

The applications of magnetic resonance imaging (MRI) in biomedicine are undergoing rapid evolution. Typically used to produce images that are reviewed and subjectively rated by a radiologist, MRI is now being utilized as a scientific apparatus capable of making noninvasive measurements in living tissues. With care, a significant number of physical and biological measurements can be performed and related to individual pixels and groups of pixels in the MR image. This presentation will address the challenges in obtaining quantitative data from MRI.

The presentation will review the principles of good practice in quantification, including quality assurance, MR data collection, and analysis. Limits on precision and accuracy are discussed and solutions proposed. Three major topics are considered. First, the signal collection process in MRI will be reviewed concentrating on geometrical relationships derived from MR images and signal-to-noise considerations. Then, physical sources of quantitation errors in MRI will be considered; especially resonant frequency offsets, radio frequency (RF) attenuation, dielectric phenomena and eddy current effects. Third, common quantitative measurements using MRI will be explored. The principles underlying the measurement of each quantity are given along with their biological and medical significance and practical approaches for achieving their accurate measurement. Shortcomings of the measurement processes and a summary of potential clinical applications are also discussed. Pathological and developmental observations will be also compared with MRI-derived quantities where appropriate.

This presentation is intended as an introduction to the field of measurement in MRI for anyone who desires to use the scope of modern measurement techniques to quantitatively determine the consequences of disease, its development or its reaction to therapy from MR images. It will be of interest to medical physicists who are considering undertaking quantitative work with MRI, as well as those already in the field.

At the end of this session the attentive participants shall:

1. appreciate the clinically important quantities that can be measured with MRI
2. be familiar with the methods and techniques used for quantitative MRI
3. have a basic understanding of the limits on precision and sources of error in quantitative MRI