Magnetic resonance image-guided laser interstitial thermal therapy

- A ConvLSTM-based model for predicting thermal damage during laser interstitial thermal therapy
- Technical Note: Advantages of a 2-Room Intraoperative 3-Tesla Magnetic Resonance Imaging Operating Suite for Performing Laser Interstitial Thermal Therapy in Pediatric Epilepsy and Tumor Surgery
- Persistent Peri-Ablation Blood-Brain Barrier Opening After Laser Interstitial Thermal Therapy for Brain Tumors
- Characterization of susceptibility artifacts in magnetic resonance thermometry images during laser interstitial thermal therapy: dimension analysis and temperature error estimation
- Nanoparticle-assisted, image-guided laser interstitial thermal therapy for cancer treatment
- The American Society for Stereotactic and Functional Neurosurgery Position Statement on Laser Interstitial Thermal Therapy for the Treatment of Drug-Resistant Epilepsy
- Biopsy and Ablation of H3K27 Glioma Using Skull-Mounted Smartframe Device: Technical Case Report
- MR-guided laser interstitial thermal therapy in the treatment of recurrent intracranial meningiomas

Stereotactic robot-assisted MRI-guided laser interstitial thermal therapy thalamotomy

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Magnetic resonance image-guided laser interstitial thermal therapy uses thermal energy to induce cell death by damaging DNA and causing protein denaturation. The current therapy is performed with simultaneous MRI stereotactic guidance and real-time feedback from the ablated lesion. [1) 2)].

It is considered less invasive than microsurgery. Main advantage is a shorter postoperative recovery period. The technique has been used for lesional and nonlesional epilepsy. Preliminary seizure control ≈ 60–70%. No long-term data is yet available.

Magnetic resonance-guided, Laser interstitial thermotherapy (LITT) is a real-time magnetic resonance thermometry - guided, minimally invasive procedure that uses a laser to produce a precise and minimally invasive heat injury to target tissue.

To deliver this energy in a minimally invasive fashion, a small diameter fiber optic applicator is inserted into the lesion through a keyhole stereotactic procedure. The thermal energy induces damage to intracellular DNA and DNA-binding structures, ultimately leading to cell death. The ablation procedure is supervised by real-time MRI thermal mapping and confirmed by immediate post-ablation T1 or FLAIR MRI images.

Magnetic resonance (MR)-guided stereotactic laser ablation is a minimally invasive alternative that uses small applicators amenable to stereotactic delivery. Heating is dependent on source wavelength such that a source laser can be chosen to produce rapid and localized heating of tissue with sharp

boundaries at relatively low powers [3].

Because optical fibers and laser energy are MR imaging (MRI) compatible, simultaneous MR thermal imaging (MRTI), with accuracy on the order of ±0.2°C in a number of tissue types enables real-time feedback control of laser output and tissue ablation. MR-guided stereotactic laser ablation has been safely used for ablation of intracranial lesions including tumors and certain epileptogenic foci in children [4] [5] [6] [7] [8] [9] [10].

Neurosurgical laser ablation is a relatively new but rapidly growing application of stereotactic neurosurgery that allows neurosurgeons to treat many previously untreatable conditions with the added benefit of shorter hospitalizations and recovery times. The vast majority of these procedures, however, are performed using a multisite workflow pattern involving transport of the patient between the operating room (OR), the computed tomography (CT) suite, and the magnetic resonance imaging (MRI) suite, often necessitating patient transfer through public pathways and requiring multiple trips if laser fiber placement is not accurate. There are significant risks posed to the patient with this practice and no existing guidelines addressing it [11].

Laser ablation is an emerging, minimally invasive treatment for selected children with intractable focal epilepsy with improved procedural morbidity. Data for children lag similar studies in adults, but the hope is for near-equivalent seizure-control rates and improved neuropsychological outcome when compared with standard open surgical resection. The approach seems particularly beneficial when dealing with deep, focal lesions, such as hypothalamic hamartomas or hippocampal sclerosis [12].

The NeuroBlate System (formerly known as the AutoLITT® System) applies focused laser energy to ablate brain tumors from the inside, with little or no effect on surrounding healthy tissue. NeuroBlate provides clinicians a new neurosurgical tool that offers real-time control and visualization of the therapy during laser ablation treatment. The NeuroBlate procedure is currently one of the only laser ablation neurosurgical procedures done in an active MRI magnet.

Indications

Magnetic resonance image-guided laser interstitial thermal therapy Indications.

Case series

2020

Patients with Glioblastoma who received concurrent LITT and surgical resection at the Department of Neurosurgery, University of Texas MD Anderson Cancer Center, Houston were identified. Patient demographic and clinical information was procured from the University of Texas MD Anderson Cancer Center electronic medical record along with preoperative, postoperative, and 1-month follow-up

magnetic resonance imaging (MRI).

Four patients (n = 2 male, n = 2 female) with Glioblastoma IDH wildtype who received combined LITT and surgical resection were identified and analyzed retrospectively. All patients received chemoradiotherapy before the presentation. All but one patient (75%) received resection before the presentation. The median age was 54 years (range: 44-56 years). The median length of hospital stay was 6.5 days (range: 2-47 days). The median extent of combined ablation/resection was 90.4%. One of the four patients experienced complications in the perioperative or immediate follow-up periods. Local recurrence was observed in one patient during the follow-up period.

Malignant gliomas in deep-seated locations or in close proximity to white matter structures are challenging to manage. LITT followed by surgical resection may provide an alternative for tumor debulking that minimizes potential morbidities and extent of residual tumor. Further studies comparing this approach with standard resection techniques are warranted [13].

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