

# Deep Brain Stimulation for Parkinson's Disease

Josue M. AVECILLAS-CHASIN M.D. Ph.D.  
 Assistant Professor  
 Department of Neurosurgery  
 University of Nebraska Medical Center

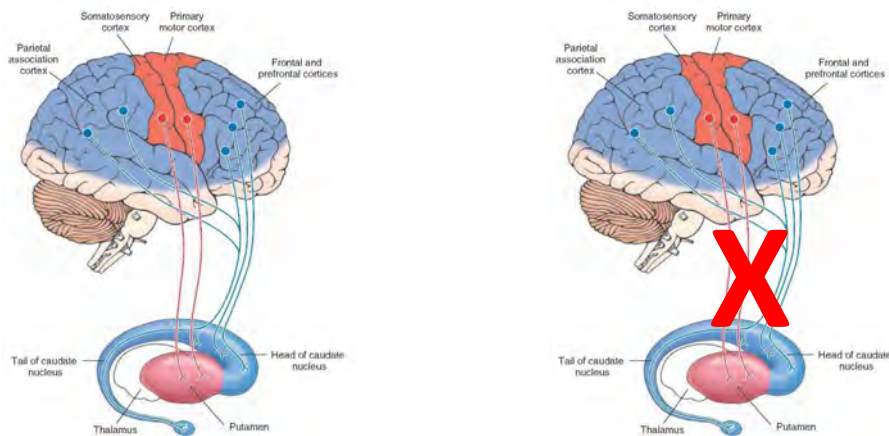
University of Nebraska  
 Medical Center



Nebraska  
 Medicine

1

## What is Parkinson's disease?



2

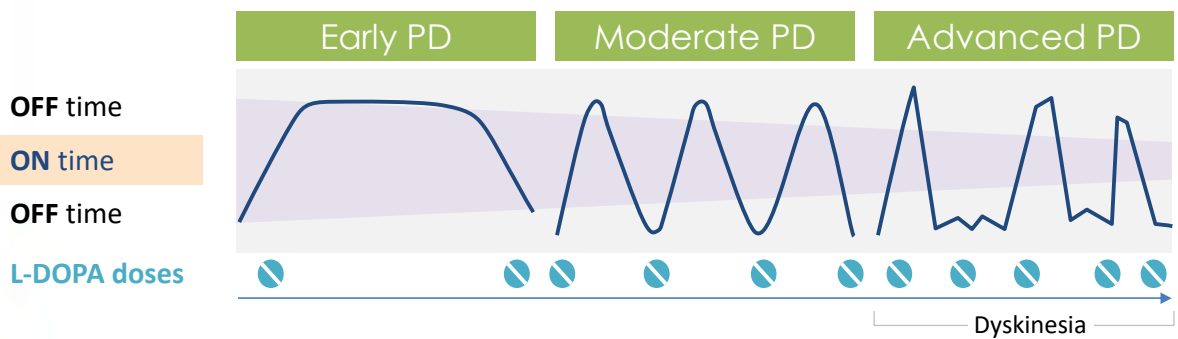
# Treatment strategies

1. Exercise
2. Rehabilitation
3. Medications



3

## ON/OFF Fluctuations with levodopa treatment



Long term use of L-DOPA may cause unintended side effects such as **dyskinesia**—rapid, uncontrolled movements

**ON/OFF fluctuations** are often a catalyst for a switch to another medication

References: Mayo Clinic, 2021; Michel J Fox Foundation, 2021.



4

# Treatment strategies

1. Exercise
2. Rehabilitation
3. Medications
4. Surgery
  1. Lesioning
  2. Deep brain stimulation



5

# History

1900-1960 Cortical ablation, pedunculotomy, cordotomy, open basal ganglia surgery, stereotactic lesioning.

