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# Quantitative Localization and 3D Shape Proximation of the Subthalamic Nucleus in Deep Brain Stimulation for Parkinson Disease

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## Introduction

Subthalamic nucleus (STN) stimulation is an effective therapy for alleviating Parkinson's symptoms, such as tremor, rigidity and bradykinesia. Extracellular recording using microelectrode is routine for the identification of STN and accurate implantation of deep brain stimulation leads, but it is mostly qualitative. It has been shown that power spectral density (PSD) of the recorded data can be used to accurately and quantitatively identify the STN.

## Methods

We recorded human subthalamic nucleus activity during stereotactic surgery using a tungsten microelectrode (FHC, Inc). We inserted 3 parallel microelectrodes for extracellular recordings in 8 patients with Parkinson disease. Recorded data were filtered using a 500 to 3000 Hz band-pass filter, sampled at a rate of 24 kHz, converted to digital using a Leadpoint system (Medtronic, Inc) and stored in a computer for offline analysis. The PSD was calculated over the 10 second recorded data in each depth by using Welch's method. We compared PSD at high frequency band (500 to 3000 Hz) in each of the recording depth in order to identify boarders and length of the STN. Then we fitted the best ellipsoid-shape to the 3 entrance and 3 exit points. Ellipsoid was modeled as a quadratic equation by using the least squares approach.

## Results

The high frequency band (500 to 3000 Hz) PSD increased significantly as the electrode entered the STN and remained significantly above the level of the thalamus and decreased as the electrode was exited from the STN. We approximated the 3-Dimension STN shape and orientation as an ellipsoid with respect to the 3 entrance and 3 exit points of the electrodes.

## Conclusions

PSD estimation method can identify the boarders and length of the STN in a quantitative and objective manner. Its accuracy seems to be comparable to visual inspection of the recorded signals by an expert. Intraoperative 3D shape approximation of the STN may help the physician in better placement of the DBS lead.

## Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of accurate implantation of deep brain stimulation leads, 2) Discuss, in small groups, available techniques for analysis of intraoperative recordings.

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