

## A Study of Ureteroscopic Lithotripsy under Local Anesthesia Using Holmium: YAG Laser

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### Abstract

**Background:** Renal stone disease is a common health problem. Removal of ureteric stones has been revolutionized by the introduction of ureteroscopes and intracorporeal lithotripsy using Holmium laser. Ureteroscopic lithotripsies are commonly performed under general or regional anesthesia and few studies have explored the feasibility of URSL using Holmium laser under local anesthesia. Our study was undertaken to assess the success rate, pain perception, tolerability and complications of URSL with Holmium laser under local anesthesia for ureteric stones.

**Methods:** It was a prospective observational study over two years wherein 100 patients of either sex who underwent URSL under local anesthesia for mid and distal ureteric stones upto 2 cm in size were included. Patient demographic data, stone characteristics, duration of operation, VAS score for pain during URSL, causes of failure and complications of the procedure were documented and analysed.

**Results:** Mean duration of the procedure was 37.7 (+/- 7) minutes. The mean VAS score for pain during URSL was 3.77 (4.3 in males and 3.41 in females). The success rate of URSL was 92% (90% in males and 93.3% in females). Overall complication rate was 25% with majority of them being minor in nature.

**Conclusion:** URSL under local anesthesia using Holmium laser can be performed in selected patients with solitary mid and lower ureteric calculi with good success rate, acceptable pain tolerance and low complication rate.

**Key words:** ureteral stones, ureteroscopic lithotripsy, local anesthesia.

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### I. Introduction

Stone disease is common and affects 0.131% of the population at any time.<sup>(1)</sup> Over a lifetime, urolithiasis can affect up to 10–15% of the population.<sup>(2)</sup> After passage of a first stone, the risk of recurrence is 40% at 5 years and 75% at 20 years.<sup>(3)</sup>

For the impacted ureteric stones, ureteroscopic lithotripsy can be performed using either pneumatic or Holmium: yttrium-aluminium-garnet (Ho:YAG) laser. While the pneumatic devices have distinct advantages of being less expensive, low maintenance requirements and having reusable and cheaper probes, most studies have concluded that Ho:YAG for intracorporeal lithotripsy during ureteroscopic management of impacted ureteral stones is highly efficient with high success rates, regardless of the stone location.

Ureteroscopic lithotripsy (URSL) has been usually performed under general or spinal anesthesia. URSL under local anesthesia is not widely performed for fear of increased risk of ureteric perforation, poor stone clearance rate or damage to the ureteroscope. However, many studies report a similar success rate and similar rates of complications when URSL is performed under local anesthesia, compared with general or regional anesthesia.

Our study was conducted to evaluate the outcomes of ureteroscopic lithotripsy under local anesthesia using Holmium:YAG laser in the treatment of mid and lower ureteric calculi.

## **II. Aim And Objectives**

### **Aim:**

To evaluate the outcomes of ureteroscopic lithotripsy under local anesthesia using Holmium laser for distal and mid-ureteric calculi.

### **Objectives:**

1. To estimate the success rate of ureteroscopic lithotripsy under local anesthesia for distal and mid-ureteric calculi.
2. To estimate the pain perception and tolerability of the procedure.
3. To evaluate the complications of the procedure.

## **III. Materials And Methods**

This was a prospective, observational study in the Department of Urology, Regional Institute of Medical Sciences, Imphal over a two year duration from October, 2019 to September, 2021. All patients of either sex having ureteric calculi who underwent URSL under local anesthesia using Holmium laser during the study period and who fulfilled the inclusion criteria were included in the study.

### **Inclusion criteria:**

- Patients of either sex,
- Aged between 18 to 70 years,
- Single ureteric calculus located in the mid or lower ureter and
- Stone size of less than or equal to 2 cm in greatest dimension.

### **Exclusion criteria:**

- Uncontrolled medical co-morbidities like diabetes mellitus, hypertension, or chronic kidney disease etc.,
- Patients with coagulopathy or bleeding disorders,
- Untreated UTI,
- Pregnant patients,
- Patients with disease of the hip joint, spine or any bony abnormality that precludes proper positioning for the procedure,
- Anatomical abnormalities of the pelvicalyceal system and ureter,
- Prior surgical intervention on the ipsilateral ureter,
- Non-excreting ipsilateral kidney on X-Ray IVP or CT Urogram and
- Patients unable or unwilling to provide consent.

