Lasers

Dornier Thulio: initial single-center clinical experience on safety and efficiency

In 2022, Dornier MedTech launched Dornier Thulio, the pulsed solid-state thulium: yttrium-aluminum-garnet (Tm:YAG) laser for various urological treatments. This cutting-edge laser operates at a wavelength of 2013 nm and boasts a maximum power output of 100 W. The absorption coefficient of the pulsed Tm:YAG laser falls between that of the holmium: YAG (Ho:YAG) laser and the thulium fiber laser (TFL). The pulsed Tm:YAG laser sets itself apart with unique laser settings, including a pulse energy of up to 2.5 J, a pulse frequency (also known as pulse rate) of up to 300 Hz, and a peak power of up to 3.7 kW. Combining the finest attributes of the gold standard Ho:YAG and TFL in one device, Dornier Thulio, powered by pulsed Tm:YAG technology, represents the optimal middle ground between both technologies and offers a potential breakthrough in the field.

A recently published study by Panthier et al. demonstrated the safety and efficiency of Dornier Thulio in laser lithotripsy based on its successful application in a first clinical trial involving 25 patients.

Study: Initial clinical experience with the pulsed solid-state thulium YAG laser from Dornier during retrograde intrarenal surgery (RIRS): first 25 cases.[1]

The French Association of Urology now recommends TFL as an alternative to the Ho:YAG laser in their urolithiasis guidelines.[2] Additionally, the pulsed Tm:YAG laser has been proposed for endoscopic laser lithotripsy (ELL) to potentially overcome the limitations of both Ho:YAG and TFL.

Objective

The authors aimed to evaluate the efficiency, safety, and laser settings of the pulsed Tm:YAG laser in ELL during retrograde intrarenal surgery (RIRS).

Method

In a single-center prospective study, 25 patients with ureteral and renal stones underwent RIRS utilizing Dornier Thulio (pulsed-Tm:YAG) laser from Dornier MedTech Laser GmbH, located in Wessling, Germany. The procedures used single-use 272 µm laser fibers, and various parameters were recorded, including stone size, stone density, laser-on time (LOT), and laser settings. The authors also assessed the ablation speed (mm^3/s), ablation efficiency ($Joules/mm^3$), and laser power (W) values for each procedure. Postoperative outcomes such as the stone-free rate (SFR) and zero fragment rate (ZFR) were also documented.

Results

The analysis included 25 patients with a median value and interquartile range (IQR) age of 55 (44–72) years. The stones had a median and IQR volume of 2849 (916–9153) mm^3 and a median and IQR density of 1000 (600–1174) HU. 17 patients had stones in the superior or inferior calyx and the pelvis. Five patients had complex stone cases, including two ureteral stones and one bladder stone.

The median and IQR pulse energy, pulse rate, and total power used were 0.6 (0.6–0.8) J, 15 (15–20) Hz, and 12 (9–16) W, respectively. All procedures used “Captive Fragmenting” pulse modulation (See Table 1).

Specifications	Results
Laser-on time (min)	35 (21.3 – 52.11)
Laser settings	
Pulse energy (J)	0.6 (0.6 – 0.8)
Pulse rate (Hz)	15 (15 – 20)
Laser power (W)	12 (9 – 16)
Pulse modulation	Captive Fragmenting (100 %)
Total laser energy (kJ)	26 (11.94 – 32.8)
Ablation efficiency (J/mm^3)	14.8 (6 – 21)
Ablation speed (mm^3/s)	0.75 (0.46 – 2)
Stone-free rate (< 3 mm)	19/20 (95 %)
Zero fragment rate (< 1 mm)	11/20 (55 %)
Intention to treat	
Stone-free rate (< 3 mm)	19/25 (76 %)
Zero fragment rate (< 1 mm)	11/25 (44 %)
Complications	
Clavien-Dindo 1-2	1/25 (4 %)
Clavien-Dindo 3-4	-

▲ *Table 1: Perioperative results of the 25 cases treated with Dornier Thulio.*

The median and IQR ablation efficiency was 14.8 (6–21) J/mm^3. In contrast, the median and IQR ablation speed rate was 0.75 (0.46–2) mm^3/s. One postoperative complication occurred (Steinstrasse).

The present study reports 76 % SFR and 44 % ZFR during RIRS for stone treatment. In a previous clinical trial, Ulvik et al. reported an SFR of 92 % and ZFR of 80 % for TFL. In comparison, Ho:YAG laser had an SFR of 67 % and ZFR of 57 %.[3] The results seem non-inferior to the Ho:YAG laser, but for the TFL, the SFR is lower than the one reported by Ulvik et al. When comparing these two studies, it should be noted that different surgical devices and fiber diameters (272 µm vs. 200 µm or 150 µm) were used at the two sites, which could affect the study results. Additionally, both studies were single-center studies with different experiences, treatment techniques, laser settings, stone modalities, patient populations, and clinical protocols, which affects the comparability of results to some extent. Excluding the complex cases from this study, the SFR is 95 %, and the ZFR is 55 % (See Table 1).

The authors of this study emphasize that the stone sizes in their cohort were large for RIRS. The dusting technique with the pulsed Tm:YAG laser is similar to the Ho:YAG laser, but a greater distance between the fiber and stone is required compared to TFL.

The laser settings used in this study resulted in a median of 0.6 J for pulse energy, 15 Hz for pulse frequency, and 12 W for power output. The authors applied an approach of low pulse energies and frequencies to minimize dusting and avoid basketing. The efficiency ratios observed (14.8 J/mm^3 and 0.75 mm^3/s) were similar to TFL efficiency ratios with similar dusting techniques.

Due to its technological characteristics, the pulsed diode-pumped Tm:YAG laser has a uniform rectangular pulse profile resembling that of TFL. However, it possesses higher pulse peak powers of up to 3.7 kW, in contrast to TFL's 0.5 kW. This pulse profile generates similar induced vapor bubbles (IVB) in water, akin to the holmium laser. Nonetheless, the expansion of these bubbles is more oval-shaped compared to the spherical bubbles produced by the Ho:YAG laser. The clinical benefits of these distinct vapor bubble dynamics have yet to be assessed.

Conclusion

Dornier Thulio, the new pulsed-Tm:YAG laser, is a safe and effective source for endocorporeal laser lithotripsy (ELL) during retrograde intrarenal surgery (RIRS) using low pulse energy and low pulse frequency. The study reveals minimal complications and comparable outcomes to thulium fiber laser (TFL). The lasering technique for pulsed-Tm:YAG may differ from TFL, with a slightly longer fiber-to-stone distance. Further clinical trials, particularly comparative studies, are necessary to determine the performance of pulsed-Tm:YAG in comparison to other laser technologies available for ELL.

Glossary

Tm:YAG: pulsed thulium: yttrium-aluminum-garnet laser

Ho:YAG: holmium: yttrium-aluminum-garnet laser

TFL: thulium fiber laser

ELL: endoscopic laser lithotripsy

RIRS: retrograde intrarenal surgery

LOT: laser-on time

SFR: stone-free rate

ZFR: zero fragment rate

IQR: interquartile range

IVB: induced vapor bubbles

References

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DMT777-THULIO-CLIN-REVA-0823-GL-EN