Atlas-Independent, Individualized Mapping of the Optimal Locus of Subthalamic DBS

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Introduction

The degree of symptomatic improvement among Parkinson's disease (PD) patients undergoing subthalamic deep brain stimulation (STN DBS) is highly variable. One reason for this variability may be differences in the location of active electrode contacts relative to some currently undefined optimal locus of stimulation. Our objective was to determine this ideal location, based entirely on individual patient anatomy and independently of any atlas-based generalizations.

Methods

We used a validated 3T MRI protocol and high-resolution CT imaging to precisely determine the location of individual DBS active contacts relative each patient STN. In 20 patients treated with STN DBS for Parkinson's disease, we developed a computational electrical field model of neuronal activation weighted by Unified Parkinson's Disease Rating Scale improvement. Our novel method allowed unconstrained identification of the locus of ideal stimulation across patients.

Results

Based on both outcomes analysis and our electrophysiological model, the average location of the leads associated with greatest symptom improvement at the lowest voltage was in a region dorsal, just posterior, and just lateral to the anatomical midpoint of the subthalamic nucleus. Interestingly, more anterior leads were associated with significantly better outcomes than more posterior leads.

Conclusions

Our results suggest that the optimal locus of stimulation in DBS for Parkinson's disease is at the dorsal border just above the STN. They also suggest that it may be beneficial to place leads further anterior than is current practice.

Learning Objectives

By the conclusion of this session participants should be able to 1) Describe the challenges and limitations of atlas-based targeting; 2) Describe a quantitative modeling method for determining optimal stimulation location

References