Comparison of inhomogeneity distortion correction methods in diffusion MRI of the spinal cord

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Abstract 718

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Purpose / Introduction

Diffusion MRI (dMRI) is a modality that describes the geometry of neural architecture. Diffusion images suffer from various artifacts originating from subject and physiological motion, eddy currents and B_0-field inhomogeneity. These can severely affect image quality particularly in the spine region. However, strategies exist to correct these distortions, including co-registration, point spread function, phase field map and reversed gradient polarity method (RGPM). In this work, we focus on the comparative evaluation of correction methods using RGPM which provides best results [1]. More precisely, we compare Voss [1,2] plus two other recent methods: FSL's Topup [3] and SPM's HySCO [4].

Subjects and Methods

Data acquisition: 116 dMRI acquisitions were conducted on 61 multiple sclerosis subjects and 9 healthy volunteers (between 1 and 3 visits/subject, 6 months interval) from Rennes and Montpellier hospitals (3T Siemens Verio and Skyra, respectively) using the following parameters: sagittal orientation, TR/TE=3600/90ms, 2x2x2mm^3 resolution, 6 b=0 and 30 non-collinear DWI (900 s/mm^2) plus one b=0 image with reverse phase-encoding direction. After QC (see below), we kept 69 acquisitions.

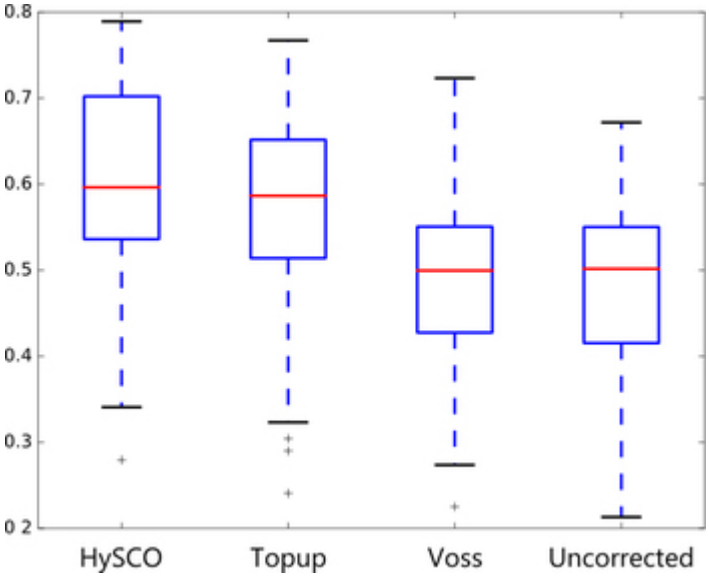
Quality control: Images with too many artifacts not related to B_0-field inhomogeneity (motion, ghosting) were eliminated, as well as acquisitions for which rigid registration between anatomical and diffusion failed (subject motion).

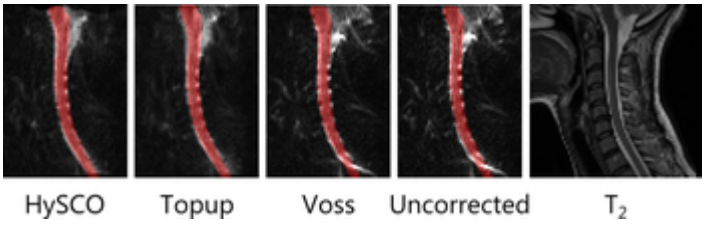
Comparing distortion correction methods: For evaluating the efficiency of either method, the whole spinal cord was segmented using the Spinal Cord Toolbox [5] on a T_2-weighted scan to obtain a binary mask which is registered to the first b=0 volume. Cross-correlation was computed (Fig.1) between each corrected dMRI and the rigidly registered T_2 image (Fig.2), only within the spinal cord region.

Results

ANOVA was performed on the cross-correlation scores, and confirmed that there is a significant improvement using correction distortion ($F=19.8$, $p=1.27\cdot10^{-11}$). Further, a Tukey's test showed that both HySCO and Topup perform better than Voss and uncorrected ($p<2\cdot10^{-4}$). However there is no significant difference between Voss and no correction. This last result is in contradiction with [1] which included 3 datasets, while we report results on 69 acquisitions.

Another finding (data not reported) is that changing the order in which RGPM images are given as input (first F>H then H>F, or reverse) yields different results, albeit no significant difference was noted.





Discussion / Conclusion

This comparative study conducted on 69 images confirms that performing a distortion correction post-processing step is important for the accuracy of the subsequent analysis; out of the 3 methods tested, HySCO and Topup provide best results.

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