Diffusion tensor imaging fiber tracking of the nigro-striatal fiber tract in the monkey brain using whole body 7T

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Introduction. Evidence that DTI-based fiber tracking has the ability to provide new insight on the organization of small fiber tract anatomy is still awaited. The internal circuitry connecting basal ganglia nuclei comprises such small tortuous fiber tracts. Imaging small fiber tracts such as nigro–striatal fibers is challenging since these fibers are of small size sometimes tortuous and travel through the basal forebrain among numerous other fiber tracts and fiber crossing areas. Our objective was thus to determine whether DTI fiber tracking can image the small nigro-striatal fiber tract at 7T.

Material and methods. An anesthetized (propofol, 2 mg/kg IV) young Macaca mulatta monkey, (3 years / 5 kg) was imaged. The monkey was intubated to secure an open airway, placed in an MR compatible stereotaxic holder and wrapped in a chemical heating pad to maintain body temperature. Body temperature, pulse oxygenation, pulse rate, expired CO2, and respiration rate were continuously monitored throughout the imaging session. A 7T MR scanner (Siemens) equipped with a head gradient coil (80mT/m G-maximum, 200mT/m/ms) was used with a custom built quadrature monkey coil. A single-shot SE acquisition with the following parameters was used: voxel size: 0.7x0.7x0.7 mm^3; TE/TR: 83/5500 ms; b=1000s/mm2; 12 directions; 43 slices; 25 avg. Total acquisition time ~30 min.

Diffusion tensor image analysis was performed using a line propagation method implemented in Brainvisa 3.0.2 software (http://brainvisa.info). The anterior part of the striato-nigro-striatal fiber tract was reconstructed by using the segmented substantia nigra and lenticular nucleus as regions of interest (ROIs). ROIs were manually traced using Brainvisa 3.0.2.

Results. The nigro-striatal fiber tract was successfully reconstructed in both hemispheres. The tract coursed from the medial part of the substantia nigra anteriorly toward the medial tip of the globus pallidus (figure 1). Fiber tracking was also successfully performed for the major fiber tracts in the brain including the corpus callosum, the corticospinal tract, the cingulate bundle, the fornix, the arcuate fasciculus, the temporal occipital fasciculus.

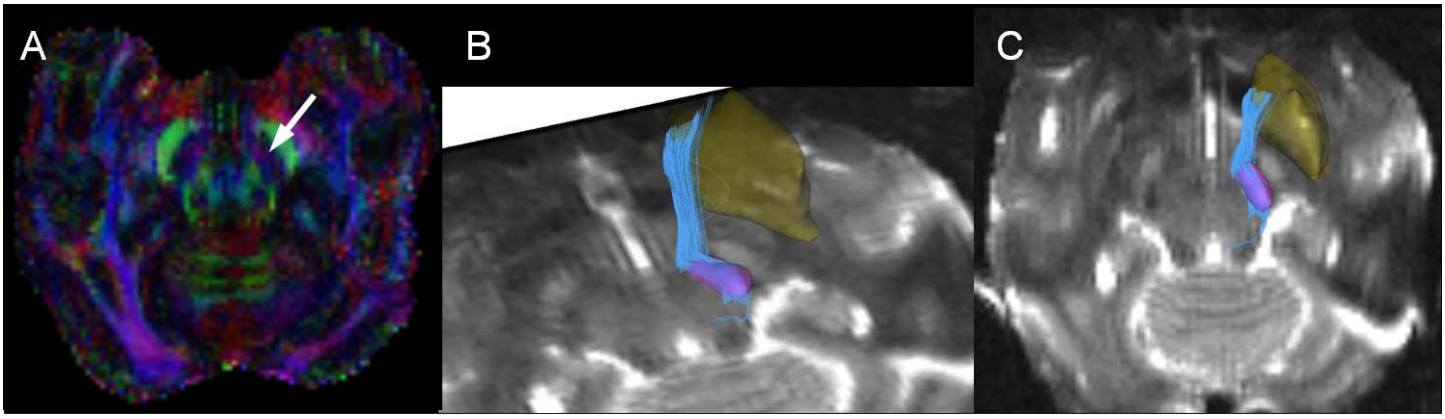

Figure 1. A) Axial RGB slice passing at the level of the substantia nigra (arrow). B) and C) Three dimensional reconstructions of the anterior part of the striato-nigro-striatal fiber tractin the left hemisphere coursing in the mesencephalon and the basal forebrain between the lenticular nucleus (yellow) and the substantia nigra (purple).

Conclusion. We provide DTI fiber tracking reconstruction of the nigro-striatal fiber bundle in the living monkey brain using a whole body 7T magnet. Very high magnetic field and increased spatial resolution allowed the reconstruction of this small basal ganglia fiber tract that is typically not reliably imaged at lower field strength. Imaging the nigro-striatal fiber tract provides a marker of the nigro-striatal pathway and has great potential to study basal ganglia pathology such as Parkinson's disease.

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