Introduction

- Globus pallidus pars interna (GPI) is a stereotactic target for stimulation and ablation in Parkinson’s disease, dystonia, and Tourette’s syndrome.
- GPI is preferentially connected to the ventrolateral group of thalamic nuclei and receives indirect input from the neocortex via cortico-strato-pallidal projections.
- Distinct parcels within GPI have been identified with tracing studies and confirmed with tractography.
- Similar parcellation has never been performed in PD patients due to calcification and microstructural changes associated with neurodegeneration.
- We hypothesized that GPI parcellation based on thalamic and cortical connections will identify sub-regions that are functionally distinct and anticipate this organization is maintained in PD patients.
- We compared the location of the motor parcel with the stimulation volume or pallidotomy lesion in PD patients undergoing therapeutic neuromodulation.

Methods

- Diffusion MRI data from 40 healthy subjects (S1200 cohort from the Human Connectome Project) and 27 patients with PD was used to parcellate the GPI.
- Probabilistic tractography was performed with the thalamus as a waypoint to frontal, insula, precentral, parietal, occipital, and temporal cortical areas.
- The images from PD patients were preprocessed using generalized q-sampling imaging after correcting for CSF contamination.
- To analyze differences in patterns of functional connectivity, individual GPI masks from the parcellation of the HCP subjects were used as seeds for resting state fMRI (rsfMRI) analysis.
- We also analyzed the location of the motor parcel relative to the location of the focused ultrasound pallidotomy lesion (n=3), and the therapeutic DBS contacts (n=7).

Results

- Six distinct parcels within the GPI were identified based on preferential probability of connectivity with different cortical regions.
- rsfMRI analysis revealed distinct patterns of functional connectivity, with the exceptions of the precentral and parietal parcels.
- The parcellation in the PD patients was comparable with HCP after the application of CSF correction.
- Ranking the DBS contacts by their preferential connectivity to ventrolateral thalamic nuclei was able to predict 8 cathodes (out of 14) and the motor GPI parcel was located within 3mm +/- 0.35 mm of the focused ultrasound pallidotomy lesion centroid.

Summary

- Probabilistic GPI parcellation, based on cortical and thalamic connectivity, is feasible and reliable in PD patients using tensor algorithms that account for free-water correction.
- Distinct GPI parcels have unique functional connectivity patterns that are preserved in PD patients.
- This is the first study to perform such parcellation in PD patients to our knowledge.
- We suggest to correct for CSF contamination with generalized q-sampling imaging before performing tractography in patients with neurodegenerative disorders.

References


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