**Sample size :** A total of one hundred (100) patients were found eligible and chosen for the final analysis during the study period.

### **Sampling and procedure:**

- Patients were chosen for the study on the basis of symptoms suggestive of ureteric colic or having a prior radiological evidence of ureteric calculus on presentation to the Department Of Urology, RIMS, Imphal.
- A concise, relevant clinical history was obtained and complete physical examination was performed.
- Pre-treatment ultrasonography and IVP or CT urography was performed in all the patients.
- Basic laboratory investigations included a complete hemogram, bleeding time (BT), clotting time (CT), electrocardiogram (ECG), urinalysis and urine culture, kidney function test (KFT), random blood sugar level and viral markers..
- All patients were prepared with an intravenous access line. Intravenous prophylactic antibiotic (inj. Amikacin 500mg) and intramuscular analgesic (Inj. diclofenac sodium 75mg) were administered 15 minutes before the procedure.
- Blood pressure, lead II ECG and pulse oximetry monitoring were carried out throughout the procedure.
- Instruments and ancillaries included cystoscope (17 Fr or 20 Fr sheath, 30 degree cystoscope, Karl Storz, Germany), ureteroscope (6-7.5 Fr, Karl Storz, Germany), guide wires (Terumo hydrophilic, 0.035 inches, floppy tip), Auriga 20W holmium laser device and 365 micron laser fibre, stone extraction devices (triprong and biprong URSL grasping forceps) and Double-J stent (5 Fr).

- Lignocaine topical gel (2%) was instilled intraurethrally. In males, atleast 30 ml of the gel was instilled and kept for atleast 10 minutes. In females, a sufficient amount of gel was instilled and kept for atleast 5 minutes to obtain adequate effect.
- Cystoscopy and safety guidewire insertion beyond the stone if possible, was done as the standard technique at the beginning of the procedure. Once the safety wire was in place, the bladder was completely drained and the cystoscope removed.
- Ureteroscopic lithotripsy was done with a semi-rigid, offset eye-piece, tapered ureteroscope (6-7.5 Fr, Karl Storz, Germany). The ureteroscope was passed into the bladder and guided into the ureter alongside the safety guidewire. In difficult cases, a second guidewire was passed into the ureter and the ureteroscope guided into the ureter using the rail-roading technique.
- Holmium:YAG laser was used to disintegrate the stone. The laser apparatus settings were adjusted to produce 2000–4000 mJ with the pulse frequency of 3–25 Hz.
- Post-procedure, a 5 Fr DJ stent was inserted into the ureter in all the patients.
- The duration of the procedure was determined from the time of insertion of the cystoscope for passage of the safety guidewire at the beginning, to the end of the DJ stenting after the URSL.
- After each procedure, patients were asked to grade the discomfort and/or pain level experienced during the 2 procedures (cystoscopy Vs URSL) separately, using a 10-point visual analog scale (VAS). Pain was considered mild when VAS was less than or equal to 3, moderate when VAS was between 4-7 and severe when it was between 8-10. In case of patients who required two staged procedures, the VAS score was taken as the average of both the sessions.
- Patients were discharged postoperatively after a short observation period of 2 hours, with oral antibiotic and analgesics.
- Patients were followed-up after 3 weeks of the procedure. In this study, success or complete stone clearance was defined as having no identifiable stone fragments radiologically at 3 weeks follow-up on X-ray (KUB) and ultrasonography.
- The DJ stent was removed 3 weeks after the procedure.

**Statistical analysis:**

All statistical analyses were performed using the IBM SPSS version 21 statistical software for Windows. Descriptive statistics were used to present the observations and results. Associations between categorical variables were assessed using Independent T-test and chi square test. A p-value of less than 0.05 was considered statistically significant.

Approval of the Institutional Research Ethics Board of RIMS, Imphal was obtained. Patient data was used only after a detailed, written, informed consent. Patient confidentiality was maintained.

