

Deep Brain Stimulation for Parkinson's Disease

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Neurosurgery
Monument Health

Disclosures



- Consultant for Omniscent Neuroscience
- Research support from DIXI Medical
- Training grant from Medtronic
- Training grant from Boston Scientific
- Training grant from Neurosurgery Research and Education Foundation

Parkinson's Disease



Parkinson's Disease (PD)

- Fastest growing neurodegenerative condition
 - Outpacing Alzheimer's Disease growth
 - Global PD population doubled from 3 million to 6 million
 - Expected to double again to 12 million by 2040
- Movement disorders prominent
 - Bradykinesia, rigidity, tremor, gait instability
- Mood and cognitive symptoms:
 - Apathy more common than depression
- Anosmia
- Autonomic symptoms
- Disordered sleep

Parkinson's Disease



Brief History

- 1817 James Parkinson described the “shaking palsy”
- 1919 degeneration of substantia nigra recognized
- 1950s dopamine depletion recognized (Nobel Prize)
- 1950 stereotactic lesioning of the globus pallidus was performed with success
- 1968 dopamine therapy (levodopa) was successful
- 1990s pallidotomy revived for post-levodopa dyskinesias
- 1990s deep brain stimulation FDA approved after RCTs
- 2026 focused ultrasound FDA approved

Parkinson's Disease



ORIGINAL ARTICLE

A Randomized Trial of Deep-Brain Stimulation for Parkinson's Disease

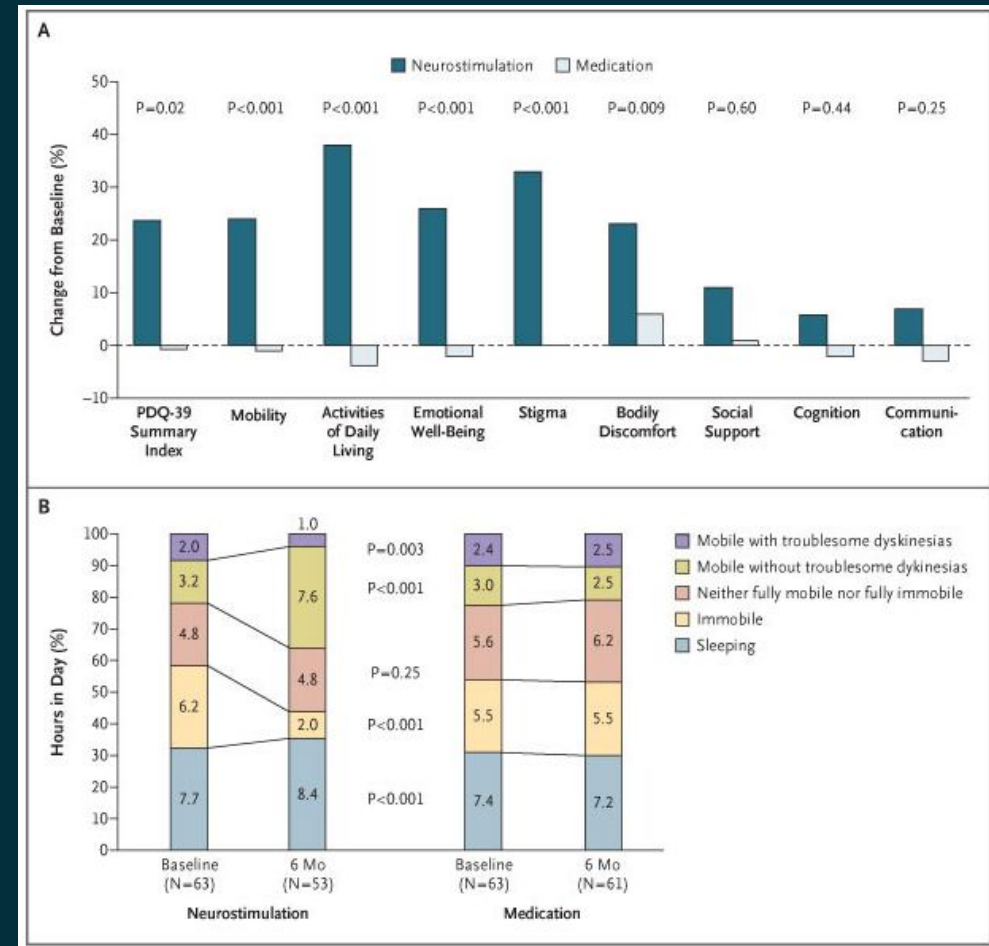
This article has been corrected. [VIEW THE CORRECTION](#)

Authors: Günther Deuschl, M.D., Ph.D., Carmen Schade-Brittinger, Paul Krack, M.D., Ph.D., Jens Volkmann, M.D., Ph.D., Helmut Schäfer, Ph.D., Kai Bötzel, M.D., Ph.D., Christine Daniels, M.D., ⁺³¹, for the German Parkinson Study Group, Neurostimulation Section [Author Info & Affiliations](#)

Published August 31, 2006 | N Engl J Med 2006;355:896-908 | DOI: 10.1056/NEJMoa060281 | **VOL. 355 NO. 9**

PD Study Group Trial

- n = 255
- Medication versus medication plus stimulation
- Neurostimulation: improvement of 24-38 % in the PDQ-39 subscales for mobility, activities of daily living, emotional



Parkinson's Disease



JAMA[®]

Original Contribution

FREE

Bilateral Deep Brain Stimulation vs Best Medical Therapy for Patients With Advanced Parkinson Disease

A Randomized Controlled Trial

Frances M. Weaver, PhD; Kenneth Follett, MD, PhD; Matthew Stern, MD; [et al](#)

Table 2. Patient Motor Diary Outcomes

Time	Best Medical Therapy (n = 134)			Deep Brain Stimulation (n = 121)			Best Medical Therapy Minus Deep Brain Stimulation	P Value ^a
	Baseline, Mean (SD)	6 mo, Mean (SD)	Mean Difference (95% CI)	Baseline, Mean (SD)	6 mo, Mean (SD)	Mean Difference (95% CI)	Mean Difference (95% CI)	
On, h/d ^b								
Without troublesome dyskinesia	7.0 (2.9)	7.1 (3.3)	0 (-0.5 to 0.5)	6.4 (2.7)	10.9 (4.2)	4.6 (3.8 to 5.3)	-4.5 (-5.4 to -3.7)	<.001
With troublesome dyskinesia	4.2 (3.1)	3.9 (3.3)	-0.3 (-0.8 to 0.3)	4.4 (3.1)	1.8 (3.0)	-2.6 (-3.3 to -2.0)	2.3 (1.5 to 3.2)	<.001
Off, h/d ^b	5.6 (2.9)	5.7 (2.8)	0 (-0.4 to 0.5)	5.9 (2.6)	3.4 (3.1)	-2.4 (-3.1 to -1.8)	2.5 (1.7 to 3.2)	<.001
Asleep, h/d	7.1 (1.7)	7.3 (2.0)	0.3 (0 to 0.6)	7.3 (1.8)	7.7 (2.0)	0.4 (0 to 0.7)	-0.1 (-0.6 to 0.4)	.66

Abbreviation: CI, confidence interval.
^aTest for the change scores from baseline to 6 months between the best medical therapy group and the deep brain stimulation group.
^b"On" and "off" time are described in the "Study Procedures" section of the "Methods."