1960-1970 **L-dopa** introduction. Only indication for surgery was tremor resistant. Then **motor complications** started to appear... motor fluctuations and L-induced dyskinesias

Better models of basal ganglia suggesting that (-) PD symptoms related with hyperactivity of **GPI and STN**



6

# History

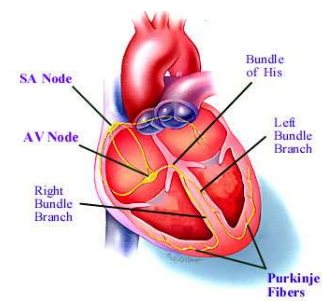
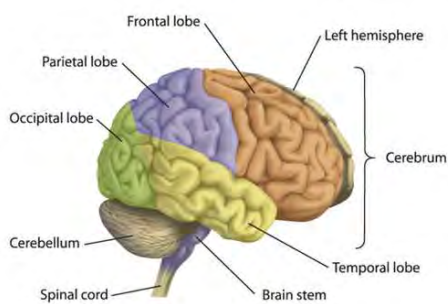
1991 Benabid **thalamic stimulation**. Results comparable to thalamotomy, ability to do bilateral.

1995 Benabid/Limousin, Grenoble-France **STN stimulation**



7

## What is Deep brain Stimulation (DBS) surgery?



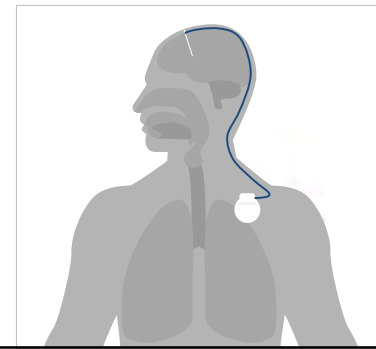
The Brain, much like the Heart is an **electrical** organ

•DBS>>*Brain Pacemaker*



8

# What is Deep brain Stimulation (DBS) surgery?



9

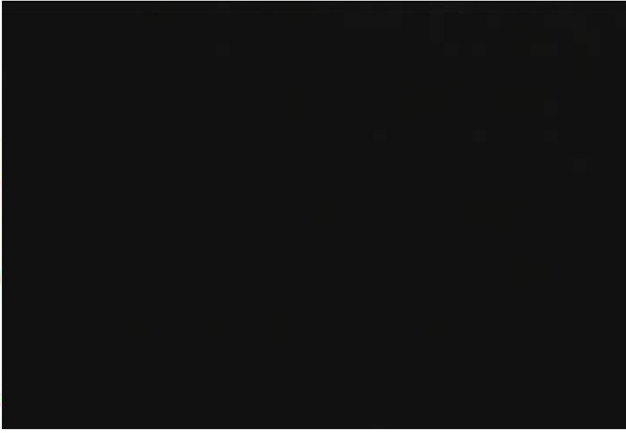
# What is Deep brain Stimulation (DBS) surgery?



Presented with permission of the patient

10

## What is Deep brain Stimulation (DBS) surgery?



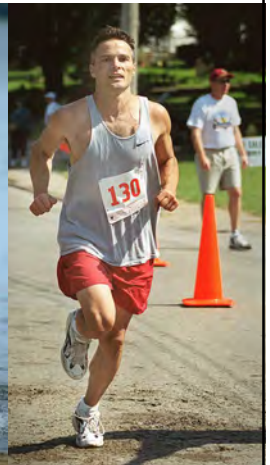
11

## What is Deep brain Stimulation (DBS) surgery?

- To **Improve** quality of life>> symptomatic treatment

- Not Cure for Parkinson's disease

- Offer **Hope** for medically intractable patients



12



# Where are we now?

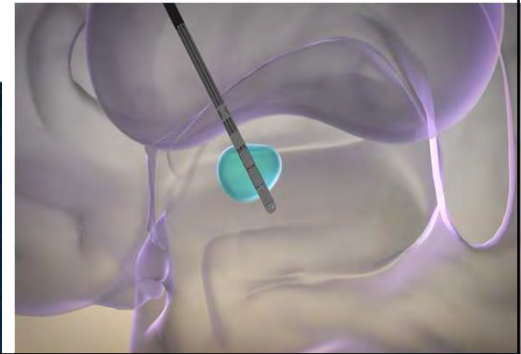
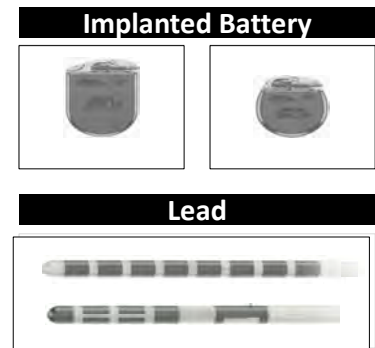
Parkinson's disease/Tremor/Dystonia

