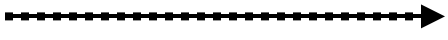
# Deep Brain Stimulation for Movement Disorders

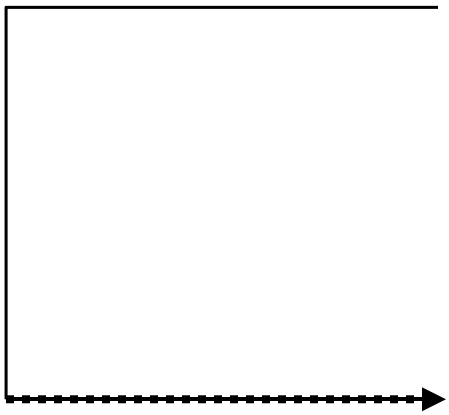
**Punit Agrawal, DO**
**Clinical Assistant Professor of Neurology**
**Division of Movement Disorders**
**OSU Department of Neurology**

# History of DBS



# History of DBS

- 1987 - First DBS implant



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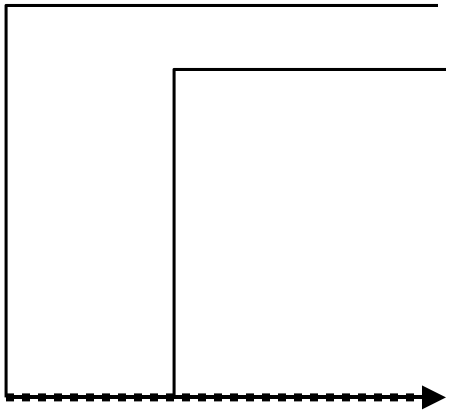

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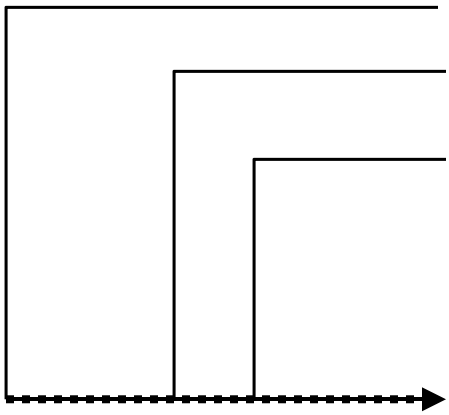

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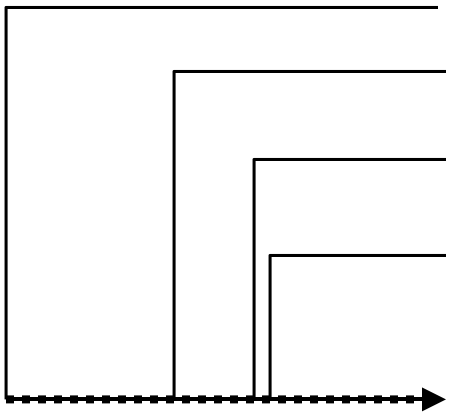

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HDE – Humanitarian Device Exemption

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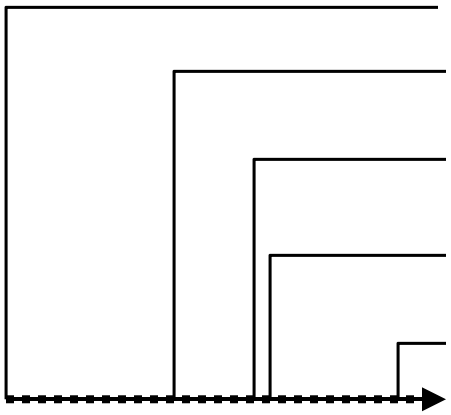

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- 1997 – FDA approval for *tremor*
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- 2010 – Over 80000 DBS implants worldwide
  - > 23 years of safety
  - >2000 published articles on DBS

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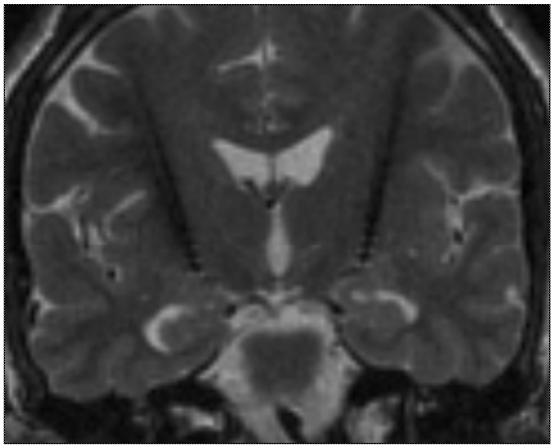
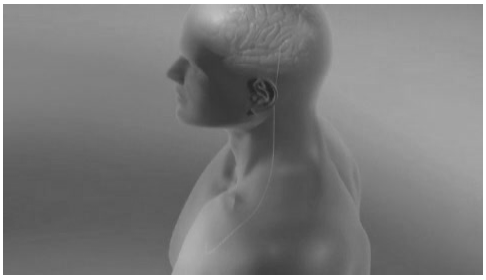
**Offers hope to severely impaired patients when symptoms are intractable despite optimal medication and other available therapies.**

- **Surgically implanted medical device into deep brain structures, and connected to a implantable programming device placed commonly in the upper chest wall. Much like a pacemaker, they can deliver electrical stimulation to a specific brain target.**




http://professional.medtronic.com/wcm/groups/mdtcom_sg/@mdt/@neuro/documents/images/dbs-bilat-man-clr.jpg



- **Stimulation of the specified target can re-modulate abnormal activity within brain circuitry that is causing the symptoms**

