Does the Presence of Intraoperative MRTI Signal Artifact During Laser Interstitial Thermal Therapy Affect Concordance Between Thermal Damage Estimate and Postoperative MRI Predicted Ablative Area

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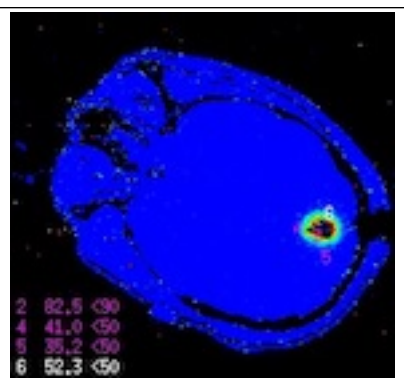
CNS 2018 ANNUAL MEETING
HOUSTON, TEXAS
OCTOBER 6-10, 2018

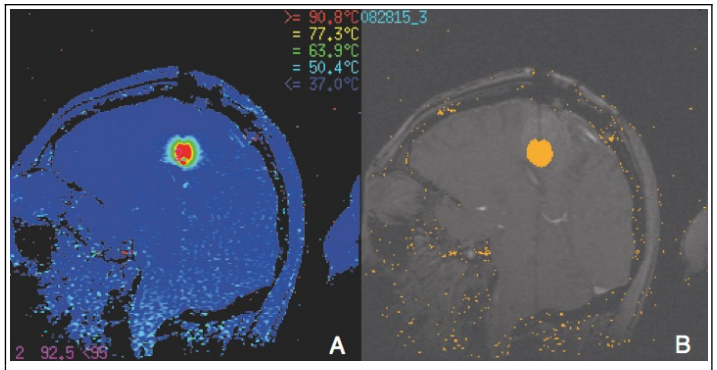
Introduction

Magnetic Resonance-guided Laser Induced Thermal Therapy (MRgLITT) is a minimally invasive procedure used to treat various intracranial pathologies. The technology utilizes intraoperative magnetic resonance thermal imaging (MRTI) to generate a thermal damage estimate (TDE) of the ablative area. Previous studies have shown that the intraoperative TDE correlates strongly with postoperative MRI ablative cross-sectional area. However, no studies have evaluated this correlation when the intraoperative MRTI contains a signal artifact or defect that distorts the ablative region.

Methods

All ablations were performed using the Visualase MRI-Guided Laser Ablation System (Medtronic). Patients were grouped based on whether the intraoperative MRTI contained signal artifact that distorted the ablative region. Intraoperative TDE from the Visualase console and postoperative T1-weighted images were acquired. Cross-sectional area of the ablative lesion from the MRI image was measured, and the difference between intraoperative TDE and postoperative MRI cross-sectional area was calculated. Mean differences were compared between the group with intraoperative MRTI artifact and the group without MRTI artifact.

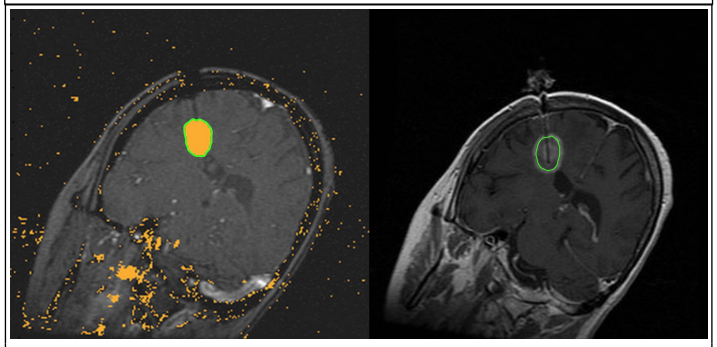




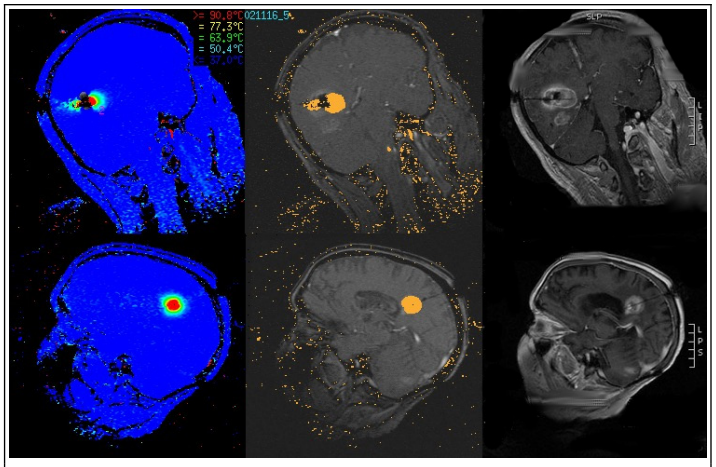
(A) MRTI image without artifact. (B) Image with TDE.

Table I: Patient Indications and MRTI Frequencies within indications

Indication for Ablation	No. of patients with MRTI Artifact; n = 41	No. patients without MRTI Artifact; n = 50	% of patients with MRTI Artifact within Indication
Total (n = 91)	40	51	43.9
Cavernoma	3	0	100
Epilepsy	3	5	37.5
Intractable Pain	1	7	12.5
Primary Glioma	3	5	37.5
Recurrent Glioma	8	13	38
Recurrent Meningioma	2	0	100
Recurrent Metastasis/Radiation Necrosis	20	21	48.7



Left: TDE image showing final ablation image with region of interest highlighted in green using OsiriX. Right: Post-LITT MRI shows the lesion of interest with polygonal line traced around it. The tracing follows the peripheral border of enhancement commonly seen on post-LITT imaging. OsiriX (Pixmeo Inc) generates an area for this based on the inherent DICOM image size data.



Top: MRTI, TDE, and post-operative MRI in a case where signal artifact was observed. Bottom: MRTI, TDE, and post-operative MRI in a case where no signal artifact was observed.

Results

91 patients undergoing MRgLITT for various surgical indications were examined. MRTI artifact was observed in 43.9% of cases overall. The mean absolute difference between TDE and the postoperative MRI cross-sectional area in the group with intraoperative MRTI artifact was 94.8 mm2 (SEM = 11.6), while the difference in the non-artifact group was 54.4 mm2 (SEM = 5.5). This indicated a statistically significant difference between the two groups (p = 0.0012).

Conclusions

MRTI signal artifact is a common occurrence during LITT. The presence of signal artifact during intraoperative MRTI results in a larger degree of variation between intraoperative TDE and postoperative MRI cross-sectional ablative area. Operators should be advised that in cases where intraoperative MRTI artifact is observed, there may be a larger degree of variation between observed intraoperative TDE and measured postoperative MRTI ablative area.