Detecting Iron Overload with MRI

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Technology description

Iron is an essential nutrient for the human body but is toxic in excess. Iron overload is a particular hazard to patients requiring regular blood transfusions. Treatment for patients with iron overload aims to reduce body iron stores by using drugs (chelators) that facilitate removal of iron from the body. Unfortunately, chelator treatment is extremely expensive and has side effects. Accurate measurement of body iron levels is critical for initiating and monitoring treatment.

The best reference for assessing total iron stores is hepatic iron content (HIC) because the amount of iron in the liver closely correlates to the rest of the body. Measuring HIC by taking liver samples is invasive and expensive, and cannot be performed in all patients. The most accurate noninvasive method to test HIC uses superconducting quantum interference device (SQUID)-based liver susceptometry. SQUID measures magnetic susceptibility of tissue, which is directly related to iron concentration. Unfortunately, SQUID susceptometry devices are expensive and complex, and as a result have very poor availability (only four functioning devices in the world).

In contrast, magnetic resonance imaging (MRI) technology is widely available. Current techniques for MRI-based liver iron quantification are based on empirical calibration between MRI signal decay rates (R_2 or R_2*) and HIC. The main drawback to current MRI methods is that the relationship between these decay rates (R_2 and R_2*) and HIC is difficult to characterize and remains purely empirical. A new approach that is accurate and repeatable, based on measuring a fundamental property of tissue without the need for special calibrations, is needed. UW–Madison researchers have developed a method for measuring iron and other substances in tissue using an MRI system, based on estimating tissue magnetic susceptibility.

The method acquires chemical-shift-encoded, water-fat separated data from a scanned region of interest. From this data a magnetic field inhomogeneity map of the system can be obtained. The field map enables estimation of the magnetic susceptibility of tissue to determine concentration of iron or other substances, such as gadolinium.
The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an improved method for assessing the concentration of iron and other substances in tissue by measuring magnetic susceptibility.

Hernando D. and Reeder S.B. 2013. Magnetic Susceptibility as a Field-Independent MRI Biomarker of Liver Iron Overload. Proceedings of the 21st Annual Meeting of ISMRM, Salt Lake City, UT.
Hernando D. and Reeder S.B. 2013. Magnetic Susceptibility as a Field-Independent MRI Biomarker of Liver Iron Overload. Proceedings of the 21st Annual Meeting of ISMRM, Salt Lake City, UT.
WARF reference number P110135US01 describes an MRI method for measuring transverse relaxation rate (R_2*) corrected for confounding factors.
Hines et al. 2012. Validation of MRI Biomarkers of Hepatic Steatosis in the Presence of Iron Overload in the Ob/Ob Mouse. J. Magn. Reson. Imaging. 35, 844-851.
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Application area

Assessing iron concentration in the liver, pancreas, heart, spleen, brain, bone marrow and other tissues

Advantages

MRI technology is accessible.
Eliminates need for calibration curves
Provides robust quantification

Institution

Wisconsin Alumni Research Foundation

Inventors

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