INTRODUCTION

Deep brain stimulation (DBS) is a challenging therapy for obsessive-compulsive disorder (OCD) and depression, targets the cortico-basal ganglia circuitry by placing the electrodes in the ventral anterior internal capsule (VC) and adjacent ventral striatum (VS) (Greenberg et al., 2010).

The primary goal of this study was to better understand the underlying circuitry that is affected during DBS in OCD patients by using probabilistic diffusion tensor imaging (DTI) tractography to evaluate the fiber pathways involved at each contact for each patient; and 2. Which pathways are likely to be accurate and reliable? (see below) to determine: 1. The pathways and structures likely to be involved at each contact for each patient; and 2. Which pathways are likely to be accurate and reliable.

Several seeding and fiber bundle passes through the IC are used, of which may differentially modulate behavior and, thus, impact OCD depression symptoms. Based on recent connectivity studies, we show that in both monkeys and humans, cortical fibers enter and are positioned within the IC according to specific rules, (see posterior WD 445-455). However, although the cortico-basal ganglia circuitry is affected, the role of the IC in OCD is not agreed upon. Thus, the purpose of this study was to determine if the IC is affected during DBS in OCD patients by using probabilistic diffusion tensor imaging (DTI) tractography.

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METHODS

Eight right-handed male patients with OCD were included in this study. Each patient underwent DBS surgery at the University of Rochester Medical Center (URMC) before 2009. The data was corrected for field inhomogeneity-induced distortions prior to averaging (Andersson et al., 2003). The quality of this pre-processing step was checked using the FMRIB's Linear Image Registration Tool (FLIRT) (Jenkinson et al., 2002). The data was coregistered to standard 1.5 mm isotropic images using the Statistical Parametric Mapping software (SPM). The data was then smoothed with a Gaussian kernel of 8 mm full width at half maximum (FWHM).

RESULTS & CONCLUSIONS

1. Several pathways are associated with each contact. Not terminating areas are assessed as DTI shows only the area of the bundle, not origin or terminus regions.

2. Cortical contacts for each patient are positioned somewhat differently. Contacts for B2 are more dorsal than those for B3, and B3 are more ventral than those for B2. These differences are within the typical individual variation. However, interestingly, the ventral basal and posterior regions are affected in different pathway trajectories.

3. Many pathways are consistent with the expected trajectories based on animal studies. Importantly, the rules that dictate the position of fibers within the IC derived from animal studies are consistent with those seen here (see Figure 3).

4. Pathways from all contact 1 seeds connect with the thalamus and brainstem. Pathways in B3, but not B2, continue to connect with the frontal lobe. This pathway extends caudally into the EC/EmC. Bottom panel: Fibers leave the lOFC and travel dorsally and split into 3 branches. Some branches travel in the PFC and the most dorsal contact tracking the dPFC. Alternatively, the fibers do not pass through the IC (see B).

5. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here. The electrical field generated at each contact will encompass a larger area than illustrated here.

6. Patient B3 had the greatest therapeutic response, based on the YBOCS score. The active electrodes were Left (L) for B3, but not B2, and Right (R) for B2. These differences are within the typical individual variation. However, interestingly, the ventral basal and posterior regions are affected in different pathway trajectories.

7. Preliminary results suggest that activation of ventral prefrontal cortical connections, including the vmPFC, OFC, and lOFC, is required for the therapeutic response to DBS. These results are consistent with those seen in animal studies and human post-mortem studies.

8. Pathways from all contact 1 seeds connect with the thalamus and brainstem. Pathways in B3, but not B2, continue to connect with the frontal lobe. This pathway extends caudally into the EC/EmC. Bottom panel: Fibers leave the lOFC and travel dorsally and split into 3 branches. Some branches travel in the PFC and the most dorsal contact tracking the dPFC. Alternatively, the fibers do not pass through the IC (see B).

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