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**Quantitative Magnetic Resonance Thermometry and Its Use with MR-Guided Focused Ultrasound**

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Focused ultrasound (FUS) uses a large area array, typically outside the body, that is geometrically or electronically focused to a point deep in the body. Such focusing provides amplification of the ultrasound intensity, thereby allowing heating of tissue to the point of coagulation at the focus, without damage to the intervening tissue. Guidance of FUS treatments deep in the body can be done quantitatively with magnetic resonance (MR) thermometry, termed MRgFUS. The physics behind MR thermometry lie in the changes in hydrogen bonding with temperature. As tissue temperature rises, hydrogen bonds break, allowing the return of the electron cloud to shield water protons, reducing the magnetic field seen by the protons, and the resonant frequency. The change in resonant frequency is -0.01 ppm per degree C and is the same for all aqueous tissues. The result of the shift in proton resonant frequency is seen in the phase of gradient echo images. Subtraction of the phase of images acquired before and during heating allows the removal of background phase from other sources, yielding quantitative temperature maps. Temperature standard deviations less than 1 degree C are readily achievable and thermal dose maps are easily calculated. Thermal dose is found from a conversion of the whole temperature-time curve to an equivalent number of minutes at 43 degrees C. A thermal dose of 240 minutes is often taken as the threshold for tissue damage. MR thermometry is complicated by the motion of the target tissue and/or motion of other organs such as occurs during respiration. More sophisticated algorithms than the simple baseline subtraction take advantage of the facts that motion can be repetitive (in the case of respiratory motion) and/or the fact that the focal region in MRgFUS is small, allowing for extraction of the heat from the phase profile without subtraction of a background phase.