# OUTCOME AND SAFETY OF THULIUM FIBER LASER FOR URINARY STONE DISEASES - A CROSS-SECTIONAL STUDY

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## ABSTRACT

### Introduction

Thulium fiber laser (TFL) was introduced into the urological armamentarium as an alternative to Ho:YAG as an energy source. This study aims to assess the outcome and safety of RIRS using TFL in patients with proximal ureteric and renal stone requiring intervention.

### Methodology

It was a hospital based cross-sectional study conducted in the Department of Urology of Birat Medical College-Teaching Hospital over a period of 6 months (September 2022 to February 2023) in adults patients with stone size upto 20mm. The outcome and safety of the procedure was assessed for stone clearance, operative time, hospital stay and procedure related complications.

### Result

We included initial 50 cases. Mean age, calculus size, calculus volume and calculus density were 40.02± 13.97 years, 14.45±3.36mm, 534.46±209.53 $mm^3$, 1046.96± 236.88 HU respectively. Complete stone clearance was achieved in 92% (46 cases) with 8% CSRF (4 cases). Procedure related complications occurred in 12% (8) cases.

### Conclusions

The TFL as a newer energy source is safe and effective for lithotripsy during RIRS with acceptable complications.

## KEYWORDS

Laser, Renal stone, TFL

## INTRODUCTION

Nephrolithiasis is a global problem affecting all geographical regions with prevalence of 3-5% and the life time prevalence is 15-25%. Nephrolithiasis has propensity to recur in most of the patients. Recurrence rates of renal stone are about 10% per year, 50% over a period of 5-10 years and 75% over 20 years period[1]. The rate of recurrence of renal calculi in patients after 1st time occurrence is 14% at 1st year, 35% in 5th year and 52% in 10th year.[2] In our set up, about 50% of our outpatients are of urinary stone disease.

Symptomatic patients with urinary stone disease require treatment and the options are conservative management, endourological management, laparoscopic surgery or open surgery. Endourological procedures are the most commonly performed procedure in the urinary stone treatment depending upon the size, location and density and available armamentarium either in the form of ureteroscopy and lithotripsy (URSL), percutaneous nephrolithotomy (PNL) or retrograde intrarenal surgery (RIRS) using flexible scope and laser as energy source[3]. Currently, Holmium:YAG and thulium fiber laser (TFL) are most commonly used lasers in urology for stone disease. Thulium fiber laser is a pulsed laser with wavelength of 1940nm was introduced into the urological practice in 2018[4]. It came as an alternative to Ho: YAG. Emitting pulsed infrared light at a wavelength of 1940 nm, which is close to the water absorption peak, a fourfold higher absorption coefficient is achieved with TFL compared to Ho:YAG, corresponding to a low threshold for tissue ablation and stone lithotripsy . Cavitation bubble dynamics also differ from Ho:YAG, and TFL produces a stream of bubbles smaller than those seen with Ho:YAG use . TFL is therefore expected to be very efficient at disintegrating stones in clinical practice [5,6]. Compared to Ho:YAG, TFL has the ability to function at very low energies and extremely high frequencies making it more versatile. In vitro study has shown that TFL works 4-5 times faster, produces finer dusts, has hemostatic properties and produces less fiber burn back compared to Ho: YAG [7].

The RIRS usingHo:YAGis a common procedure in our practice for proximal ureteric and renal stones but we introduced TFL in our institution in the July 2022. This study aims to assess the outcome and safety of RIRS using TFL in patients with proximal ureteric and renal stone diseases requiring minimally invasive intervention at Birat Medical College- Teaching Hospital.

## METHODOLOGY

It was a hospital based cross-sectional study conducted in the Department of Urology of Birat Medical College – Teaching Hospital, Morang, Nepal over a period of six months (September 2022 to February 2023). The study was approved by the Institutional Review Committee ( Ref : IRC-PA-219/2078-79).

We included adult patients with stone size up to 20 mm. We excluded patients with active urinary infection, coagulopathy, stone size > 20mm.

Patients were evaluated preoperatively as per institutional protocol. All patients were presented using 6F, 26 cm double J (DJ) stent and they received prophylactic antibiotics as per institutional protocol or culture sensitivity report. The procedure was done either in general or spinal anesthesia. Semirigid ureteroscopy using 6.5/7 Fr ureteroscope from Karl Storz was done in all patients before introduction of ureteral access sheath (10.7/12.7 Fr, Cook Medical) or 7.5Fr flexible scope (BioradMedisys, India). Calculus was dusted, fragmented or popcorned using 60W laser machine (UROLASE SP+, IPG, Russia) and 200-micron laser fiber with energy and frequency range of 0.2-1.2J and 50-125Hz respectively.

At the end of procedure, 6F 26cm DJ stenting was done in all patients and they received antibiotics, proton pump inhibitor, analgesics and alpha-blocker (Tamsulosin 0.4mg po HS). X-ray KUB was done next morning & patients were discharged on oral antibiotics and other symptomatic treatments unless any complication occurred. Patients' demography, stone status (location, size, volume and density), operating time, hospital stay and complications recorded. DJ stent removal was done @ 2weeks. Stone clearance was assesed @6 weeks postoperatively via Ultrasound, any residual fragment >2mm was considered significant (CSRF).

Statistical analysis was performed using SPSS Statistics version 27 (IBM, Armonk, NY). Continuous and ordinal variables were expressed as mean ± standard deviation and nominal variables were expressed as frequency and percentage. Comparison of proportions was done by chi-square test and continuous data by t-test. P values of < 0.05 were considered as statistically significant.

## RESULTS

We included the initial 50 cases. The baseline characteristics are mentioned below.