**IV. Results And Observations**

A total of one hundred (100) patients were found eligible for and included in the final analysis in the study.

**Table 1. Age Distribution of the patients (n=100)**

Age group of the patients (years)	Number of cases (%)
18-31	42 (42%)
32-45	37 (37%)
46-59	18 (18%)
60-73	03 (3%)
Total	100 (100%)

**Table. 1** shows the age distribution of the patients in the present study. The mean age of the patients was 35.8 years +/- 1.1 years (range 18-70 years).

42% of the patients were in the age group of 18-31 years. The mean age of the male patients was 35.0 +/- 1.1 years, while the mean age of the female patients was 36.9 +/- 1.1 years.

**Table 2. Sex distribution of the patients in the present study**

Sex	Number of patients (%)
Male	40 (40%)
Female	60 (60%)
Total	100 (100%)

**Table 2** shows the sex distribution of the patients in the present study. Male to female ratio was 1:1.5.

**Table 3. Size of ureteric stones in the present study**

Stone size (mm)	No. of mid-ureter stones	No. of lower ureter stones	Total no. of cases (%)
1-5	0	0	0
6-10	23	39	62 (62%)
11-15	08	20	28 (28%)
16-20	03	07	10 (10%)
<b>total</b>	34	66	100 (100%)

**Table 3** shows the different sizes of the ureteric stones in the present study. The stone size ranged from 6-18mm. The overall mean stone size was 10.2 +/- 2.7mm. In the male population, the mean stone size was 10.6 +/- 2.8mm while in the females, it was 9.46 +/- 2.7mm. The stone size divided into three groups. Sixty two patients (62%) had stone size between 5-10mm, twenty eight (28%) had between 11-15mm and ten (10%) had between 16-20mm.

**Table 4. Location of ureteric stones in relation to side**

Stone location (side)	Sex	Number of patients (%)
Right ureter	Male	22 (22%)
	Female	32 (32%)
Left ureter	Male	18 (18%)
	female	28 (28%)
Total		100 (100%)

**Table 4** shows the different locations of ureteric stones in relation to side in the present study. Fifty four patients (54%) had stones in the right ureter while the remaining forty six patients (46%) had stone in the left ureter. Sex wise, twenty two males (22%) had stones in the right ureter while eighteen males (18%) had stones in the left ureter. Thirty two females (32%) had a right ureteric stone while twenty eight females (28%) had a left ureteric stone

**Table 5 : Location of ureteric stones in relation to site**

Stone location (site)	Sex	Number of patients (%)
Mid-ureter	Male	14 (14%)
	Female	20 (20%)
Lower ureter	Male	26 (26%)
	Female	40 (40%)
Total		100 (100%)

**Table 5** shows the different locations of ureteric stones in relation to site in the present study. Thirty-four patients (34%) had stone in the mid-ureter while the remaining sixty six patients (66%) had stone in the lower ureter/uretero-vesical junction. Sex wise, fourteen male (14%) had mid-ureteric stones while twenty six (26%) had lower ureteric/UVJ calculus. Similarly, twenty females (20%) had mid-ureteric calculus while forty females (40%) had lower ureteric/UVJ calculus.

**Table 6. The mean duration of the procedure**

Stone location (site)	Sex	Mean duration (min)	Standard deviation	95% confidence level (margin of error)	p-value
Mid-ureter	Male	44.64	4.64	+/-2.43(=/-5.44%)	0.0012
	Female	36.75	7.36	+/-3.23(+/-8.78%)	
Lower ureter/UVJ	Male	41.13	4.79	+/-1.92(+/-4.67%)	0.001
	Female	34.05	7.82	+/-2.43(+/-7.13%)	

**Table 6** shows the mean duration of the procedure in the present study in both the sexes in different locations of the ureter. The mean overall duration was 37.7 +/- 7 minutes (range 17-51 minutes). The difference in the duration of the procedure for a given stone location between male and females was statistically significant.

