 2.7 kg/cm^2.

Laser lithotripsy was performed using a 100-W holmium: YAG-pulsed laser machine, with 365 μm fibers.

Techniques of dusting and fragmentation were both utilized.

The duration of the surgery was measured from induction of anesthesia to the securing of the per urethral catheter.

URS forceps were used to remove any lingering fragments.

In situations of impacted calculi and mucosal damage, double J (DJ) stents were kept. It was removed four to 6 weeks after an X-ray kidneys, ureters, and bladder (KUB) confirmed that there were no calculi left.

The Clavien–Dindo grading system was utilized to grade complications [7].

Stone migrations, ureteric injuries (false passage formation, mucosal tear extravasations, and ureteric avulsion), and other intraoperative complications were noted.

On the 1st post-operative day, residual fragments were defined as stones that were apparent on plain radiographs and USG of the KUB with diameter more than 4 mm [8].

The surgeon determined the need for an auxiliary surgery and informed the patients in case if there were any remaining fragments or stone migration.

RESULTS

In all, 116 patients (78 male and 38 female) with a mean age of 36.21 years were included in the present study, varying from 18 to 75 years.

Chief complaints

OUT of 116 patients, 114 patients had complaint of pain (98.27%), 18 patients had c/o fever (15.5%), hematuria was present in 6 patient (5.17%), and 12 patients had LUTS (10.34%).

In Group 1, 58 patients underwent PL, out of which 41 were male and 17 were female, mean age was 38.16 years with 21 patients stones on the left side and 37 stones on the right side, with mean stone size of 12.38 mm with standard deviation (SD) (2.32), and right-sided stone laterality was more in Group 1.

In Group 2, 58 patients underwent LL out of which 37 were male and 21 were female, mean age was 31.74 years with 30 stones on the left side and 28 stones on the right side, with mean stone size of 11.31 mm. The left side stone laterality was more in Group 2.

In Group 1 (PL), mean operative time with SD was 42.10 ±(10.16) min, and in Group 2 (LL), mean operative with SD was 46.78±(9.36) min, with p=0.011, which was statistically significant.

Mean hospital stay±SD (days) in PL group was 2.69±(0.730) days, and in Group 2 LL, mean hospital stay ±SD (days) was 2.40±(0.591) with p=0.019, which was statistically significant.

In Group 1 out of 58 patients, 11 patients had stone migration with percentage of an 18.96% and in Group 2 out of 58 patients, two patient had stone migration with percentage of 3,44%, with p=0.008, which is statistically very significant.

In Group 1, out of 58 patients, two patients had residual fragments and in Group 2, out of 58 patients, two patients had residual fragment. With p value of p=0.402 which is not significant.

In Group 1, out of 58 patients, 52 patients underwent DJ stenting (89.65%) and in Group 2, out of 58, 46 patients (79.31%) underwent DJ stenting.

In Group 1 PL (n=58), out of 58 patients, eight patients had post-operative fever, and in Group 2, laser lithotripsy out of 58 patients, three patients had post-operative fever, with p=0.113, which was not significant. Patients were managed with IV antibiotics and analgesics.

Gross hematuria was seen in one patient of PL and one patient of LL postoperatively, with p value of 1.00, which was not significant, it was managed conservatively with fluids and supportive care.

Ureteric injury was not seen in any patient in Group 1 of PL, in Group 2, two patients had ureteric injury, with p=0.154, which were managed conservatively.

Postoperatively, seven patients in Group 1 needed auxiliary procedures, three patients needed ESWL, three patients needed re-URSL, and one patient needed bladder clot evacuation with DJ stenting, in all these patients, stone size was larger than 15 mm,

Table 1: Number of patients

Male	Female	Total	Mean	Standard deviation
78	38	116	34.94	12.57

Table 2: Comparison of the patients characters stone laterality and energy modality used

Patients characters	Group 1 pneumatic lithotripsy (n=58)	Group 2 laser lithotripsy (n=58)	p-value
Age, years, mean (standard deviation)	38.16 (14.24)	31.74 (9.78)	**0.006**
Male	41	37	0.429
Female	17	21	
Stone laterality			0.092
Left	21	30	
Right	37	28	
Mean stone size	12.38 (2.32)	11.31 (2.44)	**0.017**

Bold value represents statistically significant

Table 3: Comparison of the operative and post-operative parameters (n=116)

