

Workshop #4

Individualized Troubleshooting Strategies

25 minutes per workshop with 5 min rotations- 4 rooms

PD1

PD2

Tremor VIM

Dystonia GPI

PD1

- Philip Starr
- Svetlana Miocinovic

PD 1- Case 1 - Part 1

- 63yo M w/ lower extremity tremor-predominant PD for 7 yrs, R>L
- History of ICD/punding/hypomania on dopamine agonists
- Initially underwent L STN DBS for med-refractory R-sided tremor

Outcome at 2mo post DBS:

- 95% reduction in RLE tremor and decreased rigidity
- Dyskinesia: none
- LEDD reduction: 37%

Neurostimulation parameters (Medtronic 3389 leads - Activa SC IPG)

L STN: C+ 2-, 3.0V, 60 us, 140hz

PD 1- Case 1- Part 1- One Year Later

- Progressive tremor and R-body rigidity/bradykinesia
- Increasing stim at contact 2 (best contact for tremor control) limited by dysarthria/capsular side effects
- Contact 3 with even worse dysarthria
- Contact 1 was added and frequency was increased with improved symptoms

Neurostimulation parameters (Medtronic 3389 leads - Activa SC IPG)

L STN: C+ 1- 2-, 2.7V, 60 us, 180hz

PD1- Case 1 – Part 1 - Two Years Later

- Emergence of more significant L-sided tremor - refractory to meds
- Underwent R STN DBS implantation
- Monopolar review:
 - Most significant tremor control on contact 3 and 2, but speech side effects.
 - Good tremor control without immediate side effects on contact 0 and 1

New neurostimulation parameters (Medtronic 3389 leads - Activa SC IPG)