VA/NINDS Trial

- n = 255
- Medication versus medication plus stimulation
- Neurostimulation > medical therapy alone
 - ON time (symptom free) (P<0.001)
 - ON time without dyskinesia (P<0.001)

Parkinson's Disease



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ORIGINAL ARTICLE



Neurostimulation for Parkinson's Disease with Early Motor Complications

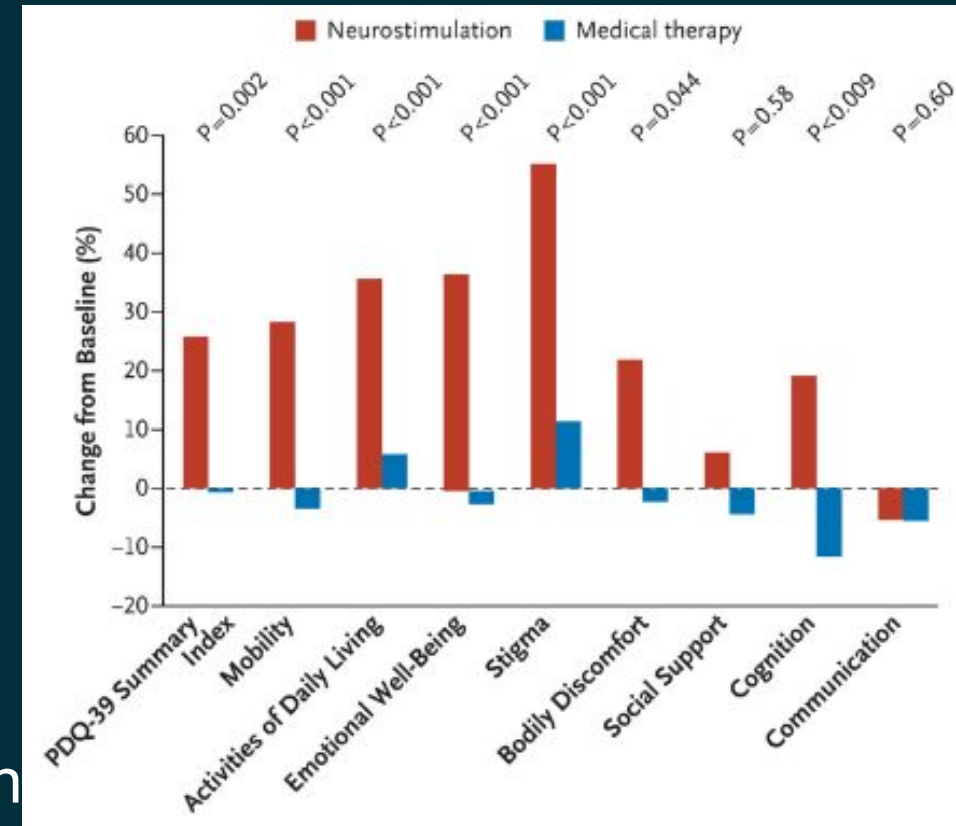
Authors: W.M.M. Schuepbach, J. Rau, K. Knudsen, J. Volkmann, P. Krack, L. Timmermann, T.D. Hälbig, ⁺⁴³, for the EARLYSTIM Study Group* [Author Info & Affiliations](#)

Published February 14, 2013 | N Engl J Med 2013;368:610-622 | DOI: 10.1056/NEJMoa1205158 | [VOL. 368 NO. 7](#)

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EARLYSTIM

- n =252 (average age 52)
- Medication versus medication plus stimulation
- Neurostimulation > medical therapy
 - motor disability ($P<0.001$)
 - activities of daily living ($P<0.001$)
 - levodopa-induced motor complications ($P<0.001$)



