Lead-OR: A multimodal platform for deep brain stimulation surgery.

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Deep brain stimulation is an established therapy for patients with Parkinson's disease and an emerging option for other neurological conditions. It consists of implanting electrodes in deep structures in the brain, through which stimulation is continuously delivered. Target structures are small in size and anatomically complex. For example, the subthalamic nucleus—the most common target for Parkinson's—is an almond shaped structure with connections spanning the whole prefrontal cortex. To be able to precisely target these structures, the surgical team uses different sources of information to characterize the patient's anatomy and decide on an implant site. These data include pre-operative magnetic resonance imaging and intra-operative micro electrode recordings and test stimulations.

The different data modalities used are usually acquired and analyzed separately, at different stages of the surgery. We set out to develop a platform to aggregate all sources of information in real time during the procedure. We also investigated the concordance between them by studying, for example, the agreement between the electrophysiological and imaging-based characterization of the subthalamic nucleus.

We established an open-source platform to aggregate multiple modalities during deep brain stimulation surgery and showed a general agreement between them based on a retrospective analysis (N=32 Parkinson's patients). Next, we proposed a new algorithm leveraging the different data sources accessible, describing aspects of the surgery from a multi-modal perspective. Specifically, we derived an estimate of how much the brain shifted due to air entering the skull during the procedure.

By providing additional information during surgery, the platform holds translational potential and could serve as decision making assistance for the surgical team while placing the electrodes and choosing the exact implant site. In the long run, more accurate placement could translate into better outcome after surgery, and therefore improving patients' response. With further validation, the current prof of concept implementation could evolve into a clinical tool routinely used for deep brain stimulation surgery.

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