## Video

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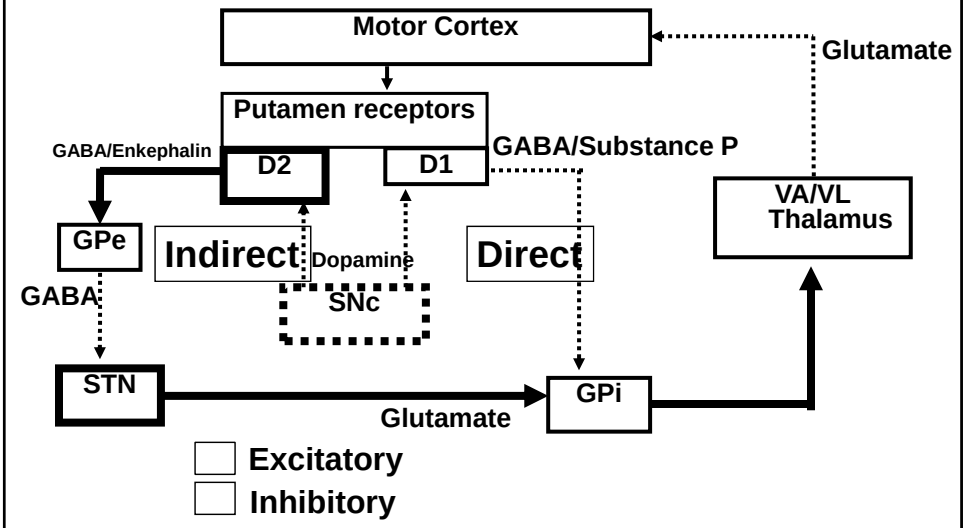
## Simple PD Circuitry

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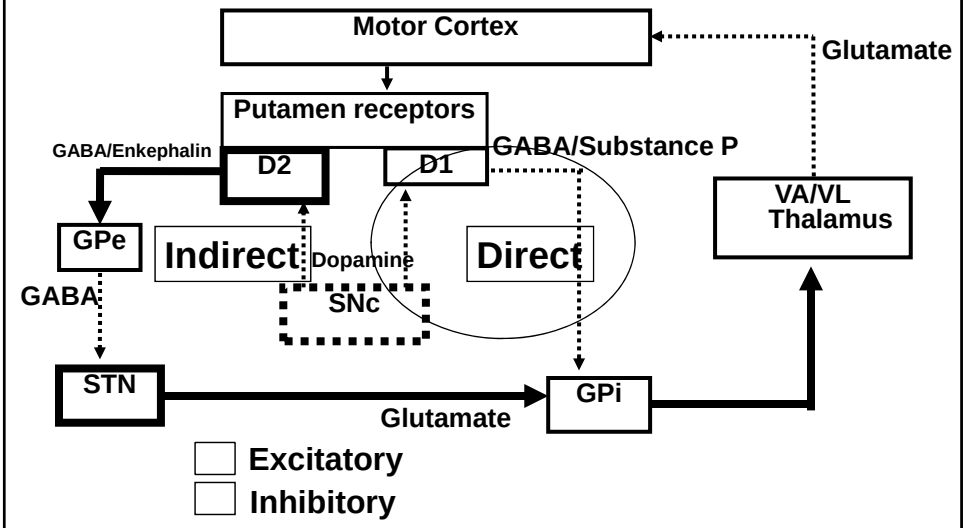

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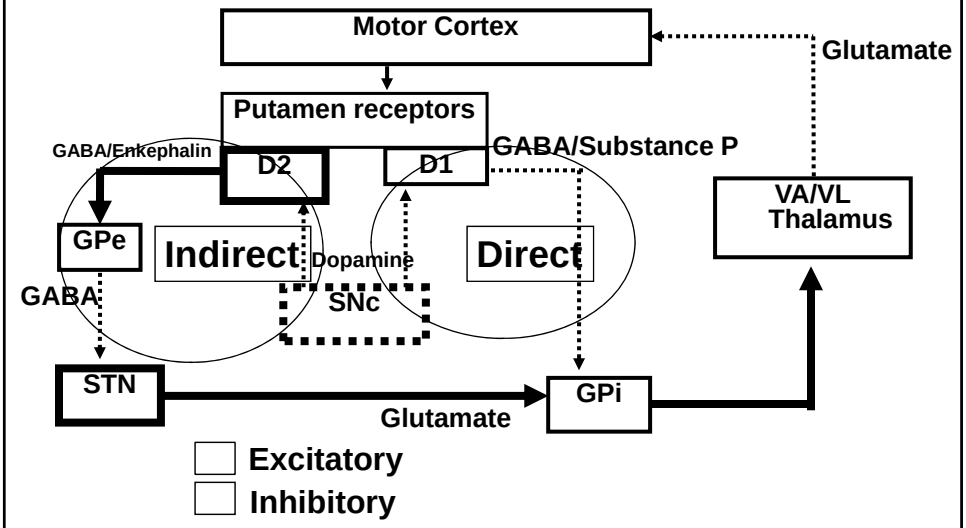