Variables	Group 1 pneumatic lithotripsy (n=58)	Group 2 laser lithotripsy (n=58)	p-value
Mean operative time±SD (min)	42.10±(10.16)	46.78±(9.36)	**0.011**
Mean hospital stay±SD (days)	2.69±(0.730)	2.40±(0.591)	**0.019**
Stone migration (%)	11 (18.96)	2 (3.44)	**0.008**
Residual fragment (%) n/N	2/58 (3.44)	4/58 (6.89)	0.402
DJ stenting (%) n/N	52/58 (89.65)	46/58 (79.31)	0.124

SD: Standard deviation, bold value represents statistically significant

Table 4: Comparison of operative and the post-operative complications

Complications	Group 1 pneumatic lithotripsy (n=58)	Group 2 laser lithotripsy (n=58)	p-value
Post OP fever (n/N)	8/58	3/58	0.113
Gross hematuria	1/58	1/58	1.00
Ureteric injury (%)	0/58	2/58 (3.44%)	0.154
Auxiliary procedures (%) (extracorporeal shockwave lithotripsy/ DJ stent/RE ureteroscopic lithotripsy)	8/58 (13.79%)	0/58	**0.003**

Bold value represents statistically very significant

In Group 2, no patient needed auxiliary procedure, with p=0.003 which is statistically significant.

DISCUSSION

Since the advent of URS, the treatment of stone disease has undergone a great revolution. The alpha-1 antagonist in medical expulsion therapy can be used to treat stones up to seven millimeters in size.

With extracorporeal shockwaves, soft proximal ureteric stones up to one centimeter in size can be treated with no intervention [9].

The preferred treatment for big mid-ureteric stones is URS with lithotripsy.

As a result of their high SFRs (>90%) [10] and less morbidity rates, pneumatic and laser energy are preferred.

Although inexpensive and safe, PL has several drawbacks, such as stone migration, especially in cases of proximal ureteric calculus [11].

The use of the laser energy to treat ureteric stones has become more popular recently. The laser's high SFR, ability to break different kinds of stones, and a lower rate of stone migration may be the reason of this shift [12].

The urological specialty is moving toward advanced technological performance because to the miniaturization of scopes and the sophistication of medical devices, which has an impact on the economy [13].

In the present study, we attempted and tried to assess the efficacy of both pneumatic and holmium LL in the treatment of stones (>7 mm) mid and lower ureteric stones at KIMS, Hubballi, a tertiary referral hospital.

In our study, there was no statistically significant differences in male-female sex ratio and stone laterality in both the groups, mean stone size was 12.38 mm in Group 1 PL, and in Group 2 LL, it was 11.31 mm, with p=0.017 which was statistically significant, it can be attributed to randomized division of the patients in particular groups.

Mean operative time was 42.10 min in Group 1 PL and in Group 2 LL, it was 46.78 min, with p=0.011, which was statistically significant, suggesting that LL took more time than PL, which was consistent with Abedi *et al*. study [3].

The results of the mentioned studies were in accordance with our results.

Mean hospital stay±SD (days) in PL group was 2.69±(0.730) days, and in Group 2, LL mean hospital stay±SD (days) was 2.40±(0.591) with p=0.019, which was statistically significant, due to milder injury to ureter in the LL group.

The finding of our study was in line with the preceding investigations in the literature about efficacy of ureteroscopic LL [3,14,15].

- In Group 1 PL, 11 patients had stone migration with percentage of an 18.96% and in Group 2, two patients had stone migration of, with percentage of 3.44%, with p=0.008, which is statistically very significant.
- Laser produces weak shockwaves which cause less retropulsion stones.

Our study shows that LL has less retropulsion as compared to PL. It is in consists with study carried by Rajankoju *et al*. [16].

In Group 1 PL, out of 58 patients, two patients had residual fragments and in Group 2 LL, out of 58 patients, two patients had residual

fragments, there was no significant difference in residual fragments in both groups in our study, which was not was in line with the preceding investigations in the literature [3,14-16] about efficacy of ureteroscopic LL.

Stents were put in >79% of the cases, with no difference in the rate of stenting between both groups.

Overall, the published URS complication rate in literature varies between 9% and 25% [17,18],

In our study, all the complications were Clavien–Dindo Grade <IV.

Post-operative fever, gross hematuria and ureteric injury did not had statistical significant in our study in both the groups.

Auxiliary procedures was not required in LL group, in our study, as laser causes less retropulsion and causes considerably less tissue injury as it has least tissue penetration [16].

CONCLUSION

Standard safe and effective techniques for addressing lower and mid ureteric calculi include pneumatic and LL.

According to our study, LL causes less stone migration and less need for reintervention.

Limitations

We acknowledge that our present study has some limitations. A larger number of patients are needed to confirm the results.

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