**Table 7. The Visual Analog Scale record for cystoscopy**

Pain intensity (VAS score)	Number of males (%)	Number of females (%)
Mild (0-3)	25 (62.5%)	48 (80%)
Moderate (4-7)	13 (32.5%)	11 (18.3%)
Severe (8-10)	2 (5%)	1 (1.6%)

**Table 7** shows the VAS scores for pain during cystoscopy in this study. Mild pain (VAS 0-3) was experienced by twenty five males (62.5%) and forty eight (80%) of females. Moderate pain (VAS 4-7) was experienced by thirteen (32.5%) of males and eleven (18.3%) of females. Severe pain (VAS 8-10) was experienced by two (5%) of males and one (1.6%) female during cystoscopy.

**Table 8. The Visual Analog Scale record for URSL**

VAS score	Number of males (%)	Number of females (%)
Mild (0-3)	17 (42.5%)	37 (61.6%)
Moderate (4-7)	17 (42.5%)	20(33.3%)
Severe (8-10)	6 (15%)	3 (5%)

**Table 8** shows the VAS scores for pain during URSL in this study. Mild pain (VAS 0-3) was experienced by seventeen males (42.5%) and thirty seven (61.6%) of females. Moderate pain (VAS 4-7) was experienced by seventeen (42.5%) of males and twenty (33.3%) of females. Severe pain (VAS 8-10) was experienced by six (15%) of males and three (5%) females during URSL.

**Table 9. Comparison of mean VAS scores for cystoscopy Vs URSL between the sexes**

Sex	Mean VAS score for cystoscopy (standard deviation)	Mean VAS score for URSL (standard deviation)	p-value
Overall	2.83	3.77	0.013
Male	3.38 (1.98)	4.30 (2.12)	0.0483
Female	2.47 (1.59)	3.41 (1.88)	0.0038
p-value	0.0127	0.0299	

**Table 9** shows the comparison of mean VAS pain scores for cystoscopy and URSL and also compares it between the sexes. The overall mean VAS score for cystoscopy was 2.83 while the mean VAS score for URSL was 3.77. Sex wise, the mean VAS score for cystoscopy was 3.38 for males and 2.47 for females whereas the mean VAS score for URSL was 4.3 for males and 3.41 for females. There was statistically significant difference when comparing the VAS scores between males and females during cystoscopy and URSL.

**Table 10.Success of local URSL in relation to stone site and sex**

Stone site	Sex	Number of cases	Success (no.)	Success rate (%)	p-value (male vs female)	Overall success rate (%)	p-value (mid- vs lower ureter)
Mid-ureter	Male	14	12	85.7%	0.9	88.2%	
	Female	20	18	90%			0.83
Lower ureter/UVJ	Male	26	24	92.3%	0.8	93.9%	
	Female	40	38	95%			

**Table 10** shows the success rate of local URSL in the different groups. The overall success rate in the present study was 92%. Success rate in males was 90% (36 out of 40 cases) while in the females it was 93.3% (56 out of 60 cases). There was no statistically significant difference in the success rate between males and females in the study. For stones in the mid-ureter, success rate was 88.2% overall (85.7% in males and 90% in females). For the lower ureter/UVJ stones, the overall success rate was 93.9% (92.3% in males and 95% in females). There was no statistically significant difference in the success rate either in terms of sex or stone location.

**Table 11. Success of local URSL in different size groups**

Stone size (mm)	No. of cases	Success at 3 weeks	Success rate (%)
5-10	62	58	93.5%
11-15	28	27	96.4%
16-20	10	9	90%

**Table 11** shows the success rate of local URSL in different size groups of stones in the present study. For size group of 5-10mm, the success rate was 93.5%, for size group 11-15mm the success rate was 96.4% and for the size group of 16-20mm the success rate was 90%.

**Table 12. Number of sessions required**

Stone site	Single session (%)	Two sessions (%)
Mid-ureter	30 (88.2%)	4 (11.8%)
Lower ureter/UVJ	64 (96.9%)	2 (3%)

**Table 12** shows the number of sessions required to complete the procedure. In the case of mid-ureteric stones, thirty patients (88.2%) completed the procedure in a single session while four patients (11.8%) required two sessions. For the lower ureter, sixty four patients (96.9%) completed the procedure in a single session while two patients (3%) required two sessions. None of the patients required a third session.