**Table 1:** Baseline characteristics

| Variable | Number | Percentage (%) | Mean±SD |
|---|---|---|---|
| **Age (years)** | 50 | | 40.02± 13.97 |
| **Gender** | Male- 33<br>Female- 17 | 66<br>34 | |
| **Stone Laterality** | Right- 29<br>Left- 21 | 58<br>42 | |
| **Stone Location** | Upper calyx- 8<br>Mid calyx- 8<br>Lower calyx-7<br>Pelvis- 13<br>Pelvi-ureteric junction -6<br>Upper ureter-8 | 16<br>16<br>14<br>26<br>12<br>16 | |
| **Stone Size (MM)** | | | 14.45±3.36 |
| **Stone Volume($MM^3$)** | | | 534.46±209.53 |
| **Stone Density (HU)** | | | 1046.96±236.88 |

Operative time, hospital stay and post procedure outcomes are mentioned in the table below( Table 2)

**Table 2:** Postoperative characteristics

| Variables | Number | Percentage (%) | Mean±SD |
|---|---|---|---|
| Scope on time (Minutes) | | | 16.32±5.18 |
| Complications | Sepsis-6 | 12 | |
| Hospital stay (Days) | | | 2.26±0.56 |
| CSRF | 4 | 8 | |

The mean flexible scope on time was16.32±5.18 minutes. Post procedure urosepsis occurred in 6 cases (12%) and these patients required stent removal during the hospital stay. The hospital stay ranged from 1-4 days (1.38±0.85), patients with sepsis required longer stay (up to 4 days). At the end of 6 weeks, complete stone clearance was achieved in 46 cases (92%), 4 cases(8%) having CSRF.

## DISCUSSION

This study was designed to assess the outcome and safety of RIRS using TFL as an energy source in the clinical practicein patients with proximal ureteric and renal stonebeing inspired by the results of preclinical studies.

In this study, mean age of the patients was 40.02± 13.97 years with male predominance ( 66%) and majority of the calculus were on right side ( 58%). In this study, mean age of the patients was 40.02± 13.97 years with male predominance (66%)and majority of the calculus were on the right side (58%). This is comparable with the study of Vaddi et al where mean age of the patients was 45.04±12.30 years with male predominance (60.3%) and right sided location (59%)[8].

The mean stone size in this study was 14.45±3.36mm (range 9mm-20mm). This similar to the studies conducted in India and Russia where the mean stone size was 15.19±4.52 mm and 16.5 ± 6.8 mm respectively.[8,9] Similarly, the mean stone density was 1046.96±236.88 HU in the current study. This was slightly higher than the study of Vaddi et al where it was 985.82±302.57 HU and the study of Enikeev et al where it was 880 ± 381 HU.[8,9] But it was lower than the study of Corrales et al with median density of 1200 (750-1300) HU.[7] Since HU is a relative measurement, it can vary across the centres depending upon multiple factors which explains the variations in the stone density in the studies. The mean stone volume in our study was 534.46±209.53 mm.[3] This volume is lower than the study of Corrales et al ( median-1800mm$^3$), Vaddi et al (1061.85±806.81 mm$^3$), Enikeev et al (median-883mm$^3$) and Sierra et al( median- 1125 mm$^3$) respectively.[7-10] The lower volume in our study can be due to the manual calculation of the volume by the reporting Radiologist as volume estimation software was not available in the CT scan available in our centre.

The mean flexible ureteroscopy on time in our study was 16.32±5.18 minutes. This is less than other similar study (33.21±16.05 minutes.[8] This difference can be because of difference in turning on of flexible scope. In the current study, the scope was introduced on fluoroscopic guidance and after entering into the pelvicalyceal system it was turned on. Further, it was turned off soon after the ablation was completed. Other similar studies have not commented upon the scope on time.[9-11]

After 6 weeks post procedure, complete stone clearance was achieved in 46 cases (92%). It was comparable with other studies in similar settings with stone free rate of 93.6%, 89% and 92.5% respectively.[8,9,11]However, they assessed stone clearance at 3 months after surgery with CT scan. The stone clearance with TFL was higher than Ho:YAG using either regular or mosses technology with 83.3% and 88.4% clearance respectively for each technology.[12] It indicates superiority of TFL over Ho:YAG. The CSRF was seen in 4 of our cases (8%) and they all opted for conservative approach.

Complication occurred in our 6 cases (12%) and they all were post procedure urosepsis and recovered after DJ stent removal (Clavien IIIa). Vaddi et al reported postoperative complications in 16.6% while Martov et al reported complication rate of 15.9%.[8, 13] But Taratkin et al reported procedure related complication in 8.4%.[11] Thus procedure related complication in our study was comparable with others.

The hospital stay in the current study ranged from 2-4 days (mean - 2.26±0.56 days). The patients who developed sepsis after the procedure has to stay longer (4 days). This comparable with the study of Tatkarin and colleagues (3 days) and Martov and team (2.4+/-1.1 days)[11,13].

## CONCLUSION

The TFL as a newer energy source is safe and effective for lithotripsy during RIRS with acceptable complications.

## RECOMMENDATION

We recommend further clinical studies to ensure optimal comparison with conventional Ho:YAG lithotripsy.

### LIMITATION OF THE STUDY

This study is limited by being single centre study, shorter follow up duration and not using CT scan to assess stone clearance. The efficiency of TFL can be evaluated by laser efficacy and ablation speed which was not used here. Further, we did not compare its efficacy with respect to stone density and volume which can be another limitation of this study.

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## CONFLICT OF INTEREST

We declare no conflict of interest.

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