Johns Hopkins Parkinson’s Disease and Movement Disorder Center
Movement Disorder Symposium
Surgical Treatments
November 8th, 2014
WS Anderson

Dept. of Neurosurgery
Johns Hopkins Hospital
Pre-Operative Assessment

- Neurology evaluation
- Neurosurgery evaluation
- Neuropsychological evaluation
- MRI
- Medical clearance
- Clarify expectations
Stereotactic Targeting – Leksell Frame
MRI Targeting

Mark the AC, PC, and one or more midline points.

Landmark  Status
AC       Stored
PC       Stored
Midline 1 Stored
Midline 2 Stored
Midline 3 Stored

AC to PC distance = 26.59 mm
Radiologic Targeting

**Vim (Vc)** 14mm lateral, 3mm anterior to PC, 2mm above AC-PC line

**GPI** 20-21mm lateral, 3mm anterior to MC, 3mm below AC-PC line

**STN** 12mm lateral, 4mm posterior MC, 4mm below AC-PC line
Operative Layout
### Operative Layout

<table>
<thead>
<tr>
<th>TEAM NAMES</th>
<th>REDOSE</th>
<th>STATION</th>
<th>Pi</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>113</td>
<td></td>
</tr>
</tbody>
</table>
Microelectrode Recording

• Isolate single action potential

• Platinum-iridium alloy glass-coated or tungsten μ-electrode.

• Tip 2-4 um

• Impedance 0.5-1 Mohm

• Record and microstimulate

• Attached to a microdrive

• Mounted to frame
Subthalamic Nucleus
Intraoperative Stimulation of STN

- 2-3 mm spread of stimulation
- Paresthesias from spread to medial lemniscus posteriorly
- Dyskinesias intraop are strong + predictor
- CST lateral
- Oculomotor nerve medial

Medtronic 3387 DBS lead

Figure A. Model 3387 and 3389 DBS Leads

Note: All dimensions are approximate.
Medtronic 3387 DBS lead
Medtronic Kinetra IPG

Table 10. Kinetra Neurostimulator Longevity Estimates (Years) for Energy Use (EU).
Programmable Parameters

- Voltage: 0-10.5 V
- Frequency: 30-185 pps
- Pulse Duration: 60-450 us
- Electrode Configuration
  - Bipolar vs monopolar
Tremor Predom. IPD

- 69 year-old RH male
- 9 year history of asymmetrical rest tremor Lt>Rt
- No Family History or effect of Alcohol
- No other significant symptoms
- Good initial response to Sinemet
- Placement of Vim DBS on the Rt (09/99)

PE - tremor with rest, posture and action grade 4/4 in Lt U/E and L/E, 2/4 in Rt U/E
VIM Stimulation for IPD
Case of IPD

• 8 year history of PD
• Dyskinesias, freezing and fluctuations
• Refractory to further medical therapy
• PE
  During on period, continuous dyskinesias on the Lt
  Dragged the Lt leg
  MMES 28/28

• Placement of STN DBS on the Rt (08/00)
• Placement of STN DBS on the Lt (04/01)
STN Stimulation for IPD - off
STN Stimulation for IPD - on
**ELECTRICAL STIMULATION OF THE SUBTHALAMIC NUCLEUS IN ADVANCED PARKINSON’S DISEASE**

Patricia Limousin, M.D., Paul Krack, M.D., Pierre Pollak, M.D., Abdelhamid Benazzouz, Ph.D., Claire Ardouin, M.A., Dominique Hoffmann, M.D., and Alim-Louis Benabid, M.D., Ph.D.