FDA approval

Covered by ALL insurance carriers including Medicare

Rechargeable option

Many other technological advances.... Directional, sensing



13

# DBS Surgery: General Concepts

- Who is a candidate?
- What can (and cannot) DBS do for patients?
- The Procedure
- What happens after surgery

University of Nebraska  
Medical Center



Nebraska  
Medicine

14

# DBS Surgery: General Concepts

- Who is a candidate?

University of Nebraska  
Medical Center

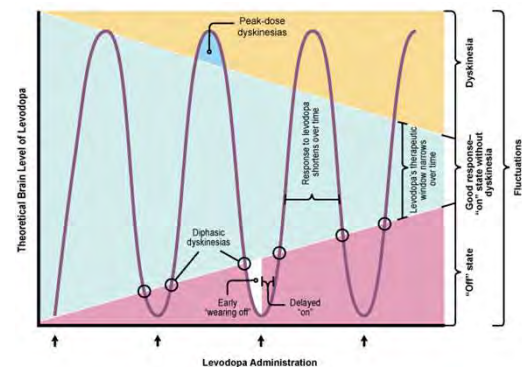


Nebraska  
Medicine

15

## Who is a candidate for DBS? Parkinson's disease

- **Motor fluctuations**
- **Dyskinesias**
- **Medication-resistant tremor**
- **Not able to tolerate medications**



16



# Who is a candidate for DBS? Tremor

- **Disabling to activities of daily living**
  - Eating
  - Dressing
  - Socializing
- **Intractable to medications**
  - Beta blockers
  - Primidone



17

# DBS Surgery: Patient selection

- Behavioral testing
  - Levodopa responsiveness (CAPSIT)– ON-OFF Test
  - UPDRS Scales
  - Videotaping
- Neuropsychological evaluation
  - Cognitive issues
  - Untreated psychiatric disease
  - **Minimize risk**
- Stereotactic MRI
  - Precise surgical targeting



18

# DBS Surgery: General Concepts

- Who is a candidate?
- What can (and cannot) DBS do for patients?

University of Nebraska  
Medical Center



Nebraska  
Medicine

19

## DBS for PD: Results (the Good!)

- RESULTS of DBS for PD
- Many 5 year+ studies
- 70% reduction in dyskinesias
  - 50% medication reduction
- 80% reduction in tremor
- 60% reduction in bradykinesia
- 70% reduction in rigidity
- 70% improvement in peak ON-time
- 70% reduction in worst OFF-time



20

## DBS for PD: Results (the not-good)

- Gait freezing (especially ON-freezing)
- Axial Instability
- Balance
- Neuroprotective (?)
- Cognitive issues (?)
- Apathy (?)
- Depression and anxiety (?)



21


## DBS Surgery: What it isn't....

University of Nebraska  
Medical Center



Nebraska  
Medicine

22

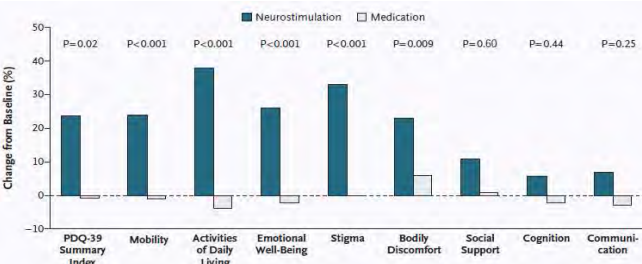


**DBS is surgery of Last Resort**

• *It's not about getting patients out of the nursing home, it's about getting patients back on the golf course. . .*

23

- 5+ studies comparing DBS with Best Medical Therapy Alone (BMTA)
  - New England Journal of Medicine
  - The Lancet
  - Journal of the American Medical Association
- **Quality of Life**
  - **measures significantly more improved in DBS group**
  - ***“I waited too long....”***



