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# A Comparative Study Between Pneumatic and Laser Lithotripsy for Proximal Ureteric Calculus

Rajan Koju,[a,d] Hemnath Joshi,[b,d] Sujan Makaju Shrestha,[a,d] Robin Karmacharya,[c,d] Narendra Shalike [a,d]

## ABSTRACT

**Introduction:** There are various modalities of breaking urinary tract calculus. The aim of this study was to compare outcome between laser and pneumatic lithotripsy in patients with upper ureteric calculus in terms of stone free rate, proximal migration and complication. **Methods:** This was a prospective comparative study done in 210 patients with upper ureteric calculus. The patients were randomized into two groups (Laser Lithotripsy and Pneumatic Lithotripsy) from April 2018 to June 2019. The main objective of both the procedures was to break stone into particles less than 3 mm which was confirmed by X-ray KUB and ultrasonography of abdomen and pelvis after six weeks and to compare effectiveness in terms of immediate stone free rate, proximal migration, operative duration and post-operative complication. **Results:** There was no difference in age, gender and stone size in both groups. Immediate stone free rate was 99.05% in Laser Lithotripsy and 76.19% in Pneumatic Lithotripsy (p value<0.001). Proximal migration in Laser Lithotripsy was 0.95% and 23.81% in Pneumatic Lithotripsy (p<0.001). There was significantly prolonged operative duration in Pneumatic Lithotripsy (14.7±4.77 min vs 13.31±3.24 in Laser Lithotripsy, p=0.014). Complications were more in Pneumatic Lithotripsy group, which was statistically significant (p=0.017). **Conclusion:** Both pneumatic and laser lithotripsy are effective and safe modalities for treating upper ureteric calculus, however laser has less chances of proximal migration and higher immediate stone free rate with less complication.

**Keywords**: **Laser lithotripsy, Pneumatic lithotripsy, Ureteric calculus**

## INTRODUCTION:

Kidney and ureteric stones are common pathologies dealt in surgical out-patient department (OPD).[1] More than 80% of out-patient cases in our department are of stone disease in the renal system. There are different treatment modalities for ureteric calculus depending upon various factors like size, density and location of calculus. Available modalities are medical therapy, open surgery, laparoscopic surgery, endoluminal surgery and Extracorporeal Shock Wave Lithotripsy (ESWL).[2]

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. The main advantage of URS is fragmentation of calculus under vision.

There are various modalities for stone fragmentation in URS – Electrohydrolic Lithotripsy (EHL), Pneumatic, Ultrasonic, Laser and dual energy source (Ultrasound+Pneumatic) Lithotripsy.

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a - Lecturer, Department of Surgery
b - Associate Professor, Department of Surgery
c - Assistant Professor, Department of Surgery
d - Dhulikhel Hospital, Kathmandu University Hospital, Dulikhel, Nepal.

**Corresponding Author:**
Rajan Koju
e-mail: kojurajan@gmail.com
ORCID: https://orcid.org/0000-0001-6329-1691

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[3] There are various types of laser; among which Holmium: Yttrium Aluminium Garnet (Ho:YAG) is the one that is commonly used as tissue penetration of Holmium laser is less than two millimetres.[4]

Both laser lithotripsy (LL) and pneumatic lithotripsy (PL) have favourable outcomes.[2] It works as a ballistic force of the compressed air whereas Ho:YAG works by creation of microscopic vaporization bubbles and rapid impulsion of the these bubbles at the tip of fibre creates a shock wave that causes breakdown of stones.[5]

There are very few published studies on comparison of different modalities of lithotripters for proximal ureteric calculus in our population. The aim of this study was to compare efficacy of pneumatic versus laser lithotripters for proximal ureteric calculus in our population.

## METHODS:

This was a prospective comparative study done in 210 cases of proximal ureteric calculus (105 in PL and 105 in LL) in Dhulikhel Hospital, Kathmandu University Hospital from April 2018 to June 2019. Ethical clearance was received from Institutional Review Committee (IRC: 10/18) of Dhulikhel Hospital, Kathmandu University School of Medical Sciences.

