

MRI monitoring of temperature and mechanical properties in tissues during thermal ablations

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Summary

Minimally invasive thermal ablations consist in inducing cellular death in pathological tissues through tissue heating (laser, RF, MW, HIFU...) or freezing (cryoablation). Magnetic Resonance Imaging (MRI) is used to monitor thermal ablations in real-time, in order to ensure that targeted pathological tissues are no longer viable, while sensitive surrounding healthy tissues remain as unaffected as possible. Currently, thermal ablation monitoring is obtained through the calculation of the delivered thermal dose, based on continuous MR Thermometry (MRT) monitoring. While the calculation of the thermal dose calls for absolute temperatures, MR Thermometry allows for relative temperature measurements (temperature changes), which can result in bias.

As an alternative/complement to temperature, mechanical properties of tissues are permanently altered by thermal ablations and have been investigated as a biomarker for thermal ablations. Magnetic Resonance Elastography (MRE) allows for non-invasive measurement of mechanical properties of tissues. MRE is clinically mainly used for the assessment of liver stiffness, but its relevance has been proven for pathologies in numerous soft tissues (brain, breast, muscle...). Our team has developed a framework for simultaneous MR measurements of changes in temperature and in mechanical properties of tissues during thermal ablations (Corbin et al., Magn Reson Med 2016; Corbin et al., Magn Reson Mat Phys Biol Med 2017; Kim et al., ISMRM 2018).

The main objective of this thesis is to extend the existing interventional MRE/MRT method to all types of tissues, including fatty tissues and bone, and to new ablation techniques such as cryoablation and High Intensity Focused Ultrasound (HIFU). Therefore, this thesis involves substantial work in the fields of MR pulse sequence programming and MR physics, Elastography and related fields (biomechanics, wave physics), and in thermal ablation hardware and devices. The candidate will be trained in MR pulse sequence programming (Siemens). Funding is for 3 years (PhD duration in France), starting in September/October 2019.

Strasbourg hospital is a leading center in clinical interventional MRI. We have a strong collaboration with Siemens Healthineers in interventional MRI. We have access to state-of-the art 1.5T interventional MRI scanners for clinical and preclinical studies, equipped with MR-compatible HIFU and cryoablation systems.

Requirements

The candidate should have a MS degree in engineering or in applied physics. He/She should want to work in a highly biomedical environment and should have excellent general scientific skills ranging from basic physics to programming. **Excellent academic record is mandatory** for this funding source (Master's grades). The ideal candidate should have acquired the following skills:

- Physics of Magnetic Resonance Imaging (MRI)
- Wave mechanics
- Programming : C++, Matlab
- Statistical analysis
- Bibliographical search
- Oral and written English

Environment



The primary location for this thesis is the Medical robotics team of the ICube laboratory. This research team hosts about 30 faculty members and 20 PhD students, and covers a large variety of research activities revolving around Medical Imaging and Robotics. The MRI environment for this project is exceptional: members of this team have access to two identical MRI platforms (preclinical and clinical), and this project benefits from a direct collaboration with the MRI manufacturer (Siemens Healthcare). They also have access to state-of-the-art thermal ablation equipment such as MR-compatible HIFU and cryoablation systems. Strasbourg is the second capital of Europe after Brussels. It is a very pleasant, highly international, middle-sized city with a major world-renowned university. The laboratory and the Department of Radiology are located at the heart of the central Hospital, in the city center. Leader of the bike-friendly city in France, Strasbourg is 1h45 away from Paris by train, and close to the French mountains les Vosges.

Application

To apply, please send CV, cover letter, and grades and rank of Master's degree to Elodie BRETON ebreton@unistra.fr