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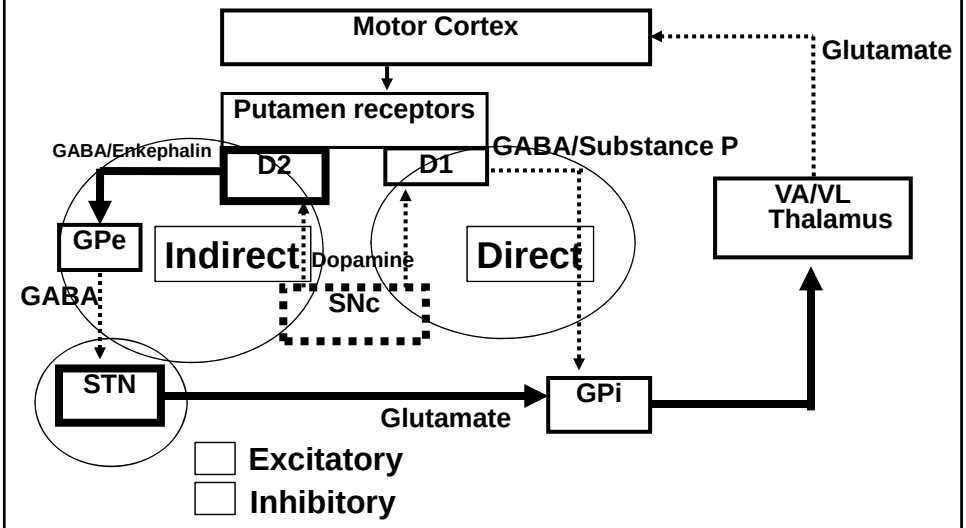
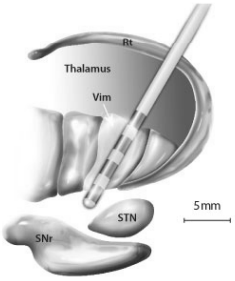
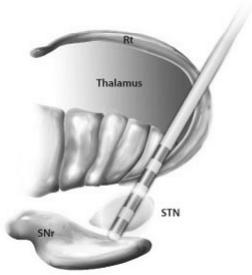


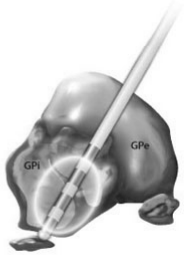
# Targets for Movement Disorders




**VIM Thalamus: Essential Tremor**




**Subthalamic Nucleus: Parkinson's disease**




**Globus Pallidus: Parkinson's disease and Dystonia**

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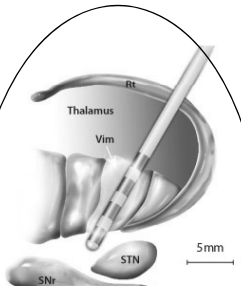


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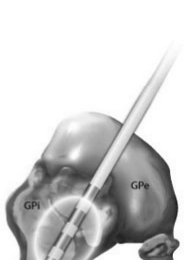


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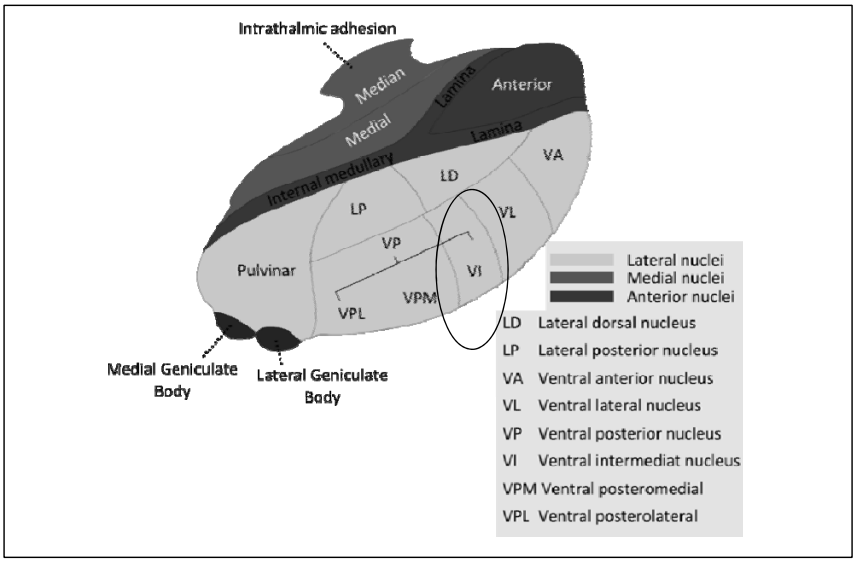


http://en.wikipedia.org/wiki/File:Thalmus.png

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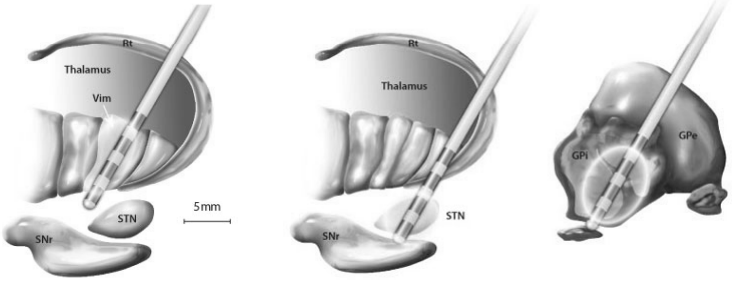


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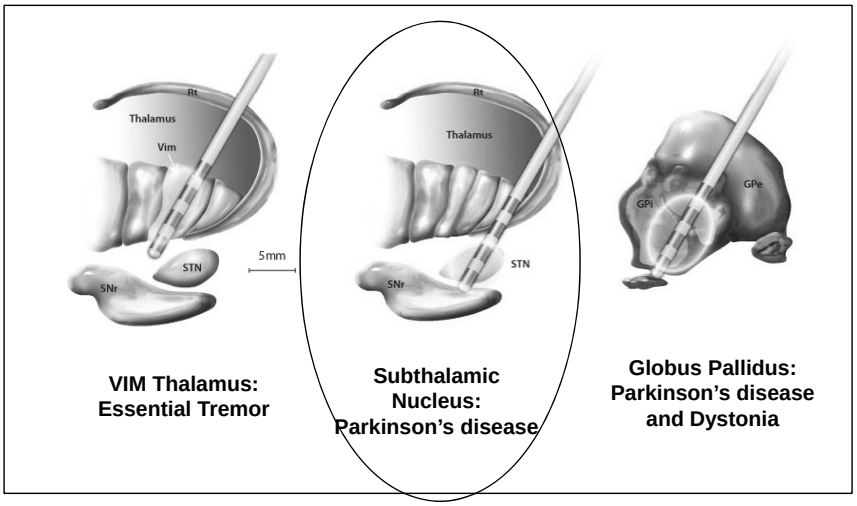