Category	Neurostimulation (%)	Medication (%)	P-value
PDQ-39 Summary Index	~25	~0	P=0.02
Mobility	~25	~0	P<0.001
Activities of Daily Living	~38	~0	P<0.001
Emotional Well-Being	~25	~0	P<0.001
Stigma	~35	~0	P<0.001
Bodily Discomfort	~25	~10	P=0.009
Social Support	~10	~0	P=0.60
Cognition	~5	~0	P=0.44
Communication	~5	~0	P=0.25

24

# DBS Surgery: The Procedure

University of Nebraska  
Medical Center



Nebraska  
Medicine

25

## Two Part Procedure

- Implantation of **DBS electrode**
  - Headframe placement
  - Staged approach
- Implantation of the **pacemaker**



26

# Implantation of the electrode: Location, Location, Location..

Parkinson's disease:

- Subthalamic nucleus (STN)
- Globus Pallidus pars interna (GPi)

Tremor (Parkinson):

- Thalamus

Dystonia:

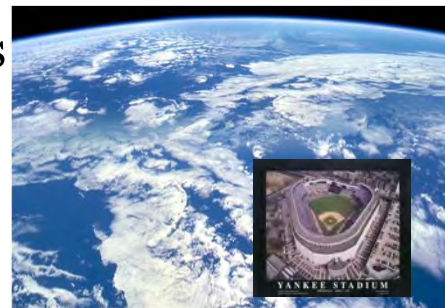
- Globus Pallidus pars interna (GPi)



27

# Implantation of the electrode:

• Hitting these brain targets is like hitting home plate from earth orbit



• These brain targets are millimeters in size

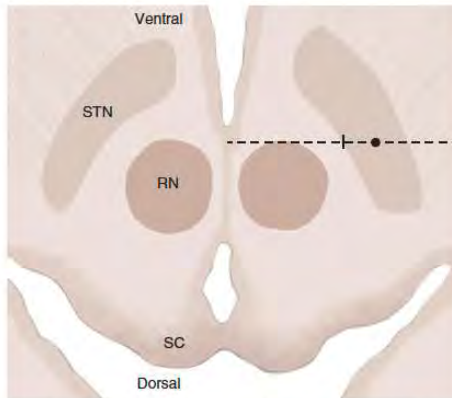
- need to hit only a small portion of them



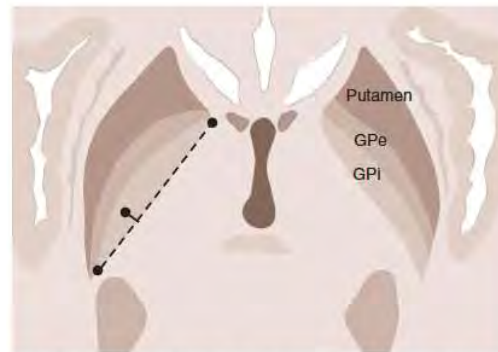
28



# Implantation of the electrode: Targets



**Figure 89-2. Midbrain at 4 mm below the midcommissural plane.** The line parallel to the ventral border of the RN (*dashed line*) is extended to the midpoint of the STN (*black dot*) or, if the lateral border is difficult to interpret, at least 2 mm away from the STN medial border (*short vertical bar*) for targeting. RN, red nucleus; SC, superior colliculi; STN, subthalamic nucleus.



**Figure 89-3. The axial cut at the midcommissural plane.** The medial border of the GPI is split into thirds (*dashed line*) and a point 3 to 4 mm lateral and perpendicular to the line at the junction of the posterior one third and anterior two thirds (*short vertical bar with black dot*) is used for targeting. GPe, globus pallidus externa; GPI, globus pallidus interna.



