Thermal Dynamics, Volumetrics and Seizure Outcomes Following Magnetic Resonance-guided Laser Interstitial Thermal Therapy (MRgLITT) in Pediatric Lesional Epilepsy

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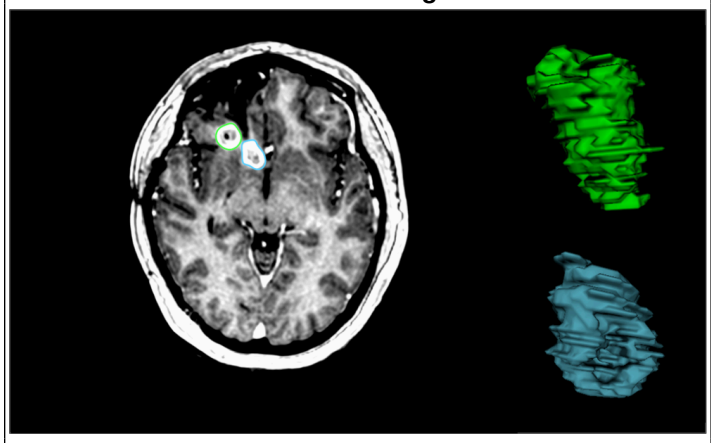
Introduction

MRgLITT has emerged as a safe and effective minimally-invasive technique for several intracranial pathologies. However, the effects of variable thermal energy on tissue ablation dynamics are poorly understood, particularly in the pediatric population. This study aims to examine the relationship between energy and volume of ablation in children undergoing MRgLITT for drug-resistant lesional epilepsy, define any correlation between volume ablated and seizure control outcome and any disparities between underlying epileptogenic pathologic substrates.

Methods

Single-center retrospective review of lesional epilepsy patients undergoing MRgLITT was performed. Volumes were measured by two raters using post-ablation T1-weighted MRI in Osirix. Inter-rater variability was analyzed via ANOVA. Linear regression analysis was performed to determine the relationship of energy to ablated volume. Fisher's exact test was used to assess independence of seizure outcome by Engel Scale from pathologic substrate or ablated volume >1.5cm3.

Method for Measuring Volumes



Volumes of ablated tissue were determined by defining regions of interest on post-ablation T1-weighted MR images in Osirix viewer (left) which were then used to calculate volumes (right).

Results

Thirteen patients had twenty total lesions ablated. Substrates included tuberous sclerosis, focal cortical dysplasia, hypothalamic hamartomas, periventricular nodular hyperplasia and mesial temporal sclerosis. Outcomes were documented to mean follow-up of 10 months. Postoperative seizure control outcome was Engel-I in nine (69.2%), Engel -II in two (15.4%) and Engel-III in two (15.4%) patients. Linear regression was calculated to predict the effect of energy on volume of ablation (p=6.47E -6, R=.841). Linear correlation between energy and volume was found to be strongest in tuberous sclerosis lesions (R=.88) and weakest in cortical dysplasia (R=.057). Inter-rater differences were insignificant (p=.73). There was no significant relationship between pathological substrate or volume of ablation >1.5 cm3 and seizure control by Fisher's Exact Test (p=.67; p=.73).

Conclusions

We characterized a linear relationship between the in-vivo application of thermal energy and ablated volume. The strength of this correlation was variable across different substrates, but pathologic substrate did not predict seizure outcome. More study is needed in larger populations before these relationships can be fully understood.

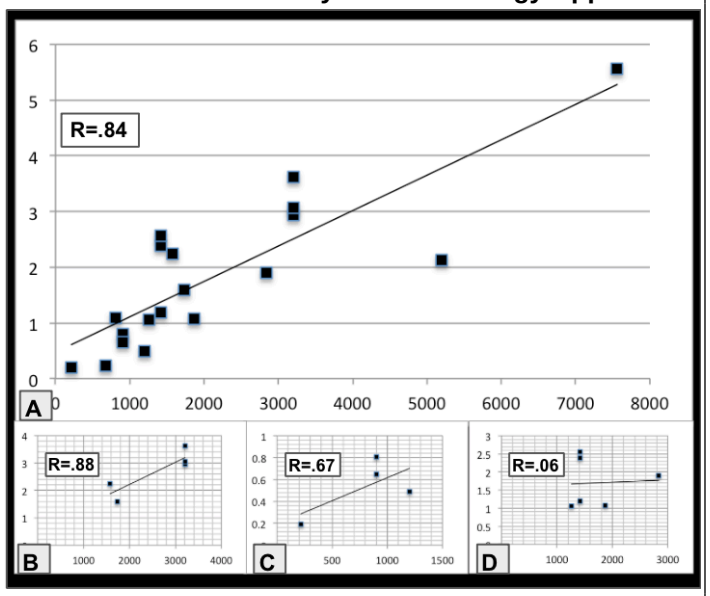
Learning Objectives

By the conclusion of this session, participants should be able to:

1) Understand the effect of variable thermal energy on the volume of ablation in the pediatric brain

2) Characterize the disparate effects of variable thermal energy on various underlying pathological substrates

Volume of Ablation by Thermal Energy Applied



A linear regression was calculated to determine the relationship between energy (joules) and volume of tissue ablated (cm3). Although there was a strong linear correlation overall (R=.84) (A), the strength of the relationship varied across pathological substrates (B-D). The correlation was strongest in tuberous sclerosis lesions (R=.88) (B), followed by hypothalamic hamartomas (R=.67) (C). Almost no linear correlation was noted in cortical dysplasia (R=.06) (D).