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**Abstract 718**

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

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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,  $2 \times 2 \times 2 \text{mm}^3$  resolution, 6  $b=0$  and 30 non-collinear DWI ( $900 \text{ s/mm}^2$ ) plus one  $b=0$  image with reverse phase-encoding direction. After QC (see below), we kept 69 acquisitions.

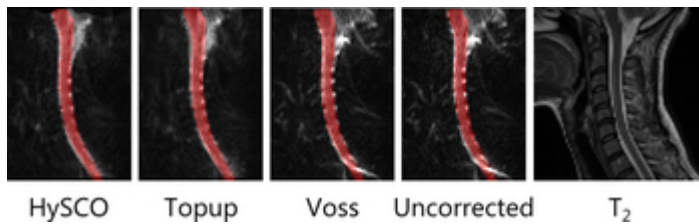
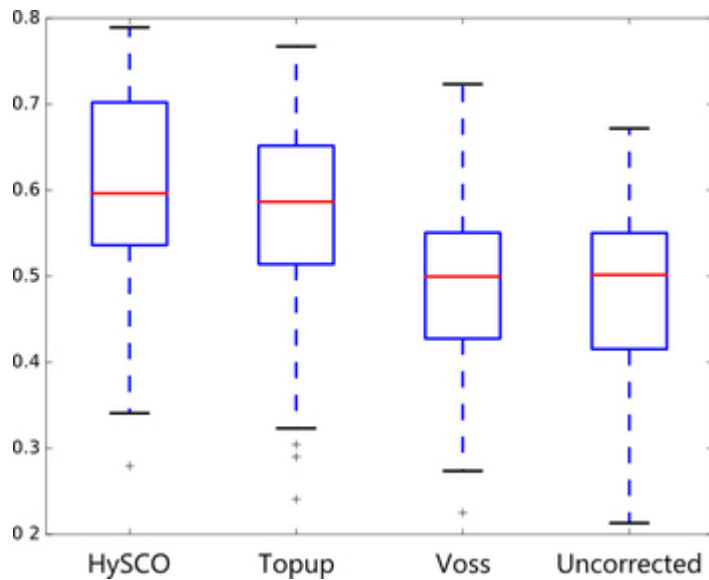
*Quality control:* Images with too many artifacts not related to  $B_0$ -field inhomogeneity (motion, ghosting) were eliminated, as well as acquisitions for which rigid registration between anatomical and diffusion failed (subject motion).

*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 ( $F=19.8$ ,  $p=1.27 \cdot 10^{-11}$ ). Further, a Tukey's test showed that both HySCO and Topup perform better than Voss and uncorrected ( $p < 2 \cdot 10^{-4}$ ). 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.

### References

- [1] Cohen-Adad, J., Henrik Lundell, and S. Rossignol. "Distortion correction in spinal cord DTI: what's the best approach." *Proceedings of the 17th Annual Meeting of ISMRM, Honolulu, USA*. Vol. 3178. 2009.
- [2] Voss, Henning U., et al. "Fiber tracking in the cervical spine and inferior brain regions with reversed gradient diffusion tensor imaging." *Magnetic resonance imaging* 24.3 (2006): 231-239.
- [3] Andersson, Jesper LR, Stefan Skare, and John Ashburner. "How to correct susceptibility distortions in spin-echo echo-planar images: application to diffusion tensor imaging." *Neuroimage* 20.2 (2003): 870-888.
- [4] Ruthotto, L., et al. "Diffeomorphic susceptibility artifact correction of diffusion-weighted magnetic resonance images." *Physics in medicine and biology* 57.18 (2012): 5715.
- [5] De Leener, Benjamin, et al. "SCT: Spinal Cord Toolbox, an open-source software for processing spinal cord MRI data." *NeuroImage* 145 (2017): 24-43.

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