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TRR 295 ReTune

Interrater reliability of deep brain stimulation electrode localizations.

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Deep brain stimulation (DBS) is an established treatment option for movement disorders and its outcome of DBS is often associated with electrode placement. To investigate the link between electrode placement and DBS-effects, an exact reconstruction of electrode placement is necessary. The open-source and semi-automatized software "Lead-DBS" facilitates a precise DBS electrode localization.

Four major steps are the core process for reconstructions of electrode placement by Lead-DBS: 1) co-registration of pre- and post-operative imaging, 2) correction of brain shift after brain surgery, 3) normalization of patient-specific imaging to standardized space and 4) electrode localization. The latter two may introduce serious bias into the process as they frequently involve manual refinement. Previous studies have assessed the variance of normalization techniques leading to a default pathway in Lead-DBS that produces similar results than manual expert segmentation. In contrast, the manual localization of an electrode model within the electrode artifact seen in postoperative scans, has not been analyzed deliberately yet. This step involves manually aligning an automatically pre-localized electrode model to electrode artifacts visible on CT and MRI. Here, we investigate the variance introduced by this processing step. Five raters where asked to localize DBS electrodes implanted in the subthalamic nucleus (STN) of 13 patients with Parkinson's disease (PD). These patients had received both post-operative CT as well as post-operative MRI scans and each DBS-electrode was localized twice (both relying on post-operative CT and MRI) in a randomized order. This led to a set of 26 DBS-electrode reconstructions using post-operative MRI and 26 DBS-electrode reconstructions using post-operative CT per rater. Raters had different levels of experience – from expert to raters who were introduced to Lead-DBS by a preceding structured training. Across users and post-operative modalities, the average difference in in electrode localization ranged between 0.52-0.75 mm, which is below the image resolution. When DBS-electrodes where localized using post-operative MRI or localizations were normalized to standard space, variability increased by 0.07-0.12 mm. Importantly, we showed that in all conditions closest contact to the clinical "sweet spot" of subthalamic DBS in PD remained stable in the majority of cases (87-95%).

We thus consider the variance introduced by raters is reasonably low when using Lead-DBS, independently of the post-operative imaging modality and even for newly trained but fairly unexperienced users. These findings are crucial to better judge scientific results provided by analyses with Lead-DBS, close a missing link in the processing pipeline that had thus far not been objectively assessed and may pave the way toward formal training for using Lead-DBS.

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