Advances in surgical treatments for Parkinson Disease

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Stereotactic neurosurgery for movement disorders

- 1890s - Lesions in basal ganglia
  - Pallidotomy – Globus Pallidus lesion for PD
  - Thalamotomy – Thalamic lesion for ET

Victor Horsley
Father of stereotactic Neurosurgery
Thalamotomy is an invasive procedure, where a selected portion of the Thalamus is surgically destroyed (ablated) to create a lesion.
Thalamotomy

- Permanent
- Can not be adjusted
- Variable in size

- Bilateral is not recommended: high risk of permanent neurological deficit
  - Speech problems
  - Cognitive decline

- Can be used in selected cases of disabling tremor when DBS is too risky or not feasible
Stereotactic neurosurgery for movement disorders

- 1890s - Lesions in basal ganglia
- 1990s – Deep Brain Stimulation
Deep Brain Stimulation

Implanted electrode delivers continuous high frequency electrical stimulation to structures involved in the control of movements.

- Reversible
- Adjustable
Targets for DBS in PD

STN
Subthalamic Nucleus

Thalamus

Gpi
Globus Pallidus
DBS system components

- DBS electrode
- Programmer
DBS is proven and effective treatment

- First DBS surgery – early 1990s
- FDA approved in USA
  - Essential tremor - 1997
  - Parkinson disease - 2002
  - Dystonia - 2003
  - Obsessive Compulsive Disorder – 2009
- More than 100 thousand patients implanted
For the development of DBS of the STN, a surgical technique that reduces tremors and restores motor function in patients with advanced Parkinson disease.
DBS is not a cure Parkinson disease

DBS is a powerful symptomatic treatment

- Improves **motor** problems caused by PD
- Is not expected to improve non-motor problems
  - Cognition (memory, attention etc.)
  - Mood and behavior
  - Blood pressure control, etc..

**Exception:**

- if these problems are caused by medications, decrease of medications can help with non-motor problems
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD
Not everything that looks like PD is PD

- Vascular Parkinsonism
- Drug-induced Parkinsonism
- Post traumatic Parkinsonism
- Post infectious Parkinsonism
- LBD – Lewy Bodies Dementia
- FTDP – Frontotemporal dementia-parkinsonism
- PSP – Progressive Supranuclear Palsy
- CBD – Corticobasal degeneration
- MSA – Multiple Systems Atrophy

Watch for look-alikes!!!
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD
Indications for DBS in PD

Diagnosis of **advanced** levodopa responsive idiopathic PD

All currently available pharmacological treatment should be optimized:
combination of medication from different groups
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD

The best predictor of improvement after DBS is improvement from medications

At least 30% improvement in UPDRS motor scores between On and Off medications
Response to chronic Levodopa therapy

Chronic levodopa response is a narrowing of the therapeutic window

Genio è calzante, nel tuo caso...
L'ho appena inventato!
Motor fluctuations:

- Dyskinesia
- Wearing off before next dose
- Unpredictable wearing off
- Sudden wearing off
- Dose failure
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD

AND

Presence of motor fluctuations despite optimal medication management
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD

Exception:

TREMOR can be resistant to medication but improves with DBS
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD

AND

Parkinsonian tremor that causes disability despite optimal medication management
Indications for DBS in PD

Diagnosis of advanced levodopa responsive idiopathic PD

AND

Presence of motor fluctuations despite optimal medication management

OR

Parkinsonian tremor that causes disability despite optimal medication management

Tremor is an exception to the medication responsiveness rule!!
B-STN DBS vs Medications
Therapeutic effects of DBS in PD

- Decrease dyskinesia
- Longer periods and better quality of mobility
- Improvement of quality of life
- Decrease medication intake
Chronic levodopa response is a narrowing of the therapeutic window

Chronic levodopa response is a narrowing of the therapeutic window.

Long-term effects of DBS on motor symptoms of PD
5 year follow up after B-STN DBS

OFF-Medication Motor Score Improvements

<table>
<thead>
<tr>
<th></th>
<th>6 m</th>
<th>1 y</th>
<th>3 y</th>
<th>5 y</th>
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<tr>
<td>Tremor</td>
<td>79%</td>
<td>75%</td>
<td>83%</td>
<td>75%</td>
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<tr>
<td>Rigidity</td>
<td>58%</td>
<td>73%</td>
<td>74%</td>
<td>71%</td>
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<tr>
<td>Slowness</td>
<td>42%</td>
<td>63%</td>
<td>52%</td>
<td>49%</td>
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Deep Brain Stimulation
Potential complications and risks

- **Surgery-related** – very rare <1%
  - Stroke
  - Bleeding in the brain
  - Seizure
  - Transient confusion
  - Infection (typically occurs at the site of generator)
    - up to 10%

- **Stimulation-related**:  
  - Usually can be minimized or eliminated by adjusting stimulation settings
  - Tingling, slurry speech, Balance problems
Expert consensus

