



# Evaluation of 200 Mm, 365 Mm and 500 Mm Fibers of Laser Ho YAG in Transurethral Lithotripsy of Ureteral Stone

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## Abstract

**Introduction:** At present, different Holmium: YAG laser caliber for endoscopic stone treatment are used, which includes 200, 365, 500 and 1000 Mm fiber. Currently there are not enough studies to compare the performance of these fibers. In this retrospective investigation the outcome of 200, 365 and 500 Mm fibers of Laser Ho YAG in Transurethral lithotripsy of ureteral stone evaluated.

**Methods:** Seventy-four subjects with mean age of  $35.3 \pm 5.4$  years old treated by endoscopic laser management from January 2016 to June 2017. The main purpose of investigation was to evaluation Mean Operation Time(MOT), Stone Free Rate (SFR) and complications of 200 Mm, 365 Mm and 500 Mm fibers of Laser Ho YAG in Transurethral lithotripsy.

**Results:** MOT and SFR were significantly different in 500 Mm laser caliber ( $P=0.046$ ,  $P=0.029$ , respectively). There was no remarkable difference between the three groups in this regard.

**Conclusion:** Based upon our data, the clinical potency of the Ho: YAG laser was great in all three fiber calibers. The most important results of this comparison were the significantly higher SFR with increased laser caliber.

**Keywords:** Ho:YAG laser; Transurethral lithotripsy; Ureteral stone; Laser caliber

## Introduction

Urinary calculi have serious implications in urology. Ureteral stones have many complications such as obstructive uropathy and subsequent deterioration of renal function.<sup>1</sup> There are 5 different options for treatment of ureteral calculi: (1) extracorporeal shockwave lithotripsy, (2) ureteroscopic procedures, (3) percutaneous nephrolithotomy, (4) laparoscopic ureterolithotomy, and (5) open stone surgery.<sup>2</sup>

Recent advances in endoscopic methods have facilitated the observation of the urinary tract via the urethra for urologists.<sup>3</sup> Also, ureteroscopy has become a powerful diagnostic and therapeutic modality because of the development of small tools for utilization with endoscopes.<sup>4</sup>

There are a variety of modalities for stone fragmentation, including ultrasonic, electrohydraulic, pneumatic and laser lithotripsy.<sup>5</sup>

Nowadays, the holmium: yttrium-aluminum-garnet (Ho:YAG) laser is used for different urologic surgeries, including management of urinary calculi and soft tissue lesions.<sup>6</sup> Compared with other equipments, the laser has a lower complication rate.<sup>7</sup>

The effect of the Ho:YAG laser is dependent on energy

density.<sup>8</sup> For distinctive energy outputs, fiber diameter impacts and ablation efficiency of calcified tissue depend on energy density.<sup>9</sup>

Presently, different Ho:YAG laser calibers are used for endoscopic stone treatment, which include 200, 365, 500 and 1000 Mm fibers. Currently, there are not enough studies comparing the performance of these fibers.

In this retrospective investigation, we compared the outcome of 200, 365 and 500 Mm fibers of Ho:YAG laser in transurethral lithotripsy of ureteral stone.

## Methods

One hundred seven patients from January 2016 to June 2017 were hospitalized; In Shohada e Tajrish Hospital, tertiary referral center, Tehran, Iran; with diagnosis of ureteral stone that 93 case treated by endoscopic laser management and 74 subjects with mean age of  $35.3 \pm 5.4$  years old enrolled in the study according to inclusion and exclusion criteria. The elaborate checklist concerning ureteral calculi consisted of three parts: (1) Demographics data, (2) Clinical feature, (3) Intra and post operative data. The inclusion criteria were subjects with ureteral stones 9-20 mm in diameter. The exclusion criteria were history of ureteral obstruction, kidney anomalies, positive urinary

culture, pregnancy, and renal failure (serum creatinine  $\geq 3$  mg/dL).

Computed tomography (CT) scan was the diagnostic modality to detect the number, size and location of urinary calculi. Success was described as complete clearance and the absence of any stone fragments on post operation Kidney, ureter, and bladder.

Patients were placed in the lithotomy position after spinal anesthesia and ureteroscopy was done. After the stone was visualized, the laser fiber was crossed through the working channel of the ureteroscope and then laser was discharged under direct vision of urologist. For treatment, we used a Ho:YAG laser (manufactured in Iran). Lithotripsy was done until the stones were fragmented and became as small as sand particles. Ureteroscopy combined with Ho:YAG laser was done by a single urologist using an 8 Fr rigid ureteroscope.

In cases of difficult dilation, prolonged procedure and residual stone, JJ stent was placed into the ureter for 2 weeks after lithotripsy. If ureteral injury did not occur, a ureteral stent was entered and fixed to the Foley catheter. The ureteral catheter was dismissed one day after surgery. Single dose prophylactic intravenous antibiotics were administered before surgery.

Data were analyzed using Statistical Package for Social Sciences Statistics version 18 (SPSS, Chicago, IL, USA). Normality test was performed by the Kolmogorov–Smirnov test. The qualitative data were presented with frequency and percentage and their analysis was done with chi-square test and Fisher exact test. Descriptive statistics (mean  $\pm$  standard deviation) and Student *t* test were used to show and analyze the quantitative outcomes. *P* values less than .05 were considered statistically significant.

## Results

The demographics data of 3 groups were similar according to gender, age, side of stone, mean size of stones and comorbidities (hypertension, diabetes mellitus, parathyroid disease and irritable bowel disease) (Table 1). Intra- and postoperative data of patients are gathered in Table 2. MOT and SFR were remarkably different in groups treated with 365 and 500 Mm laser caliber ( $P=0.046$ ,  $P=0.029$ , respectively). Despite of higher complication rate and stone migration in 365 laser caliber, there was no remarkable difference between the three groups.

