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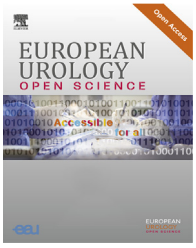

Open to Debate – Referee

Which Is the Best Laser for Lithotripsy? The Referee Point of View

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Laser technology is one of the most important innovations introduced in endourology. The Ho:YAG laser has been considered the gold-standard laser for lithotripsy over the past 30 yr, thanks to its efficacy and safety profile [1]. By contrast, the newer thulium fiber laser (TFL) is gaining in popularity among urologists because of its supposed better dusting capability, which has led some of the urological community to regard it as being a game-changer, even though robust clinical studies are still lacking [1].

The ideal laser for lithotripsy should be effective, safe, capable of multitasking, cost-effective, fast, ergonomic, and noiseless. The question arises as to whether we have a single laser machine that includes all these features? The answer is: not yet! Here we consider the reasons why not.

In this debate, sides led by Olivier Traxer [2] and Kurshid Ghani [3], both highly internationally regarded scientists in the field, share their convictions regarding TFL and Ho:YAG lasers. Several laboratory studies have shown superiority of TFL over Ho:YAG lasers in terms of being more efficient and faster for stone ablation [4]. In truth, when it was introduced in clinical settings, the amazing expectations for TFL were, at least in part, disregarded. The very low energies and very high frequencies used in in vitro studies were not as efficient in real life as previously postulated, leading urologists to shift to clinical TFL settings almost similar to those used for Ho:YAG lasers. Absorption by water is four times greater for TFL than for Ho:YAG [4], defining TFL as a contact laser. It is likely, as postulated by Hyung and Ghani [3], that TFL experiments were performed in an ideal setting for its physical features, with the fiber always in contact with phantom stones owing to the presence of a robotic arm and with the laser continuously activated. This is completely different from the clinical scenario. In fact, it is challenging to always remain in contact with the stone during lithotripsy because of breathing movements and displacement of fragments due to both retropulsion and active irrigation, so that some of the energy generated is dispersed in water instead of being delivered to the stone owing to the high coefficient of absorption, with some consequent concerns regarding increases in intrarenal temperature. In addition, laser firing may be intermittent because of impaired vision due to the presence of huge amounts of floating dust and in order to decrease the maximum intrarenal temperature. By contrast, stone ablation with Ho:YAG laser can occur at 1–2 mm away from the tip, overcoming the aforementioned difficulties during lithotripsy [5]. Last but not least, Ho:YAG laser is also considered the gold standard for benign prostatic hyperplasia (BPH) surgery.

Conversely, Traxer et al [2] state that, in fact, the only weakness of TFL is identification of the optimal settings for stone ablation. In a recent randomized clinical trial, Ulvik et al [6] demonstrated the higher efficacy and safety of TFL compared to Ho:YAG laser for the treatment of ureteral and renal stones. However, careful consideration of the study reveals some biases, such as surgeon variability, the unusual laser settings used, and, most importantly, the comparison with low-energy Ho:YAG laser without any possibility of high- or super high-frequency or pulse-

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modulation technology such as the Moses technology or similar. In other words, this is like comparing a Tesla Roadster with a Fiat Panda instead of with a Ferrari to demonstrate the superiority of an electric engine over a thermic one: it is quite counterintuitive!

Indeed, TFL have better results in reducing stone retropulsion. As reported by Traxer and colleagues [7,8], this can be explained by different laser pulse shapes, prolonged peak power levels, and higher water absorption, leading to minimum turbulence in the field. TFL has lower peak power than Ho:YAG. This is useful in stone retropulsion reduction, but is less helpful in fragmentation. Even though some urologists prefer a dusting technique also in mini-PCNL, the quintessence of this procedure is taking advantage from the vacuum cleaner effect that perfectly works in tandem with the stone fragmentation. Owing to the low peak power of TFL, higher power is needed to achieve stone fragmentation, especially for hard stones, leading to potential injuries to tissue, stone carbonization, and sparks of light.

In addition, an in vitro study comparing the intraureteral/renal temperature generated by TFL during lithotripsy in comparison to Ho:YAG laser at the same power settings revealed higher temperatures with TFL, probably because of its very high coefficient of absorption in water, exceeding the threshold for tissue damage in some situations [9]. No clinical data are available on this issue and this is a concern that really deserves more investigation to better define the safety profile of TFL.

As reported by Traxer and colleagues [10], TFL generates a more uniform and focused laser beam that can be transmitted by laser fibers with a smaller core diameter (50–150 μm), whereas Ho:YAG lasers can only safely use fibers with a core diameter >200 μm. This translates into better irrigation through the working channel and better scope deflection, and possibly further scope miniaturization in favor of TFL [11].

There is certainly no doubt about the superior ergonomics of TFL, as mentioned by Traxer et al [2]. TFL devices are smaller and lighter than Ho:YAG lithotripters, thereby saving precious space in the endourological operating room (OR), which is always overcrowded with medical equipment [4]. Moreover, TFL consumes almost ten times less electricity than its Ho:YAG counterpart, therefore seeming to be more environmentally friendly [4]. Another issue in favor of TFL is the electrical installation in the OR. While TFL works with the standard outlets available in every OR, high-power Ho:YAG laser machines need a dedicated power supply. This may require an overhaul of the electrical installation in the OR, which has related costs and may impose mobility restrictions within the OR [4]. Moreover, TFL becomes essential when two lasers are needed during simultaneous bilateral surgery, such as mini simultaneous bilateral endoscopic surgery (SBES), as usually only a single high-amperage plugging system per OR is available [11]. In addition, the maintenance costs are undoubtedly lower for TFL than for Ho:YAG laser machines because the lifetime of laser diodes is very long and there are no lenses or mirrors that are very fragile and impact-sensitive [4].

Last but not the least, TFL produces less noise in the OR than Ho:YAG, especially high-power lasers. It has been demonstrated that TFL produces 3.1–4.3 dB less noise than the standard holmium laser, which translates into less than half the overall noise energy, providing a less noisy and quieter working environment and therefore facilitating greater concentration, communication, and task completion by OR staff [12].

In conclusion, while we should be happy to have a new promising laser technology available, we should not uncritically adopt it only on the basis of superior results obtained in a laboratory setting that is significantly different from daily clinical practice. Thus, we have to keep on performing clinical studies with robust methodology in order to provide solid scientific evidence of the clinical superiority of TFL over Ho:YAG according to an aphorism of the father of Italian science, Galileo Galilei: "Scientific truth is not decided by majority nor by enthusiasm for an idea".

It seems that, as is often in life, the truth is in the middle. At present, TFL is not a game-changer, as it does not allow anything to be carried out that was not possible before its advent. However, it is indeed a wonderful technology, especially for retrograde intrarenal surgery, for which dusting is a must, and TFL should be available in all departments that can afford to have more than one laser machine. On the contrary, in departments that can afford only one generator (which are the majority), the choice is still only in the direction of Ho:YAG thanks to its ability to cover all kinds of stones and BPH surgery.

Veritas filia temporis [Truth is the daughter of time]

Marco Tullio Cicerone, 43 BC

Conflicts of interest: Guido Giusti is a consultant for Coloplast, Rocamed, Olympus, Boston Scientific, BD-Bard, Cook Medical, and Quanta System. Matheus Pupulin has nothing to disclose. Silvia Proietti is a consultant for Quanta System.

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