Diffusivity Anomaly at Midline of Transcallosal Motor Pathway

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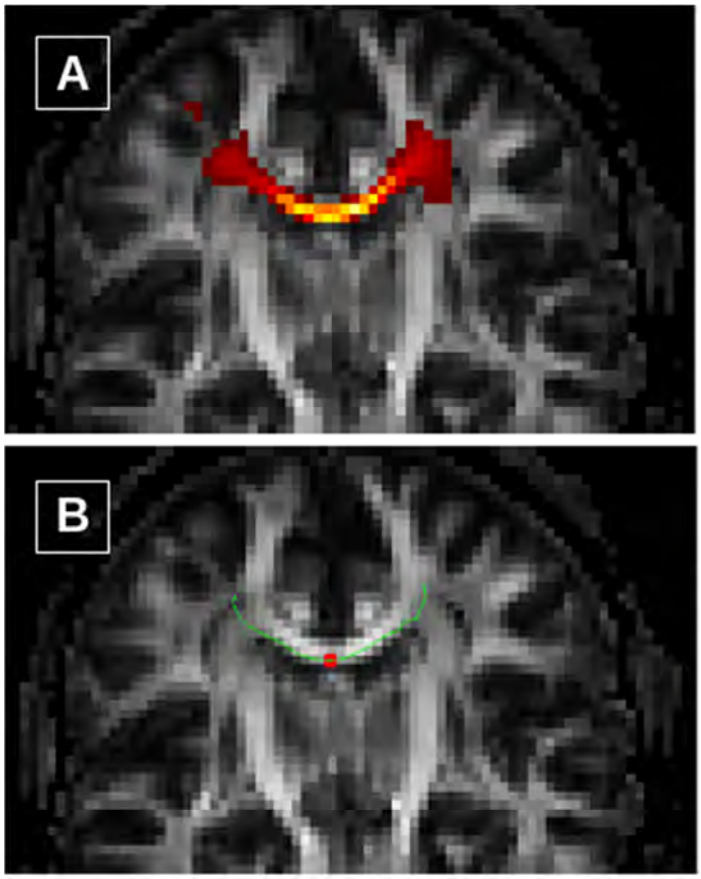
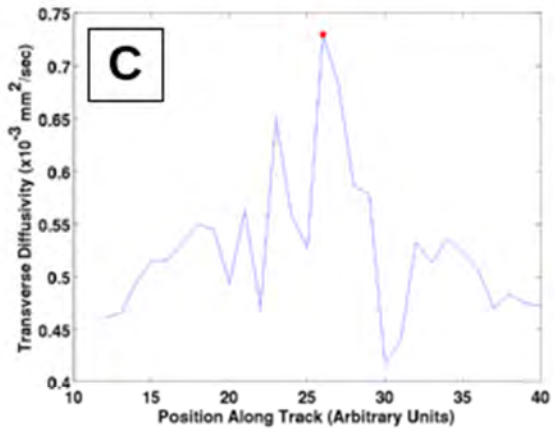
Target Audience – Researchers using diffusion MRI (dMRI) to characterize disease.

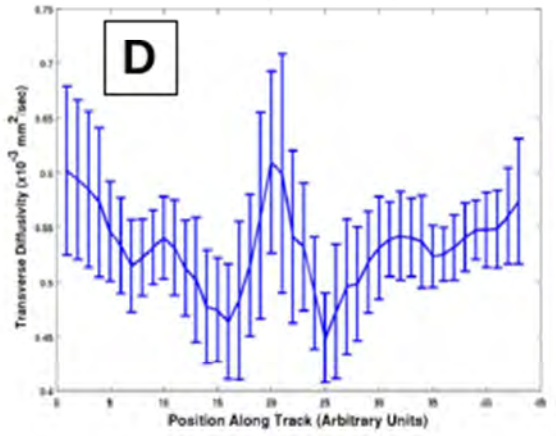
Purpose – To call attention to a naturally-occurring anomaly in measures of diffusivity along the transcallosal motor pathway. By selecting specific white matter pathways, tractography provides a means for tightening the correlation between imaging and function, correlation that is typically weak in diseases such as multiple sclerosis. For example, when measured along the motor pathway, transverse diffusivity (TD), a marker for demyelination, correlates with scores on the 9-hole peg test, a test of hand and arm function[1]. However, the natural variability of diffusivity along white matter pathways may obscure other important correlations. While variability is expected at regions with crossing fibers, we have consistently observed an elevated value of TD at the midline of the corpus callosum.

Methods – Under an IRB-approved protocol, 18 multiple sclerosis patients and 18 age-and sex-matched controls were scanned on a Siemens TIM Trio (Siemens Medical Systems, Erlangen). High angular resolution diffusion imaging (HARDI) with 2mm isotropic resolution was acquired, followed by probabilistic tractography[3], producing a track density map. The center track was defined from the track density map[4], and TD was averaged at positions along the center track. TD was calculated from the diffusion tensor, which in turn was determined by a log-linear least squares fit to the HARDI data[5]. A white matter mask generated from an anatomical image was used to exclude contributions from cerebrospinal fluid and gray matter.

Results – The figure shows the track density map along the transcallosal motor pathway (A) and the center track defined from the pathway (green line, B). The point at the midline of the corpus callosum is indicated by a red square in (B). Average TD along the center track (C) peaks at the midline (red square, corresponding to location of red square in B). This pattern was found repeatedly in all patients and controls, as emphasized in D), which shows the mean and standard deviation of TD along the center track among all the controls.







Conclusion – The consistency of this pattern among a number of subjects suggests that it is a real phenomenon. The location of the anomaly coincides with angular dispersion of fibers observed on histology[2]. Further imaging-histology comparisons may be necessary to confirm the phenomenon.

References - 1. Lowe MJ, Horenstein C, Hirsch JG, et al. Neuroimage. 2006;32:1127-33.
2. Budde MD, Annese J. Front Integr Neurosci. 2013;7:3. 3. Lowe MJ, Beall EB, Sakaie KE, et al. Hum Brain Mapp. 2008;29:818-27.
4. Sakaie KE, Lin J, Stone L, et al. Proceedings 20th Scientific Meeting of the International Society for Magnetic Resonance in Medicine; 2012; Melbourne.
5. Basser PJ, Mattiello J, LeBihan D. Biophys J. 1994;66:259-67.