An Introduction to Quantitative Imaging

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Highlights:

- Appreciate what is offered by quantitative imaging
- Learn about the types of measurement and sources of error
- Learn how errors can be minimised by following simple practical steps

Title: Practical Tips and Tricks to Maximize Repeatability

Target audience: researchers and clinicians wishing to understand and implement quantitative methods.

Objectives: to point out some of the issues and solutions to problems involved in making quantitative measurements from MRI data.

Purpose: to improve understanding of the components of quantitative imaging. MRI scanners produce images that are sensitive to the shape, size and physical properties of tissue within the patient or subject. The main types of quantitative measurement that are made usually fall into one of the following categories:

- Volumetric – measures of areas and volumes. Examples include tumour volume in oncology, and lesion volume in multiple sclerosis.
- Parameter maps of calculated tissue properties. Examples include T_2^* maps for monitoring iron overload in liver; dynamic contrast-enhanced MRI (DCE-MRI) parameters in oncology.
- Blood flow velocity maps in cardiology and vessel pathologies; perfusion maps in ischaemic brain disease.
- Functional MRI (fMRI) activation maps in psychology and psychiatry.

Methods: MRI scanners are designed primarily to produce images for the radiologist that are of diagnostic quality, but they are prone to measurement inaccuracies. When used as a scientific measurement instrument, these deficiencies become more apparent. However, an MRI scanner has only a limited set of elements used in the picture-producing pipeline, and most measurement bias can therefore be traced to one or more of:

- Radiofrequency (RF) pulses
- Receiver system
- Magnetic field gradient system
- Static magnetic field inhomogeneities and instabilities
- Patient/subject
- Data sampling schemes
- The human evaluator
- Processing software

The aim of this talk is to make participants aware of the nature of these inaccuracies and point out simple ways to minimise their impact on accuracy and repeatability.

Results: Using 'case studies' of different types of measurement, we look at the elements of the measurement process that give rise to errors.

Discussion: Quantitative imaging and analysis methods are attractive because they offer unbiased procedures for assessing patient data. However, the pitfalls mean that they must be applied carefully.

Conclusion: This talk examines in more detail the sources of inaccuracy, their impact and ways in which this impact can be alleviated. The presentation will finish with some further considerations for quantitative studies that involve scanning using multiple MRI machines in several institutions.

Reference: Tofts PS (ed.). *Quantitative MRI of the Brain.* John Wiley and Sons; 2003.