What to Consider when getting Deep Brain Stimulation Surgery

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Objectives

To understand the indications for surgical management of movement disorders, including the criteria used to identify patients who may benefit most from early selection and treatment.

To know the efficacy of and risks associated with Deep Brain Stimulation.
Surgery for Parkinson’s Disease

- History
- Current surgical options
- Deep Brain Stimulation
- Indications
- Outcomes
- Risks
- Future

Baltuch 2005
Giovanni Aldini (1762-1834)

- Nephew of Luigi Galvani
- 1789 – Bologna: Prof of Physics
- Advocate of *Animal Electricity*
- First to attempt ECT for behavioral disorders
Eras of *Functional Neurosurgery*

**Open surgery**
- 1921 Leriche – *cervical rhizotomy*
- 1937 Bucy – *cortectomy for tremor*
- 1939 Meyers – *basal ganglia lesioning*
- 1948 Pool – *caudate stim for depression*

**Stereotactic (closed) surgery**
- 1947 Spiegel and Wycis - *first stereotactic surgery*
- 1950 Talairach – *applied in movement disorders*
- 1954 Hassler – *thalamotomy for PD tremor*
- By 1969 over 37,000 published cases

*L-Dopa = end of the surgical era*
- *(for a short while)*

**Rebirth**
- 1990 Laitinen – *revived pallidotomy/thalamotomy*
- **1991 Benabid - Deep Brain Stimulation**

Speelman 1998, Jankovic 1995
Early Stereotactic Surgery

Heimburger 2005
Current Surgical Procedures

- **Deep Brain Stimulation**
  - STN, GPi, Vim
- Radiofrequency lesioning
  - pallidotomy, thalamotomy
- Radiosurgical lesioning
  - Gamma Knife
DBS Procedure

Stage I – Implant electrode
- Frame placement
- CT with frame
- CT/MR fusion & targeting
- Micro-electrode recording
- Macro Stimulation
- Implantation

Stage II
- Pulse Generator Placement
Current DBS Options

• AWAKE:
  – Frame bases
    • With MER
  – Frameless
    • With MER

• ASLEEP:
  – Frameless
    • MRI Guided
    • CT Guided
STN vs. GPI

Lancet 2013

Subthalamic nucleus versus globus pallidus bilateral deep brain stimulation for advanced Parkinson's disease: a randomized controlled trial.

INTERPRETATION:
Although there was no difference in the primary outcomes, findings suggest that **STN could be the preferred target** for DBS in patients with advanced Parkinson's disease.
**Patient Selection**

- **Good Candidates**
  - Typical PD with tremor
  - Age under 70
  - Good levodopa response
  - Motor fluctuations
  - Dyskinesias
  - Good general health
  - Good cognitive state
  - Good family/social support

- **Poor Candidates**
  - Atypical Parkinsonism
  - Age over 75
  - Poor levodopa response
  - Cognitive impairment
  - Severe mood disorder
  - Severe medical problems
  - Poor family/social support
Screening Process

Neurological evaluation:
Candidate predicted to have good outcome by clinical observation

UPDRS Ratings OFF and ON

Neuropsychological Screening

Neurosurgical Consultation
Deuschl, NEJM Aug. 2006

- Randomized trial of DBS for PD
- 156 patients
- DBS + Rx vs. Rx alone
- End points: 6 mo PDQ-39 & UPDRS-III

- **Outcomes favored DBS**
  - PDQ **75%** vs. 25% (p<0.001)
  - UPDRS **85%** vs. 13% (p<0.001)
Outcomes

Deuschl 2006
Risks

Goodman, et al 2006
100 Consecutive patients / 191 implanted devices

- **Infections**  7 (3.7%)
- Cerebral infarct  1
- *Intracerebral hemorrhage*  1
- Subdural hemorrhage  1
- Air embolism  1
- Wound hematomas  2
- Skin erosions  2
- Seizures  3
- Electrode revisions  6 (3.1%)
- Postoperative confusion  13 (6.8%)
- **Mortality**  0
- **Permanent deficits**  0
Complications

DBS Annualized Complication Rates
2006-2013

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Other Risks

JAMEY VERSION 1.0
(2006 MODEL)

HEAD BUMPAGE (2)
(HELPS KEEP HATS IN PLACE)

BIONIC IMPLANT
(DBS, GPS, MP3?)

