LONG-PULSE VERSUS SHORT-PULSE LASER LITHOTRIPSY PERFORMANCE

Peter Kronenberg (Amadora, PORTUGAL), Olivier Traver (Paris, FRANCE)
peter.kronenberg@gmail.com

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). The 272-μm core laser fibers used (Rocamed™ - MF2725T) were stripped and cleaved according to manufacturer recommendations. Tests were performed using a novel laser lithotripter model from Rochamed™ 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-HPe; 5Hz x 2.0J) lithotripsy 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-HPe 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-HPe settings, regardless of pulse type. More fiber tip degradation with harder stone material or with LoFr-HPe settings is observed in both pulse modes, however, these damages are considerably less evident in long-pulse lithotripsy (Figure 4).

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.