

3D visualization of intraoperative stimulation test results in deep brain stimulation.

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I. INTRODUCTION

Deep brain stimulation (DBS) is a treatment for movement disorders such as Essential Tremor (ET). The implant position of the electrode is crucial. After preoperative surgical planning and exhaustive intraoperative tests, the collected information is only “mentally” visualized and analyzed to decide on the optimal implant position of the DBS lead. We propose a method to present this multitude of information for surgical decision making using patient-specific simulations of electric field (EF) distribution in combination with intraoperative accelerometry based tremor evaluation and direct-targeting technique of DBS.

II. METHOD

Five ET patients participating in a clinical study (written informed consent) were included in the presented protocol. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008. After preoperative selection of the anatomical target position, two microelectrodes were inserted per hemisphere on parallel trajectories. Stimulation tests were performed on 5 to 10 positions per trajectory and several stimulation amplitudes per position to evaluate side effects and changes in tremor using an accelerometer fixed to the patient's wrist. To estimate the extension of the stimulation, electric field simulations were performed for 2 to 3 amplitudes per position resulting in different tremor improvements. To identify the optimal implant position for chronic stimulation, we summarized all data in “Improvement Maps” by assigning each voxel in the stimulation test region the highest improvement in tremor and by visualizing them in relation to patient-specific anatomy. Postoperatively the optimal implant positions for the 5 patients (10 hemispheres) were identified.

III. RESULTS

The clinical teams were able to identify the optimal implant position for the 5 patients with more ease and in less time compared to the routine discussion using pen and paper. Additionally, for 7 of the 9 improvement maps, the highest improvement region was found to be in the posterior subthalamic area inferior and posterior to the ventro-intermediate (VIM) nucleus of the thalamus (routine clinical target).

IV. CONCLUSION

Visual analysis of the results of intraoperative stimulation tests in form of improvement maps assists the clinicians in determining the optimal implant location of the chronic DBS lead and in comparing results between patients.

V. CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

VI. REFERENCES

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