Improving DBS targeting using 3D visualization of intraoperative stimulation tests
Ashesh Shah, Fabiola Alonso, Jean-Jacques Lemaire, Karin Wårdell, Daniela Pison, Jerome Coste, Erik Schkommodau, Simone Hemm-Ode

To cite this version:

HAL Id: hal-01658463
https://hal-clermont-univ.archives-ouvertes.fr/hal-01658463
Submitted on 8 Dec 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Improving DBS targeting using 3D visualization of intraoperative stimulation tests

Ashesh Shah1, Fabiola Alonso2, Jean-Jacques Lemaire3, Karin Wårdell2, Daniela Pison1, Jerome Coste3, Erik Schkommodau1, Simone Hemm-Ode1,2

1Institute for Medical and Analytical Technologies, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland
2Department of Biomedical Engineering, Linköping University, Linköping, Sweden
3Centre Hospitalier Universitaire de Clermont-Ferrand, Image-Guided Clinical Neurosciences and Connectomics (EA 7282, IGCNC), Université d’Auvergne, Clermont-Ferrand, France

Background
For a typical DBS surgery, a significant amount of patient data is collected. Multiple image data sets (MR and CT) are acquired to be used for planning. Surgical teams identify different anatomical landmarks in these images and use them to plan a trajectory to the target. During surgery, along this planned trajectory, an electrode is inserted and stimulation tests are performed. The changes in patient’s symptoms with varying stimulation parameters and position of the electrode are noted and used to decide the optimal position to implant the DBS lead. Currently, the various information collected during the surgery is “mentally” visualized and analyzed for surgical decision making. We present here a method to visualize and analyze this multitude of information for surgical decision making using patient-specific simulations of electric field distribution in combination with intraoperative accelerometry based tremor evaluation and direct-targeting technique of DBS.

Method

Preoperative information
- Stereotactic CT and MR (x2) data sets were acquired.
- Using iPlan Stereotaxy (Brainlab) software, surgical team outlined different thalamic nuclei, identified the target structure and planned 2 parallel trajectories and 5-10 stimulation test positions per trajectory.
- 3D co-ordinates of the trajectory, anatomical structures and target were exported using an interface based on VVLink and VTK (Kitware).

Intraoperative information
- Stimulation tests were performed at the pre-determined positions using an exploration electrode-Neuroprobe (Alpha Omega Engineering).
- Improvement in tremor was evaluated using a 3-axes accelerometer attached to the patient’s wrist and recording data in synchronization with stimulation current amplitude.
- Effective stimulation current amplitudes were identified using post-operative data analysis.

Patient-specific EF simulations
- Preoperative MR T1 was segmented into gray matter, white matter and cerebro-spinal fluid.
- Brain tissue model is developed by assigning different conductivity values to the segmented areas.
- A model of the exploration electrode was placed at the different stimulation test locations using the co-ordinates from the planning data.
- The distribution of the electric field was simulated for different effective stimulation current identified using accelerometric tremor.

Improvement Maps
- Each EF simulation is assigned the corresponding improvement in tremor based on the stimulation current amplitude used as input.
- The large number of EF simulations per hemisphere (on average 17) made visual analysis difficult. Therefore, using voxel-based processing, each voxel in the tested region was assigned the maximum value of improvement.

• This voxel-based processing divided the tested region into smaller parts based on the observed improvement in tremor. Visual analysis of such data revealed “hotspots” where DBS lead could be implanted.
• EF simulations of side-effect inducing amplitudes are also visualized (in red). This allows the identification of no-go zones.

References