Parkinson's Disease



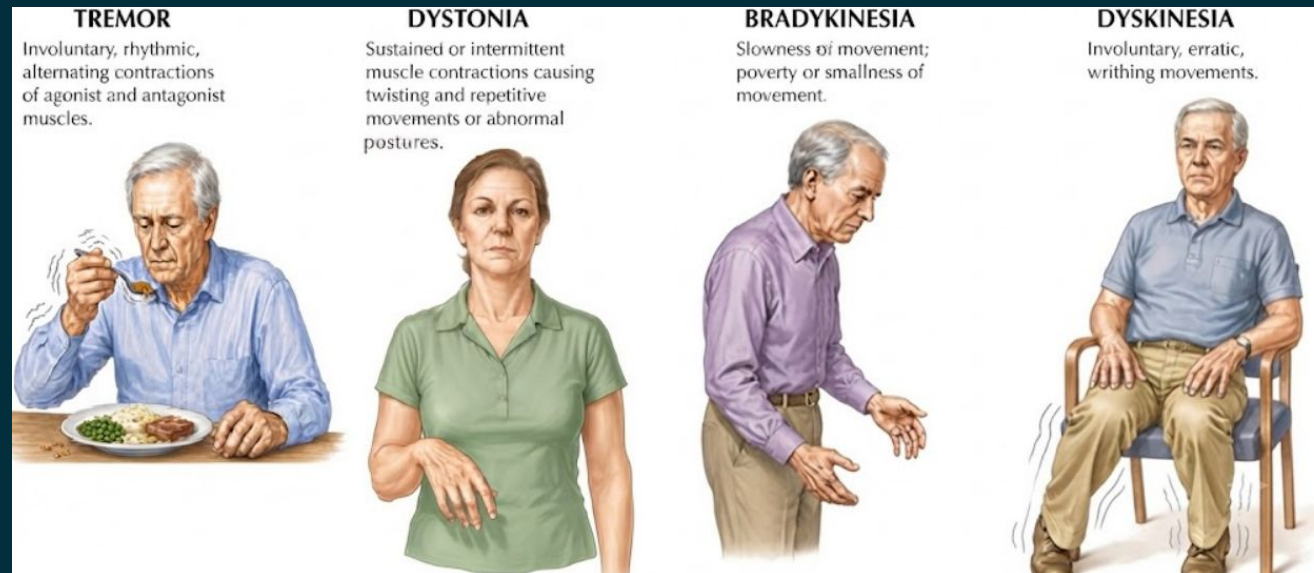
Quality of Life

- Eliminating the “ON/OFF” Rollercoaster
 - Adding 4-5 hours of “ON” time in the day where medication works
- Restoring fine motor Activities of Daily Living (ADLs)
- Eliminating dyskinesia
 - Stopping unwanted, troublesome movements
- Relief from “OFF” state discomfort
 - Dystonia is often painful and can be eliminated or greatly improved
- Improving social stigma/anxiety

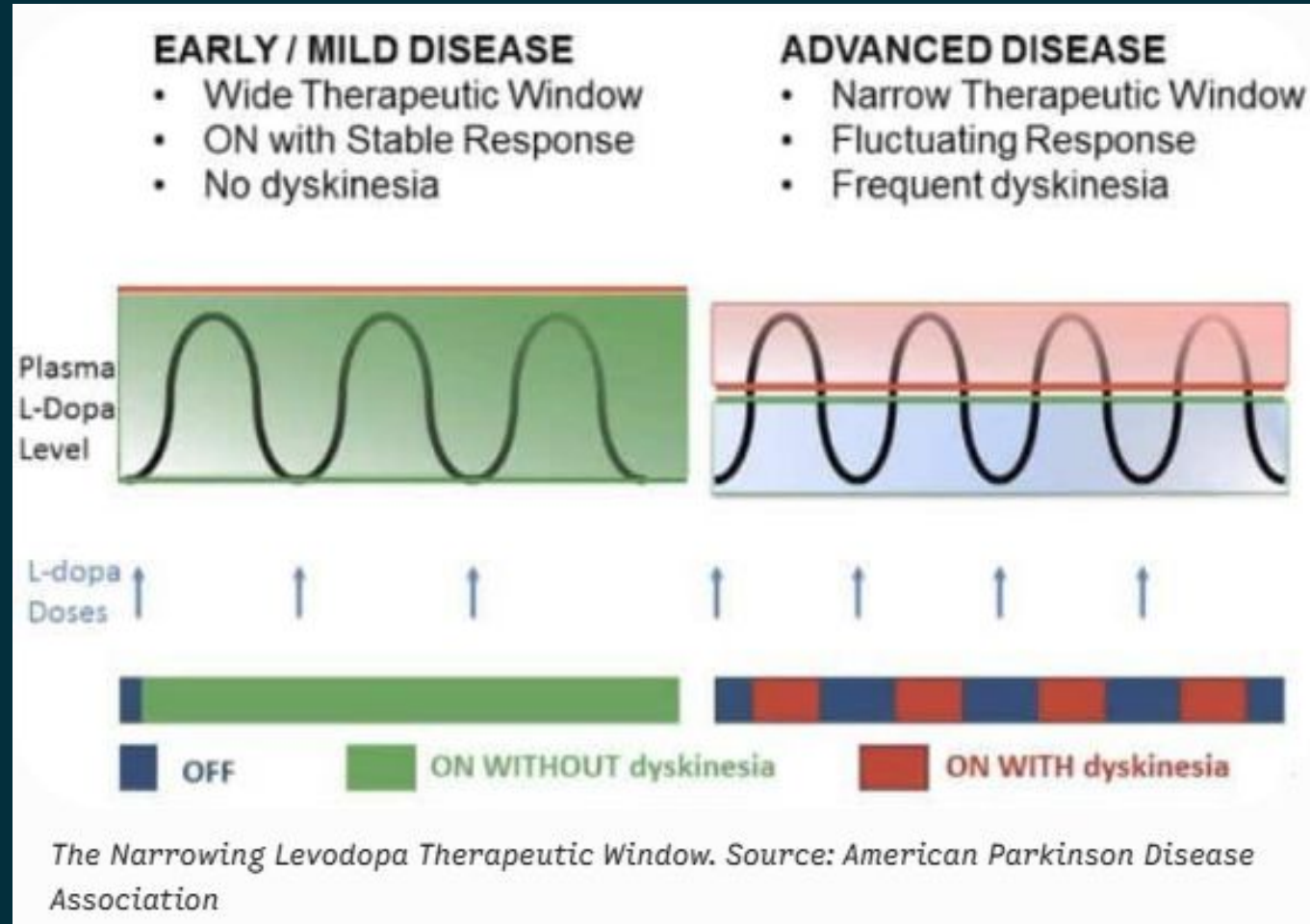
Parkinson's Disease

Motor Improvement through “Electrical Dopamine”

- Best predictor of response is response to medication (Levodopa)
- EXCEPT: Tremor can improve even when Levodopa does not help
- Deep brain stimulation (DBS) will improve symptoms to a similar degree
- It will not make patient better than their best
- DBS helps: tremor, bradykinesia (slowness), rigidity, dystonia, dyskinesia



