EFFECTS OF VOXEL SIZE, B-FACTOR AND AVERAGING ON THE TEST-RETEST REPRODUCIBILITY OF DTI-DERIVED FRACTIONAL ANISOTROPY AT 4T

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INTRODUCTION

Diffusion tensor imaging (DTI) of *in-vivo* human brain provides insights into normal and abnormal white matter anatomical connectivity [1,2], but little is known about measurement reliability at very high magnetic field systems (> 3T) as function of acquisition protocol. Here we assess the impact of acquisition variables (voxel size, b-value, number of averages) on test-retest reproducibility of fractional anisotropy (FA) estimates in a group of healthy subjects at 4T.

MATERIALS AND METHODS

Data Acquisition: Three healthy volunteers (1m, 2f, mean age 27+-6) were scanned each on two sessions at least a week apart using a 4.0 T Bruker Medspec scanner equipped with an eight-channel multi receive system. In each session a structural image was acquired (3D MPRAGE, 1x1x1 mm^3, GRAPPA IPAT = 2) and a set of diffusion weighted images (twice Refocused SE-EPI sequence [3], GRAPPA IPAT=2, 5 b0 images, 30 diffusion images [4], total scan time about 4:30min per acquisition, two separate acquisitions per protocol). In each session the following acquisition variables were used in the diffusion images to later assess test-retest reproducibility effects: voxel size (1.8^3, 2^3, and 2.5^3 mm^3), b-value (700, 1000, 1300 s/mm^2)

Data Analysis: Each subject, session and DTI protocol was treated as an independent sample to determine FA estimates. For each dataset the b0 images were extracted, averaged and used as reference volume to perform the eddy currents correction using FSL. After that, TrackVis was used to calculate FA maps and streamlines. FA maps were all co-registered to a fixed reference image using SPM allowing us to define fixed ROIs for estimating mean FA in each subject, session and protocol. Three ROIs were considered: "Corpus Callosum" (CC, hand-drawn using MRIcro on the sagittal view of the reference FA map), "Arcuate fasciculus" (AF) and "Cingulum" (both hand-drawn with TrackVis following the guidelines described in [5]). The protocol with two acquisitions (NA=2) was processed as a single diffusion file concatenating the 2 homologue datasets and then post-processing as a 60 gradient directions single acquisition. The protocols with one acquisition (NA=1) were evaluated with b=1000 s/mm^2. Mean FA and its Standard Deviation were measured in each ROI using MRIcro. For each ROI and acquisition protocol the test-retest reproducibility was defined as $200*(FA_{test}-FA_{retest})/(FA_{test}+FA_{retest})$, expressed in percent. The mean reproducibility across the three ROIs was also computed.

RESULTS AND DISCUSSION

Figure 1 summarizes the FA group reproducibility results for the condition of NA=2 for each ROI and their mean as function of voxel size and b-values. Figure 2 shows side by side FA reproducibility results for NA=1 and NA=2, for each voxel size and b=1000 s/mm^2.

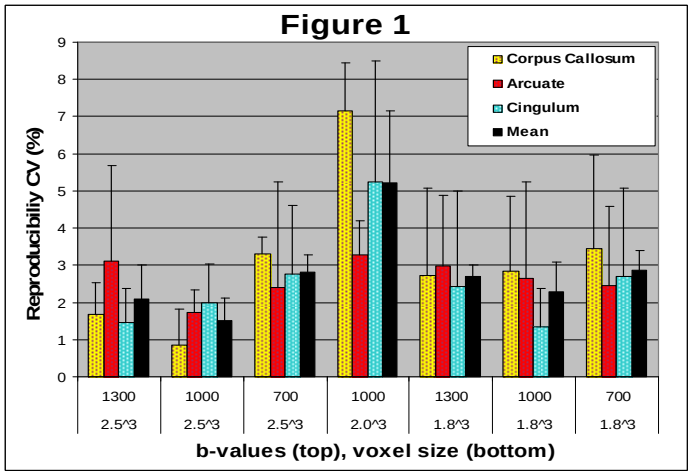

Figure 1: Group test-retest FA reproducibility (NA=2)

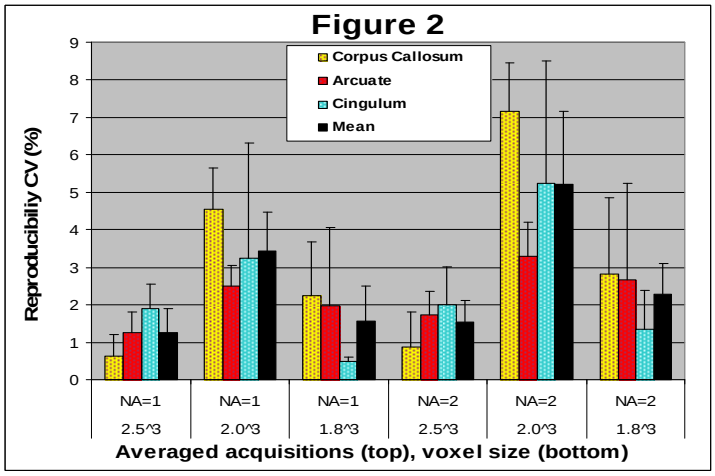

Figure2: Group test-retest FA reproducibility (b=1000 s/mm^2)

We found that except for voxel size 2^3 mm^3 group FA reproducibility is uniform across the ROIs, b-values and resolutions, with a slight trend of better reproducibility for NA=1 (1-2%). Both FA and reproducibility values are in good agreement with measurements done using clinical systems [6,7]. More subjects have to be studied to confirm these preliminary results and future work will include an analysis of the FA distributions within ROIs and reproducibility from tractography metrics.

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