MER-determined STN Width as a Predictor of Post-Operative UPDRS Improvement

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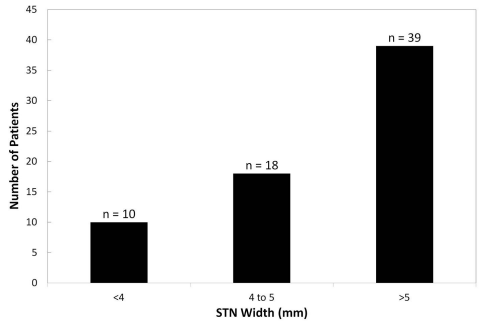
Introduction

DBS of the STN is an effective treatment for medically refractory Parkinson's Disease. Intraoperative measurement of STN width through microelectrode recording (MER) is a common proxy for optimal electrode location (1).

Methods

Records were reviewed for 126 patients who underwent their first single-sided STN DBS placement for PD between 2005 and 2010 at UAB Medical Center. Patients lacking preoperative, intraoperative, or postoperative records were excluded. Reviews of preoperative and 3-month postoperative UPDRS Part III, intraoperative MER records, and postoperative MRI scans were conducted. Global UPDRS scores were split into ipsilateral, contralateral, and midline scores. The final cohort consisted of 67 patients (mean age = 60 yrs (± 11), length of disease = 13 yrs (± 5.6), baseline UPDRS global = 37 (± 11), contralateral = 15 (± 5.6), ipsilateral = 9.0 (± 4.2), midline = 4.2 ((± 4.0)). STN widths were defined as depths associated with increased background activity and motor-driven, spiking action potentials on MER. Additionally, widths were normalized to AC-PC length (mean = 25.69 mm (± 1.65)). Relationships between STN width and UPDRS improvement were investigated using correlation and multivariate linear regression.

Figure 1. STN Widths of Final Cohort



Patients were stratified into three groups based on conventional operative STN thresholds for suitable DBS trajectories, 4mm and 5mm.

Table 1. Operative Outcomes

STN width: Mean = 5.1 mm (± 1.6) Range = 0.0 to 8.7 mm

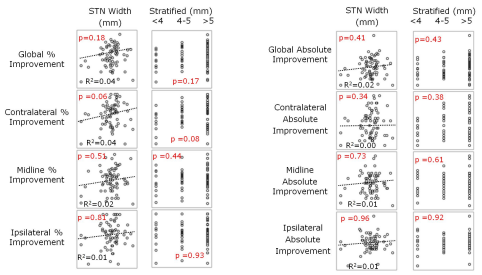
Score	Percentage Improvement	Absolute Improvement
Global	38% (± 24)	15 (± 10)
Contralateral	**58% (± 24)**	**9 (± 5)**
Ipsilateral	13% (± 50)	1 (± 4)
Midline	32% (± 31)	4 (± 4)

Improvement in UPDRS scores as percentage and absolute difference.

Results

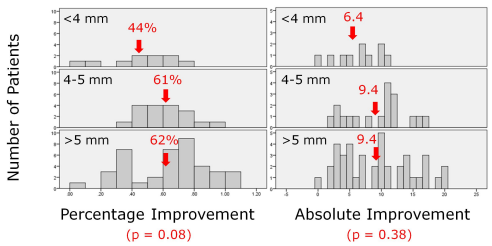
Mean global and contralateral UPDRS improvements were 38% (± 24) and 58% (± 24). Mean STN width was 5.1 mm (± 1.6, min = 0.0, max = 8.7). There were no statistically significant relationships between STN width and UPDRS improvement, with and without AC-PC normalization (R2<.05). Stratification also failed to produce statistically significant relationships.

Figure 2. Statistical Analysis



Scatter plots of STN widths/stratified STN widths (x-axes) and outcomes (y-axes). P-values are not statistically significant. Best fit lines and R2 values are displayed.

Firgure 3. Contralateral UPDRS Improvements by Group



Groups are labeled by STN width stratification in top left corners. Left column shows the frequencies (y-axis) of each percentage improvements (x-axis) for each group. Right column shows frequencies (y-axis) and absolute improvements (x-axis). Means of groups are represented by bold red arrows. P-values are not statistically significant.

Conclusions

This retrospective analysis raises questions about seeking maximal electrophysiological width of STN as a proxy for optimal outcome in DBS for PD. While a loose association exists between MER STN width >4mm and contralateral UPDRS improvement, the number of unknown factors involved in DBS warrant further refinement of operative techniques. Indeed, prior studies by other groups suggest the region around the STN, not the STN itself, may be the optimal location for DBS placement (2). We suggest that current strategies for DBS placement in PD be subject to more robust prospective investigation.

Learning Objectives

1) Critically analyze the current techniques for intraoperative target identification in STN DBS.
2) Develop strategies for improving MER utilization in STN DBS.
3) Apply concepts from STN DBS for PD in the management of other neurological disorders.

References

1. Sterio D, et al. Neurophysiological Refinement of STN Targeting. Neurosurgery. 2002 Jan;50(1):58-67; discussion 67-9.
2. Paek SH, et al. Electrode position determined by fused images of preoperative and postoperative magnetic resonance imaging and surgical outcome after subthalamic nucleus deep brain stimulation. Neurosurgery. 2008;63:925–937.