**TABLE 3. Dose of Antiparkinsonian Medications before and 12 Months after Surgery for 20 Patients with Long-Term Bilateral Stimulation of the Subthalamic Nucleus.***

<table>
<thead>
<tr>
<th>DRUG</th>
<th>BEFORE SURGERY</th>
<th>12 MO after SURGERY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOSE mo/day</td>
<td>NO. OF PATIENTS</td>
</tr>
<tr>
<td>Levodopa and DDI†</td>
<td>1224±723</td>
<td>20</td>
</tr>
<tr>
<td>Bromocriptine</td>
<td>30±12</td>
<td>14</td>
</tr>
<tr>
<td>Listuride</td>
<td>3 and 5</td>
<td>2</td>
</tr>
<tr>
<td>Pergolide</td>
<td>3 and 4.5</td>
<td>2</td>
</tr>
<tr>
<td>Cabergoline</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Apomorphine</td>
<td>9–200</td>
<td>10</td>
</tr>
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</table>

*Plus–minus values are means ±SD.
†DDI denotes dopa decarboxylase inhibitor.
‡P<0.001 for the comparison with the value before surgery.
§Levodopa was discontinued in one patient.

A Randomized Trial of Deep-Brain Stimulation for Parkinson’s Disease
and Jürgen Voges, M.D., Ph.D., for the German Parkinson Study Group,
Neurostimulation Section

BACKGROUND
Neurostimulation of the subthalamic nucleus reduces levodopa-related motor complications in advanced Parkinson’s disease. We compared this treatment plus medication with medical management.

METHODS
In this randomized-pairs trial, we enrolled 156 patients with advanced Parkinson’s disease and severe motor symptoms. The primary end points were the changes from baseline to six months in the quality of life, as assessed by the Parkinson’s Disease Questionnaire (PDQ-39), and the severity of symptoms without medication, according to the Unified Parkinson’s Disease Rating Scale, part III (UPDRS-III).
RESULTS
Pairwise comparisons showed that neurostimulation, as compared with medication alone, caused greater improvements from baseline to six months in the PDQ-39 (50 of 78 pairs, P=0.02) and the UPDRS-III (55 of 78, P<0.001), with mean improvements of 9.5 and 19.6 points, respectively. Neurostimulation resulted in improvements of 24 to 38 percent in the PDQ-39 subscales for mobility, activities of daily living, emotional well-being, stigma, and bodily discomfort. Serious adverse events were more common with neurostimulation than with medication alone (13 percent vs. 4 percent, P<0.04) and included a fatal intracerebral hemorrhage. The overall frequency of adverse events was higher in the medication group (64 percent vs. 50 percent, P=0.08).

CONCLUSIONS
In this six-month study of patients under 75 years of age with severe motor complications of Parkinson’s disease, neurostimulation of the subthalamic nucleus was more effective than medical management alone. (ClinicalTrials.gov number, NCT00196911.)
Outcome Studies: STN-DBS

![Graph showing change from baseline for various outcomes with Neurostimulation and Medication, with p-values for each category: PDQ-39 Summary Index, Mobility, Activities of Daily Living, Emotional Well-Being, Stigma, Bodily Discomfort, Social Support, Cognition, Communication.](image-url)
Bilateral Deep Brain Stimulation vs Best Medical Therapy for Patients With Advanced Parkinson Disease:
A Randomized Controlled Trial

Frances M. Weaver, PhD
Center for Management of Complex Chronic Care, Hines VA Hospital, Hines, Illinois

for the CSP 468 Study Group

Context—Deep brain stimulation is an accepted treatment for advanced Parkinson disease (PD), although there are few randomized trials comparing treatments, and most studies exclude older patients.

Objective—To compare 6-month outcomes for patients with PD who received deep brain stimulation or best medical therapy.

Design, Setting, and Patients—Randomized controlled trial of patients who received either deep brain stimulation or best medical therapy, stratified by study site and patient age (<70 years vs ≥70 years) at 7 Veterans Affairs and 6 university hospitals between May 2002 and October 2005. A total of 255 patients with PD (Hoehn and Yahr stage ≥2 while not taking medications) were enrolled; 25% were aged 70 years or older. The final 6-month follow-up visit occurred in May 2006.

Intervention—Bilateral deep brain stimulation of the subthalamic nucleus (n=60) or globus pallidus (n=61). Patients receiving best medical therapy (n=134) were actively managed by movement disorder neurologists.
Main Outcome Measures—The primary outcome was time spent in the “on” state (good motor control with unimpeded motor function) without troubling dyskinesia, using motor diaries. Other outcomes included motor function, quality of life, neurocognitive function, and adverse events.

