Ablation of Human Brain Tumors Using Histotripsy

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Background, Motivation and Objectives

Treatment of human brain tumor can be extremely challenging because of the variety of tumor type, size, consistency and location. Surgical resection plays an integral role however the morbidity can be high if a tumor is large, fibrous or adjacent to crucial brain regions. A minimally invasive mechanism of softening or liquefying brain tumors has the potential of preventing cranial surgical morbidity as it pertains to brain tumors. Histotripsy has been demonstrated to transcranially ablate a wide range of locations and volumes through excised human skull. We hypothesize that histotripsy can be used to fractionate various brain tumors with different mechanical properties, thus working as a non-invasive treatment or an adjunct tool to facilitating tumor resection. This study demonstrates the effectiveness of using histotripsy to ablate excised human brain tumor.

Methods

A total of 15 human brain tumor samples (10 meningiomas, 2 brain metastasis and 3 astrocytoma) from 9 patients were collected from University of Michigan Brain Tumor Bank. The tumor samples embedded in the agarose gel were treated by an 8-element, 1 MHz transducer with an aperture diameter of 8 cm and a focal distance of 7 cm. Pulses at p- of 45MPa were delivered at PRFs of 50-200 Hz. Each sample was ablated at a dose of 1000-2000 pulses per location. All treatments were completed within 45 minutes. Histology slices of the ablated tumor samples were evaluated.

Results/ Discussion

Histotripsy ablation was confirmed by histology in all brain tumor samples. H&E slides showed dense cellular structures in the untreated tissue, while the ablation zone consists of acellular debris with sharp boundaries between treated and untreated regions of tissue. The results of this initial study demonstrate that histotripsy can be used to ablate human brain tumors of varying types.

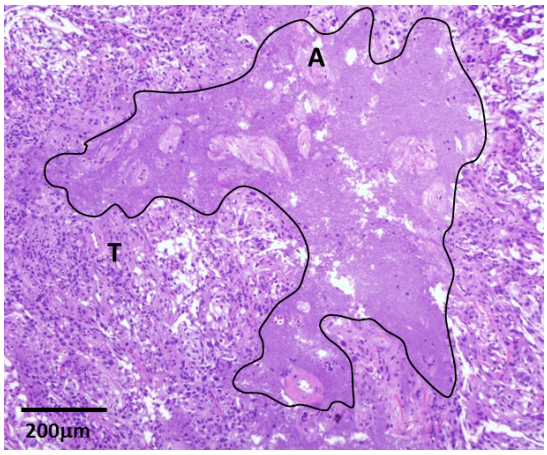

Figure 1. Meningioma sample post treatment. Hematoxylin and Eosin staining shows an area of geographic necrosis of ablated tumor (A), surrounded by areas of viable tumor (T).