Deep Brain Stimulation for neuropathic pain

Deep brain stimulation (DBS) for chronic pain has been controversial. Despite the discouraging outcomes from the multicenter clinical trials in the twentieth century, there is sustained interest in optimizing its use to improve patient outcomes.

Recently published data lends tentative support for DBS as a means of treating chronic pain. Still, high level-of-evidence data remain elusive. There are a handful of ongoing and prospective clinical trials exploring DBS for pain in the context of closed-loop neuromodulation, invasive electroencephalography monitoring, stimulation parameters, and novel intracranial targets. DBS is a potentially viable method of treating chronic pain. Procedure success is dependent on a number of factors including proper patient and intracranial target selection. Outcomes for ongoing and future clinical trials will help clinicians refine DBS used for this clinical indication [1].

In 2020, twenty-two articles were included in a review. In total, 228 patients were implanted with a definitive DBS system for pain. The most common targets used were periaqueductal/periventricular gray matter region, ventral posterior lateral/posterior medial thalamus, or both. Poststroke pain, phantom limb pain, and brachial plexus injury were the most common specific indications for DBS. Outcomes varied between studies and across chronic pain diagnoses. Two different groups of investigators targeting the affective sphere of pain have demonstrated improvements in quality-of-life measures without significant reductions in pain scores.

DBS outcomes for chronic pain are heterogeneous thus far. Future studies may focus on specific pain diagnoses rather than multiple syndromes and consider randomized placebo-controlled designs. DBS targeting the affective sphere of pain seems promising and deserves further investigation [2].

Case series

The spinal cord injury (SCI) patient population is overwhelmingly affected by neuropathic pain (NP), a secondary condition for which therapeutic options are limited and have a low degree of efficacy. The objective of a study of Black et al. was to identify novel deep brain stimulation (DBS) targets that may theoretically benefit those with NP in the SCI patient population. They hypothesized that localized changes in white matter identified in SCI subjects with NP compared to those without NP could be used to develop an evidence-based approach to DBS target identification.

To classify localized neurostructural changes associated with NP in the SCI population, they compared white matter fiber density (FD) and cross-section (FC) between SCI subjects with NP (N = 17) and SCI subjects without NP (N = 15) using diffusion-weighted magnetic resonance imaging (MRI). They then identified theoretical target locations for DBS using fiber bundles connected to significantly altered regions of white matter. Finally, they used computational models of DBS to determine if our theoretical target locations could be used to feasibly activate our fiber bundles of interest.

They identified significant increases in FC in the splenium of the corpus callosum in pain subjects when compared to controls.They then isolated five fiber bundles that were directly connected to the affected region of white matter. The models were able to predict that our fiber bundles of interest can be feasibly activated with DBS at reasonable stimulation amplitudes and with clinically relevant

implantation approaches.

Altogether, they identified neuroarchitectural changes associated with Neuropathic Pain in the spinal cord injury cohort and implemented a novel, evidence-driven target selection approach for DBS to guide future research in neuromodulation treatment of NP after SCI [3].

Sixteen patients (13 male and 3 female patients) with neuropathic pain underwent bilateral ACC DBS. The mean age at surgery was 48.7 years (range, 33-63 years). Patient-reported outcome measures were collected before and after surgery using a Visual Analog Scale, SF-36 quality of life survey, McGill Pain Questionnaire, and EQ-5D (EQ-5D and EQ-5D Health State) questionnaires.

Fifteen patients (93.3%) transitioned from externalized to fully internalized systems. Eleven patients had data to be analyzed with a mean follow-up of 13.2 months. Post-surgery, the Visual Analog Scale score dropped below 4 for 5 of the patients, with 1 patient free of pain. Highly significant improvement on the EQ-5D was observed (mean, +20.3%; range, +0%-+83%; P = .008). Moreover, statistically significant improvements were observed for the physical functioning and bodily pain domains of the SF-36 quality-of-life survey: mean, +64.7% (range, -8.9%-+276%; P = .015) and mean +39.0% (range, -33.8%-+159%; P = .050), respectively.

Affective ACC DBS can relieve chronic neuropathic pain refractory to pharmacotherapy and restore quality of life [4].

1)
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