Deep Brain Stimulation & Outcomes for Essential Tremor

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Deep Brain Stimulation

• Surgical placement of electrodes into specific brain areas
• Wires conduct electric current powered by a battery
• Stimulation is calibrated to inhibit tremor and avoid side effects
• FDA approved in 1997
• Thalamic stimulation is effective
• Tremor is effectively suppressed for more than 10 years\textsuperscript{1,2}

Complicating Factors

- Head Tremor
- Voice Tremor
- Proximal Tremor
- Task Specific Tremor
- Thyroid
- Muscle weakness
- Neuropathy
- Medication side effects

- Stress
- Poor placed electrodes
- Poor stimulation calibration
- Diagnosis
- Progression
8-13 years DBS Outcomes

- Longest outcomes study
- 13 patients (7 bilateral)
- Functional Improvement (ADLs) 31.7%
- Hardware complications 23%
- Dysarthria and disequilibrium were common in patients with bilateral stimulation.
- DBS-related surgery every 47.9 months
# Initial Response

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Age at evaluation (years)</th>
<th>Target nucleus (VIM)</th>
<th>Age at surgical implantation (years)</th>
<th>Time with DBS</th>
<th>Initial tremor improvement (%)</th>
<th>Number of IPG replacements</th>
<th>Operatory complications and electrode revisions</th>
<th>Side effects of stimulation</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>82</td>
<td>Bilateral</td>
<td>73</td>
<td>9 years, 6 months</td>
<td>&gt;75</td>
<td>2</td>
<td>None</td>
<td>Mild gait ataxia and dysarthria</td>
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<tr>
<td>2</td>
<td>M</td>
<td>80</td>
<td>Left</td>
<td>68</td>
<td>11 years, 10 months</td>
<td>50–75</td>
<td>2</td>
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<tr>
<td>3</td>
<td>M</td>
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<td>Left</td>
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<td>12 years</td>
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<tr>
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<td>65</td>
<td>13 years, 8 months</td>
<td>&gt;90</td>
<td>3</td>
<td>Electrode migration (Unknown cause)</td>
<td>Mild gait ataxia and dysarthria</td>
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<td>50–75</td>
<td>4</td>
<td>Electrode migration (Unknown cause)</td>
<td>Mild gait ataxia</td>
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</tbody>
</table>

DBS, deep brain stimulation; IPG, internal pulse generator replacement; VIM, ventral intermediate.
Other Studies

• 2003-2010
• 5 Groups reporting*
• 85 patients
• 5-7 years
• 32-51% Improvement in ADLs
• Speech change 75%
• Imbalance 56%
• *Zhang, Blomstedt, Pawha, Sydow, Rehncrona
Surgical Complications

• Bleeding
• Infection
• Wire damage
• Wire migration
• Post op confusion
• Imbalance
• Suboptimal placement
Possible Adverse Effects

Reversible

• Numbness
• Tingling
• Speech slurring or slowness
• Swallowing problems
• Uncoordinated hands
• Uncoordinated walking
• Muscle tightness
• Muscle cramps

May be permanent

• Imbalance
• Problems walking – ataxia
• Cognitive change
  – Word finding
Unilateral DBS

- Age 80
- ET for 30 years
- Primidone 300mg
- Propranolol 160mg
- Tremor bothersome 7/10
- 3rd medication intolerable

Exam:
- Postural R0 L2,
- Proximal R1 L1
- Finger to finger R1 L1-2
- Action/intention R2-3 L1
- Pronation - tremor increased
- No rest, leg tremor
- Very mild head/voice
- Normal gait, coordination intact, normal posture, no bradykinesia, no rigidity
PreDBS – OR – 0 - 1 – 2 – 2.5 yr
Fine Tuning Yr 3

1. Time to
2. THE TIME
3. NOW is THE TIME
4. NOW is THE TIME
5. NOW is THE TIME
6. NOW is THE TIME FOR ALL
7. NOW is THE TIME FOR ALL
8. NOW is THE TIME FOR ALL

-Final
Bilateral DBS

- 64, ET 25 years
- Severity 10/10
- Keppra, Neurontin, clonazepam, primidone, propranolol
- Side effects
  - Sedation, MCI, Imbalance

- Proximal 3+ R>L
- Distal - postural 3+ L>R
- Action 2-3+ L>R
- Head tremor 3+
- Voice 1-2+
- Pronation - no tremor
- No rest, chin or leg tremor
- Mild imbalance, intact coordination

Implantation date 2013 left then right 2 months apart
Bilateral DBS

• Second side
  – No adverse effects
  – 90% improvement per patient
  – First side >95% improvement ADLs to include threading a needle
Honeymoon & 1st Adjustment
Goals of DBS Programming

1. Determine optimal stimulation
2. Avoid stimulation side effects
3. Optimize battery longevity
4. Monitor wires, battery and skin long-term
5. Re-calibrate as needed for tremor and side effects
### ACBL Team Private Score

<table>
<thead>
<tr>
<th>Bd. No.</th>
<th>Contract</th>
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<th>IMPs</th>
<th>Contract</th>
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<td>30</td>
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<td>-</td>
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</tbody>
</table>

**Baseline – Year 3**

- Team Number 1

**Notes:**

- Baseline
- Team: Sierra Farris
- Score: 1450
- IMPs: 15

**Signature:**

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Summary

• Less risk of permanent adverse effects with unilateral surgery
• Persistent speech, gait and balance problems may be reversible with less intense stimulation
• Reversible and modifiable
• Replace battery every 3-4 years
Safety Issues

1. MRI*
2. Heat ultrasound
3. Arc welding
4. >33 feet scuba diving
5. *conditional – requires medical oversight from experienced DBS clinician
Focused Ultrasound

- MRI guided thalamic permanent lesion using sound waves
- 47% improvement at 3 mo
- Tremor increased 38% at 12 mo
- 1/3 patients experienced balance and sensory problems
- Ineffective in 9/56

For more information on FUS and other surgical options please visit essentialtremor.org or read the full FUS study results at The New England Journal of Medicine.