

Poster AM15-0401

Introduction and Objectives:

Next generation laser lithotripters have become available in the market. Besides pulse energy and frequency, these new lithotripter models allow the urologist to choose between different pulse lengths (Figure 1), however their lithotripsy efficiency is still unclear. The authors decided to evaluate the lithotripsy performance of long-pulse mode and compare it to the traditional short-pulse mode, to evaluate the changes that occur at the laser fiber tip, and to use a testing procedure free from human interaction.

Materials and Methods:

Contrary to single pulse or manual experiments of previous studies, an automated laser fragmentation testing system was used to perform lithotripsy experiments creating ablation fissures on artificial stones made from soft and hard stone material (Figure 2).



Figure 2 – (A) and (B) Artificial stones made of Plaster of Paris and BegoStone Plus®, whose physical properties are comparable to softer stones like struvite and harder stones such as calcium oxalate mono-hydrate, respectively. (C) The novel laser lithotripter MH 01 – ROCA FTS 30 from Rocamed™, capable of short and long-pulse lithotripsy. (D) and (E) An automated laser fragmentation testing system made of Lego Technic, capable of doing precise and reproducible experiments.

LONG-PULSE VERSUS SHORT-PULSE LASER LITHOTRIPSY PERFORMANCE

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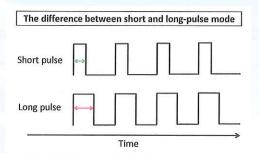


Figure 1 — Comparing the traditional short-pulse mode with the new long-pulse mode, laser lithotripter settings are exactly the same with the same pulse frequency, pulse energy, and the same power level, thus the same amount of energy is delivered. However, in short-pulse mode the energy delivered by a single laser pulse occurs during a certain period of time (green double arrow), while in long pulse mode that same amount of energy is distributed over a longer period of time (red double arrow).

The 272-µm core laser fibers used (Rocamed™ – MF272ST), were stripped and cleaved according to manufacturer recommendations. Tests were performed using a novel laser lithotripter model from Rocamed™ that allows traditional and long-pulse lithotripsy settings (Figure 2C). High-frequency low-pulse energy (HiFr-LoPE; 20Hz x 0.5J) and low-frequency high-pulse energy (LoFr-HiPE; 5Hz x 2.0J) lithotripter settings were employed to cover most typical lithotripsy conditions. All combinations were tested using both the traditional short-pulse and the novel long-pulse mode, in multiple 30-second-long lithotripsy experiments. Ablation volumes were measured and compared. Laser-fiber tips were photographed before and after lithotripsy to complement the results.

Results:

Short-pulse mode is always more ablative than long-pulse mode (p<0.00001). regardless of stone material or lithotripter settings, with an average 17.4% higher ablation volume, 25.0% at LoFr-HiPE and 9.9% at HiFr-LoPE (Figure 3). Short-pulse mode makes 25.2% wider fissures, and although less ablative, long-pulse mode creates on average 13.0% deeper fissures. Ablation volume increased with softer stone material or with LoFr-HiPE settings, regardless of pulse type. More fiber tip degradation with harder stone material or with LoFr-HiPE settings is observed in both pulse modes, however, these damages are considerably less evident in long-pulse lithotripsy (Figure 4).

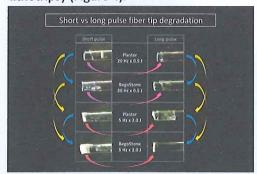


Figure 4 – Experiments revealed more fiber tip degradation with harder stone material (blue arrows), as well as with higher pulse energy settings (yellow arrows), regardless of pulse mode. Nevertheless, comparing long and short pulse settings, long-pulse mode seems to spare the cladding and the fiber tip, showing less cladding degradation (pink arrows) as well as less fiber tip opacification (red arrows).





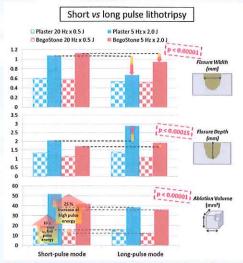


Figure 3 – Initial experiments showed that long-pulse mode produced significant narrower fissures, particularly if using LoFr-HiPE and regardless of stone material. In relation to fissure depth there is an inversion of the pattern seen before with fissure width, with long-pulse mode producing deeper fissures, specially with softer stone material. Concerning ablation volume, short-pulse mode remains the more efficient lithotripter setting, with a 9.9% and 25.2% increase at low and high pulse energy settings, respectively. All these results are statistically extremely significant.

Conclusions:

- Traditional short-pulse lithotripter settings are more ablative than novel long-pulse settings.
- Low frequency with high pulse energy settings remains the more ablative setting with long-pulse mode.
- Harder stone material is still more difficult to ablate, with long-pulse mode.
- Long-pulse shows less fiber tip degradation than short-pulse lithotripsy.

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