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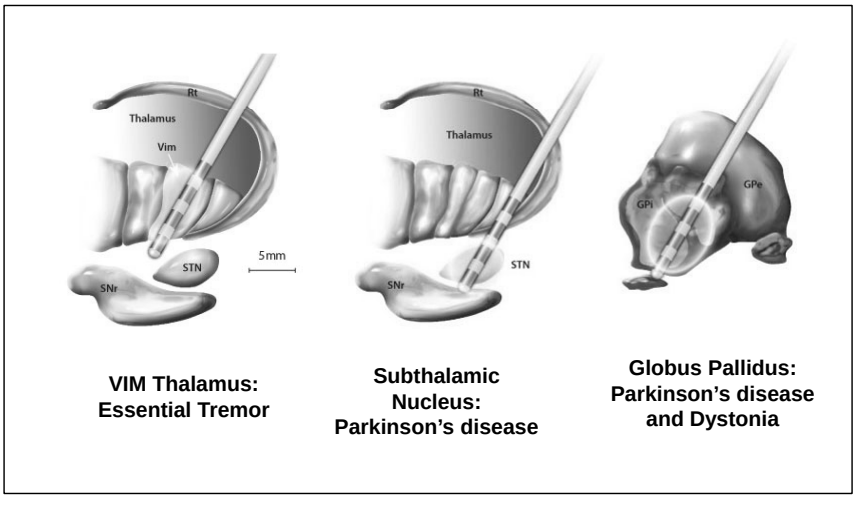


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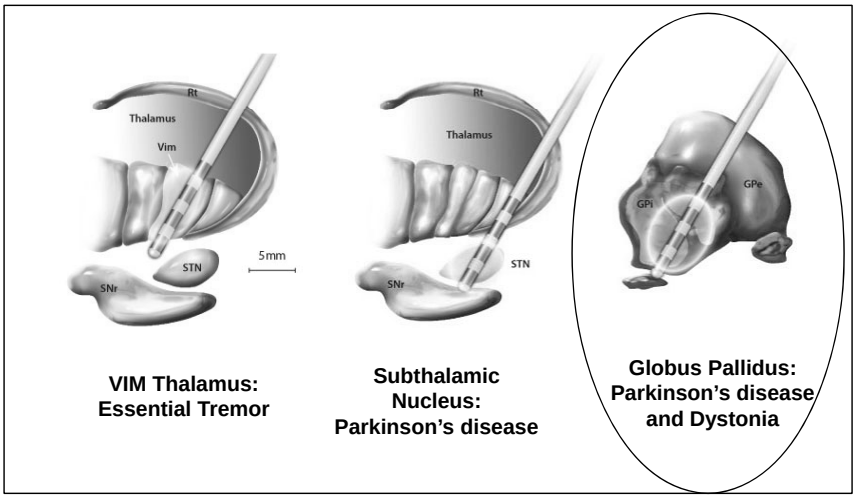


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# Tremor

**Video**

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# Tremor

- **Consider DBS if refractory to medications:**

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| | | | |
|---|---|---|---|
| **Propranolol** | **Primidone** | **Gabapentin** | **Benzodiazepines** |
| **PD medications** | **Carbamazepine** | **Mirtazapine** | **Clozapine** |

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- **Target area of stimulation: VIM Thalamus**

**Video with the permission from Medtronics:**
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# American Academy of Neurology Tremor Guidelines – released June 2005

- **Unilateral thalamic VIM DBS resulted in a significant (60 to 90%) reduction of contralateral limb tremor**

**Zesiewicz TA, Elbe R, Louis ED, et al. Practice Parameter: Therapies for essential tremor. Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* 2005;64:2008-2020**

# Tremor – DBS Off vs On


## Video

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- ***Loss of smell***
- ***Excessive drooling***
- ***Gastro-esophageal Reflux***
- ***Depression/ Anxiety***
- ***Memory /Cognitive changes***
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- ***Skin changes***
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# PD Dyskinesia

## Parkinson's Disease with Medication Refractory Tremor

**Video**

**Clear Idiopathic Parkinson's Disease with Medication Intolerance**

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  - **3) *Medication intolerance***

