Decreased anisotropy in the corpus callosum of patients suffering from limb kinetic apraxia

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Introduction: Limb kinetic apraxia (LKA) has been reported to accompany a variety of brain lesions localized adjunct to the primary motor cortex. Here, we applied diffusion tensor imaging (DTI) in patients with LKA but without obvious damage to the CC apart from slight atrophy to identify its possible involvement not visible on structural Magnetic Resonance Imaging (MRI).

Patients and methods: Three patients with characteristic clinical symptoms of LKA and signs of precentral and postcentral atrophy participated. The CC appeared slightly atrophic but otherwise normal (**Figure 1**). Six age-matched subjects (mean age 55 vs 70) from a database of patients with primary brain tumors served as controls. Only patients with frontopolar or temporal tumors and no patients with high-grade gliomas were chosen. MRI studies were conducted at 3 Tesla (Magnetom Trio, Siemens, Erlangen, Germany) using an 8-channel phased-array head coil. For DTI measurements, 38 sections parallel to the AC-PC-plane at isotropic resolution of 2.2 x 2.2 x 2.2 mm^3 with 24 independent gradient directions were acquired using the single-shot stimulated echo acquisition mode (STEAM) technique (b-values: 0 and 1000 s/mm^2; 3 acquisitions; total acquisition time 20 min) (2). Postprocessing and data analysis was performed using DeffCoN (in-house software, developed by M. Küntzel). Regions of interest (ROIs) for the evaluation of fractional anisotropy (FA) were placed in three midsagittal planes using a recently published regional classification of the CC accounting for the topology of the transcallosal fiber bundles (3). Corresponding to the cortical areas, the CC is partitioned into five areas above a geometrical anterior-posterior baseline: (I) prefrontal, (II) premotor, (III) motor, (IV) sensory, and (V) parietal, temporal and occipital.

Results: In comparison to controls, the mean FA values in all three LKA patients were found to be significantly lower in areas (II) to (V) with the most explicit differences observed in areas (III) and (IV) (Figure 2). Mean FA values in the control group are consistent with the values published previously in a younger control group (3).

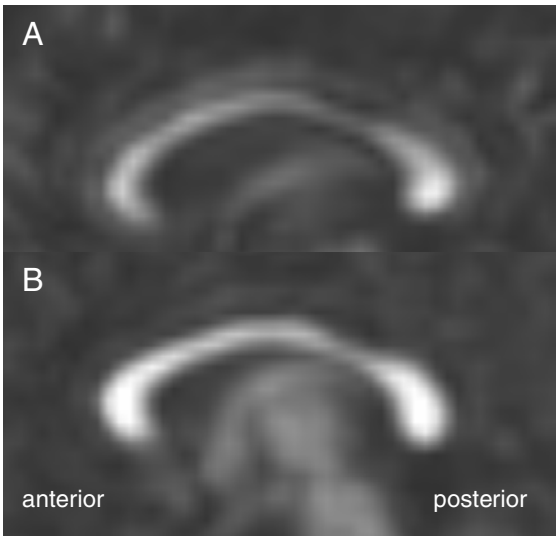

Figure 1: Typical midsagittal FA maps of (**A**) a patient and (**B**) a control subject. Note the thin CC of the patient.

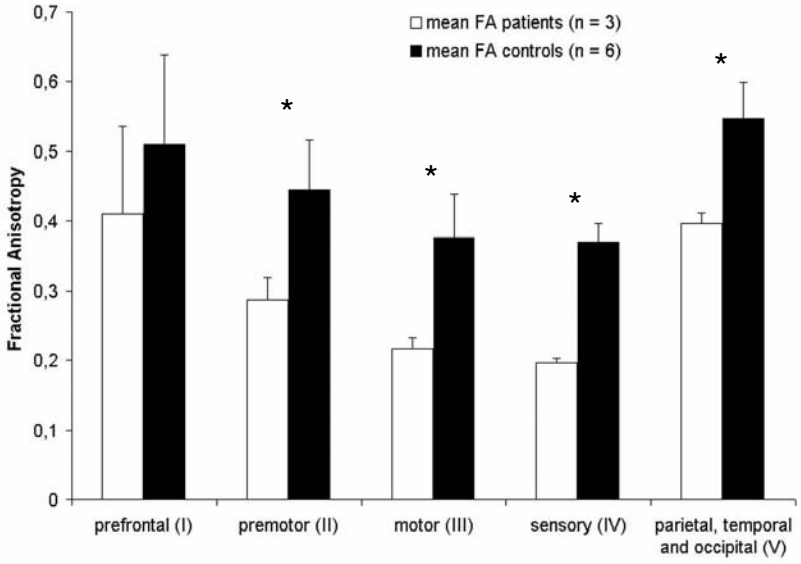

Figure 2: Mean FA values in the CC of patients and controls. Error bars indicate standard deviation. *Significant difference (Student's t-test, $p < 0.01$)

Conclusion: Our findings add first evidence towards secondary affection of the CC after circumscribed lesions of pre- or postcentral areas involved in the generation of limb kinetic apraxia. Even though standard structural MRI only revealed a slight CC atrophy but no lesions, DTI was able to identify generalized region-specific changes represented by reduced anisotropy. Pertinent findings were most pronounced in regions connecting to primary sensorimotor areas. Patients of the type described here usually develop a generalized neurodegenerative disease starting focally, the best known example being primary progressive aphasia with Alzheimers pathology. The technique described here may turn out to detect this generalization at the earliest possible stage in neurodegeneration with focal onset.

References: (1) Scepkowski LA, Cronin-Golomb A. The alien hand: cases, categorizations, and anatomical correlates. Behav Cogn Neurosci Rev 2003;2:261-277. (2) Rieseberg S, Merboldt KD, Küntzel M, Frahm J. Diffusion tensor imaging using partial Fourier STEAM MRI with projection onto convex subsets reconstruction. Magn Reson Med 2005;54:486-490. (3) Hofer S, Frahm J. Topography of the human corpus callosum revisited – comprehensive fiber tractography using diffusion tensor magnetic resonance imaging. Neuroimage 2006;32:989-994.