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Prefrontal Cortical Connectivity-Based Segmentation of the Anterior Limb of the Internal Capsule: Implications for Stereotactic Targeting for Refractory OCD

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Introduction

Although most patients with obsessive-compulsive disorder (OCD) are well controlled with pharmacological and cognitive behavioral therapy, 10-20% remain severe and refractory. Stereotactic targeting of the anterior limb of the internal capsule (ALIC) has been used for decades to treat these patients. However, there is uncertainty about optimal targeting within the ALIC, as different locations appear to have variable efficacy. Using diffusion tensor imaging (DTI), we segmented the ALIC based on prefrontal connectivity to evaluate the effect of various stereotactic targets.

Methods

ALIC segmentations based on frontal Brodmann area (BA) connectivity were generated and combined for 40 subjects from the Human Connectome Project (HCP) using connectivity-based seed classification (Figure 1a). Literature review revealed five stereotactic targets within the ALIC. Targets were modeled as 5mm spheres (Figure 1c) and were evaluated for overlap with various DTI-defined ALIC segments. Deterministic tractography was performed on an 842-subject HCP DTI template using modeled targets as seeds to identify involved connectomic networks (Figure 2).

Results

All 40 ALIC segmentations exhibited a dorsal-ventral axis of organization. On average, the combined segmentation was accurate for 66.2% of individuals (Figure 1b). The region assigned to BA11 (orbitofrontal cortex, OFC) exhibited the greatest consistency across individuals, with 12.1% being consistently assigned in all 40 subjects. According to the segmentation, a mean of 63.9% of modeled lesion volume within the ALIC intersected with the BA11 region. All five modeled targets exhibited connectivity to OFC in the 842-subject HCP template.

Conclusions

These results clarify the organization and variability of the ALIC. This variability suggests that patients may benefit from pre-operative tractography for individualized targeting, although current stereotactic targets tend to involve the most consistent ALIC subregions. These findings also suggest that stereotactic targeting for OCD likely involves modulation of prefrontal-subcortical tracts connecting the OFC, which bears relevance to the cortico-striato-thalamo-cortical (CSTC) model of OCD pathophysiology.

Learning Objectives

By the conclusion of this presentation, participants should be able to (1) describe the organization of the ALIC, (2) discuss the variability in tract organization in the ALIC and implications for pre-operative imaging, and (3) describe the locations and connectomics of historical stereotactic targets.

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