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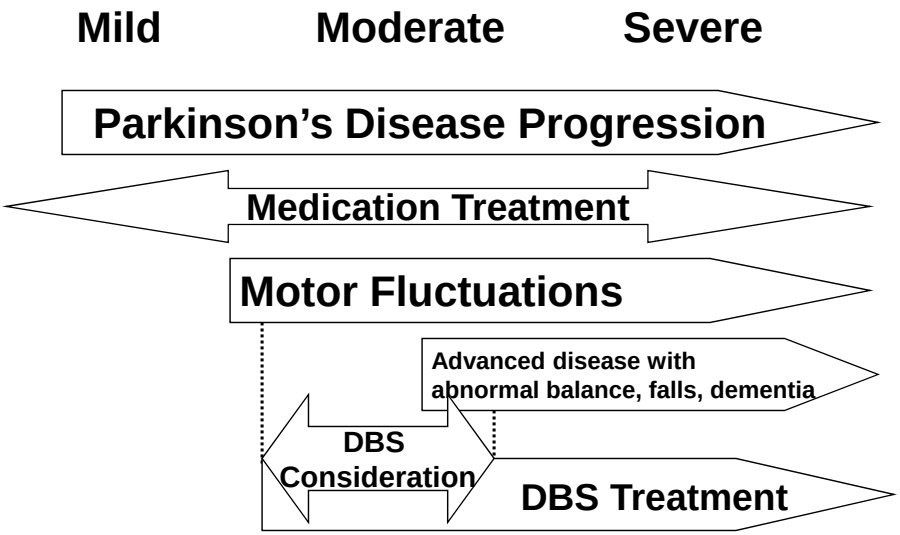
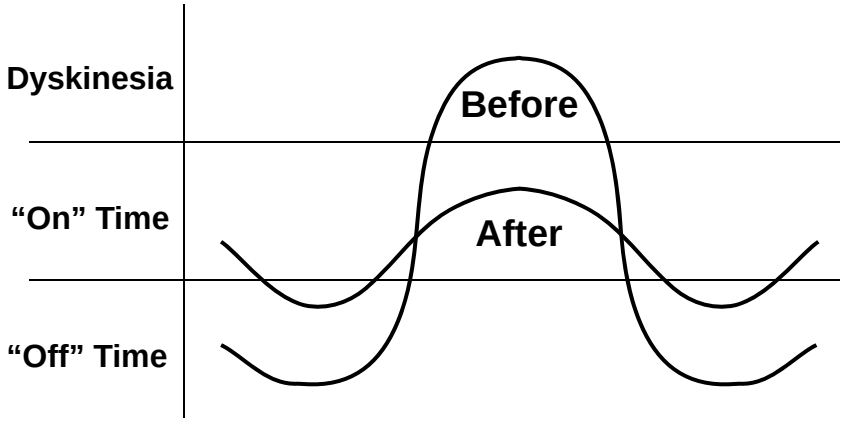
- **No co-morbid psychiatric/behavioral problem**
- ***Realistic expectations* and good social support**

## PD – DBS Treatment Window



## Efficacy: Benefits of Activa Therapy Impact on Mobility




This graph is only for illustrative purposes and does not represent actual "on" and "off" time.

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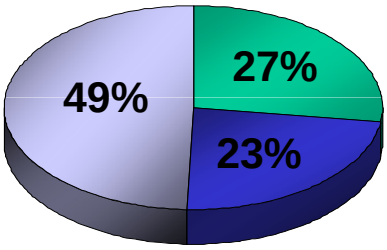
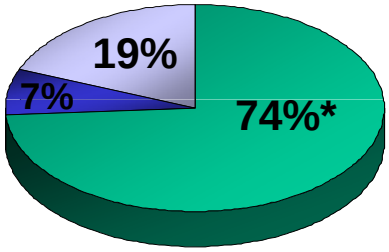
## "ON" Time Without Dyskinesias Improves from 27% to 74% of a Patient's Waking Day"




Before Surgery
*(n=96)*




6 Months After Surgery
Bilateral STN Activa® Implant
*(n=91)*

☐ 'ON' with Dyskinesia ☐ 'ON' without Dyskinesia ☐ 'OFF'

* The Deep-Brain Stimulation for Parkinson's Disease Study Group. Deep-brain stimulation of the subthalamic nucleus for the pars interna of the globus pallidus in Parkinson's disease. *N Eng J Med.* 2001;345:956-63.

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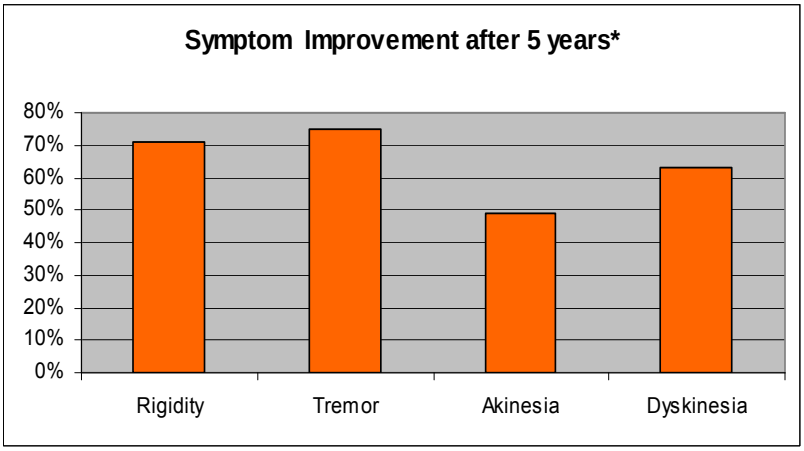
# DBS: PD




***Sources: Krack P, Batir A, Van Blercam N, et al. Five-year follow-up of bilateral stimulation of the subthalamic nucleus in advanced Parkinson's disease. *N Engl J Med.* 2003;349:1925-1934.**

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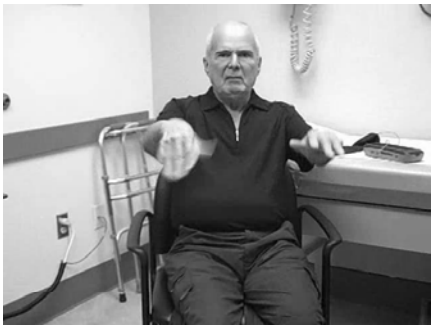
# Parkinson's Disease Off and On DBS



## Video

**Right video with the permission from Medtronics:**
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## American Academy of Neurology PD Guidelines – Released in April 2006

- **10 - 20% of people with Parkinson disease may be eligible for surgical intervention and treatment**

**AAN Guideline Summary for Patients and their Families: Medical and Surgical Treatment for Motor Fluctuations and Dyskinesia in Parkinson Disease, 2006**

## Dystonia

- **Definition: sustained muscle contractions causing posturing, twisting, or repetitive movements**
- **Can be primary or secondary**
- **Dystonia is commonly described based on involved areas:**
  - **Focal: one area (torticollis, blepharospasms, writer's cramp, or other occupational dystonia)**
  - **Segmental: two or more contiguous areas**
  - **Hemidystonia: either left or right side of the body**
  - **Generalized: crural or other parts**

