1. Models

1.1. Scherrer (DIAMOND)

DIAMOND models the set of tissue compartments in each voxel by a finite sum of unimodal continuous distributions of diffusion tensors. This corresponds to an hybrid tissue model that combines biophysical and statistical modeling. As described in (Scherrer et al., 2015), the DW signal S_k for a gradient vector $\mathbf{g}_k$ and b-value b_k is modeled by: $S_k = S_0\big[\sum_{j=0}^{N} f_j \left(1 + \frac{b_k \mathbf{g}_k^T \mathbf{D}_j^0 \mathbf{g}_k}{\kappa_j}\right)^{-\kappa_j}\big]$, where S_0 is the non-attenuated signal, N is the number of compartments and κ_j and $\mathbf{D}_j^0$ are respectively the concentration and the expectation of the j^{th} continuous tensor distribution. DIAMOND enables assessment of compartment-specific diffusion characteristics such as the compartment FA (cFA), the compartment RD (cRD) and the compartment MD (cMD). It also provides a novel measure of microstructural heterogeneity for each compartment.

The estimation of a continuous distribution of diffusion tensors requires DW data acquired with same timing parameters δ and Δ (Scherrer et al., 2015). Therefore, we fitted one DIAMOND model for each $\{\delta, \Delta\}$ group (*i.e.*, for each TE group), leading to 12 DIAMOND models. One shell was missing in each TE group; we predicted its signal using the corresponding DIAMOND model. The model estimation was achieved as follows. We first computed the mean and standard deviation of S_0 (μ_{S_0} and σ_{S_0}) within each TE group and discarded DW-signals whose intensity were larger than $\mu_{S_0} + 3\sigma_{S_0}$ (simple artefact correction). We then estimated DIAMOND parameters as described in Scherrer et al. (2015), considering Gaussian noise and cylindrical anisotropic compartments. For the genu we considered a model with one freely diffusing and one anisotropic compartment; for the fornix we considered a model with one freely diffusing compartment and two anisotropic compartments.

References

Scherrer, B., Schwartzman, A., Taquet, M., Sahin, M., Prabhu, S.P., Warfield, S.K., 2015. Characterizing brain tissue by assessment of the distribution of anisotropic microstructural environments in diffusion-compartment imaging (DIAMOND). Magn Reson Med , to appear.