Intraoperative Stimulation of Subthalamic Nucleus During Asleep Surgery Reduces Required Current Threshold for Motor Evoked Potentials

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Introduction

Asleep, image-guided DBS surgery is becoming standard at many institutions. The placement of subdural electrocorticography strips also allows for both the recording of motor evoked potential during surgery and programming of closed-loop protocols. In this study we investigate the modulatory influence of STN DBS stimulation on threshold EMG response and correlate these responses to the anatomical electrode location.

Methods

Patients scheduled to undergo STN DBS were consented for participation with intraoperative ECoG strip placement and DBS research protocols and intraoperative recording. The Tucker David Technologies (TDT) 5Z5D bioamp processer was used for STN stimulation and ECoG recording. Median nerve SSEP phase reversal methodology identified electrodes over motor cortex. MEPs were then conducted identifying qualitative minimum current (n) threshold to elicit a resultant EMG response. The effect of DBS for each electrode pair (0-/1+,1-/2+,2-/3+) was tested with DBS off (baseline), stimulation (DBS), and off again (washout). DBS conditions were tested with 5 increasing MEP stimulation amplitudes. All data was analyzed using MATLAB software using maximum recorded EMG response. Statistics were calculated using a one-way ANOVA at individual ECoG stimulation amplitudes with subsequent post hoc analysis between baseline/DBS and DBS/washout. Post-operative scans were used to reconstruct three dimensional images in Lead-DBS software.

Results

Nine Parkinson's patients underwent asleep, image-guided STN stimulation with left-sided subdural strip placement and right EMG recording at our institution. Of those, 6/9 reduced EMG threshold for cortical stimulation at one or more DBS lead pairs. Three of these patients had particularly robust responses at the two superior electrode pairs (2-/3+), which anatomically located between the STN and thalamus on reconstructed images.

ID	Sex	Age	Onset	Sx	Proccedure	SSEP
80301	M	70.0	2011	diskinesia/tremmor(L)	B STN	Left
63ce7	M	67.8	2011	tremmor(R)	B STN	Left
1dd75	M	71.5	2007	tremmor(L)	B STN	Left
50ad9	M	77.4	2004	tremmor (R)/bradykinesia (L>R)/gait	B STN	Left
56a68	M	77.0	1997	tremmor(R)	L STN	Left
B305e	M	71.5	2009	tremmor/bradykinesia/dystonia	B STN	Left
329c6	F	74.4	2007	tremmor(L)/dyskinesia/gait	B STN	Left
c1c8c	M	63.8	1982	tremmor/diskinesia/bradykinesia(L)	B STN	Left
b26b7	F	52.3	2009	tremmor/bradykinesia/gait	B STN	Left
Mean	**M(78)/F(22)**	**69.5**				

Table 1: Summary of patient demographics.

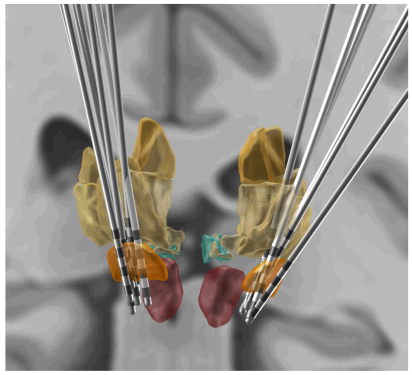

Figure 1: Summary of patient electrode locations.

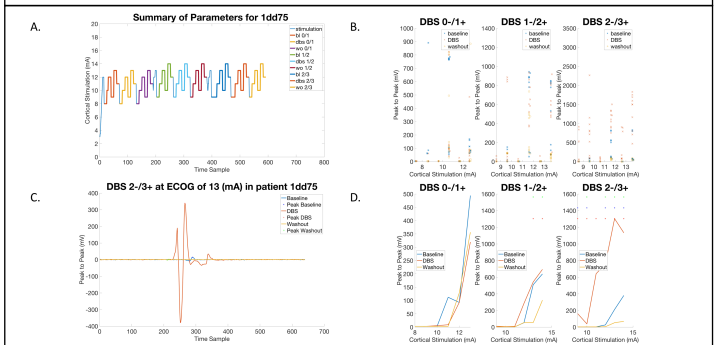

Figure 2: **A.** Experiment summary for patient 1dd75. **B.** Single EMG recording from DBS electrode 2-/3+ at 13 mA cortical stimulation, peak to peak values extracted as shown. **C.** Scatter plot of all resulting peak to peak EMG values. **D.** Peak to peak response versus cortical stimulation at each DBS electrode pair. Significance at each cortical stim amp denoted for ANOVA (Red), and post-hoc analysis for DBS versus baseline (Blue), and DBS versus washout (Green).

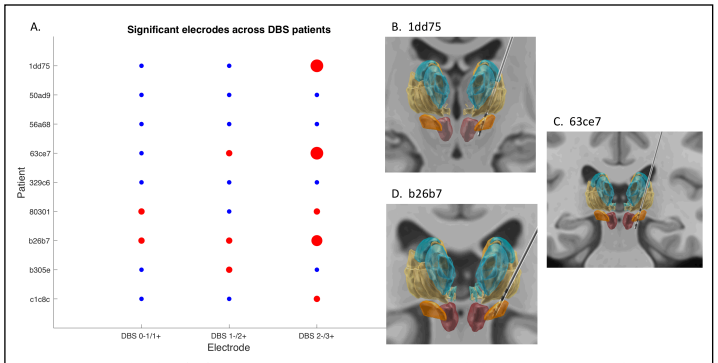

Figure 3: **A.** Summary of significant (Red) electrodes across electrode pairs and patients. Size of effect proportional to number of cortical stimulation conditions with significant results (ANOVA and both post-hoc analyses, as well as mean peak to peak value over 25 mV for the DBS condition). **B-D.** Left STN electrode placement for patients 1dd75, 63ce7, and b26b7 respectively.

Conclusions

Bipolar DBS stimulation produces consistent positive effects MEP thresholds, with the superior electrode pairs demonstrating a marked modulatory effect in most patients. This modulation appears to involve the zona incerta rather than internal capsule or STN. Our next aim is to relate the field of effect from paired stimulation to cortical regions by evaluating DTI pathways.

Learning Objectives

To investigate the role effect of STN stimulation on MEP.

References

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