**Minimal processing pipeline of diffusion MRI data in brain cancer patients**

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**ABSTRACT**

**Purpose:** Diffusion MRI (dMRI) in neuro-oncology is a promising tool in tumour diagnosis, surgical planning and assessment of white matter damage post-radiation [1], among many other applications. Numerous studies showcased the power of dMRI in describing tissue structure, but majority of the investigations are still conducted outside the clinical environment. In order to establish the foundations of robust, ROI based analyses, we developed a minimal image processing pipeline for diffusion MRI to achieve artifact removal, spatial alignment, and cross-modal registration to deal with the massive structural changes induced by the disease. With the recent development of the MRI-Linac new ways are opening up for a more precise dose painting, which enables sparing of the more sensitive tissues, while boosting through areas that allow higher doses.

**Materials & Methods:** The pipeline was tested on 393 diffusion MRI scans (range of scans: 2-43, median: 8) in 38 patients (20 females) with large variation in age (range: 24-88, median: 57), disease history and treatment. Settings of the diffusion MRI scans: 1.5 T GE Signa HDxt scanner; voxel size 0.86x0.86x3.5-6.5mm³; one non-diffusion weighted image (non-DWI) and 27 DWI with b-value = 1000-1200 s/mm² were acquired. The MD Anderson Cancer Center kindly provided patient data and advice during the pipeline development. Every image processing step was performed in ExploreDTI [2]. Fig. 1 shows an overview of the pipeline on a sample subject, briefly: motion and distortion correction of the DWIs and rigid registration of all images to the CT scan from the RT planning in one resampling step. Robust estimation of the DTI model was performed with REKINDLE [3]. A 1mm³ isotropic MNI152 template with full brain parcellation was warped to every CT-coregistered set of (non-) DW images. Extraction of region specific diffusion scalars, e.g.: fractional anisotropy (FA) or mean diffusivity (MD) is possible via the registered atlas labels.

**Results:** Fig. 1 shows high spatial agreement between CT and DWIs via the DEC (directionally encoded colour) map. The colour describes the locally dominant direction of diffusion, by convention: anterior–posterior direction is green, left-right is red and superior–inferior is blue. Fig. 2 shows a series of dMRI...
scans revealing the progression of the tumour on the MD map, fused with the DEC map. The subject is the same as in Fig. 1. Due to the increased diffusivity of the tumour, MD provides better contrast than FA. **Conclusions:** The described pipeline provides the backbone of further investigations on brain tumour patients based on DTI derived white matter characteristics. While the current pipeline enables ROI based analyses, further improvement can be achieved with correcting for susceptibility distortions, which also enables fiber tractography based investigations at the cost of additional acquisition: good quality T1W image or field-map.

**Fig. 1: Overview of the image processing pipeline**

**Fig. 2: DTI based showcase of tumor progression, the patient received RT on Day 153**

**References:**