Electrode displacement strain imaging for thermal ablative therapies

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Radiofrequency ablation is a minimally-invasive thermal therapy for tumor destruction, the success of which is dependent on the ability to image the treated region. Imaging modalities such as ultrasound and Computed Tomography (CT) are currently utilized clinically. CT provides superior image quality but is cumbersome to use and not real-time, while ultrasound, though portable and easy to use, does not offer good image quality and contrast. The need of the hour is a technique that provides high quality imaging capabilities, while being easy to implement. Ultrasound elasticity imaging includes various implementations, one of which is quasi-static strain imaging or elastography. This technique makes use of the stiffness gradient between ablated and non-ablated tissue that results from an elevation of the stiffness of ablated tissue during the thermal ablation procedure. Quasi-static elastography involves perturbation of tissue and tracking of the induced motion, utilizing radiofrequency ultrasound data acquired before and after the perturbation. This dissertation is focused on an adaptation of quasi-static strain imaging (eventually also extended to dynamic strain imaging) tailored specifically to imaging electrode-based thermally ablative therapies. The technique, termed 'electrode displacement strain imaging', involves the generation of tissue motion via minute perturbations of the treatment electrode. The results of our simulations and experiments verify the feasibility of this method and illustrate the advantages afforded by this technique over conventional strain imaging. This dissertation includes results from finite element analyses (FEA) and tissue mimicking (TM) phantoms imaged using clinical ultrasound systems. *Ex vivo* and *in vivo* animal experiments were also performed to test the technique on ablated tissue. Mechanical modulus measurements were performed on tissue samples to refine the existing modulus values used in FEA simulations and in the construction of TM phantoms. Our experimental results are promising and warrant future research efforts to extend the work presented in this dissertation to clinical practice.