

Principles of the use of contrast agents

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Summary

Contrast agents are frequently used in MRI to enable additional information to be extracted from an image. They may be used to enhance a particular feature, where that feature (e.g. a tumour) has preferential uptake of the contrast agent, or to highlight regions where the contrast agent has been unable to reach e.g. due to a perfusion defect. This can be made more quantitative; a knowledge of the underlying contrast mechanism may be used to calculate the actual concentration of contrast agent in a particular region of the image at a particular time. Images may also be acquired repeatedly over time allowing the rate of uptake and washout of the contrast agent to be monitored. Contrast agent time-courses may be further analysed to extract a range of parameters indicative of underlying biological function.

This lecture will introduce the basic principles in using contrast agents in quantitative imaging and will discuss in detail the most common types of contrast agent, based on the paramagnetic element gadolinium. The effect that the contrast agent has on an MR image will be discussed in terms of the delivery of the contrast agent to the tissue of interest and the underlying mechanisms that produce the contrast in the image. Appropriate image acquisition schemes that are sensitive to the mechanism of contrast will be considered and methods to quantify the concentration of contrast agent in a particular region of the image will be presented. Example images datasets will be made available to view and manipulate using the image processing software ImageJ (open source software available to download from <http://rsbweb.nih.gov/ij/>).

Outline

- MR contrast agents
 - properties of contrast agents
 - Gadolinium-based agents
 - other contrast agents
- Effects of contrast agents in MR images
 - delivery of contrast agent
 - mechanism of contrast - T_1 , T_2 and T_2^* effects
 - image acquisition considerations
 - example applications
- Quantification of contrast agent concentration
 - calculating the concentration of contrast agent
- Dynamic imaging methods
 - image acquisition considerations
 - extracting signal intensity time-courses
 - example applications
- Summary