Surgical Treatment for Movement Disorders

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Deep brain stimulation (DBS)

DBS is a FDA-approved surgical procedure used to treat the debilitating symptoms of several movement disorders:

- **Parkinson’s Disease**: STN, GPi
- **Essential Tremor**: VIM
- **Dystonia**: GPi
- Other investigational indications/targets
- **Focal epilepsy** (new): ANT
Deep brain stimulation (DBS)

- DBS is non-ablative: it does not damage healthy brain tissue by destroying nerve cells. DBS alters the activity of malfunctioning brain circuits.
- DBS is non-curative: it does not treat all symptoms, underlying symptoms often progress.
- DBS is currently only for patients whose symptoms cannot be controlled with medications.
Preoperative evaluation: are you a candidate for DBS?

- Medical history and neurological exam
- Lab tests
- High-resolution brain MRI
- Neuropsychological tests
- Psychiatry
- Physical, occupational and/or speech/language therapy

Once the preoperative evaluation is complete, a decision is made regarding DBS candidacy, including choice of brain target.
The DBS system consists of three components:

The **lead** is a thin electrode inserted into the brain.

An **extension** cable, connecting the lead and neurostimulator.

The **neurostimulator** is a battery and pulse generator that is implanted under the skin, usually near the collarbone.
Two stage procedure

• **Part 1: DBS electrode (lead) implantation into the brain.** Performed under sedation with brief awake testing. Typically 1 night in the hospital after this surgery.

• **Part 2: Neurostimulator and extension cable implantation.** ~3 weeks after Part 1. This procedure is done under general anesthesia. Outpatient procedure

(In some cases we place brain electrodes in two stages. If so, we will perform part 2 when we place the second brain electrode)
DBS surgical procedure

Target planning on high-resolution MRI
A small incision is made in the scalp and a hole drilled through the skull to expose the brain.
DBS surgical procedure

There are several strategies to precisely place the DBS lead in the target:

Frame-based
DBS surgical procedure

There are several strategies to precisely place the DBS lead in the target:

Frame-based

Frameless
DBS surgical procedure
There are several strategies to precisely place the DBS lead in the target:

Microelectrode recording
There are several strategies to precisely place the DBS lead in the target:

Microelectrode recording
DBS surgical procedure

There are several strategies to precisely place the DBS lead in the target:

Awake testing
DBS surgical procedure

There are several strategies to precisely place the DBS lead in the target:

Image-guided “asleep” surgery
DBS surgical procedure
There are several strategies to precisely place the DBS lead in the target:

“Directional” DBS leads
DBS surgical procedure: My approach

“semi awake” or “mostly asleep” placement of brain leads

Under general anesthesia:
Local anesthetic for scalp block
Placement of the headframe
Incision and scalp preparation
Skull preparation/drilling
Brain lead placement

After reversal of anesthesia:
Intraoperative CT for lead localization
DBS surgical procedure: My approach

Intraoperative CT lead localization
DBS surgical procedure: My approach

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60 yo F with severe essential tremor
Persistent uncomfortable paresthesias with intraop stimulation
Lead was retracted 0.5 mm x 2 along electrode trajectory
Paresthesias resolved with continued good tremor control
DBS surgical procedure: Awake testing

My day is planned to fix my tremor and go forward with my life. My surgery went great. I'm feeling good, better than I thought I would of ther something like this DJ.
DBS surgical procedure: Awake testing

Video used with the patient’s kind permission
66 yo healthy female with severe bilateral essential tremor

Bilateral VIM DBS in 2013
Significant benefit in RUE tremor
No improvement in LUE tremor

Pain and motor contractions with stimulation of the R brain lead
DBS surgical procedure: My approach
DBS surgical procedure

Part 2: extension and neurostimulator are placed with under general anesthesia, ~3 weeks later
DBS surgical procedure

Typical DBS incisions
After surgery, referring neurologist begins approximately monthly programming sessions to optimize stimulation and adjust medications.

There are very few activity restrictions related to implanted DBS devices.
What are the risks?

