ACUTE AND LONG-TERM CHANGES IN PARKINSON’S DISEASE PATIENTS TREATED WITH DEEP BRAIN STIMULATION TARGETING SUBTHALAMIC NUCLEUS: INSIGHTS PROVIDED BY MOLECULAR IMAGING AND BRAIN MAPPING

MEHR JAIN¹,², ALEXANDRE BOUTET, MD, MSC¹,³, DAVE GWUN¹, PABLO RUSJAN, PHD⁴, CLEMENS NEUDORFER, MD¹, GAVIN J. B. ELIAS, BA¹, JÜRGEN GERMANN, MSC¹, WALTER KUCHARCZYK, MD¹,³, ALFONSO FASANO, MD, PHD¹,⁵,⁶, GWENN S. SMITH, PHD⁷, ANDRES M. LOZANO, MD, PHD¹.

¹UNIVERSITY HEALTH NETWORK, TORONTO ²UNIVERSITY OF OTTAWA, FACULTY OF MEDICINE, ³JOINT DEPARTMENT OF MEDICAL IMAGING, UNIVERSITY OF TORONTO, ⁴RESEARCH AND IMAGING CENTRE AND CAMPBELL FAMILY MENTAL HEALTH RESEARCH INSTITUTE AT THE CENTRE FOR ADDICTION AND MENTAL HEALTH, TORONTO, ⁵EDMOND J. SAFRA PROGRAM IN PARKINSON’S DISEASE, MORTON AND GLORIA SHULMAN MOVEMENT DISORDERS CLINIC, TORONTO, ⁶KREMBIL BRAIN INSTITUTE, TORONTO ⁷DEPARTMENT OF PSYCHIATRY AND BEHAVIORAL SCIENCES, JOHN HOPKINS UNIVERSITY SCHOOL OF MEDICINE, BALTIMORE
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BACKGROUND

- Deep brain stimulation (DBS) is most commonly used for movement disorders, particularly Parkinson’s disease (PD)
- Subthalamic nucleus (STN) is an important hub or the motor circuit when studying DBS targeted for PD
- Molecular imaging modalities such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT) provide insight into neural changes induced by DBS
- To date a review has not summarized acute and long-term effects of STN-DBS indicated for PD, likely because heterogenous in experimental designs employed in available studies have limited data interpretation
- **Primary objective**: To use brain mapping techniques to summarize acute and long-term changes studied by PET and SPECT in PD patients treated with STN-DBS
The colors represent the globus pallidus externa (light blue); globus pallidus internus (green); pedunculopontine nucleus (red); subthalamic nucleus (yellow); thalamus (purple); ventral intermediate nucleus of thalamus (dark blue).
METHODS

• In May 2019, we conducted a comprehensive Medline search and summarized 39 PET and SPECT articles studying STN-DBS in PD patients scanned at rest.
• Functional magnetic imaging was excluded to maintain homogeneity in comparison as perceived safety issues have limited number of published studies.
• Reported results were divided into acute (i.e. DBS on vs off) and long-term changes (i.e. DBS on versus preoperative).
• We selected studies that employed conservative statistics using p-value correction for multiple comparisons.
• We mapped the reported areas of metabolic change using various atlases overlaid on MRI (T1 MNI brain) axial images. Brain regions were obtained from spatial parcellation according to published atlases (cortical: An Atlas of Intrinsic Connectivity of Homotopic Areas; subcortical: EWERT et al., 2016; brainstem: Ascending Arousal Network Brain Stem Network atlas; cerebellum: Diedrichsen et al., 2009). These brain regions were ordinally ranked by number of studies reporting significance.
• Brain regions with significant increase in metabolic activity (hot colors) are shown in (A), whereas brain regions with significant decrease in metabolic activity (cool colors) are shown in (B). (See figure 2 and 3)
• Maps of acute and long-term changes were compared.
RESULTS

• Most commonly seen acute changes were in motor areas, thalamus, STN and the cerebellum, with inconsistencies in directionality of change.
• The pallidum showed acute changes however these were not as unanimously seen across studies
• Long-term stimulation showed broad metabolic changes in the frontal, parietal and temporal lobes, and the cerebellum, with inconsistencies in directionality.
• Decreases in the globus pallidus and thalamus were seen as well though not commonly present across studies.
Figure 2. Acute metabolic changes of STN-DBS
Figure 3. Chronic metabolic changes of STN-DBS
CONCLUSION

Molecular imaging showed acute and long-term impact of STN-DBS in motor areas and cerebellum. Acute changes were seen in subcortical areas while long-term changes presented in cortical areas. To decrease inconsistencies across studies, standardized reporting of DBS studies (i.e. electrode placement, VTA, etc.) and larger sample sizes may be beneficial.