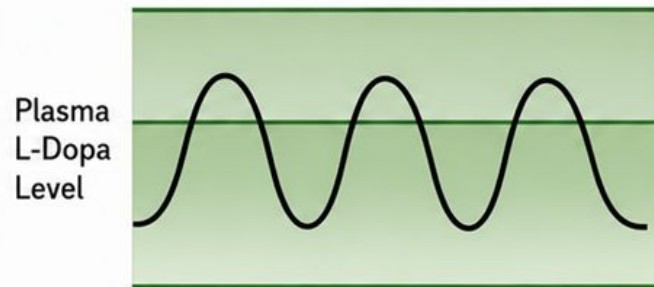
ON Time and OFF Time



ON Time and OFF Time

EARLY / MILD DISEASE

- Wide Therapeutic Window
- ON with Stable Response
- No dyskinesia

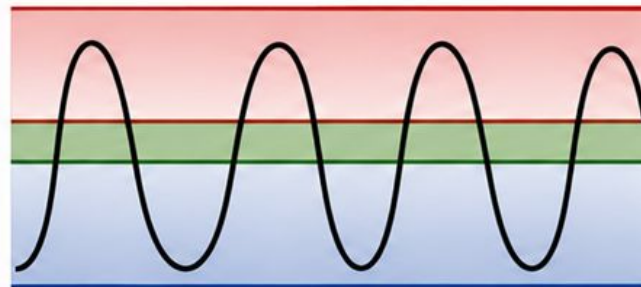


L-dopa Doses



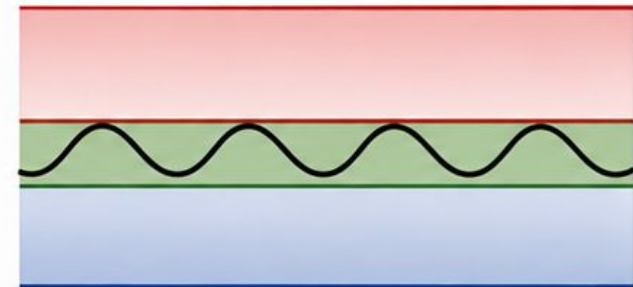
ADVANCED DISEASE (MEDICATION)

- Narrow Therapeutic Window
- Fluctuating Response
- Frequent dyskinesia



ADVANCED DISEASE (WITH DBS)

- Wider Therapeutic Window
- More Stable Response
- Reduced dyskinesia



OFF

ON WITHOUT dyskinesia

ON WITH dyskinesia

Sub-therapeutic (OFF)

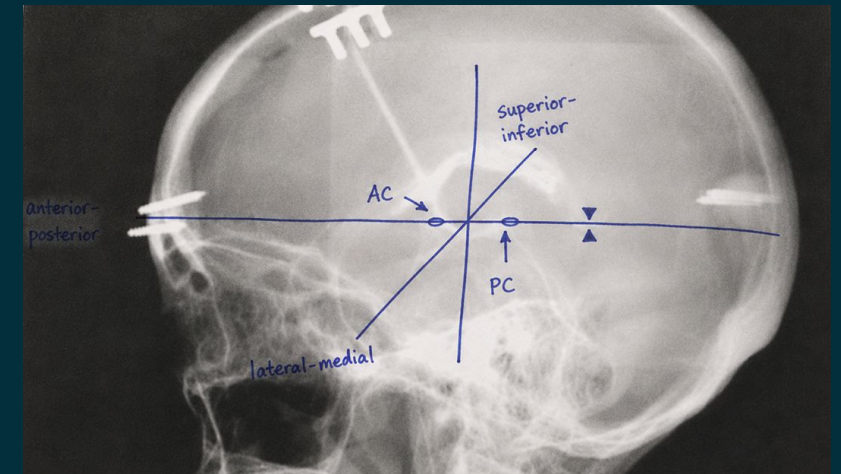
Dyskinesia

The Impact of Disease Progression and DBS on the Levodopa Therapeutic Window in Parkinson's Disease.

Source: American Parkinson Disease Association

Historical DBS Surgery

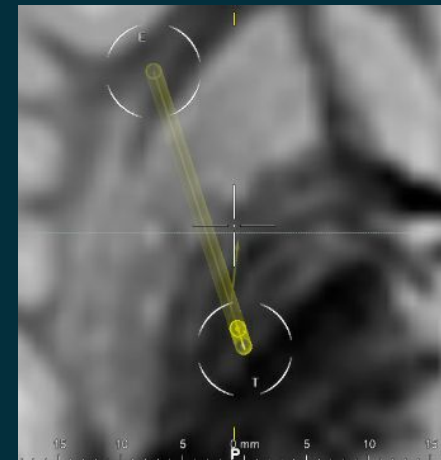
- Awake, requiring active patient participation
- Estimation based off atlas coordinates
- Intraoperative stimulation and interpretation of results



Modern “Asleep” DBS

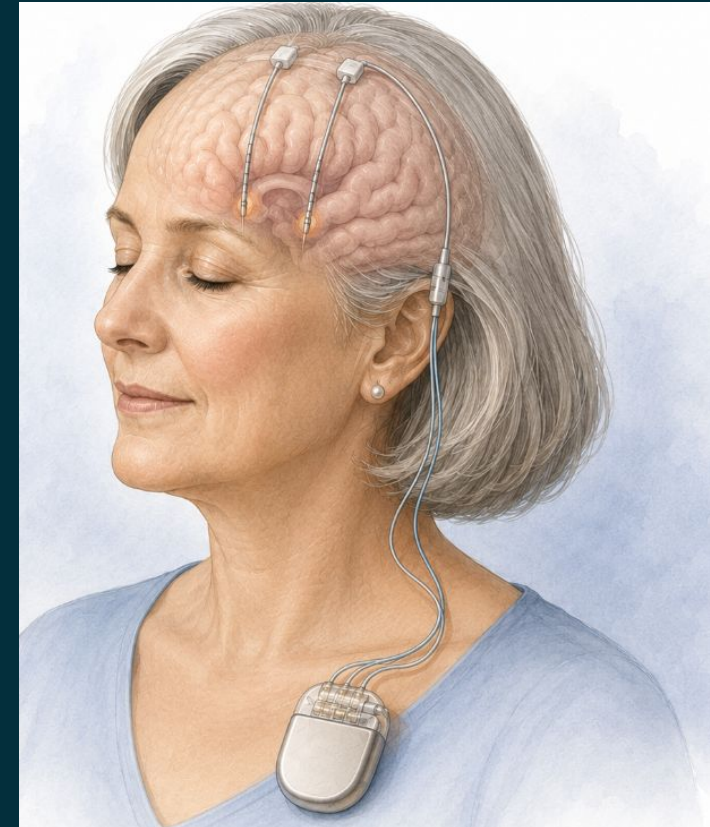
Surgery

- High quality MRI imaging obtained under anesthesia
- Direct visualization of targets
- Equal outcomes to awake testing
- Surgery under anesthesia
- Single stage surgery
- Minimal hair shave
- Robotic accuracy within 1 mm



Modern DBS Devices

- Directional stimulation to adapt to anatomy and patient response
- Rechargeable versus non-rechargeable options
- Respond to brain physiology (Medtronic)
- Allow for remote programming (Abbott)
- Visual programming (Boston)



