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

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INTRODUCTION

➤ 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) and dystonia. During GPi DBS and pallidotomy eye movement impairments were reported: conjugate eye deviation, ocular fixation and saccade movement disturbance.

➤ The basal ganglia 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. The GPi is the main output of the basal ganglia (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, suggesting that GPi might be involved in saccade 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).

PATIENTS, MATERIEL AND METHODS

➤ Ten patients (5 PD; 5 essential tremor, mean age 60.5 SD 6.5) who undergone neurosurgical stereotaxic procedure for severe movement disorders were retrospectively analyzed. We explored (DTI) acquired routinely in our institution for the surgical planning and result analysis (1.5 Tesla, Magnetom, Sonata, Siemens).

➤ DTI fiber tracking (FT; voxel = $0.52 \times 0.62 \times 2 \text{ mm}^3$, fiber length $\geq 15 \text{ mm}$, Fractional Anisotropy threshold ≥ 0.22 ; Iplan 3.0, BrainLab, Germany) was carried on within the right and left hemispheres. FT was performed between the proximal (retro chiasmatic) optical tract and the GPi. The two region-of-interests (ROIs) were manually outlined on the MRI anatomical images (White Matter Attenuated Inversion Recovery sequence WAIR) used for surgical planning (anatomic mapping).



Fig.1 Coronal plane, MRI 1.5 T imaging, White Mater Attenuated inversion recovery (WAIR) sequence. On the right side, putamen (purple), GPe (green), GPi (blue) and optic tract (yellow) are contoured.

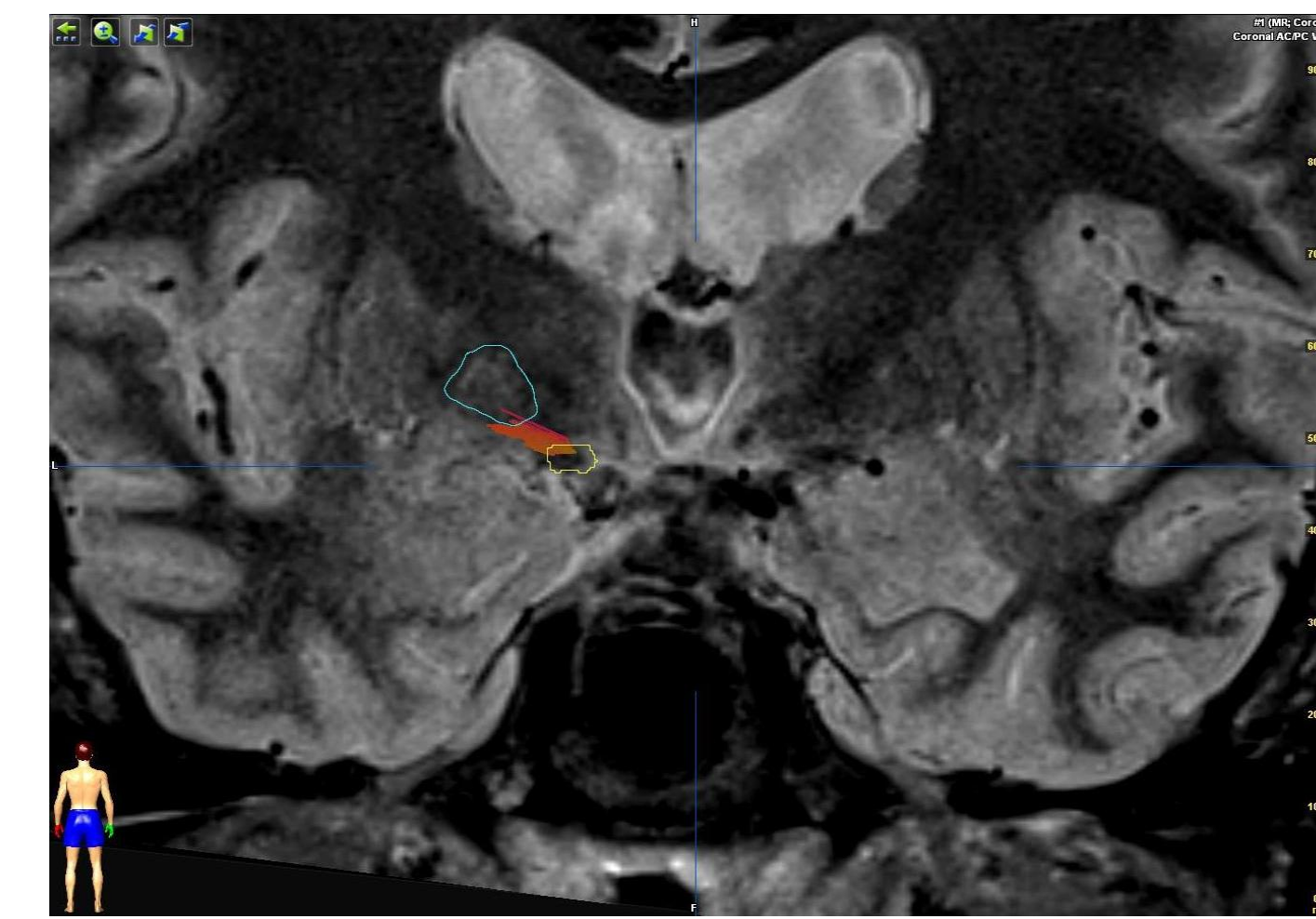


Fig.2 Coronal plane, MRI 1.5 T imaging, White Mater Attenuated inversion recovery (WAIR) sequence. Fiber bundle is obtained from two ROIs: optic tract (yellow) and GPi (blue).

RESULTS

➤ In all the 20 regions (10 patients; right and left hemispheres) we have found a fascicle that connected the optical tract and the GPi.



Fig.3 and 4 DTI imaging of the left Gpi (blue) and the left optic tract (yellow). Fiber bundle (red) can be seen, connecting the optic tract to the GPi.

DISCUSSION

➤ In this preliminary study, using DTI FT, we identified direct optic tract connection to the Globus pallidus; this pathways could be involved in saccade control and eye fixation.

➤ 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.

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