UP-SIZED BOILER ROOM
(+/- 30 LBS)

UPGRADED PANTS
WITH ‘SKOSH’ MORE ROOM TO ACCOMODATE NEW BOILER

“OLD MAN” STICK FOR POKING STUFF (AND WALKING)

JAMEY VERSION 2.0
(POST DBS STN INSTALLATION)
### Table 4. Adverse Events during the Six-Month Study.*

<table>
<thead>
<tr>
<th>Event</th>
<th>Neurostimulation Group</th>
<th>Medication Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serious adverse event†</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Perioperative cerebral hematoma</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Suicide 5 mo after surgery</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Car accident during psychotic episode</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Readmission to the hospital</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Worsening of mobility</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Infection at the stimulator site</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Erroneous stimulator shut-off</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Vertebral fracture from fall</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hip fracture from fall</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total nonserious adverse events‡</strong></td>
<td>77</td>
<td>96</td>
</tr>
<tr>
<td>Mild</td>
<td>35</td>
<td>8</td>
</tr>
<tr>
<td>Moderate</td>
<td>32</td>
<td>39</td>
</tr>
<tr>
<td>Severe</td>
<td>10</td>
<td>49</td>
</tr>
</tbody>
</table>

*Deuschl 2006*
Limitations of Surgery

- Improvement limited by patient’s best condition “on” medications
- Little effect on autonomic dysfunction
- Little effect on depression
- Akinesia, speech, postural stability, freezing of gait, and cognitive function worsen within 1 to 5 years
- Unknown (likely no) alteration in natural history of Parkinson’s Disease
Future of Parkinson’s Surgery

Motor Cortex Stimulation
Trans-cranial magnetic Stimulation
Neural Transplantation
GDNF Therapy
Gene Therapy
Stem Cell Transplant
CNS drug delivery
Future of DBS

Current FDA approval

- PD, Essential Tremor & Dystonia

Experimental

- Epilepsy, obsessive compulsive disorder, multiple sclerosis, post-traumatic tremor, tremor after cerebral infarct, cluster headaches, trigeminal neuralgia, chronic pain, coma?
How much is being done?

PubMed Search:
– In 2013 alone = 4156 publications!!!
IMPACT

> 1 MILLION people are currently diagnosed with PD in the United States

1 in 100 Americans over the age of 60

1.6% of Medicare beneficiaries

Variations by county from 1% to 13%
Environmental Factors

**Risks:**
- Rural residence X 1.56
- Well water X 1.26
- Living on a farm X 1.42
- Pesticide (rotenone, paraquat) X 1.94

**Protective:**
- Smoking X 0.59
- Coffee X 0.69
Quality of Life/Motor Function Improvements

Five additional hours of good movement control each day compared to medication alone

21 percent improvement in Parkinson’s disease related quality of life compared to medication alone at six months

28 percent improvement in the activities of daily living at six months compared to medication alone. These include bathing, dressing, writing clearly and drinking from a glass. Improvement in total motor function, including shaking, stiffness and movement difficulties from Parkinson’s disease (15 percent with Medtronic DBS Therapy vs. 2 percent with medication alone)

Significantly Reduced Medication Use

Significant reduction in the amount of medication needed to treat Parkinson’s disease

By reducing the need for levodopa, DBS Therapy simplifies a patient’s medication schedule

Long-Term Safety and Effectiveness

Established long-term safety and effectiveness of Medtronic DBS Therapy for advanced Parkinson’s disease through 36 months

The long-term data will further support the already extensive access and insurance coverage for the therapy
Vanderbilt Trial – Early DBS: April 2014
   – Dr. David Charles, et al.
   – The phase III trial will recruit 350 patients at 15 academic medical centers

DBS activates stem cells: March 2014
   – Dr. Maurice Curtis, University of Auckland
   – treatment increased the level of plasticity in the brain