Modern DBS Devices

THE LANCET
Neurology

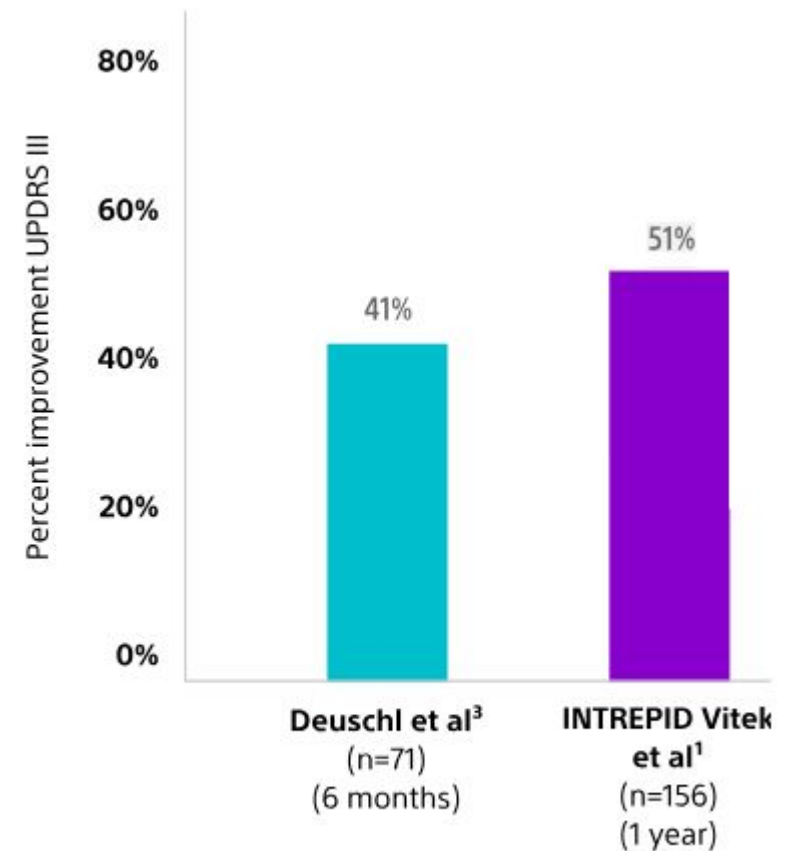
ARTICLES · Volume 19, Issue 6, P491-501, June 2020

Subthalamic nucleus deep brain stimulation with a multiple independent constant current-controlled device in Parkinson's disease (INTREPID): a multicentre, double-blind, randomised, sham-controlled study

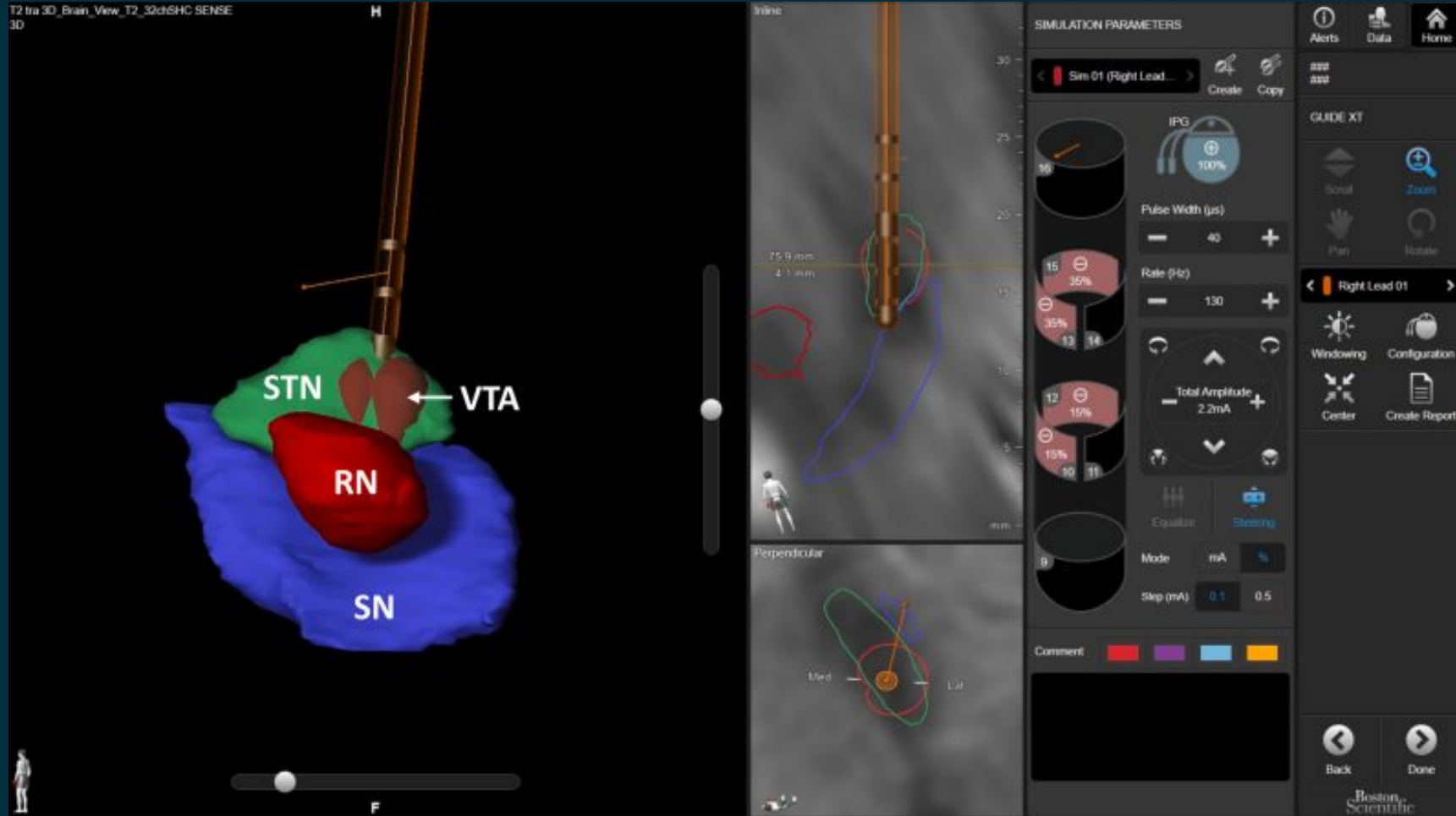
[Prof Jerrold L Vitek, MD](#) ^a   · [Roshini Jain, MS](#) ^c · [Lilly Chen, MS](#) ^c · [Prof Alexander I Tröster, PhD](#) ^d · [Lauren E Schrock, MD](#) ^a · [Paul A House, MD](#) ^g · et al. [Show more](#)

