ABCs of DBS

Where we were and where we are going.

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Disclosures

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• Partner and President of National Capital Neurosurgery
• Speakers Bureau
  • Abbott Labs
  • Medtronic Inc.
History of Movement Disorder Surgery

- 1930-1940 “Tractotomy”
  - Severing connections in the brain
- 1940’s Stereotactic Pallidotomy and Thalamotomy: Spiegel and Wicis
  - Burning holes in the brain
- 1950’s Choroidal Artery Ligation: Cooper
  - Surgical strokes: 10-15% complication rate
- 1970’s - 90’s Resurgence of Pallidotomy: Laitenen
- 1980’s to present Neural Transplantation: Madrazo
- 1975- present for chronic pain
- 1987’s to present for Movement Disorders Benibid
- 1990’s Chronic Stimulation

Current
- Lesioning of the brain using U/S
- Alternative method of L-Dopa Administration
- Directional leads to minimize side effect
Neural Prosthetic

- Electrical stimulation to modulate output from target
- Based on “lesioning” studies
- Mimic lesioning with fewer adverse events
- Symptomatic treatment
  - Tremor
  - Bradykinesia
  - Rigidity
  - Freezing
  - Dystonia
  - Dyskinesia
Neural Prosthetic

• DBS limitations - Cannot treat -
  • Cognitive symptoms - memory, thinking
  • Gait and balance issues
  • Autonomic symptoms
  • Urinary issues
  • Blood pressure
Parkinson’s Disease

• Death of Dopaminergic Cells in the brain - not just the SN
  • Suicide? - apoptosis
  • Murder? - toxic exposure
  • Both
  • genetic predisposition
  • toxin exposure
Deep Brain Stimulation for PD

Baseline Assessment

"On without Dyskinesias" 27%

"Off" 50%

"On with Dyskinesias" 23%

6 Months after DBS

"Off" 19%

"On with Dyskinesias" 7%

"On without Dyskinesias" 74%

DBS v. Best Medical Therapy for PD

• Bilateral Deep Brain Stimulation vs Best Medical Therapy for People with Advanced Parkinson’s Disease - JAMA 2009; 301(1) 63-73
• 255 Randomized Patients 121 - DBS, 134 - Best Medical Therapy - compared “on time.” motor function, QOL, Cognitive function and adverse events
• DBS patients gained an average of 4.6h/d of “on time” vs. 0h/d p<0.001
• 71% improvement of motor function for DBS vs. 32% medical group  p<0.001
• 7/8 QOL scores significantly improved with DBS as did the summary of QOL vs. No significant improvement p<0.001
• Cognitive function slightly decreased at the 6month mark with DBS
• More adverse events with DBS p<0.001 (49 adverse events with DBS vs 15)

• Conclusion: Deep Brain stimulation is superior to best medical therapy for people with Parkinson’s Disease, in regard to increased “on time”, UPDRS scores and Quality of Life self assessment.
DBS Techniques

- Awake v Asleep
- Microelectrode recording
- Test Stimulation
- Image guided placement
- Frame based
- Frameless
- Robotic
Awake vs. Asleep

Asleep Implantation
- Image guidance only – MRI placement
- Electrophysiologic guidance
- No testing for benefit/side effect

Awake Implantation
- Image guidance - Not for MRI placement
- Electrophysiologic guidance
- Testing for benefit/side effect
DBS - Stereotactic Frames

- Frame based surgery –
  - Offers submillimeter accuracy
  - Older technique – more cases have been done with the frame
  - Requires imaging the day of surgery – lengthens the surgery
  - Rigidly affixes the patient to the bed – has led to discomfort
  - One frame for all patients – some patients are not suitable
  - Frame placement may effect accuracy
DBS - Frameless

• Frameless Surgery  
  • Offers submillimeter accuracy (no different than frame based)  
  • Limited number of cases (<50% of current cases)  
  • Imaging is all done before the surgery – shorter operative time  
  • Patient may move on operating table without sacrificing accuracy  
  • No limitations based on patient anatomy or size
Image Guided Surgery

- DBS done in the MRI scanner
  - Cannot do microelectrode recording (MER)
  - Cannot do test stimulation
  - Patient is asleep
- DBS done with CT
  - Fused with MRI for detail and anatomic delineation
  - MER can be done
  - Test stimulation is difficult when patient is asleep
Robots and DBS

• Pointers
  • Surgeon uses Robot to point
  • Planning is done the same
  • MER possible
  • Test stimulation possible
DBS Technology

- Directional Leads
- Rechargeable Batteries
- Primary Batteries
- Bluetooth Communication
- RF Communication
- MRI Conditional
Directional Leads
## Batteries – Pulse generators

<table>
<thead>
<tr>
<th>Rechargeable batteries</th>
<th>Primary Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Last longer</td>
<td>• Last no more than 5-6 years</td>
</tr>
<tr>
<td>• Requires daily recharge</td>
<td>• Very little to no daily maintenance</td>
</tr>
<tr>
<td>• Recommend if battery drain &lt;2 years</td>
<td>• Can abruptly loose charge</td>
</tr>
<tr>
<td>• Will need eventual replacement</td>
<td>• Emergency replacement</td>
</tr>
<tr>
<td>• (15 years)</td>
<td>• Upgrade with battery changes</td>
</tr>
<tr>
<td>• No upgrade</td>
<td></td>
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</tbody>
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DBS Targets

• Subthalamic Nucleus (STN)
• Globus Pallidus, internal segment (GPi)
• Ventral Intermediate nucleus (Vim)
GPi Reasoning

- Significant Dyskinesia with lower doses of L-Dopa (low LED*)
- More gait and postural issues
- Speech preservation important
- Behavioral concerns
  - Depression
  - Aggression
- Maintenance L-dopa dosing

*Levodopa Equivalent Dosing
STN reasoning

• Reduction of LED
  • Side effect issues
• Advanced PD
• Tremor predominance
• General considered better target
• Dyskinesia not a predominant problem
• Ease of programming
  • Immediate feedback on lead efficacy
Vim Reasoning

- Medication well tolerated
  - Treating most symptoms
- Tremor Predominant
- Advanced age with disabling tremor
- Less likely to lower LED
- Does not treat bradykinesia or rigidity as well
Surgical Goals in DBS

- SAFELY place the DBS lead in a location that mitigates symptoms with minimal or no side effects. Keeping the patient comfortable.
- 1. Safety
- 2. Accuracy
- 3. Benefit
DBS Principles

A well placed lead will improve symptoms in someone with idiopathic Parkinson’s Disease

Symptom improvement does not mean symptom arrest in all patients

Medication reduction is NOT a primary goal for DBS

Improved quality of life IS a primary goal for DBS