- DBS is the best performed by an experienced neurosurgeon with expertise in stereotactic surgery
- working as a part of multidisciplinary team of experts
- Good relationship between referring neurologist and DBS team are very important for continuity of care

Deep brain stimulation for Parkinson disease: an expert consensus and review of key issues,
DeLong MR at all,
Arch Neurol. 2011
DBS programming

- DBS programming can take 3 to 6 months to obtain optimal results.
  - Optimize stimulation
  - Minimize stimulation related side effects, if any
  - Decrease medication
- DBS programming is best accomplished by a highly trained clinician

Deep brain stimulation for Parkinson disease: an expert consensus and review of key issues, DeLong MR at all, Arch Neurol. 2011
Deep Brain Stimulation Programming parameters

- **Electrode configuration**
  - Choice of active electrode
  - Monopolar vs bipolar

- **Pulse Width**
- **Frequency**
- **Amplitude**

**Diagram:**
- Pulse width (μs) [duration of each stimulus]
- Frequency (Hz) [number of pulses per second]
- Amplitude (V) [intensity of stimulation]
DBS Programming Parameters

Interleaving

Monopolar vs bipolar

Up to 4 different groups of stimulation
Patient hand held controller
Future options for DBS programming

Shaping electrical field:
- Directional
- Segmented
- Steerable
Shaping electrical field:
- Directional
- Segmented
- Steerable
New options for Implantable Pulse Generators
Implantable Pulse Generators

1. **Activa PC** – dual channel stimulator
   - In PD need replacement in 3-5 years

2. **Activa SC** – single channel stimulator
   - Needs to be recharged regularly
   - Need replacement every 9 years

3. **Activa RC** – rechargeable
BRIO
Rechargeable implantable neurostimulator.

St. Jude’s Medical

- Tested and approved for at least 10 years of sustained therapy, even when used at high power settings
- Smallest DBS IPG available offering increased implant flexibility and improved cosmetic appearance
- Flexible recharging schedule helps to ensure therapy compliance, and fits patients' lifestyles
- Advanced antenna technology enables easy and reliable recharging

Press Release June 12th 2015
DBS systems in development
New DBS surgical techniques

- MRI guided “asleep” DBS surgery
  - UCH Neurosurgeon Steven Ojemann
- The only in the region real-life MRI-guided DBS
ClearPoint System

MRI-guided asleep DBS

- MR visualization of target
- MR-guided placement of electrode

SmartFrame® adjustable trajectory guide and SmartFlow™ cannula
Future technological advances: “On-demand” stimulation
Multidisciplinary DBS team at UCH MDC

- **Neurosurgeons:**
  - Steven Ojemann, Aviva Abosch
- **Neurologists:**
  - Olga Klepitskaya, Lauren Seeberger, Drew Kern
- **Pediatric neurologist:** Abigail Collins
- **Neuropsychologists:** Brian Hoyt and others
- **Rehabilitation:** Heather Baer
  - **Physical therapists:** Jane Ott, Renee Peters
  - **Speech therapist:** Jill Newcombe
- **Psychiatrists:** Alison Heru, Rachel Davis
- **Programming clinician:** Christen Epstein, NP
- **Neuroradiology:** Jody Tanabe
- **Neurophysiologist:** John Thompson
- **DBS coordinator:** Holly Williams
Multidisciplinary DBS team

Referral to a DBS center

Initial evaluation by a movement disorders neurologist

DBS Evaluation Pathway

Video “On-Off” Evaluation

Cognitive Evaluation by neuropsychological testing

Speech Pathology

Rehabilitation Evaluation

Brain MRI

Neurosurgery Evaluation

If required additionally:
Psychiatric evaluation
Social Worker

DBS Team Meeting

DBS surgery

Medication management

DBS programming and medication management

Physical therapy
Speech therapy
Stereotactic neurosurgery for movement disorders

- 1890s - Lesions in basal ganglia
- 1990s - Deep Brain Stimulation
- Re-emergence of ablative (lesion) surgeries:
  - Thalamotomy by
  - Gamma knife
  - Focused Ultrasound
Re-emergence of ablative surgery

Gamma knife

• Radiation surgery where specialized equipment focuses beams of radiation on a target in the brain

• *Indications:*
  • brain tumors,
  • abnormal blood vessels,
  • trigeminal neuralgia
Re-emergence of ablative surgery
High intensity Focused Ultrasound

HIFU or FUS is a medical procedure that applies HIFU energy to locally heat and destroy diseased or damaged tissue through ablation.

*Indications*: tumors, ex: prostate cancer
Incision–free invasive stereotactic surgery

- = Thalamotomy
- Effective treatment for tremor
- Surgical risks are similar to traditional thalamotomy
- Absence of MER eliminates functional targeting
- Bilateral lesions are not recommended
- Can be a viable option in selected cases
Questions?