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Extended Abstract

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Laser treated metallic probes for cancer treatment in MRI systems

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Hyperthermia involves exposing body tissue to high temperatures (up to 113F) to destroy cancer cells. Common methods to deliver heat include the heating of probes or needles using external microwave, radiofrequency (RF) wave or ultrasound sources. The objective of this work is to develop a metallic probe or needle that is comprised of two sections ? a tip section to be inserted in a tumor, that subsequently heats up due to induced Eddy currents when exposed to a fluctuating RF magnetic field (as in those used in current Magnetic Resonance Imaging (MRI) systems); and a body section away from the tip with reduced heating to minimize damage to the normal surrounding tissue. Such a metallic probe offers superior maneuverability for placement in a tumor (due to the higher stiffness of metals) while offering real time imaging during treatment (since the energy source is an MRI system). While tip heating in MRI systems is well known and has been actively researched, the emphasis here was to reduce interaction of the body of the probe with the fluctuating RF magnetic field in the MRI system thereby reducing heating. This was accomplished by laser assisted diffusion of Ag, Au and Pt in to MP35N wires. The performance of these laser treated MP35N wires were evaluated in a RF magnetic field and are reported here. The results are presented along with predictions from a model developed as part of this work to capture the physics of the heating (or lack thereof) of the laser treated wire body in the fluctuating RF magnetic field of the MRI system

MRI-guided laser interstitial thermal therapy (LITT) is the selective ablation of a lesion or a tissue using heat emitted from a laser device. LITT is considered a less invasive technique compared to open surgery that provides a nonsurgical solution for patients who cannot tolerate surgery. Although laser ablation has been used to treat brain lesions for decades, recent advances in MRI have improved lesion targeting and enabled real-time accurate monitoring of the thermal ablation process. These advances have led to a plethora of research involving the technique, safety, and potential applications of LITT.

LITT is a minimally invasive treatment modality that shows promising results and is associated with decreased morbidity. It has various applications, such as treatment of glioma, brain metastases, radiation necrosis, and epilepsy. It can provide a safer alternative treatment option for patients in whom the lesion is not accessible by surgery, who are not surgical candidates, or in whom other standard treatment options have failed. Our aim is to review the current literature on LITT and provide a descriptive review of the technique, imaging findings, and clinical applications for neurosurgery. MRI-guided laser interstitial thermal therapy (LITT) is the selective ablation of a lesion or a structure using heat liberated from a laser. LITT has been used for a variety of lesions in various organs such as lung, liver, bone, and prostate. In the brain, LITT is considered a less invasive procedure than open surgery, performed under real-time MRI guidance to treat several intracranial pathologies. Although other techniques have been used for focal tissue ablation, such as radiofrequency, cryo-, and microwave ablation, laser ablation has superior precision and predictable volume of tissue ablation thus avoiding collateral damage. In this review, we present background on LITT in neurosurgery and discuss the technique, indications, and potential complications of MRI-guided LITT.

LITT is a less invasive treatment modality with a lower incidence of complications compared to open surgery. The principle of LITT is selective ablation of tumor cells by heat and is monitored by real-time MRI thermometry. LITT has a range of applications, such as treatment of glioma, metastases, radiation necrosis, chronic pain, and epilepsy. LITT is used for selected lesions and in selected patients as a safer alternative treatment option for patients in whom the lesion is not accessible by surgery, in patients who are not surgical candidates, or in those in whom other standard treatment options have failed. Complications of LITT include hemorrhage, brain edema, thermal injury of adjacent structures, and treatment failure. Reported rare complications include permanent neurologic deficit, brain parenchymal infection, transient focal neurologic deficit, seizures, and cerebrospinal fluid leak. A learning curve and increased operator experience was observed by some authors to decrease the incidence of complications.

Although the current literature did not provide significant and/or accurate survival benefits, it establishes the feasibility of the procedure and helps explore the potential indications and possible complications. Future prospective randomized controlled clinical trials with a larger number of patients and adequate follow-up periods are needed to determine patient outcomes and evaluate survival benefits.

Bottom Note: *This work is partly presented at International Conference and Trade fair on Laser Technology, July 20-22, 2015, Orlando, Florida, USA*