Comparison of FA values from TBSS vs manual ROI

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Introduction; Assembling a diffusion tensor data set of typically developing children is beyond the scope of many clinical sites which nonetheless are interested in exploring the use of DTI in normal and disease states. For those sites, manual ROI analysis may suffice if it can be shown that manual ROI analysis yields tensor metrics concordant with measures derived from automated computerized analysis of tensor data. The aim of this investigation was to evaluate concordance between measures of FA derived using Tract Based Spatial Statistics (TBSS) and manual ROI analysis of WM and tracts of varying FA, location, and orientation in normal school-aged children.

Materials and methods: The 24 children were part of an IRB-approved study to acquire normative tensor data. MR imaging: 3T, SS-EPI, 30 directions, 3 acquisitions, b=0 & 700, 2 mm^3 voxel, TR/TE 8240/74. Operator-independent computerized analysis was done using TBSS (FMRIB Software Library, FMRIB Oxford, UK); the target image was a 9 year old. All subjects were nonlinearly registered to the target subject and affine transformed into MNI152 standard space. Voxel-by-voxel nonparametric statistical analysis on the FA skeleton was performed to detect regional age-related changes in FA using randomization with TFCE ($p < .05$) fully corrected for multiple comparisons across space. Clusters of statistical significance were analyzed using a custom program written in IDL; the FA value was averaged on the skeleton over 7 contiguous voxels in a 2D plane consistent with the plane used in the ROI method. ROI analysis was done on the color maps which were not spatially normalized, after eddy current and motion correction and image registration using the Philips PRIDE platform. A single experienced neuroradiologist manually placed regions of interest (ROIs) 3 times on the anterior and posterior limbs of the internal capsule (ALIC and PLIC), callosal genu, splenium, and body, uncinate, and superior longitudinal fasiculus (SLF). FA values from the 3 ROIs were averaged. The concordance of FA values obtained by the two approaches was assessed by the percent FA difference (%ΔFA) defined as $200 \times (FA_{TBSS} – FA_{ROI}) / (FA_{TBSS} + FA_{ROI})$. The mean and SD of %ΔFA were calculated for the various tracts.

Results: Measures of FA by TBSS and ROI were within 5% of each other for the PLICs, the callosal genu, body, and splenium, the right SLF, and both cingulum. However, but the FA values differed by >10% for the left SLF and both uncinate while the FA values derived from ROI analysis and TBSS differed from 14-38% in the ALIC. Review of the FA skeleton after transforming TBSS results back to native space showed marked decreases in FA along the caudal portion of the ALIC not appreciated on the directionally encoded color maps and presumably accounting for the discrepant FA values.

Conclusions: The “gold standard” for determination of FA has not been determined; these different analytical techniques appear to be at variance in different regions of the brain. The large discrepancies in the FA values derived from TBSS and ROI analyses within the anterior limbs of the internal capsules suggests one of these techniques may be unreliable in some locations of the brain.

Table I. % ΔFA (TBSS - ROI)

	Mean	SD
Lt PLIC	-0.4	5.4
Rt PLIC	0.3	6.6
Lt ALIC	-38.7	10.4
Rt ALIC	-13.7	17.1
Genu	2.8	3.9
Splenium	3.7	3.5
Callosal body	-8.1	9.8
Lt SLF	-10.6	6.9
Rt SLF	-3.3	8.8
Lt cingulum	5.1	8.6
Rt cingulum	4	11.1
Lt uncinate	-18.5	11.7
Rt uncinate	-21.5	15

Table II. Plot of mean of % differences between TBSS and ROI