

## Advantages/Disadvantages of MR Guidance

Focused ultrasound allows focal energy deposition deep in the body. This energy can be used to thermally coagulate tissues for noninvasive surgery, for example, for tumor treatments and for targeting and enhancing drug delivery. The clinical use of focused ultrasound depends on the ability of the operator to precisely aim the beam to the targeted tissue. MRI, which is one of the methods currently used for this guidance, has several advantages over other methods: First, it provides superb soft-tissue contrast, delineating the anatomy for treatment planning and targeting. This is important in order to deliver the energy precisely to the targeted tissue and also to determine that the ultrasound beam has a path through soft tissues free from gas or bone (except with trans-skull treatments). Second, MR mapping of proton resonance frequency shift using phase imaging provides a method to determine the temperature-elevation maps during ultrasound exposures. These maps can be used to verify the focal location at temperatures that are below the threshold of thermal damage, thus allowing adjustments when misalignment is detected. At higher therapeutic powers, the temperature elevation maps obtained during the sonication can provide data for the calculation of thermal dose, data that describe the extent of induced tissue damage. The temperature-elevation maps can also be used as input into a feedback control algorithm that controls the power delivery to assure adequate treatment. Finally, contrast-enhanced T1-weighted scans can be used after the treatment to determine the extent of the tissue that is not perfused by blood; this serves as an indicator of the treatment's effectiveness. For targeted drug delivery, special MRI-enhancing drugs can be developed allowing quantification of the delivery of the therapy agent by MRI.

There are several disadvantages of MRI guidance: First is the high cost of treatment monitoring because a MRI scanner is engaged for the duration of the treatment. Second, MRI imaging is sensitive to motion, making it difficult to use moving parts during the treatment or to monitor a moving organ such as the liver or heart. Third, special equipment that is MRI compatible must be used. Fourth, many treatment positions are compromised due to the limited size of the MRI bore; the magnet bore also limits the nature of the devices that can be used. Finally, the speed of MRI thermometry is relatively slow compared to, for example, ultrasound imaging that allows for fast tissue motion tracking [1],[2],[3],[4].

In this presentation, these advantages and disadvantages will be discussed and compared with ultrasound imaging that is commonly used for HIFU guidance.

## Bibliography

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