Universität Basel

Research Project

Experimental and clinical validation of a fully integrated platform of MRI guided focused ultrasound thermotherapy in moving organs

Third-party funded project

Project title Experimental and clinical validation of a fully integrated platform of MRI guided focused ultrasound thermotherapy in moving organs
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Organisation / **Research unit**
Departement Biomedical Engineering / Center for medical Image Analysis & Navigation (Cattin)
Department
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Status Completed

The main goal of this project is to prepare and further to perform clinical trials using a MRI-guided high intensity focused ultrasound (MRgHIFU) device of the newest generation (phased array), for non-invasive ablation of localized cancer in moving organs. Consistent research effort has been made in the field of MRgHIFU in Europe since 1995. Since July 2008, a state-of-the-art MR compatible HIFU system is available at the Radiology Service/C.I.B.M. - HUG. The main components of the system are: (1) a 256 element phased array transducer, operating at 1MHz, up to 250 W acoustic power; (2) a programmable 256 channel generator; each channel delivers an RF sinus wave, with independent control of the phase, frequency and amplitude; (3) a position-ing mechanism for the transducer in the YZ plane; and (4) a software package for on line temperature mapping and hardware control. The fundamental objective is to implement closed loop temperature feedback control (exploiting fast on line MR thermometry) simultaneously with focal spot locking on a moving target (exploiting the very low latency of electronic steering of the beam), within a unique treatment method. Initial information on tissue thermal response will be extracted from a few spared locations, performing moderate power sonications. We shall develop a new technology to lock the ultrasound focus to the moving target based on electronic steering of the beam, rapid MR imaging and external sensor collected data. Under general anesthesia, the complementary information from applied ventilator pressure is considered sufficient. In the future, when treating patients awake under free breathing, the motion at the surface of the organ/patient will be monitored with an optical fiber sensor. To learn the 4-dimensional (3D+time) motion of the liver during the initial training step, our existing 4DMRI method will be adapted for smaller volumes with a smaller slice distance. Given the patients individual breathing depth distribution observed during several breaths during the training step, a representative set of 4D stacks is reconstructed covering the entire range of breathing depths. Rapid acquisition of contrast-optimized navigation images and temperature-sensitive imaging is a pre-requisit for controlled and safe HIFU treatment. Furthermore, integration of both image acquisition methods and 4D motion detection and modulation onto the MR scanner s software and hardware environment is mandatory to enable real-time control and feedback during the interventional procedure. This will require the development and optimization of rapid sequences with a predefined contrast. Navigator imaging, temperature measurements, interleaved sequencing and real time feedback capability will be developed. Within the framework of the current project we shall perform: 1. experimental validation on phantom demonstrator for a novel technique (3D) of focal point locking on a moving target; 2. in vivo experiments (sheep model, targeting kidney and liver left lobe) to demonstrate the safety, effectiveness and reproducibility of treatments with dual (mechanical and electronic) displacement of the focal point,

under volumetric temperature control with real time feedback; 3. phase I clinical trials on abdominal tumor, and/or soft tissue tumors, and/or renal tumors renal tumors, and, if successful technology, liver (left lobe) tumors. The Animal Research Facilities of the University Medical Center in Geneva is a state-of-the art equipped structure holding on 5000 square meters, having at its disposal the technical and human in-frastructure necessary for setting up trials on rabbits and large animals. They will provide full technical support to the project. The promoter of the clinical trials will be the University Hospital of Geneva. This institution will subscribe the legal insurance for clinical research. There is no conflict of interest with regards to a private sponsor of the study.

Financed by
Swiss National Science Foundation (SNSF)

Add publication

Published results

2250053, Arnold Patrik, Respiratory-Induced Organ Motion Compensation for MRgHIFU, Publication: Thesis (Dissertationen, Habilitationen)

2250101, Arnold, Patrik; Preiswerk, Frank; Fasel, Beat; Salomir, Rares; Scheffler, Klaus; Cattin, Philippe C, 3D organ motion prediction for MR-guided high intensity focused ultrasound, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

2250102, Preiswerk, Frank; Arnold, Patrik; Fasel, Beat; Cattin, Philippe, A Bayesian Framework for Estimating Respiratory Liver Motion from Sparse Measurements, 978-3-642-28557-8 (E-Book) ; 978-3-642-28556-1 (Print), Abdominal Imaging : Computational and Clinical Applications, Publication: Book Item (Buchkap., Lexikonartikel, jur. Kommentierung, Beiträge in Sammelbänden etc.)

2250103, Preiswerk, F.; Arnold, P.; Fasel, B.; Cattin, P.C., Towards more precise, minimally-invasive tumour treatment under free breathing, 1557-170X, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

2250104, Preiswerk, F.; Arnold, P.; Fasel, B.; Cattin, P. C., Robust tumour tracking from 2D imaging using a population-based statistical motion model, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

2250148, Rares Salomir„ Hybrid ultrasound/magnetic simultaneous acquisition and image fusion for motion monitoring in the upper abdomen, 0020-9996, Investigative radiology, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

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