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High-resolution intra-operative data for the generation of probabilistic stimulation maps in DBS of Vim for ET.

#35633 Oral presentation

Dorian Vogel[(1)], Karin Wårdell[(2)], Jérôme Coste[(3)], Jean-Jacques Lemaire[(3)], Simone Hemm[(1,2)]

1. Institute for Medical and Analytical Technologies, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland

2. Department of Biomedical Engineering, Linköping University, Linköping, Sweden

3. Service de Neurochirurgie, CHU Clermont-Ferrand, Clermont-Ferrand, France

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Abstract:

Group analysis consists of using an anatomical space as reference, transferring data such as contact location and extend of stimulation from each patient and relating them to the symptomatic effect. Analyzing past implantations should support understanding the mechanisms of action of DBS and predicting outcome in new patients.

Most studies place their focus on the chronic stimulation situation, with the lead at a fixed position in the brain. This results in few data samples per patient, requiring large cohorts. On the other hand, intra-operative tests are an attractive source of data. The aim of this study was to develop a fully automated pipeline for analyzing the results of intra-operative stimulation tests of ventro-intermediate nucleus of the thalamus (Vim) for ET using high-fidelity data and exemplify the pipeline on a group of patients.

Data from 19 DBS patients (6 ET, 16 PD) from the University Hospital Clermont-Ferrand (France) was used to create an MR template including patient-specific labels, resulting in a probabilistic definition of 57 deep brain structures.

Data from the 6 ET patients in the group was used to create a probabilistic stimulation map (PSM). Tremor reduction was assessed during intra-operative stimulation tests using a wrist-worn acceleration sensor. These scores were combined with patient-specific electric field (EF) simulations into a 4D volume. The latter was first summarized into a weighted mean map (average of the improvement weighted by the EF norm). Voxels with low occurrence of fields (10% of max) and number of patients (2 of 6) were excluded. Secondly, the significance of the relationship between tremor reduction and electric field was estimated with Linear mixed models using patient as a random effect. Voxels in the weighted mean map with $|p|>0.05$ were excluded.

Figure 1 presents the anatomical structures of the group-specific deep brain atlas together with the clusters presenting a positive and negative relationship between EF and tremor reduction (respectively green and red surfaces with black edges). The largest part of the cluster significant for positive correlation covers the inferior half of the Vim and extends in the direction of subthalamic nucleus in the posterior subthalamic area, covering parts of Forel fields.

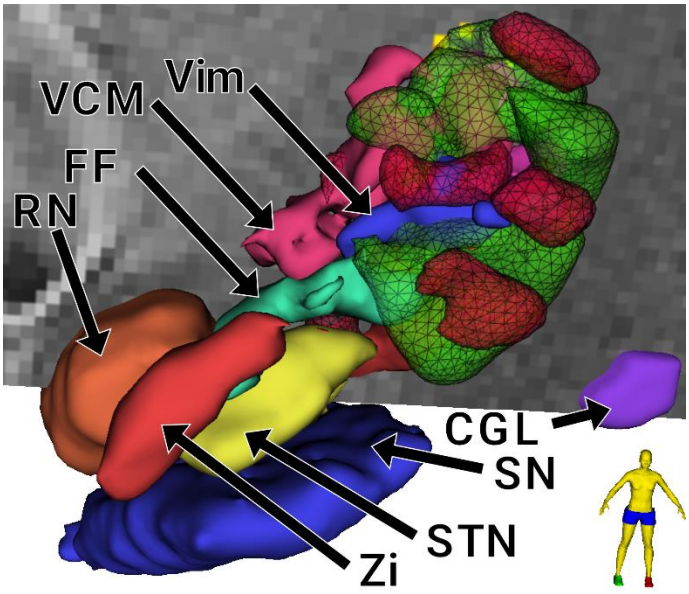

Figure 1: 3D visualization of the clusters significative for positive (green) and negative (red) correlation between tremor reduction and norm of the electric field. As background the group-specific T1/WAIR anatomical template and the probabilistic definition of red nucleus (RN), Forel's fields (FF), ventro-caudal medial thalamus (VCM), ventro-intermediate thalamus (Vim), zona incerta (Zi), subthalamic nucleus (STN), substancia nigra (SN) and corpus geniculatim lateral (CGL).

A fully automated, reproducible workflow was established to normalize and analyze intra-operative data and allowed to identify regions with significant relationship between electric field and tremor suppression. In the future more patients will be integrated to conduct statistical verification of the identified regions.