29

# Sleep vs. Awake Surgery



30

## Implantation of the electrode: Awake Surgery??

- Parkinson's disease **does NOT** exist in the sleeping state
  - The brain signals we use to precisely target the areas for DBS implantation are altered by the sleeping state or general anesthesia
- Patient **WILL** be sedated for skin incision and burr hole placement
- Patient **WILL NOT** feel any pain by the brain mapping or electrode implantation
- **THE BRAIN FEELS NO PAIN !**



31

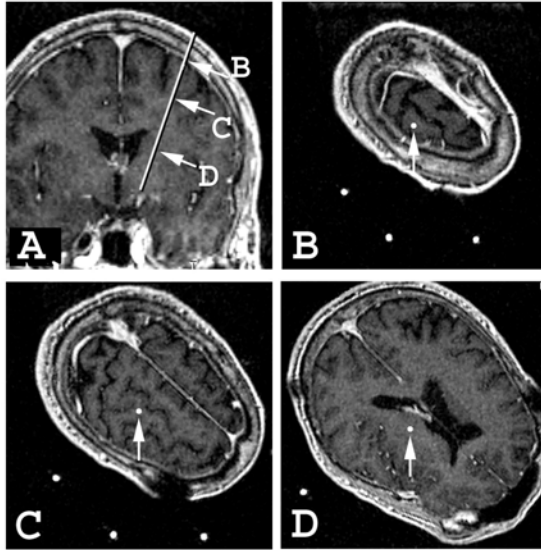
## Implantation of the electrode: Headframe

- Morning of surgery
- 15 minutes
- Local & Sedation
- Followed by CT scan

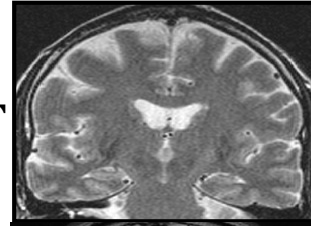


32

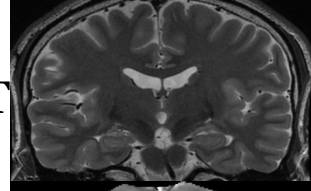
## Implantation of the electrode: Plan



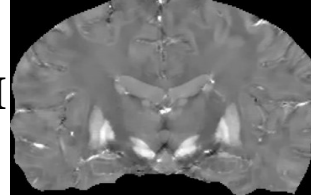
1.5 T



3.0 T

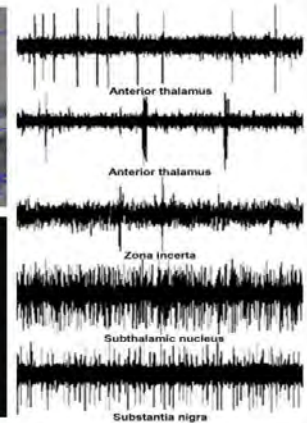
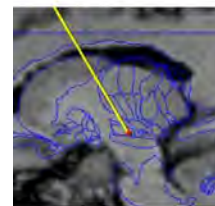
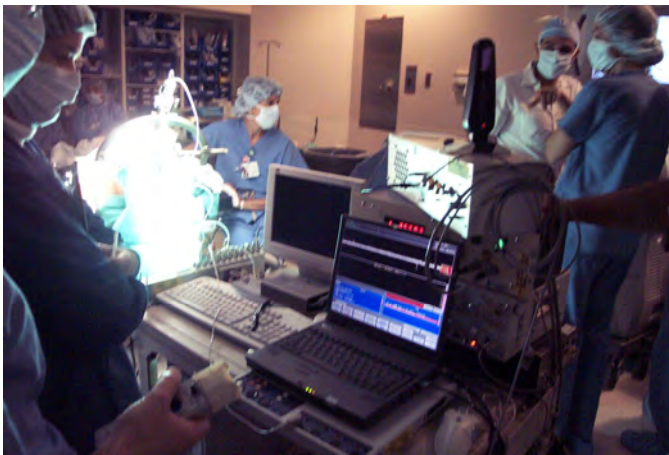


