

Hot Topics in Body MRI

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MR-HIFU: Technical Overview

TARGET AUDIENCE –

Radiologists, Medical Physicists, Radiation Oncologists, and Technologists working with MRI, and interested in therapeutic ultrasound.

OBJECTIVES –

- 1) Describe the basic principles of High-Intensity Focused Ultrasound (HIFU) therapy
- 2) Review the role of MRI for guiding and monitoring HIFU treatments
- 3) Review the existing clinical applications of MR-HIFU and areas currently under development

Overview –

The purpose of this talk is to introduce participants to the applications of MRI-guided high-intensity focused ultrasound (MR-HIFU) therapy for applications in the abdomen and pelvis. MR-HIFU is a non-invasive, image-guided method for tissue ablation and drug delivery in the body. Ultrasound energy is focused in soft tissue or bone and local energy absorption causes rapid heating in a localized volume typically less than 1 cc. During heating, MRI is used to monitor tissue temperature in real-time to ensure adequate temperatures are achieved. The temperature information provided by MRI can also be used to control the treatment in a closed-loop fashion. Larger target volumes in the body are treated by mechanical or electronic scanning of the ultrasound focus in tissue. Clinical MR-HIFU systems are available from multiple vendors, and are all based on a common design of a focused ultrasound transducer embedded into the patient table of an MR scanner. Treatments are performed with patients lying on top of the transducer such that the focus is able to reach the target tissue volume.

The principal advantages of MR-HIFU are the ability to treat diseased tissue in situ completely non-invasively, to predict the region of coagulated tissue from the temperature information measured with MRI, and to reduce recovery times for patients. The main challenges for MR-HIFU are long treatment times, the inability to transmit through bone and bowel, and the inability to monitor temperatures in fat and bone.

Currently MR-HIFU is approved for the treatment of uterine fibroids and bone tumors, although not in all jurisdictions. In both of these applications rapid relief of pain has been observed, along with shrinkage of treated tissue volumes. Applications under development include prostate treatments using intracavitary HIFU devices, breast, liver and renal tumor ablation, hyperthermia in soft tissues, and targeted drug delivery.

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