Effects of Variable Power on Tissue Ablation Dynamics During Magnetic Resonance Guided Laser-Induced Thermal Therapy

Sean Munier, Nitesh Patel, Shabbar Danish

Department of Neurosurgery, Robert Wood Johnson Medical School, Rutgers University, New Brunswick, USA

Background: Magnetic resonance-guided laser-induced thermal therapy (MRgLITT) is a real-time MRI guided, minimally invasive procedure used to treat various intracranial pathologies. Little is known about the effects of varying power on ablation. This work seeks to evaluate the effects of variable power on the maximal estimated thermal damage during ablation and duration required to reach maximal ablation.

Methods: We used real-time ablation data from 93 patients across various intracranial pathologies. All ablations were performed using the Visualase Thermal Therapy System (Medtronic Inc., Minneapolis, MN), using a 980-nm diffusing tip diode laser. Cases were stratified into low, medium, and high power. Maximal thermal damage estimate (TDE$_{max}$) achieved and time to reach maximal damage (t$_{max}$) was measured and compared between groups. Ablation area change for cases in which an initial thermal dose was followed by a subsequent dose, with increased power, was also assessed.

Results: TDE$_{max}$ in the high power group (284.2 ± 77.5 mm$^2$) was significantly greater than TDE$_{max}$ in the medium power group (206.5 ± 53.2 mm$^2$) and low power group (180.5 ± 70.1 mm$^2$). The t$_{max}$ of the high power group (93 ± 41 seconds) was shorter than the t$_{max}$ of the low power group (137 ± 52 seconds). In cases where a second thermal dose was delivered at higher power, the TDE expanded an average of 51.4 mm$^2$ beyond the initial TDE generated by the initial ablation.

Conclusion: Increased power results in a larger TDE$_{max}$ and faster ablation rate. In cases where an initial thermal dose does not fully ablate the target lesion, a second ablation at higher power can increase the area of ablation. Future studies are needed to examine clinical outcomes as well as the effects of previous therapies on ablation dynamics.