Three intraoperative complications were encountered due to perforation of the middle ureter, successfully treated with a DJ stent for 6 weeks.

## Discussion

Urolithiasis affects 5%-15% of the population worldwide.<sup>10</sup> Treatment of renal calculi has seen changes over the last few decades with a shift from open surgery to minimally invasive and endoscopic interventions.

In fact, improvements in endoscopic technology have made retrograde stone removal more attractive procedures for treatment of urinary calculi.<sup>11</sup>

The mechanism of action of Ho:YAG laser lithotripsy is photothermal<sup>12</sup> and the rate of efficiency with this laser is high. Ho:YAG energy heats the stones to a critical threshold temperature at which the stone structure is changed, resulting in a stone crater and small particles. Therefore, unwanted upward migration of calculi or fragments is minimized.<sup>5</sup> Thus, its efficacy in stone fragmentation and clearance is not dependent on stone composition.<sup>13</sup>

**Table 1.** Demographic and Clinical Feature of Subjects

Variable	200 Mm (n = 28 )	365 Mm (n = 24 )	500 Mm (n = 22)	<i>P</i>
Mean age $\pm$ SD, y	36.2 $\pm$ 4.3	34.6 $\pm$ 3.2	35.4 $\pm$ 5.1	$\geq 0.05$
Male, No. (%)	17 (61)	17 (71)	13 (59)	$\geq 0.05$
Previous history of TUL, No. (%)	3(11)	4 (16)	3 (13)	$\geq 0.05$
Stone laterality , No. (%)				$\geq 0.05$
Right	17 (61)	13 (71)	13 (59)	
Left	11 (39)	11 (29)	9 (41)	
Stone location , No. (%)				$\geq 0.05$
Upper	8 (28)	7 (29)	7 (32)	
Middle	5 (18)	6 (25)	4 (18)	
Lower	15 (54)	11 (46)	11 (50)	
Stone diameter, mm	12.1 $\pm$ 2.3	11.9 $\pm$ 3.8	11.7 $\pm$ 4.2	$\geq 0.05$
Number of stones, No. (%)	1.2 $\pm$ 0.1	1.1 $\pm$ 0.4	1.2 $\pm$ 0.4	$\geq 0.05$
Duration of stone impaction, No. (%)				$\geq 0.05$
1 month	19 (68)	18 (75)	16 (73)	
Between 1 to 4 months	4 (14)	4 (16)	4 (18)	
More than 4 months	5 (18)	2 (9)	2 (9)	

**Table 2.** Patient Intraoperative and Postoperative Data

Variable	200 Mm (n=28 )	365 Mm (n=24 )	500 Mm (n=22)	P
Complications, No. (%)				0.120
Ureteral perforation	0 (0)	2 (9)	1 (4)	
Postoperative fever	2(7)	1 (4)	0 (0)	
Stone migration	0 (0)	0 (0)	3 (13)	
Mean operation time $\pm$ SD, min	13.1 $\pm$ 2.2	11.9 $\pm$ 2.0	11.1 $\pm$ 2.1	0.046
Mean hospital stay $\pm$ SD, h	21.1 $\pm$ 2.2	20.9 $\pm$ 2.7	21.2 $\pm$ 2.6	0.628
Immediate stone-free status, No. (%)	22 (78)	21 (87)	22 (100)	0.029
Stone status, No. (%)				0.636
Upper	8 (100)	5.6 (80)	7 (100)	
Middle	3.3 (67)	3.6 (60)	3 (75)	
Lower	15 (100)	9.9 (90)	11 (100)	
Stone migration, No. (%)	1 (3)	2 (9)	1 (4)	0.765

There are different types of laser fibers, and with increasing fiber diameter, the level of energy density increases. This comparative study was designed to compare the efficacy and safety of three Ho:YAG fiber caliber in the management of ureteral calculi.

In a study, Kuo et al evaluated outcomes of fiber diameter on stone lithotripsy in 1998. They found no relation between fiber diameter and rate of success in lithotripsy. Despite that, in our study we compared three types of fibers with different diameters (200 Mm, 365 Mm and 500 Mm) and concluded that increased fiber diameter leads to increased stone free rate (SOT) ( $P=0.046$ ), decreased mean operation time (MOT) ( $P=0.046$ ) and decreased steinstrasse ( $P=0.020$ ).<sup>14</sup>

Excess irrigation flow through the endoscope working channel leads to a better view which was achievable by 200 mm laser fiber in contrast to 365 mm and 500 mm fibers. Despite these benefits of the 200 mm laser fiber, it is remarkably more expensive than other fibers and its lifetime is lower than fiber 365 and 500 mm calibers.

Grasso<sup>15</sup> in 1996 mentioned that the size of the vaporization zone of stone and thus the efficiency of stone shattering were directly related to the diameter of fiber. He also reported that the most efficient and faster debulker of large bladder stones is the largest fiber (1000 mm). We also experienced that larger fibers have a greater range of efficacy for fragmentation of ureteral stones.

Regarding complications, no additive incidence of ureteral stricture was detected after endoscopic lithotripsy in this series and other studies.<sup>6</sup>

Based upon our data, the clinical efficacy of the HO:YAG laser was excellent in all 3 fiber calibers. According to our experience in referral center of laser treatment of stone, the most important results of this comparison were the significantly higher SFR with increased laser caliber. Regarding complications, there was no remarkable difference in urosepsis and perforation risk between three groups.

#### Ethical Considerations

The ethics committee of the Laser Application in Medical Sciences Research Center approved the study protocol and informed consents were obtained from all the subjects.

#### Conflict of Interests

None declared.

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