Informed consent was taken from all patients. Patients with active Urinary Tract Infection (UTI), abnormal renal function, coagulopathy, spine deformity and pregnancy were excluded from our study. Urine culture, ultrasonography of abdomen and pelvis and Intravenous Urography (IVU) or Computed Tomography (CT) IVU were done in all cases before surgery.

A single dose of intravenous (IV) Ciprofloxacin was given 30 minutes before surgery. All patients were given spinal anaesthesia and kept in lithotomy position. URS was done by three surgeons of Urology unit, Dhulikhel Hospital.

URS was done with 9.5 and 7.5 Fr scope (Karl Storz, Germany) semi-rigid scope under direct vision with 0.035 guidewire placement. For PL group, 1 and 1.2mm Nidhi lith-probe was passed through working channel of URS. The tip of the probe was rested on the surface of the stone and probe was activated. Pressure was set in the range from 2.5-2.7 kg/cm2, frequency of 8 pulse/sec. For LL group, tip of laser fibre was kept 2 mm away from stone. Fibre used was of 200 micron and power setting were 8-12 Watt with frequency of 8-10 Hz. Lumenis 20-Watt holmium laser was used in our procedure.

Stones were broken down to particles less than 3 mm. Double J (DJ) stent was kept in cases with mucosal injury, impacted stone and purulent discharge from collecting system. It was removed after six weeks after confirming stone free status with X-ray KUB. No visible radio-opacity of ureteric stone in X-ray KUB and no echogenic structure of radiolucent ureteric calculi on sonogram KUB region was considered stone free rate. Immediate stone free rate was considered as the absence of calculi in the fluoroscopy at the time of surgery. Complications related to procedure like mucosal injury, bleeding, perforation, stricture and infection were expected.

All data were evaluated by Statistical Package for Social Sciences (SPSS™) version 20.0. Qualitative data was analysed with Chi-square test. Quantitative data was analysed with mean and standard deviation and student t-test. P-value less than 0.05 was considered statistically significant.

## RESULTS:

Table 1 demonstrates the distribution of demographic and clinical characteristics between the two groups which include gender, laterality,

*Table 1. Comparison of demographic and clinical characteristics.*

| Variables | | LL (n=105) | PL (n=105) | Statistics |
|---|---|---|---|---|
| Mean age ± SD, in years | | 35.67 ± 12.64 | 34.68 ± 12.69 | t (N = 210) = 0.5664, p = 0.572 |
| Gender | Male | 66 (62.9%) | 67 (63.8%) | $X^2$ (df = 1, N= 210) =0.0205, p = 0.886 |
| | Female | 39 (37.1%) | 38 (36.2%) | |
| Stone laterality | Bilateral | 2 (1.9%) | 6 (5.7%) | $X^2$ (df = 2, N= 210) = 2.2528, p = 0.324 |
| | Left | 49 (46.7%) | 50 (47.6%) | |
| | Right | 54 (51.4%) | 49 (46.7%) | |
| Mean Stone size ± SD, in mm | | 9.50 ± 1.64 | 9.53 ± 1.86 | t (N = 210) = 0.1240, p = 0.902 |

stone size and age which were comparable in both the groups. There were more bilateral cases in the pneumatic group however it was statistically not significant.

Table 2 illustrates operative and post-operative status which showed there was significant stone migration and higher re-URSL rate in PL group (p value<0.001), however, there was no significant difference in hospital stay. DJ stenting was more in PL group which was statistically significant.

Stone migration was noted in the cases with stone larger than 12 mm size. In LL group, there was one case of stone migration which was managed with re-URSL after two weeks. In PL group, there were 25 cases of stone migration, 15 underwent re-URSL and 10 underwent ESWL before removal of DJ stent (six weeks). In majority of cases DJ stenting was done as most of the cases there was impacted stone causing narrowing of lumen.

