Determination of the exact position of the stimulation electrode during awake brain surgery

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Introduction

The gold standard for localization of brain functions during surgery is direct electrical stimulation (DES). This method allows for identification of brain areas and fiber pathways that are indispensable for normal motor, language or cognitive functions. DES is used to safely optimize the tumor resection. New MRI techniques (i.e., MRI-based tractography) provide a non-invasive alternative for DES. Because MRI-based tractography is able to visualize white matter tracts already prior to surgery, it potentially adds valuable information to the decision making process. In our hospital, we already routinely use this information during surgery, but always rely on DES for confirmation of results; see Figure 1 for an example.

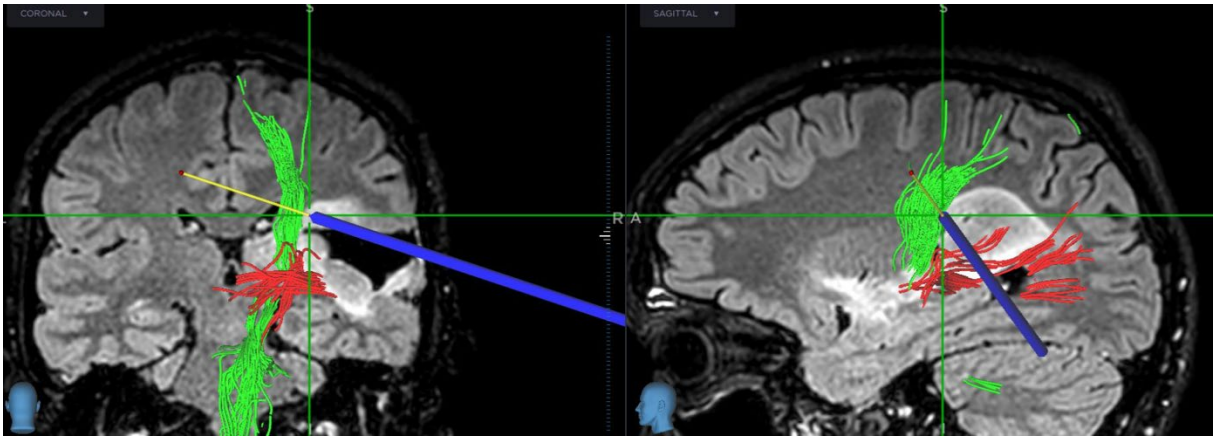

Figure 1 *Intraoperative screenshot of the neuronavigational system. The figure shows a coronal (left) and sagittal image of a patient with a brain tumor (white areas). MRI and tractographic results (green = motor pathways) were acquired before surgery. Navigation is used for real-time localization of anatomical structures during surgery (based on preoperative images). A pointing device (blue line) indicates a site where electrical stimulation elicited motor movements in the patient (the yellow line represents a virtual extension of the probe). In this case, tractographic results and DES show good (qualitative) agreement.*

The problem
In order to assess the accuracy and clinical relevance of MRI-based tractography, we want to compare it to the results of intraoperative DES. Unfortunately, this is not a trivial problem. First of all, the navigational system has an error of up to 5 mm. Second, the brain deforms during tumor resection, adding additional uncertainty to the coordinates of the DES sites that are obtained with the navigational system. A possible solution to this problem is to take local anatomical information into account. For instance, the resection cavity (including DES sites) could be sampled with the probe and registered to postoperative MRI images (that include anatomical and tractographic information). Once DES sites and fiber pathways are in similar coordinate space, metrics can be developed to calculate agreement between measurements. Goal of this research project is to develop a procedure that enables accurate transfer of the intraoperatively determined DES sites to a postoperative MRI scan.

Your work
You will work in the research group of the Department of Neurosurgery of the ETZ in Tilburg, which participates in the program *Highly Specialised Care & Research programme 2020-2024* that is funded by ZonMW (https://www.zonmw.nl/nl/onderzoek-resultaten/kwaliteit-van-zorg/programmas/project-detail/topspecialistische-zorg-en-onderzoek/een-epersonaliseerd-zorgpad-voor-iedere-hersentumorpatient/). This program has two overarching themes: Neuroimaging (eg, fMRI, DTI) and Cognition. It includes six research projects that are strongly interrelated and whereby 6 PhD candidates jointly focus on optimization of the balance between oncological and functional outcomes in the individual brain tumor patient, each from a different perspective. Main partners are Tilburg University and Technical University Eindhoven.

Student background
(Bio)Medical Engineering, Medical Technology & Physics, Applied Mathematics, or similar.

Duration
6-12 months

Student skills
Image registration, programming (MATLAB or Python), modelling, quality assurance

Location
Department of Neurosurgery of the ETZ in Tilburg

Contact
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