Quantitative Susceptibility Mapping

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Quantitative susceptibility mapping (QSM) is an emerging MRI technique for imaging and quantifying tissue magnetic susceptibility. In the presence of a strong magnetic field such as those supplied by MRI scanners (e.g. 3 T and higher), tissue susceptibility perturbs the spatial profile of the magnetic field in an appreciative way. Specifically, this perturbation alters the resonance frequency and subsequently phase values in the MRI gradient echo signals. Based on this frequency shift, computing the underlying 3-dimensional susceptibility distribution is however an ill-posed inverse problem. There are two major challenges imposed by the reality of incomplete data. First, the magnetic field outside the human body is not measurable because of the lack of MRI signal. Consequently, only a subset of the field information is available for establishing a mathematical relationship. Second, the linear equation that governs the relationship between field shift and magnetic susceptibility is a convolution that unfortunately contains null coefficients in the convolution kernel. Therefore, there is no unique solution to the deconvolution problem. This talk will review and discuss recent progresses in addressing these challenges. Applications of QSM and susceptibility tensor imaging of susceptibility anisotropy will also be illustrated and discussed, for example, for visualizing high resolution brain anatomy, quantifying brain iron and myelination and studying tissue microstructure and connectivity.