The Impact of EPI-based Distortion Correction of Dynamic Susceptibility Contrast MRI in Patients with Glioblastoma

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Purpose

MRI-based Echo Planar Images (EPIs) are sensitive to magnetic susceptibility induced geometric and intensity distortions (Figure 1), which we correct using two independent methods. 1, 3 We evaluate the overall impact of the EPI distortion corrections by ranking 134 regions in Montreal Neurological Institute (MNI) space with decreasing rCBV change affected by the distortion corrections.

Method

45 newly diagnosed glioblastoma patients of age 40-84

- Dual Gradient-echo (GE) - spin-echo (SE) negative and positive phase encoded EPI sequences (Figure 1). Contrast passage during positive phase encoded EPIs (DSC).
- Two correction methods (FSL TOPUP 2,3 and EPIC 4) each use negative and positive phase encoded EPIs (Figure 1) to compute deformation fields (Figure 2). Deformation fields used to correct DSC.
- Relative cerebral blood volume (rCBV) from DSC 4 normalized to MNI space by co-registering first dynamic DSC to 3D fluid attenuated inversion recovery (FLAIR) anatomical images.

Results and Discussion

- Major rCBV changes in and close to the basal forebrain (Figure 2 and 3).
- rCBV changes most pronounced in many of the same regions for GE rCBV and SE rCBV. Note that TOPUP and EPIC was made for SE EPIs and that GE rCBVs suffer from EPIs with additional signal loss and may also be less accurately co-registered from the use of GE EPIs.
- Similar rCBV change across regions in left and right parts of the brain (Figure 2 upper right), opposed to locations of enhancing tumor (Figure 2 lower right).
- Differences in deformation fields across GE and SE EPIs.

Conclusion

GE and SE rCBVs will benefit from distortion correction especially in lateral regions close to and in the basal forebrain.

References

2 Smith, S. M. et al. (2004). Advances in functional and structural MR image analysis and implementation as FSL.