SHEAR WAVE VELOCITY IMAGING USING TRANSIENT NEEDLE VIBRATION FOR MONITORING THERMAL ABLATIVE THERAPIES

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Abstract

Thermal ablation is a minimally invasive technique used for the treatment of localized tumors, with the method of energy deposition typically being radiofrequency (RF) or microwave (MW). Visualization of treated region is essential with this treatment, as untreated malignant tissue can lead to tumor recurrence. Magnetic resonance imaging (MRI), computed tomography (CT), and ultrasound are used to monitor thermal ablation procedures. MRI and CT provide good delineation of the ablation margins but are less applicable in real-time and expensive. Traditional ultrasound, while portable and cost-effective, poorly differentiates ablated from untreated tissue. Elastography is an ultrasound technique that images the stiffness differential between ablated and untreated tissue and has shown success delineating thermal ablations by imaging strain. However, strain is not an inherent tissue property; the Young's Modulus provides more quantitative information. In this dissertation, we develop a shear wave tracking method termed 'electrode vibration elastography.' Transient perturbation of the ablation needle generates shear waves, which are tracked with high frame rate ultrasound. Shear wave velocity is then estimated, which is proportional to the Young's Modulus of the tissue. We demonstrated the feasibility of our technique using finite element analysis (FEA), tissue-mimicking (TM) phantoms, and *ex vivo* experiments. In addition, global and local mechanical testing was performed to corroborate our imaging results. Our results are promising and warrant further study to develop a viable clinical imaging modality to be used to monitor thermal ablation procedures.