# Consider DBS for Primary Dystonia after other treatments fail

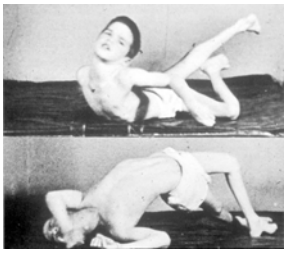
- Currently approved under Humanitarian Device Exemption (HDE)
- Candidates
  - Primary Dystonia (i.e. DYT1 positive), including generalized and segmental dystonia, hemidystonia and cervical dystonia (torticollis)
  - Disabling symptoms that are inadequately treated by medications or other treatments
  - Approved for pediatrics (age 7 and older)

ORIGINAL ARTICLE

Pallidal Deep-Brain Stimulation in Primary Generalized or Segmental Dystonia

N Engl J Med 2006;355:1978-90.

- Double blind, class I study
- 40 pts with GPi DBS randomized to Stimulation or Sham for 3 months
- At 3 months, all patients received open label active stimulation until the 6-month outcome measure
  - Stim ON: 15.8±14.1points
  - Sham: 1.4±3.8 points (P<0.001)
- BFMDRS score reduction



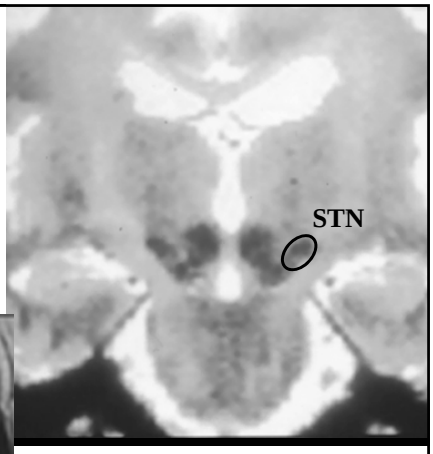
# DBS Evaluation

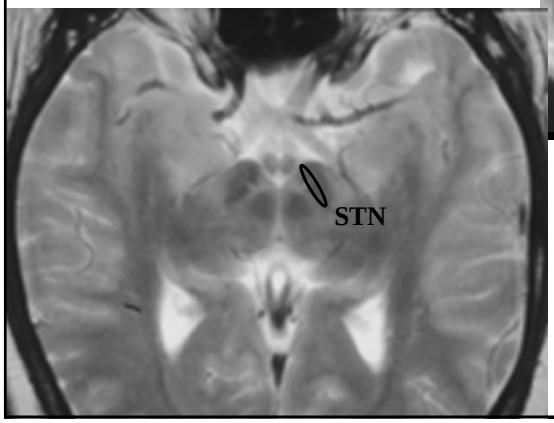
- Movement Disorder Neurology
  - Evaluate medications and disease
  - Discuss realistic goals of therapy
  - Levodopa ON-OFF assessment in Parkinson's disease
- Neurosurgery
  - Discuss surgery, implantable devices, risks
- Brain Imaging
- Neuropsychological testing

# Poor Candidates for DBS

- Significant dementia or cognitive impairment
  - Neuropsychological compromise
- Untreated depression, anxiety, psychosis, or other psychiatric illness
- Unable to cooperate during surgical procedure
- Unable to cooperate during programming visits
- Unrealistic expectations of outcomes
- Co-existing medical problems that significantly increase risks of surgery
  - Uncontrolled heart disease, lung disease, hypertension, or diabetes.
- Significant structural abnormalities detected by brain imaging that would pose higher risk of brain surgery

