Technical Considerations for the Clinical Application of DTI: A Physicist's Perspective

Derek K Jones
CUBRIC, School of Psychology, Cardiff University, UK

In this presentation, I will be presenting the view of a hard-nosed physicist, who is keen on collecting the very best data possible in the time permitted. In particular, I will be focusing on the choice of acquisition parameters for the pulse sequence that will optimize data quality and maximize interpretability of the data. We will go systematically through the steps that we can take to maximize data quality - both in terms of participant expectation and experience, and in terms of designing the acquisition protocol.

Some of the things that a physicist worries about are accuracy, precision and statistical rotational invariance in the data that one subsequently analyzes – and so there will be a focus on what we can to maximize each of these aspects.

We shall begin by noting that diffusion MRI is a technique based on signal loss – so we are constantly battling against SNR limitations. This ultimately puts a limit on the resolution that can be achieved, given the signal is proportional to voxel dimensions. With a further recommendation that voxel sizes are isotropic, this then puts a constraint on slice thickness and therefore number of slices. We will then review the need for cardiac gating in DTI – and the practicalities involved there. The effective TR will then be dependent on the heart rate – and this will dictate the number of slices per R-R interval. In turn, this dictates the total number of diffusion-weighted measurements that we can make in a given scan time. We will then discuss the different ways of 'spending' those measurements in terms of different sampling schemes (e.g., six directions repeated 6 times, or 30 unique sampling directions), focusing on how they may impact different analyses of the diffusion data. Further details of these practical considerations for choosing a diffusion MRI protocol can be found in Jones and Leemans (2010).

Finally, we shall review practical steps for assessing data quality and for identifying artifacts in the image data – with suggestions for ameliorating them.

REFERENCE

Jones DK, Leemans, 'Diffusion Tensor Imaging' in *MR Neuroimaging - Protocols and Methods* Edited by Modo, M., & Bulte, J.W. Methods in Molecular Biology Series. Humana Press. (in press)