INTREPID Trial

- n = 313
- DBS with or without multiple independent current control



Modern DBS Devices



Modern DBS Devices

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Original Investigation

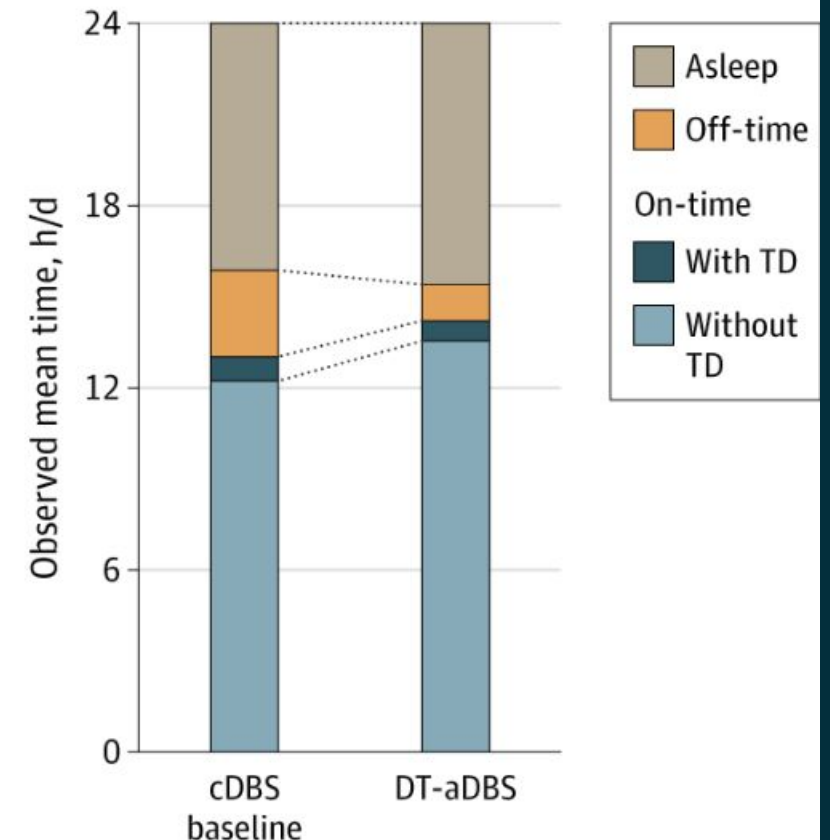
Long-Term Personalized Adaptive Deep Brain Stimulation in Parkinson Disease A Nonrandomized Clinical Trial

Helen M. Bronte-Stewart, MD, MSE¹; Martijn Beudel, PhD²; Jill L. Ostrem, MD³; [et al](#)

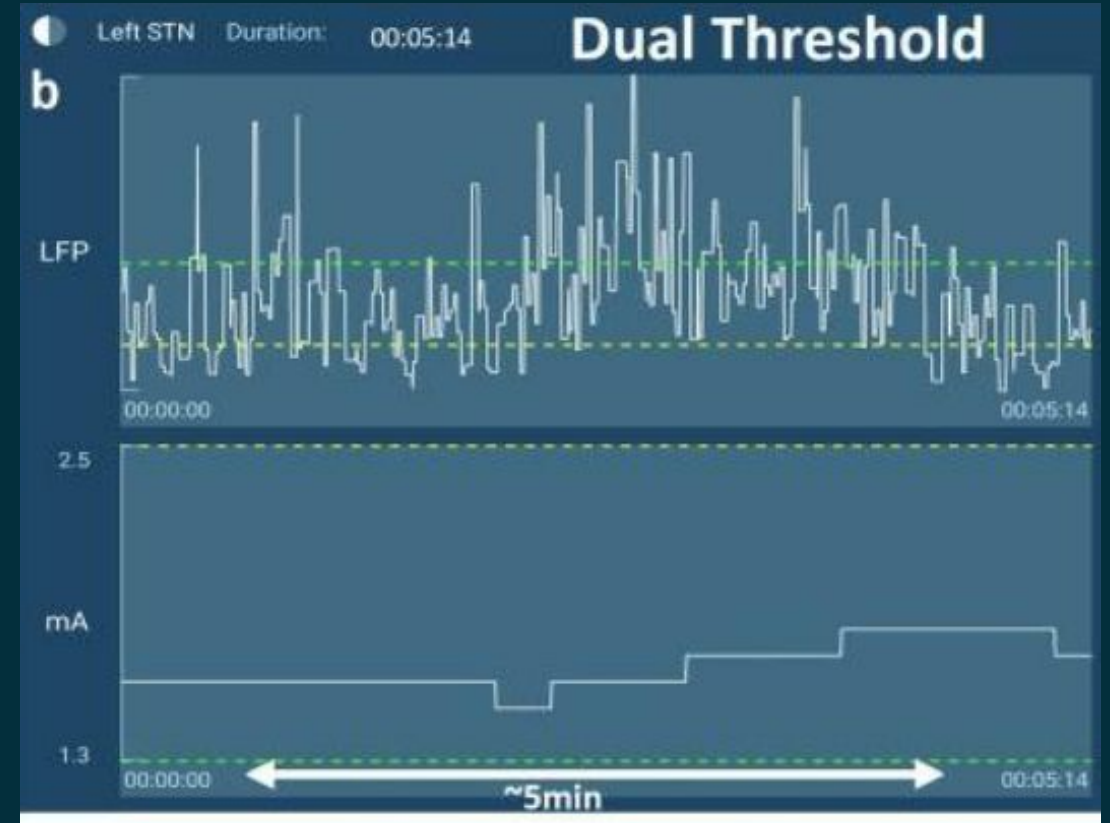
ADAPT Trial

- n = 68
- Adaptive versus non adaptive stimulation
- Adaptive DBS added 1.3-1.6 hours of ON time

D Motor diary data: DT aDBS



Modern DBS Devices



Modern DBS Devices



Accelerated symptom improvement in Parkinson's disease via remote internet-based optimization of deep brain stimulation therapy: a randomized controlled multicenter trial