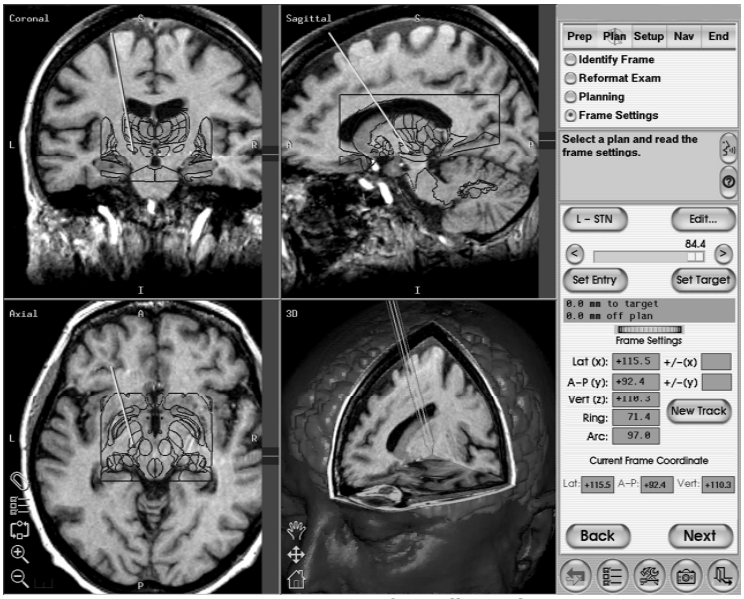
# Targeting



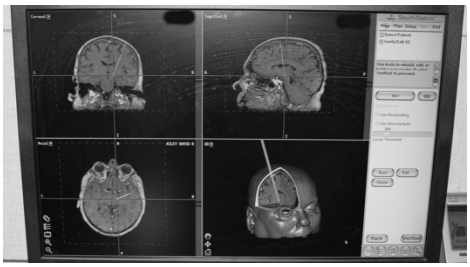

Courtesy of Professor AL Benabid

# Anatomical Atlas Morphing and Targeting

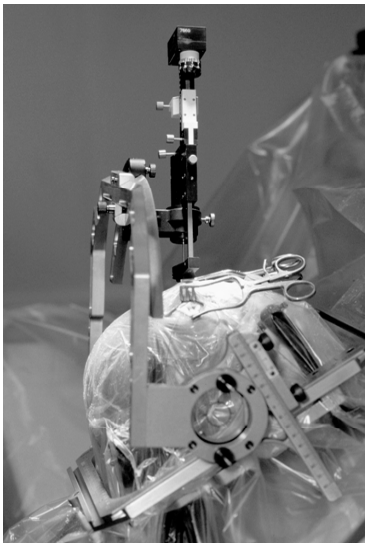



Courtesy of Dr. Ali Rezai

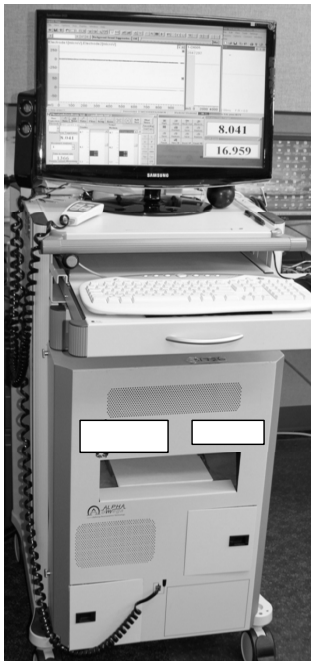
# Surgery

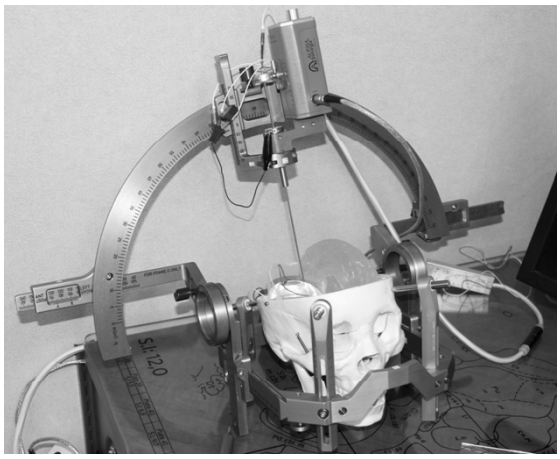


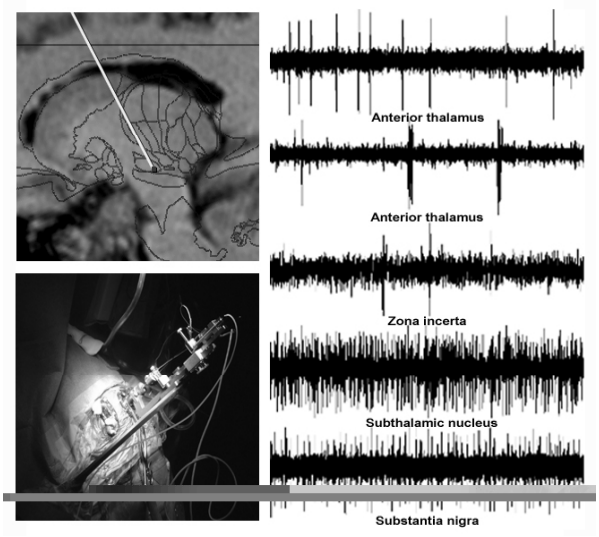
Courtesy of Dr. Ali Rezai

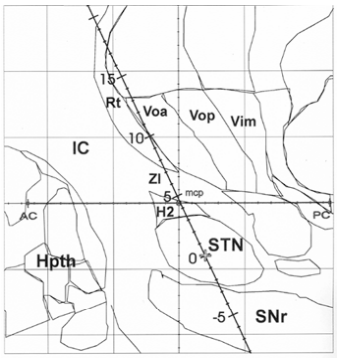


http://en.wikipedia.org/wiki/File:Parkinson_surgery.jpg






**Courtesy of Dr. Ali Rezai**

# Intra-operative Testing

**Video**

**Video with the permission from Medtronics:**
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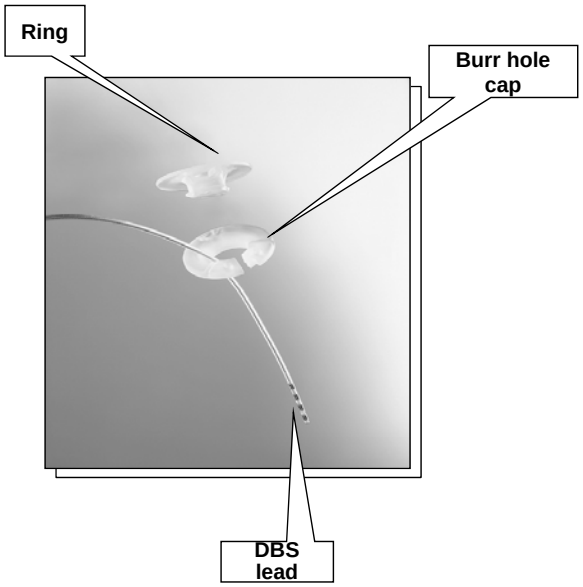


