Structural changes associated with duration of subthalamic nucleus deep brain stimulation in patients with Parkinson’s disease with a focus on olfactory processing

Conclusions

- STN-DBS in PD significantly impacts ipsilateral white-matter volume
- STN-DBS does not affect on sub-cortical brain areas
- Longer periods of STN-DBS was associated with significantly larger OB volumes
- ET control group exhibited significantly larger OB volumes following short STN-DBS compared to PD patients
- The significant increase in OB volume provides an anatomical explanation for the clinical effect that has demonstrated positive olfactory responses in PD patients following STN-DBS treatment.
- An increase in OB volume following STN-DBS supports neuronal plasticity, and demonstrates the non-motor impact of STN-DBS
- Increased OB volume suggests the possible success of non-surgical alternatives such as olfactory training in PD patients not eligible for DBS

Future Directions

- Larger sample size of PD patients that have survived more than 580 days of stimulation, sample size of healthy brain MRI’s to compare to diseased population
- Acquiring pre and post STN-DBS smell tests using UPSIT and Sniffin Sticks Test
- Use of olfactory training in patients with olfactory deficits that do not meet the criteria for DBS surgery

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References


Background

- Parkinson’s disease is the second most prevalent neurodegenerative disease in the U.S. (Chen, 2010)
- Olfactory dysfunction occurs in 90% of PD patients, before onset of motor symptoms (Hummel et al., 2009)
- Olfactory dysfunction has been linked to decreases in appetite, increases in contact with hazardous events, disturbances in social communication, and depression (Cory et al., 2012; Mora et al., 2001)
- No treatment options currently exist for olfactory deficits in PD

Objectives

- STN-DBS - used for treating advanced PD - has been shown to improve olfactory function
- One study demonstrated that eleven PD patients that underwent a range of two to thirty-one months of stimulation showed improvement in OD (Hummel et al., 2005)
- A second study, with forty-five PD patients, showed significant improvement in olfaction in nine of the patients that received bilateral STN stimulation in conjunction with dopamine agonists compared to no stimulation in the group that received standard medical care
- In humans, changes in olfactory function – loss and gain - can be correlated with changes in olfactory bulb volume

Methods

- Approval for study obtained through the Colorado Multiple Institution Review Board (COMIRB). All medical analyses were conducted on de-identified data collected during the standard-of-care procedures for routine STN-DBS implantation surgery in patients with idiopathic PD, using a retrospective chart-review
- Obtained T1/T2-weighted MRI of 30 PD patients, and 3 ET patients for analysis
- Raw DICOMS were converted to NIFTI format using Statistical Parametric Mapping (SPM 12) in Matlab, which is a standardized format for analyzing 4D neuroimaging data
- Voxel-based morphometry gross tissue segmentation (Computational Anatomy Tool)
- Cortical parcellation and sub-cortical segmentation (Freesurfer)
- Pre and Post Ipsilateral STN stimulation (Long: 477 Days)

Results

- The significant increase in OB volume provides an anatomical explanation for the clinical effect that has demonstrated positive olfactory responses in PD patients following STN-DBS treatment.
- An increase in OB volume following STN-DBS supports neuronal plasticity, and demonstrates the non-motor impact of STN-DBS
- Increased OB volume suggests the possible success of non-surgical alternatives such as olfactory training in PD patients not eligible for DBS