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Tissue Ablation Dynamics in Subsequent Topographically Overlapping Thermal Doses of Previously Damaged Tissue During Magnetic Resonance-Guided Laser-Induced Thermal Therapy

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Introduction

Intraoperative dynamics of Magnetic Resonance-guided Laser Induced Thermal Therapy (MRgLITT) has been previously characterized for ablations of naïve tissue. However, most treatment sessions require the delivery of multiple doses and little is known about the ablation dynamics when additional doses are applied to heat-damaged tissue.

Methods

92 ablations from 20 patients across three unique surgical indications were examined. All ablations were performed using the Visualase MRI-Guided Laser Ablation System (Medtronic), which employs a 980 nm diffusing tip diode laser. Single-dose intraoperative thermal damage was used to calculate the duration required to reach TDE = 75 mm2 (tTDE75) as well as 50% (t50) and 97% (t97) of maximum damage (TDEmax). Primary comparisons were made between naïve versus damaged tissue and secondary comparisons were made between completely versus partially overlapping ablations.

Results

During the delivery of a laser dose, TDE expands with a decreasing rate. We found no significant difference in the optimal ablation duration (t50 and t97) between the first and second ablations. However, when case-controlled, the duration required to reach TDE = 75 is increased for second ablations (15.5%). When two ablations partially overlap, a significant decrease in TDEmax (213 vs. 164 mm2) was detected in the absence of a correlation with laser power or duration.

Learning Objectives

To determine the differences in ablation dynamics between naïve versus damaged tissue.

Conclusions

The ablation of partially-ablated tissue resulted in a reduced volume of tissue damage. Whether this can be compensated for by increasing the laser power or dose duration is currently unknown. This should provide the basis for future studies examining these variables. Operators should take into account a possible reduction in TDE when ablating partially-damaged tissue.

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