*Table 2. Comparison of operative and post-operative parameters (N=210).*

| Variables | LL (n=105) | PL (n=105) | p-value |
|---|---|---|---|
| Mean operative time ± SD (min) | 13.31 ± 3.24 | 14.7 ± 4.77 | t (N=210) = 2.4701, p = 0.014 |
| Mean Hospital stay ± SD (days) | 1.01±0.1 | 1.08 ± 0.61 | t (N = 210) = 1.1604, p = 0.247 |
| Immediate stone free rate (SFR) | 104 (99.05%) | 80 (76.19%) | $X^2$ (df =1, N= 210) =25.2843, p <0.001 |
| Stone migration (%) | 1 (0.95%) | 25 (23.81%) | $X^2$ (df=1, N= 210) =25.2843, p <0.001 |
| re-URSL (%) | 1 (0.95%) | 15 (14.29%) | $X^2$ (df=1, N= 210) =13.2603, p <0.001 |
| DJ stenting (%) | 73 (69.52%) | 92 (87.62%) | $X^2$ (df= 1, N = 210) =10.2101, p <0.001 |
| Complications (%) | 2 (1.90%) | 10 (9.52%) | $X^2$ (df = 1, N = 210) = 5.6566, p = 0.017 |

There were two complications in LL group, one case of fever and another of bleeding due to mucosal injury. In PL group there were ten complications, five cases of fever and another five cases of bleeding. Complication rates were statistically significant(p=0.017). Post-operative fever was managed with analgesics and intravenous antibiotics. No stricture was noted in any patient in three months follow-up period.

## DISCUSSION:

Urinary calculus is one of the common problems dealt in surgical out-patient department. There are various modalities of treatment for ureteric calculus which depend on location, size, density and obstructive features. Stone less than five millimetres can be treated with medical expulsion therapy with alpha-1 antagonist. Soft proximal ureteric stone less than one centimetre can be treated non-invasively with extracorporeal shockwave.[6] With advancement in medical science there have been major changes in the modality of treatment for urolithiasis.[7] Endoluminal surgery is the choice of treatment for urolithiasis. In endoluminal surgery also there are various sources of energy for breaking stone. Pneumatic lithotripsy though cheap and safe one, has certain limitations like stone migration especially in case of proximal ureteric calculus.[8] In such proximal calculus holmium laser is preferred as it produces weak shock wave preventing migration of calculus. It is a reliable source of lithotripter regardless of density and composition of calculus.[9] Our study has shown LL is better option than PL in regards to SFR, less stone migration, less rate of DJ stenting and decreased rate of re-intervention.

Razaghi et al. reported 100% immediate SFR in LL arm (N=12) and 42.9% in PL arm (N=14) p=0.001; no migration in LL arm and 57.1% in PL arm for upper ureteric calculus.[8]

Bapat et al. reported high SFR in LL arm (97.01 vs 86.01%) and less auxiliary procedure in LL arm (1.99 vs 13.98%) for proximal ureteric calculus.[10] Garg et al. also reported higher immediate stone free rate in LL arm (p=0.001) with high stone migration in PL arm (16%).[11] Results of these studies were in accordance with our study.

Akdeniz et al. reported 89.9% SFR in PL arm (N=109) and 87.9% SFR in LL arm (N=107) p=0.791.[12] Irer et al. reported similar complication rate in PL (N=314) and LL arms (N=324); however there were more proximal migration in PL arm.[13] Rabani et al. reported 79.31% stone free rate in LL arm (N=58) and 77.96% in PL arm (N=59) p=0.52.[14] Results of these studies were contrary to our study.

Laser causes less tissue injury as it has least tissue penetration. There was no significant difference between mean hospital stay as all cases were done under spinal anaesthesia and we preferred to keep patients for one day as most of our patients were from remote places.

Cost factor was not considered in this study as there is no difference in cost between the two techniques in our institute.

Limitation of this study was short follow-up, not comparing the density of stones and comparing surgery done by various surgeons of different calibre.

## CONCLUSION:

Laser Lithotripsy group had less stone migration, less chance of re-intervention and high SFR than Pneumatic Lithotripsy group. However, both modalities were effective and safe for management of proximal ureteric calculus.

**Conflict of interest:** Authors declare that no competing interest exists.

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