Results—Patients who received deep brain stimulation gained a mean of 4.6 h/d of on time without troubling dyskinesia compared with 0 h/d for patients who received best medical therapy (between group mean difference, 4.5 h/d [95% CI, 3.7-5.4 h/d]; P<.001). Motor function improved significantly (P<.001) with deep brain stimulation vs best medical therapy, such that 71% of deep brain stimulation patients and 32% of best medical therapy patients experienced clinically meaningful motor function improvements (≥5 points). Compared with the best medical therapy group, the deep brain stimulation group experienced significant improvements in the summary measure of quality of life and on 7 of 8 PD quality-of-life scores (P<.001). Neurocognitive testing revealed small decrements in some areas of information processing for patients receiving deep brain stimulation vs best medical therapy. At least 1 serious adverse event occurred in 49 deep brain stimulation patients and 15 best medical therapy patients (P<.001), including 39 adverse events related to the surgical procedure and 1 death secondary to cerebral hemorrhage.

Conclusion—In this randomized controlled trial of patients with advanced PD, deep brain stimulation was more effective than best medical therapy in improving on time without troubling dyskinesias, motor function, and quality of life at 6 months, but was associated with an increased risk of serious adverse events.
Complications

Clinical Article
Complications in subthalamic nucleus stimulation surgery for treatment of Parkinson’s disease. Review of 272 procedures

F. J. Seijo¹, M. A. Alvarez-Vega¹, J. C. Gutierrez¹, F. Fdez-Glez², B. Lozano²

Fig. 2. Number of complications expressed as percentage of total – 61% = none; 32% = one; (5 + 2 = 7)% = more than one

Table 1. Percentage of patients with complications

<table>
<thead>
<tr>
<th>No complications</th>
<th>Aborted procedures</th>
<th>Misplaced leads</th>
<th>Intracranial haemorrhage</th>
<th>Seizures</th>
<th>Hardware complications</th>
<th>Others</th>
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<tbody>
<tr>
<td>62%</td>
<td>10.7%</td>
<td>3.8%</td>
<td>6.92%</td>
<td>10%</td>
<td>3.84%</td>
<td>10.7%</td>
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Table 2. Type of intracranial haemorrhage

<table>
<thead>
<tr>
<th>Patients</th>
<th>Cortical venous infarct</th>
<th>Seizures</th>
<th>Ventricular haemorrhage</th>
<th>Thalamic haemorrhage</th>
<th>Intracerebral haematoma</th>
<th>Mesencephalic haematoma</th>
<th>Urgent surgery</th>
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<tbody>
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x Present complication.
Essential Tremor

Indications & Patient Selection

• Medically refractory Essential Tremor

• Exclusions: Cognitive impairment; psychiatric disease
Figure 2: Effects of deep brain stimulation in patients with essential tremor. Essential tremor rating scale (items 5 + 6) for (A) contralateral upper limb action tremor and (B) contralateral upper limb postural tremor at baseline and with stimulation on and off. 1, $P<0.00001$; 2, $P<0.00005$. Reproduced with permission from reference 13 © (2003) BMJ Publishing Group.
Essential Tremor

- 71 yo male with 27 year history of tremor with action > posture
- family history, alcohol effect, symmetrical.
- drank with a straw, shaved and ate some foods with two hands.
- Failed beta blockers, primidone.
- Right Vim DBS implanted
Vim

bursting cell

EMG wrist extensor

tremor cell

cutaneous cell

light touch to thumb

L 13.5 mm

10 mm

1 sec
DBS for Dystonia

The Nexdrive® micropositioner’s adjustable Z-stage eliminates depth-to-target calculation. Its lightweight design and simplified user interface make Nexdrive an ideal addition to Nexframe for the implantation of deep brain stimulation leads.

- Stable Lightweight Platform
- Integrated Turnkey System
- Single Unit Recording Capacity
- Manual or Motorized Actuation