**Table 13. Causes of failure of local URSL**

Cause of failure	Sex	Number of cases (%)	Treatment
Stone migration in kidney	Male	1 (2.5%)	ESWL
	Female	1 (1.6%)	“
Intolerable pain	Male	3 (7.5%)	URSL under spinal anesthesia
	Female	3 (5%)	“

**Table 13** shows the causes of failure of local URSL and their incidence. The most common cause of failure was intolerable pain, which was seen in five patients (5%) overall. The procedure failed in three males (7.5% of males) and three females (5% of females) due to intolerable pain. They were treated with URSL under spinal anesthesia at a later date. Stone migration into the kidney lead to failure of the procedure in a total of two patients (2% overall). Sex wise, one patient each (2.5% of males and 1.6% of females) had stone migration into the kidney. They elected to undergo ESWL at a later date.

**Table 14. Complications of URSL**

Complications	Number of cases	Percentage of total cases
Hematuria	7	7%
Dysuria	11	11%
Pyelonephritis	1	1%
Urosepsis	1	1%
Fever	5	5%
Total	25	25%

**Table 14** shows the various complications encountered in the present study. The most common complication was dysuria seen in eleven patients (11%), followed by transient hematuria seen in seven patients (7%) and mild fever seen in five patients (5%). All of these complications were managed with rest and conservative therapy (oral antibiotics, anticholinergics, antipyretics and hydration). Two febrile patients and one patient with hematuria were admitted for observation and discharged the following day. There was one case each of urosepsis and pyelonephritis. Both the patients were admitted and managed by appropriate intravenous antibiotics, crystalloids, NSAIDs and monitored intensively. The overall complication rate was twenty five (25%) percent in this study.

## V. Discussion

In order to be established as a treatment modality, URSL under local anesthesia must be able to reproduce the results of the procedure under general or regional anesthesia. The pain associated with the ureteroscopic lithotripsy must be reasonably tolerable and acceptable.

Yalcinkaya et al<sup>(4)</sup> reported success rate of 83% in their experience with URSL under local anesthesia. A similar success rate (88%) was reported by Abdel-Razzak et al.<sup>(5)</sup> Taylor et al<sup>(6)</sup> also recorded a very high success rate of 98% in their series of day care ureteroscopy. Sallami et al<sup>(7)</sup> reported an overall success rate of 84.2% in their series of 100 patients. The stone free rate was 91% in the study by Chan et al<sup>(8)</sup>. In our study, the overall stone free rate of local URSL was 92% which is consistent with success rates in other reported series of URSL.

Our study showed increased pain perception in the males compared to females, which is to be expected due to the anatomical differences in the urethra. This also underlines the need to provide adequate time for the local anesthetic effect to take place in the males. In the study by Taylor et al<sup>(6)</sup>, they reported that the mean VAS pain score was higher in the ureteroscopy group (3.36+/-1.75) than in the cystoscopy group (3.13+/-1.92), the difference not being statistically significant. However, in the study by Sallami et al<sup>(7)</sup>, the mean VAS pain score was higher in the cystoscopy group (4.52+/-1.72) than in the ureteroscopy group (3.61+/-1.35).

Our study also showed a slightly longer operative time in the males compared to females.

The overall complication rate after URS is 9-25%<sup>(16,17,18)</sup>. Most are minor and do not require intervention. In the present study, the overall complication rate was 25%.

URSL under local anesthesia reduces the need for medications (analgesics, anti-inflammatory), prolonged hospitalization, and freeing-up valuable operating room time, thereby lowering the overall cost with comparable success and safety.

The salient observations of this study were:

- Ureteroscopic diagnosis and treatment can be accomplished under local anesthesia in carefully selected patients with acceptable pain tolerance and in patients of both sexes.
- There is high success rate for stone clearance in well selected patients.
- URSL under local anesthesia carries low risk of complications.



## VI. Conclusion

Our study concluded that URSL using holmium laser can be performed in selected patients with solitary mid and lower ureteric calculi with good success rate, acceptable pain tolerance and low complication rate.

**Source of support :** none

**Conflicts of interest :** none.

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