Diffusion Tensor Imaging of the Internal Capsule and Corpus Callosum

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Purpose
The purpose of this study was to obtain normative anisotropy data and to determine whether these data correlate with known histology. The internal capsule and corpus callosum are two large, well-circumscribed white matter tracts that have regional differences in histologic characteristics. We hypothesize that such regional histologic differences may be reflected in differences in their anisotropy values as measured with diffusion tensor imaging (DTI).

Materials & Methods
Diffusion tensor imaging using a clinical 1.5 T system with a diffusion-weighted echo-planar imaging (EPI) sequence was performed on 21 healthy subjects (14 female, 7 male) ranging in age from 14 to 74 years (mean ± SD = 46.2 ± 17). The fractional anisotropy (FA), a sensitive measure of the degree of myelination and coherence of white matter fibers, and mean diffusivity, a measure of the average translational motion of water in all directions, of the anterior and posterior limbs of the internal capsule and the genu and splenium of the corpus callosum were measured. Student's paired t-test was used to compare the FA or MD between regions. The results also were stratified by sex and analyzed using the Wilcoxon signed-rank test.

Results
Significant differences in the anisotropy values between the anterior and posterior limbs of the internal capsule and between the genu and splenium of the corpus callosum were detected. Specifically, the FA of the posterior limb of the internal capsule was significantly higher than that of the anterior limb (0.64 and 0.53 respectively, p < 0.001), and the FA of the splenium of the corpus callosum was significantly higher than that of the genu (0.80 and 0.71 respectively, p = 0.001). When stratified by sex, this difference in the splenium and genu of the corpus callosum was present in females (0.81 and 0.69 respectively, p < 0.005) but not in males (0.79 and 0.76, respectively, p = NS). No significant differences in the MD were found between these areas.
Conclusion
Certain histologic differences, namely the presence of gray matter in the anterior limb of the internal capsule (1) and the presence of a larger percentage of unmyelinated fibers in the genu of the corpus callosum as compared to the splenium (1), likely contribute to the FA differences found in this study. The heavily myelinated corticospinal tract (CST) located in the posterior limb of the internal capsule on the other hand likely does not contribute to the FA differences, given that the overall myelin density of the CST appears to be lower than the surrounding areas of the posterior limb in a significant number of healthy subjects (3, 4). The sex differences regarding the corpus callosum raise questions for future research. Diffusion tensor imaging is capable of detecting subtle differences in white matter anatomy and histology.

References