QSM



33

## Implantation of the electrode: Microelectrode recording (MER)



34



## Implantation of the electrode: Intraoperative testing



35

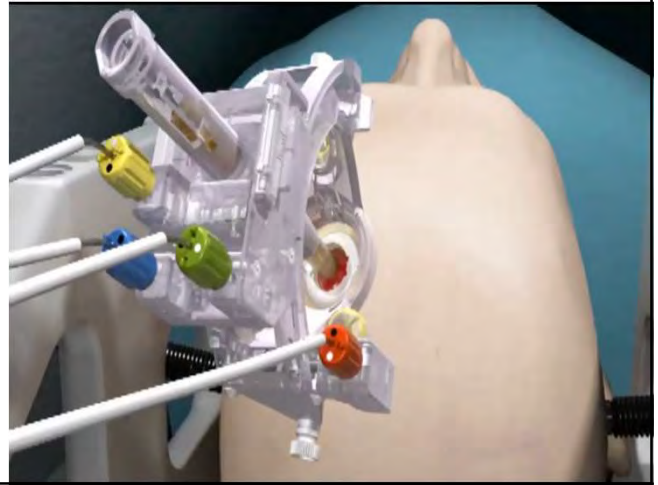
## Implantation of the electrode: Intraoperative testing

- Macrostimulation with DBS electrode
  - Clinical benefits
  - Side effects



36

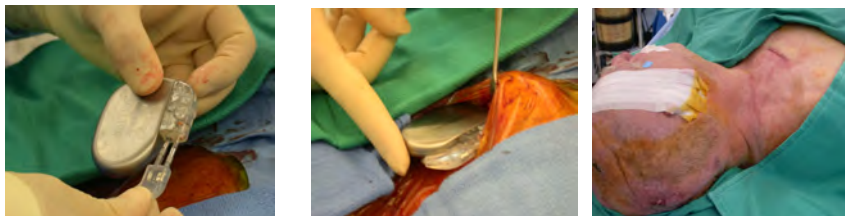
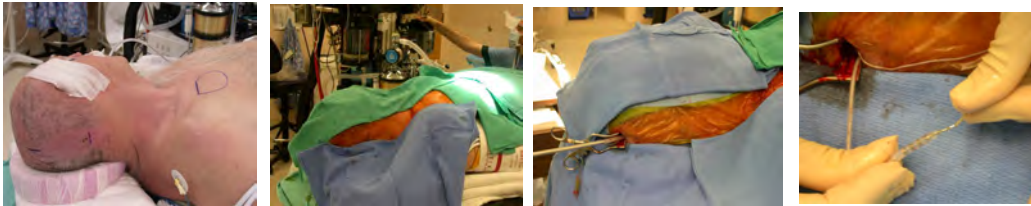
## Implantation of the electrode: Asleep Intraoperative MRI



37

## Implantation of the Pacemaker

- Outpatient
- General Anesthesia



38

# Complications

Hemorrhage: 1%

Infection: 3 %

Hardware related: 3%

Speech--- Variable, more likely with pre-existing problems



39

# What Happens After Surgery?

University of Nebraska  
Medical Center



Nebraska  
Medicine

40



# Programming

- Movement Disorder Neurologist
- Advanced practice provider
- Nurses
  
- **Weeks to Months** (Tremor shortest, Dystonia longest)
- Medication AND stimulation adjustments
- **Patience!**
  
- Lifestyle management
  - Exercise



41

## Our approach at UNMC

History  
 Neurological examination  
 Imaging  
**Diagnosis**  
**Co-morbidities**  
 Quality of life: work and personal life  
 Conservative  
 Neuropsychological evaluation  
**Multidisciplinary consensus**  
 Plan

Special Imaging  
 Surgical Treatment  
 Postoperative follow-up  
 Adjustments  
 Other treatments as needed



42

## Our approach: Multidisciplinary

- Neurologists
- Neurosurgeons
- Neuroradiologists
- Neuropsychologists
- Advanced practice providers
- Anesthesiologists
- Neurophysiologists
- Psychiatrists



43

## DBS for Parkinson's disease: Conclusion

- **Medication complications, Medication resistant, Not able to tolerate medications**
- **This is no longer surgery of “last resort”**
  - The efficacy and safety of DBS **supports its use in earlier-stage patients**
  - **Advantage of DBS over medical management alone**
- **Better operative procedure:** Image Guidance, Less risk
- Rigorous patient selection



44