Effect of combination of b values and Rician noise filter on diffusional kurtosis and tensor imaging metrics in spinal cord in vivo

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Purpose:

Diffusional kurtosis imaging (DKI)[1] and diffusion tensor imaging (DTI) provide complementary information for spinal cord investigation in vivo, in addition to conventional MR imaging. Diffusion metrics derived from DKI and DTI data are used for quantitative evaluation of spinal cord condition. The purpose of this exhibit is to present the effects of the combinations of b-values and Rician noise filter for DKI and DTI in the spinal cord, for clinical use in particular.

Outline of contents:

We will explain the fitting models of DTI and DKI and effects of the combination of the selected b values.

1) Unlike DTI fit, the logarithm of the signal intensity is fit to a parabola using relative small b-values[2] and using higher b value (over 2000-3000 s/mm^2) is not useful for DKI fit in vivo spinal cord.

2) The different combinations of b values result in the different diffusion metrics, such as mean kurtosis (Figure 1). In other words, suitable selection of b values is important for the specific purpose of the study. For example, to evaluate intra spinal tumors, combinations of b-values should be changed from the combination used for degenerative disease in the spinal cord.

We will present examples that illustrate the differences in the diffusion metrics of spinal cord between data with Rician noise filter and data without in clinical cases.

1) In general, background noise in the diffusion MRI data with relatively low b values (under 2000-3000 s/mm^2) is not problematic in the brain because of the sufficient signal-to noise ratio (S/N). In fact, measurement of diffusion metrics such as fractional anisotropy (FA) and apparent diffusion coefficient (ADC) has rarely affected by noise filter.

2) In spinal cords, S/N of the diffusion-weighted MR images are often low because of its structural nature. Therefore, Rician noise removal is important for more accurate estimation of diffusion metrics[3]. FA and mean diffusivity in the normal spinal cord tend to show higher values with using Rician noise filter[4]. Moreover, mean kurtosis of the spinal cord in vivo showed dramatically different values with Rician noise filter because DKI is a noise sensitive method.

Summary:

This exhibit will demonstrate the fitting models of DTI and DKI, effects of the combination of the selected b values and effects of Rician noise for diffusion metrics in the spinal cord in vivo. Selection of suitable combination of b values and using Rician denoising technique lead to appropriate DKI and DTI metrics estimation and they will lead to better results of research and clinical use.

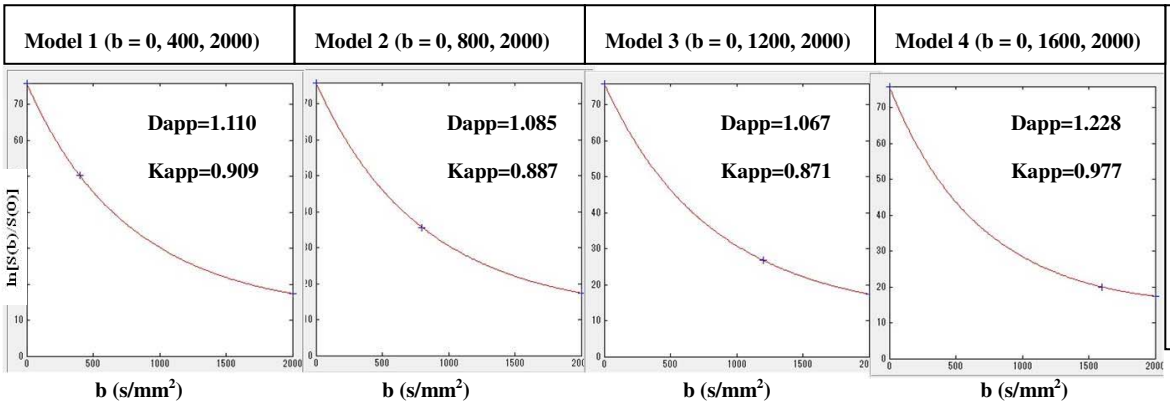

Figure 1. Comparisons of DKI fitting models using different combinations of b values in spinal cord. Note that Dapp: apparent mean diffusivity (10^{-3}mm^2/s) and Kapp: apparent mean diffusional kurtosis.

Reference: **1.** Jensen JH, Helpern JA, Ramani A,et al. Diffusional kurtosis imaging: the quantification of non-gaussian water diffusion by means of magnetic resonance imaging. Magn Reson Med. 2005;53(6):1432-40. **2**. Jensen JH, Helpern JA.MRI quantification of non-Gaussian water diffusion by kurtosis analysis.NMR Biomed. 2010;23(7):698-710.**3**. Wiest-Daesslé N, Prima S, Coupé P,et al. Rician noise removal by non-Local Means filtering for low signal-to-noise ratio MRI: applications to DT-MRI.Med Image Comput Comput Assist Interv. 2008;11(Pt 2):171-9.**4**. Vernekar D, Qian W, Zhang Z et al. In Vivo Human Spinal Cord Diffusion Tensor Imaging Using Rician Noise Filter. Proc. Intl. Soc. Mag. Reson. Med. 20. 2012; 621.