Analysing mcDESPOT data with an arbitrary number of T2 components

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Target audience Those working with MR techniques for measuring myelin content.

Purpose Multicomponent driven equilibrium single pulse observation of T1/T2 (mcDESPOT) is a myelin water fraction mapping technique and it has been applied for detection of demyelination in MS lesions and NAWM[1]. mcDESPOT derives two-component relaxation information from spoiled and fully balanced steady-state (SPGR and bSSFP) imaging data acquired over multiple flip angles. However, the two water-pool model may be inadequate to address the complex nature of water pools in brain. In this study, we tested a model containing an arbitrary number of T2 components using a non negative least squares algorithm.

Methods Conventional mcDESPOT measurements were performed on a 3.0T whole body MR scanner (Achieva 3.0T, Philips Medical Systems, Best, The Netherlands) using an eight-channel phased-array head coil for reception and the internal quadrature body coil for transmission. Three steps were taken in the analysis of the data: a) DESPOT-HIFI to obtain single component T1 and B1 maps[2]; b) DESPOT-FM to obtain the B0 map[3]; c) with known T1, B1 and B0 maps, a multi-component T2 (40 T2 times from 5ms to 2 second) relaxation model was introduced to fit the mcDESPOT curve using the nonnegative least-squares algorithm[4].

Results An example of a T2 distribution from a brain tissue (genu of corpus callosum) is shown in Figure 1. Three different water environments can be observed in this T2 distribution: myelin water, intra/extracellular water, and CSF. Myelin water fraction (MWF) was calculated by MWF=myelin water / total water and we assumed the signal range lower than 10ms was the myelin water signal. The calculated MWF map from the T2 distributions is shown in Figure 2. The MWF analyzed by the conventional mcDESPOT method is also shown in figure 2 for comparison.

Discussion The multi-component T2 distribution showed three pools, suggesting that a two-pool model may be inadequate for addressing the complex water distribution in brain. The MWF map created from T2 fitting of mcDESPOT curve showed significant lower MWFs compared to values arising from the conventional two-pool model mcDESPOT analysis. Unlike for the case for the two pool model fits of the mcDESPOT data, the myelin maps created by NNLS did not exhibit evidence of MWF being constrained at the parameter limit. We did not consider the possibility of magnetization exchange with the multi-component T2 distribution model; however, exchange is believed to play a minor role the determining the MWF in the two pool model fit.

Conclusion In this work, we analyzed mcDESPOT data using a T2 relaxation model with an arbitrary number of components. The results show that a two pool model may be unable to describe the complex water environments found in brain. MWF values obtained the NNLS T2 distribution of mcDESPOT were smaller and closer to values obtained from the literature[4].

References