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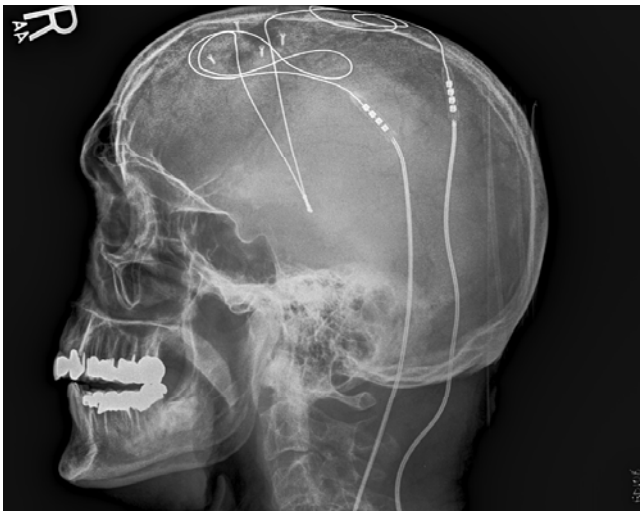
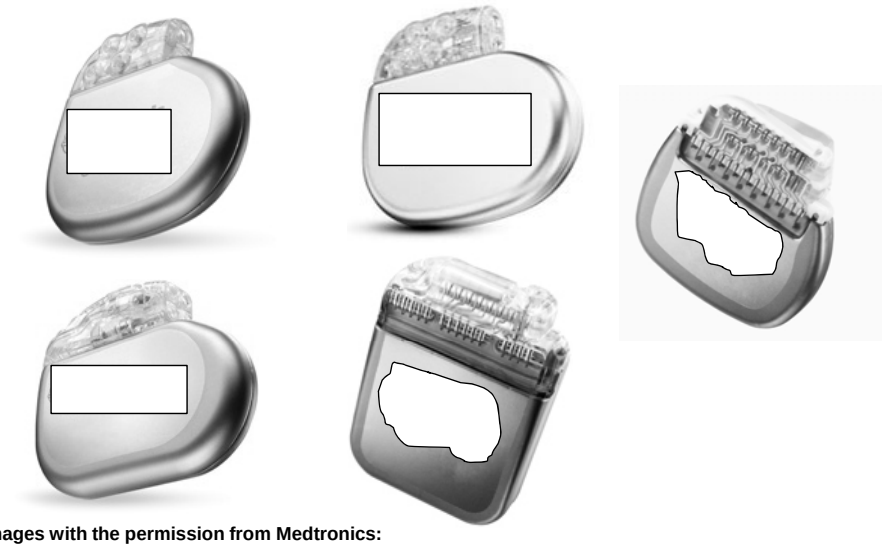



# DBS Neurostimulators



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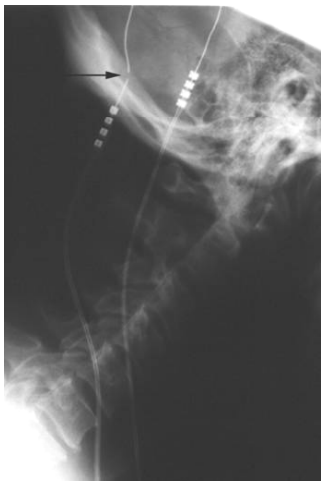
# Potential Complications/Risks



- ***Stroke***
  - ***Hemorrhage or Infarction (inherent in any stereotactic procedure) : May be silent or symptomatic***
- ***Confusion or cognitive changes (may be transient)***
- ***Infection (typically occurs at neurostimulator site in chest when it does occur)***
- ***Device related (hardware failure)***

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# DBS Post-Implant Programming

- **First programming 4-6 weeks after surgery**
- **Adjustments in first 3-6 months**
- **Neurostimulator is replaced when battery needs replacing (outpatient procedure)**

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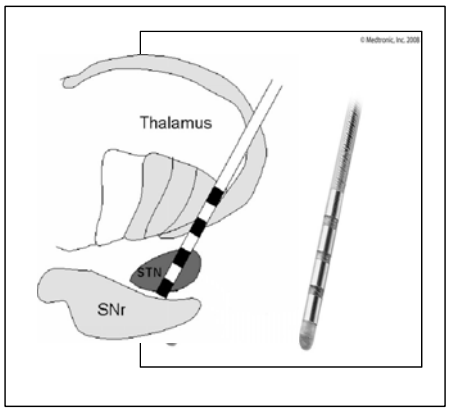
# Individualized Therapy

- **Adjustable parameters maximizes the therapeutic effect:**

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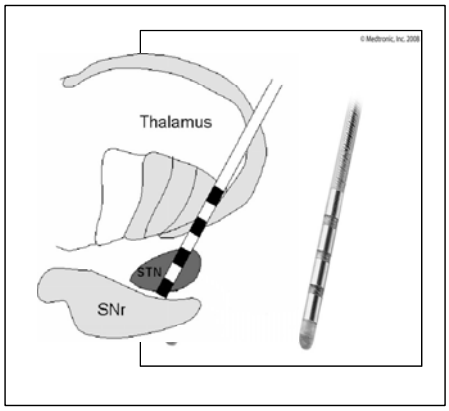
# Individualized Therapy

- **Adjustable parameters maximizes the therapeutic effect:**
  - **Electrode(s)**
  - **Polarity**
  - **Amplitude**
  - **Pulse width**
  - **Rate**
- **Stimulation related side effects reversible with adjustments**

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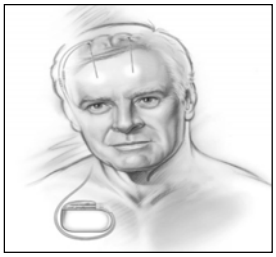
# Patient Access Review Devices





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  - Electrical or radiofrequency therapeutic devices
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  - Metal/theft detectors
  - Store refrigerators, industrial microwave ovens
  - Arc welding equipment, high voltage power lines

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- Caution with other medical devices (external defibrillation, cardiac pacemakers)

# Summary

- **Overall, DBS has potential for being life altering for for those suffering from essential tremor, Parkinson's disease and also primary dystonia.**
- **With proper patient selection we have excellent outcomes.**
- **Though some restrictions, continued DBS therapy does not have many limitations.**