[Alireza Gharabaghi](#) , [Sergiu Groppa](#), [Marta Navas-Garcia](#), [Alfons Schnitzler](#), [Laura Muñoz-Delgado](#), [Vicky L. Marshall](#), [Jessica Karl](#), [Lin Zhang](#), [Ramiro Alvarez](#), [Mary S. Feldman](#), [Michael J. Soileau](#), [Lan Luo](#), [S. Elizabeth Zuber](#), [Benjamin L. Walter](#), [Chengyuan Wu](#), [Hong Lei](#), [Damian M. Herz](#), [Ming-Hua Chung](#), [Yagna Pathak](#), [Bram Blomme](#), [Binith Cheeran](#), [Corneliu Luca](#) & [Daniel Weiss](#)

ROAM Trial

- RCT: in clinic versus remote programming
- 15 day faster improvement (54.2 versus 39.1 days)

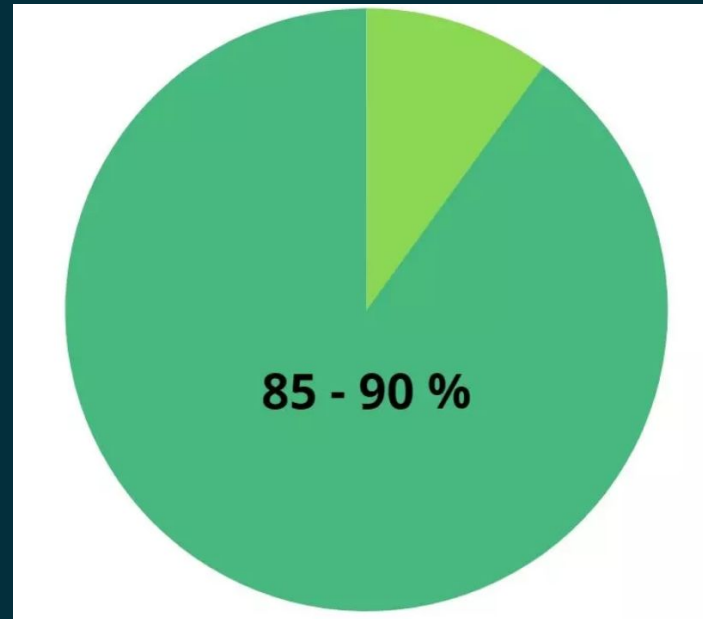
Outcomes (Parkinson's Disease)



Outcomes (Parkinson's Disease)

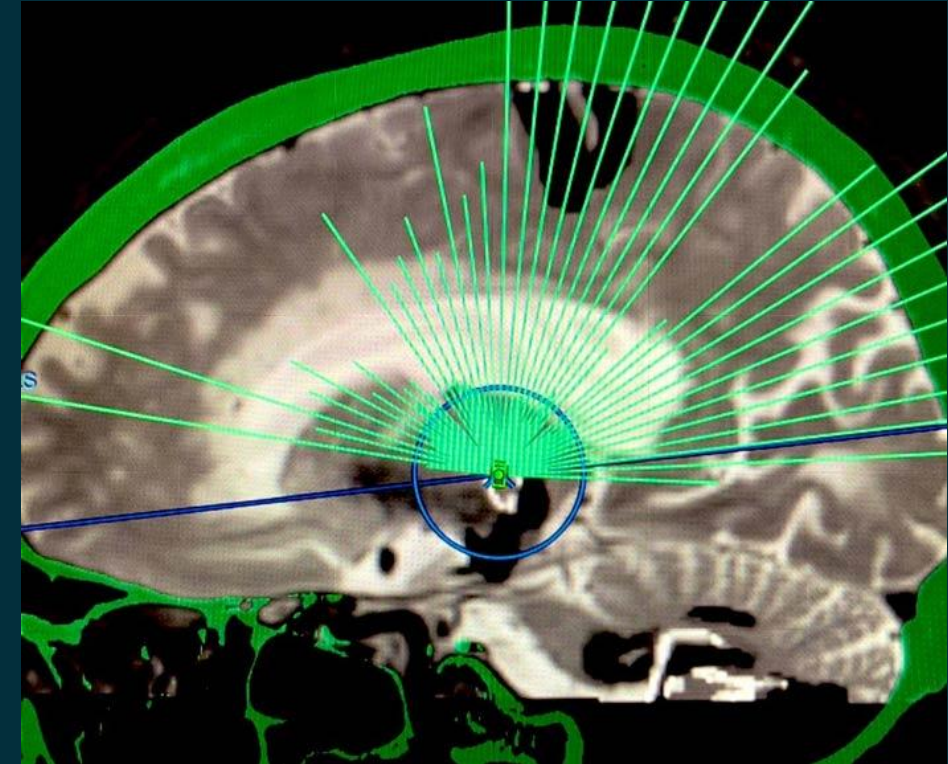
Patient satisfaction?

- 85-90% would chose to have DBS again



Alternatives to DBS

- Focused Ultrasound is indicated for PD (2026) and essential tremor (ET)
 - It is incisionless surgery
 - MR thermography performs real time monitoring
 - Test heating can simulate permanent lesion (not always performed)
 - Lesion is permanent (no battery changes)



