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DTI Fiber tracking Analysis of the visual input to the pallidum in humans: preliminary results

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Purpose

Deep brain stimulation (DBS) of the Globus Pallidus interna (GPi) and the subthalamic nucleus (STN) is a current surgical technique for the treatment of movement disorders such as those in Parkinson's disease (PD). During GPi DBS eye movement impairments (saccade movement disturbance) were reported. The basal ganglia (BG) are well known to influence eye movement through action of the caudate nucleus, the STN and the substantia nigra reticulata, but little is known about the GPi. GPi is the main output of the BG that has been extensively explored for movement and behavioral controls. However, recent experimental studies in monkeys have shown the existence of GPi neurons modulating their activity in relation to saccade, and smooth pursuit, suggesting that GPi might be involved in saccade and pursuit control loops. This hypothesis could be consistent with clinical observations. We hypothesized that direct visual input into the GPi could be detected using diffusion tensor imaging (DTI) and fiber tracking (FT); these fibers could belong to the supraoptic commissural system (Ganser, Meynert, Gudden).

Methods

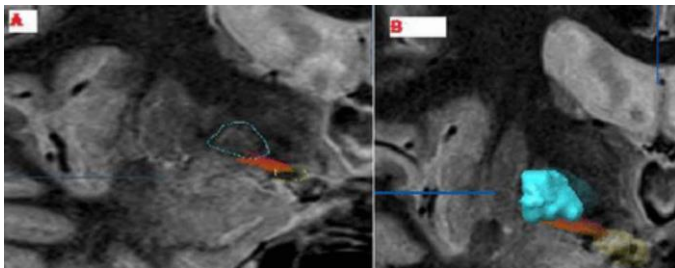
Ten patients (5 PD; 5 essential tremor) who undergone neurosurgical stereotaxic procedure for movement disorders were retrospectively analyzed. We explored DTI acquired routinely for the surgical planning. DTI fiber tracking (FT; voxel = $0.52 \times 0.62 \times 2$ mm³, fiber length ≥ 15 mm, FA threshold ≥ 0.22 ; Iplan 3 BrainLab) was carried on within the right and left hemispheres. FT was performed between the optical tract and the GPi. The two region-of-interests were outlined on the MRI anatomical images used for surgical planning.

Results

In all the 20 regions (10 patients right and left hemispheres) we have found a fascicle connecting the optical tract and the GPi. In this study, using DTI FT, we identified direct optic tract connection to the GPi; this pathway could be involved in saccade, eye pursuit control.

Conclusions

Further works are mandatory to evaluate this hypothesis, using both functional and structural approaches, enabling the description of an optical-basal ganglia connectome, which could be useful to interpret clinical observations.



A: Coronal plane, MRI 1.5 T WAIR sequence. Fiber bundle is obtained from two ROIs: optic tract (yellow) and GPi (blue) **B:** DTI of the left GPi (blue) and the left optic tract (yellow). Fiber bundle (red) can be seen, connecting them.

Keywords

Anatomy, eye movements: saccades and pursuits, imaging methods (CT, FA, ICG, MRI, OCT, RTA, SLO, ultrasound)