DBS is *elective* brain surgery

- The most common complications are **device- or wound-related**: infection, parts eroding through the skin, mechanical or electrical problems with the hardware

- Some side effects are related to **electrical stimulation**: numbness, tingling, worsening of tremor, mood problems, speech/language impairments. Typically, these side effects are not permanent and can be resolved by adjusting the device

- **Serious complications** are rare, but include brain hemorrhage, seizures and brain infection, which can cause neurologic deficit, coma or even death
Questions?
Deep Brain Stimulation for Parkinson’s Disease

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Parkinson’s Disease

- A complex, progressive degenerative neurologic disorder that causes loss of control over body movements
- Primary motor symptoms:
  - Tremor
  - Rigidity
  - Akinesia/bradykinesia
  - Postural instability
Parkinson’s Disease

- Etiology is not entirely clear: genetic predisposition plus environmental factors
- Motor symptoms arise when the substantia nigra degenerates
- Dopamine producing neurons die
- Reduced levels of dopamine lead to most of the symptoms of PD
Parkinson’s Disease

• Medical treatment: replace dopamine—very effective
• BUT, there are limitations...
  Increasing dosages
  Increasing side effects
  • Dyskinesia
  • Hallucinations
  • Wearing off
  • Unpredictability
Parkinson’s Disease
DBS Therapy with Medications Provides an Additional 5.1 Hours of “On” Time to Smooth Out Motor Function Throughout the Day* 

*Activa Therapy Clinical Summary, 2009.
For patients <75 with severe motor complications of Parkinson's disease, neurostimulation was more effective than medical management alone at 6 mo

Deuschl et al., 2006 NEJM
There are three brain targets that have been FDA approved for use in Parkinson’s disease.

- The most commonly utilized brain targets include the subthalamic nucleus (STN) and also the globus pallidus interna (Gpi)
- Target choice is tailored to a patient’s individual needs
- The preoperative evaluation helps determine choice of brain target
Who is a good candidate for DBS?

- PD symptoms for at least 4 years
- On/off fluctuations, with or without dyskinesia
- Good response to PD medications, especially carbidopa/levodopa, albeit only temporary or partial
- Exception: medication-refractory tremor
“Window of Opportunity” for DBS Therapy in Parkinson’s Disease

In order to obtain maximum benefit, PD patients should be referred at the optimal time, or during a “window of opportunity” when DBS therapy may be most effective, characterized by:

• “On” time characterized by disabling dyskinesias (or other nonmotor side effects)
  OR
• “Off” time characterized by disabling tremor, rigidity, or akinesia/bradykinesia
  OR
• Upredictable “on/off” motor fluctuations
  OR
• Medication-resistant tremor
What is expected after DBS surgery for PD?

• Most patients still need to take medication after DBS, but patients experience reduction of their PD symptoms and/or improved response to medications and may therefore decrease their dosage.

• Decreased medication side effects such as dyskinesias (involuntary movements).

• PD is a progressive disorder, symptoms will continue to worsen despite DBS, but the benefit of DBS persists.
Questions?
Gamma Knife Thalamotomy for Essential Tremor

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Gamma knife thalamotomy

Does Your Hand Shake When You...

Drink a glass of water? Write a note? Dial a phone number?
If so, you may be suffering from Essential Tremor. Our team from the Swedish Radiosurgery Center has successfully treated patients for over 15 years — using Gamma Knife, a non-surgical approach to treat Essential Tremor.

DRAWING SAMPLE BEFORE TREATMENT

DRAWING SAMPLE AFTER TREATMENT

Learn more about Essential Tremor and find out if Gamma Knife treatment is right for you.

1-206-320-7187  Swedish.org/essentialtremor
Seattle, Washington, USA
Gamma knife thalamotomy procedure

1. Headframe placement
2. MRI with headframe
Gamma knife thalamotomy procedure

3. Stereotactic radiation dose planning
Gamma knife thalamotomy procedure

4. Radiation treatment
Gamma knife thalamotomy
Gamma knife thalamotomy procedure

Pros:
Minimally invasive
Outpatient procedure
No anesthesia
No programming visits or hardware implantation

Cons:
Unilateral (1 y between sides)
2-6 months for complete effect
Rare radiation-related complications
No physiologic confirmation
Irreversible
Likely less efficacious for high amplitude tremor, head or vocal tremor
Thank you