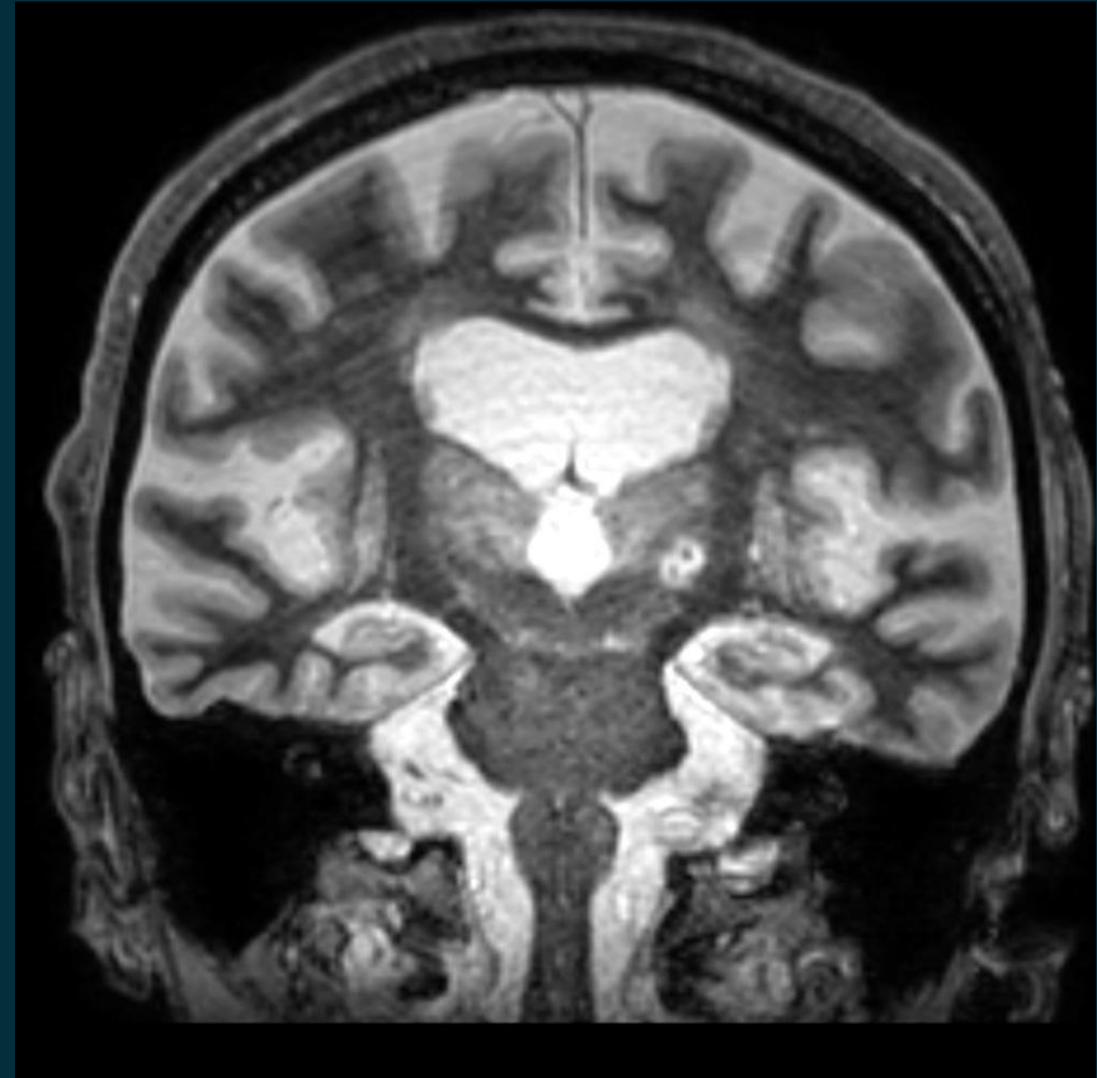
Alternatives to DBS

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 - Gait cannot be tested
 - 50% have gait instability in the first 6 months
 - 10% have permanent gait instability



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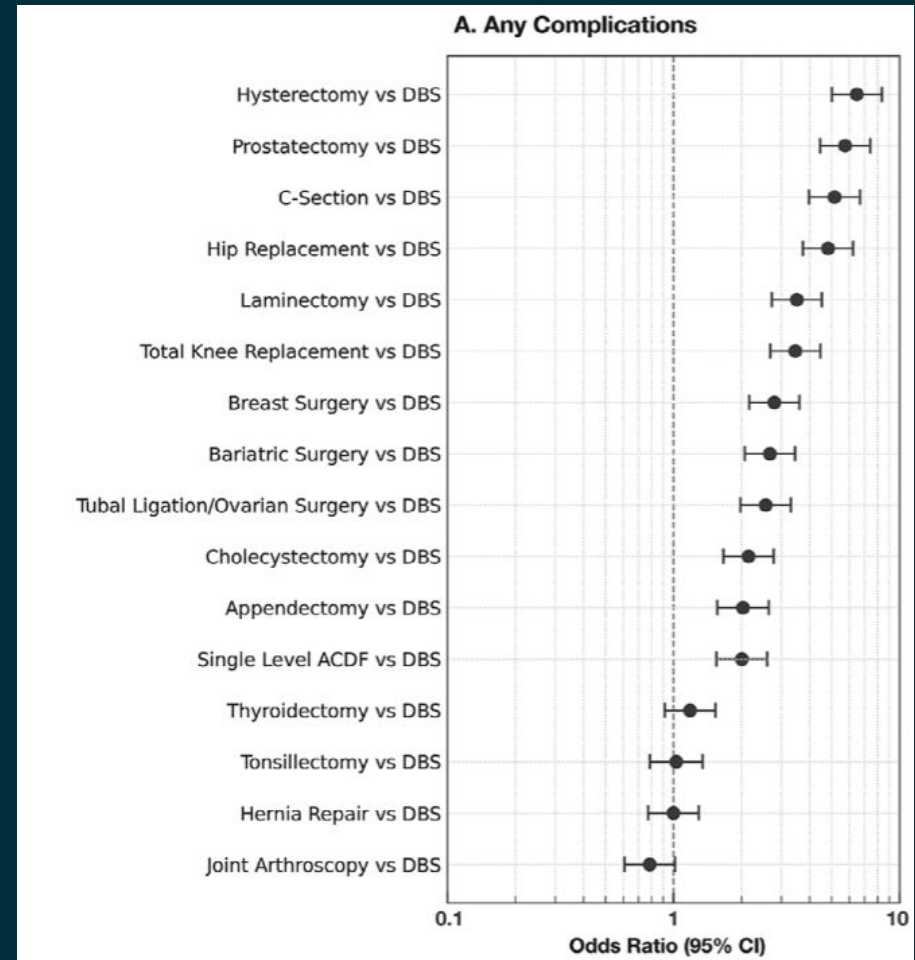
Risks of DBS Surgery

- No surgery is without risk
 - ~3-5% risk of infection needing explant
 - < 1% risk of hemorrhage

RESEARCH ARTICLE

Reframing the Risks of Deep Brain Stimulation: A Comparison of 2.8 Million Elective Surgeries From the NSQIP Database

Lucas R. Philipp, MD, MPH , Kevin Hines, MD , Justin Williams, MD, Jingya Miao, MS ,
and Chengyuan Wu, MD, MSBmE 



POD 0 for Surgery (PD/ET DBS)



- Overnight stay in step down
- Post-operative CT for localization (1mm cut)
 - Merged with pre-op MRI
- Post-operative Xrays for directionality
- Discharge POD1

POD14 for Surgery (PD/ET DBS)



- Post-op check
- Incision check
- Remove sutures (if applicable)

POD~21 for Surgery (PD/ET DBS)

- DBS Programming in clinic (up to 1 hour)

