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Title
Patient-Specific Structural Connectivity in OCD DBS Targets: A Comparative Study of NAC/ALIC and amSTN.

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Oral Presentation

Introduction:
Deep Brain Stimulation (DBS) targeting the anterior limb of the internal capsule (ALIC), nucleus accumbens (NAC), and the anteromedial subthalamic nucleus (amSTN) has emerged as an effective treatment for patients with treatment-resistant obsessive-compulsive disorder (OCD). The Frontopontine-corticothalamic (Fp-Ct) network, which incorporates these regions, forms part of a critical pathway for symptom relief in OCD. This study aims to map the white matter pathways of the Fp-Ct network using patient-specific structural connectivity data from OCD patients who have undergone DBS and apply tractometroc analysis to both target regions for OCD DBS.

Methodology:
We analyzed structural and diffusion MRI data from 22 OCD patients (10 females, average age 42.9 ± 9 years, baseline Y-BOCS score: 30 ± 6) treated with DBS at the University of Cologne. Using MRtrix3 software, we generated 40 hemisphere-specific tractograms via probabilistic tractography, based on 3-tissue constraint sphere deconvolusiton modelling. We used the T1 image to define the white matter/ grey matter boundaries. We created a whole brain tractogram starting with 10 million streamlines from the white matter-grey matter boundary and refining them to 1 million streamlines targeting NAC/ALIC and amSTN regions. Structural connectivity matrices for the Fp-Ct network were constructed using the HCP842 tractography atlas, examining streamline counts, fractional anisotropy (FA), and mean diffusivity (MD).

Results:
Significant structural connectivity differences were found between NAC/ALIC and amSTN across both hemispheres ($p < 0.001$). Qualitatively we found that the amSTN have streamlined reaching distant regions like the Dorso Lateral prefrontal cortex (DLPFC), dorso-anterior cingulate cortex (DACC), brainstem and cerebellum. On the other side the NAC/ALIC presented more streamlines towards the prefrontal cortex and amigdalo-fugal tracts. Quantitatively structural connectivity percentages with the Fp-Ct tracts for NAC/ALIC were R=20.4% and L=20.6%, while for amSTN, they were R=64.3% and L=64.7%. FA values, reflecting fiber coherence, were significantly different between NAC/ALIC (R=0.33±0.04; L=0.34±0.04) and amSTN (R=0.48±0.05; L=0.48±0.05). No significant differences were observed in MD, suggesting similar cellular density in both regions.

Conclusions:
Our structural connectivity analysis highlights the importance of NAC/ALIC and amSTN in the Fp-Ct network for OCD DBS. The differences in FA values suggest greater fiber coherence in NAC/ALIC towards the mPFC, while the amSTN presented more connectivity to the DLPFC and DACC, which may have clinical implications. These findings underscore the potential of using structural connectivity as a biomarker to enhance DBS targeting and improve patient outcomes in treatment-resistant OCD.