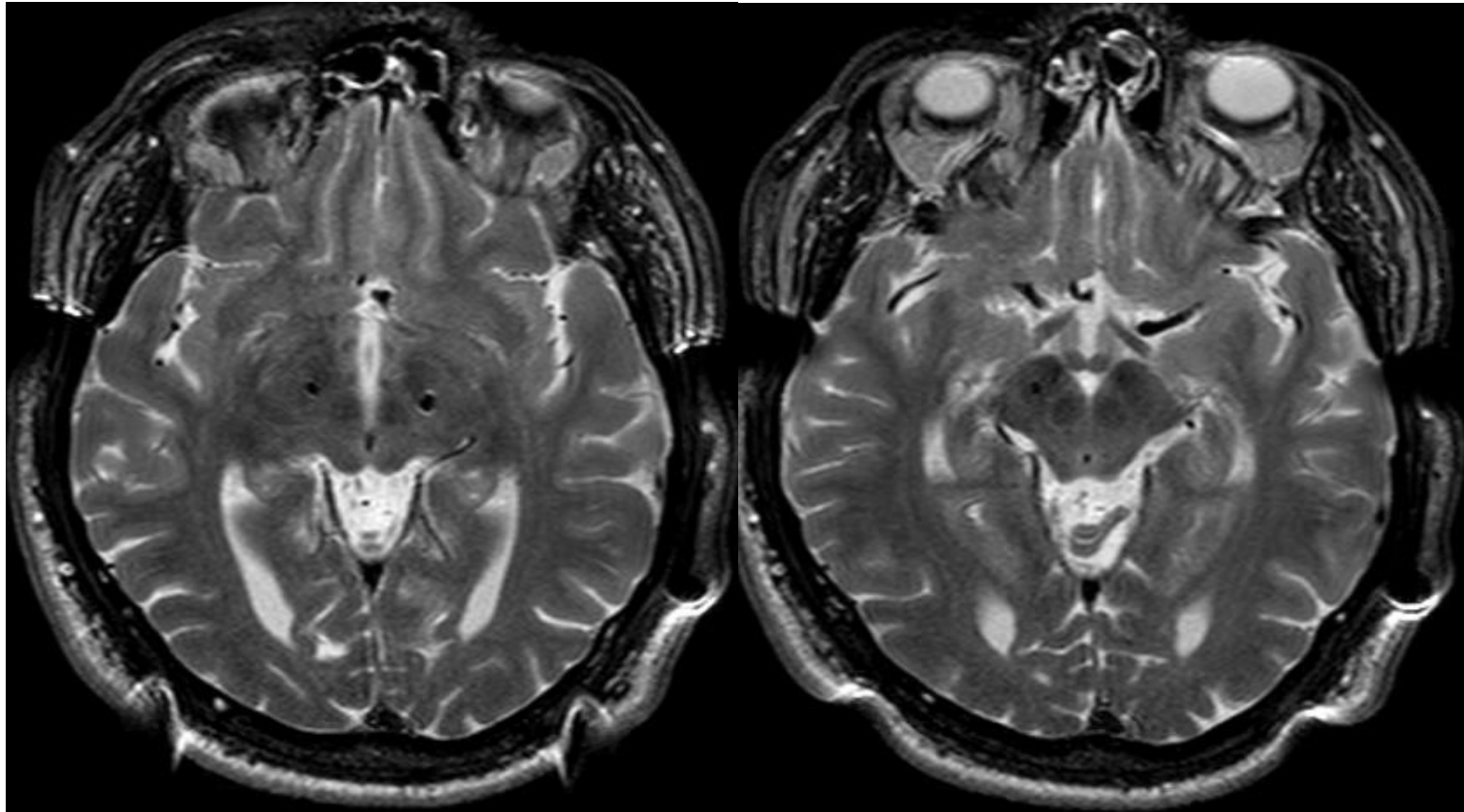
L STN: C+ 1- 2-, 2.7V, 60 us, 180hz

R STN: C+ 0-, 2.6V, 60us, 150hz

- In follow up, he reports good LLE tremor control, but personality changes described as “goofiness, elated mood, Kramer personality”, somewhat similar to what he experienced on dopamine agonists.

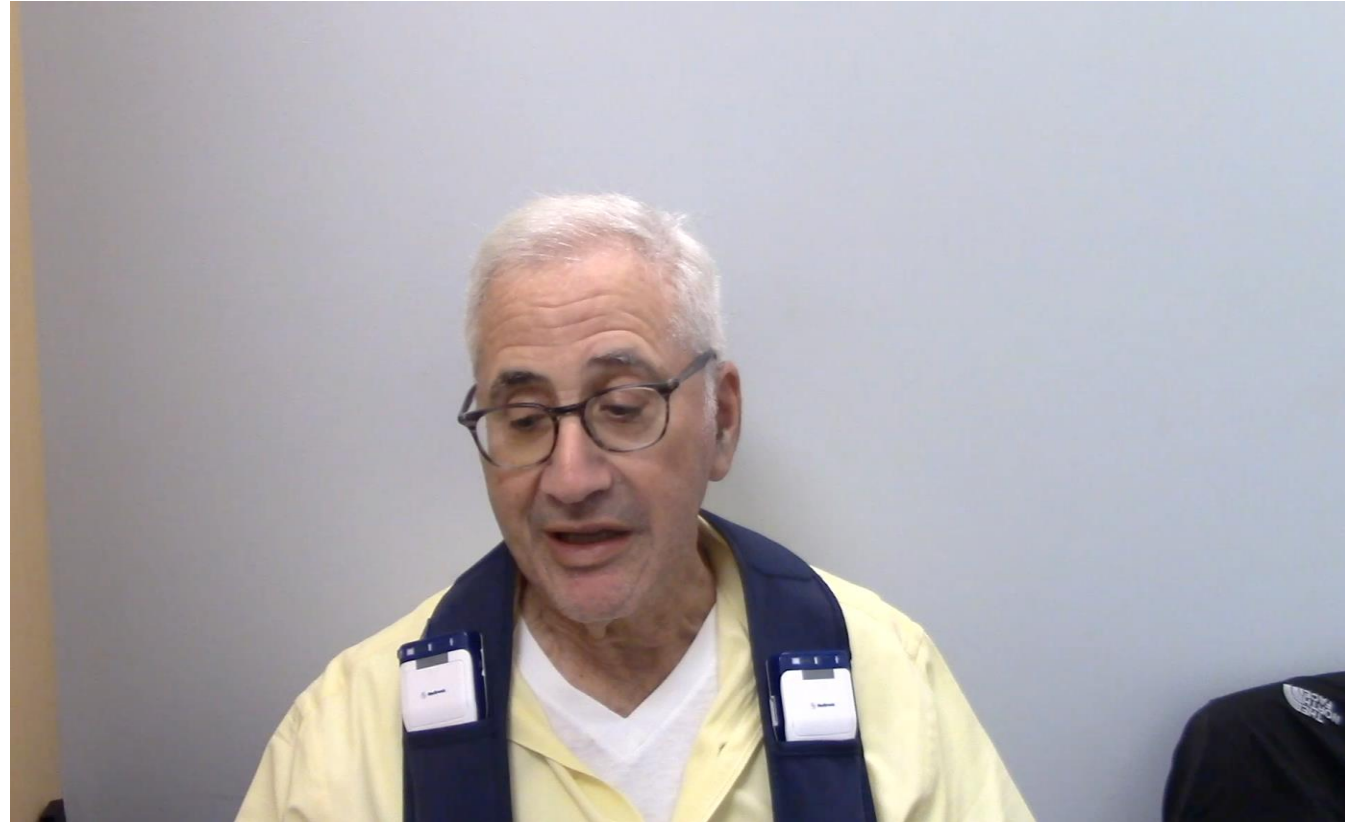
PD 1- Case 1- Part 1: Discussion

1. What is the problem?
2. What can you do to troubleshoot?
3. How would you adjust programming settings?
4. What do you think of the lead placement?



PD 1- Case 1 - Part 2

- Several years later, he gradually increases stimulation on both left and right STN to address progressive tremor.
- However, he develops progressive difficulty with his speech, issues with swallowing, and right hand “clawing”
- Seen in clinic for evaluation



New Neurostimulation parameters (Medtronic 3389 leads - Activa SC IPG)

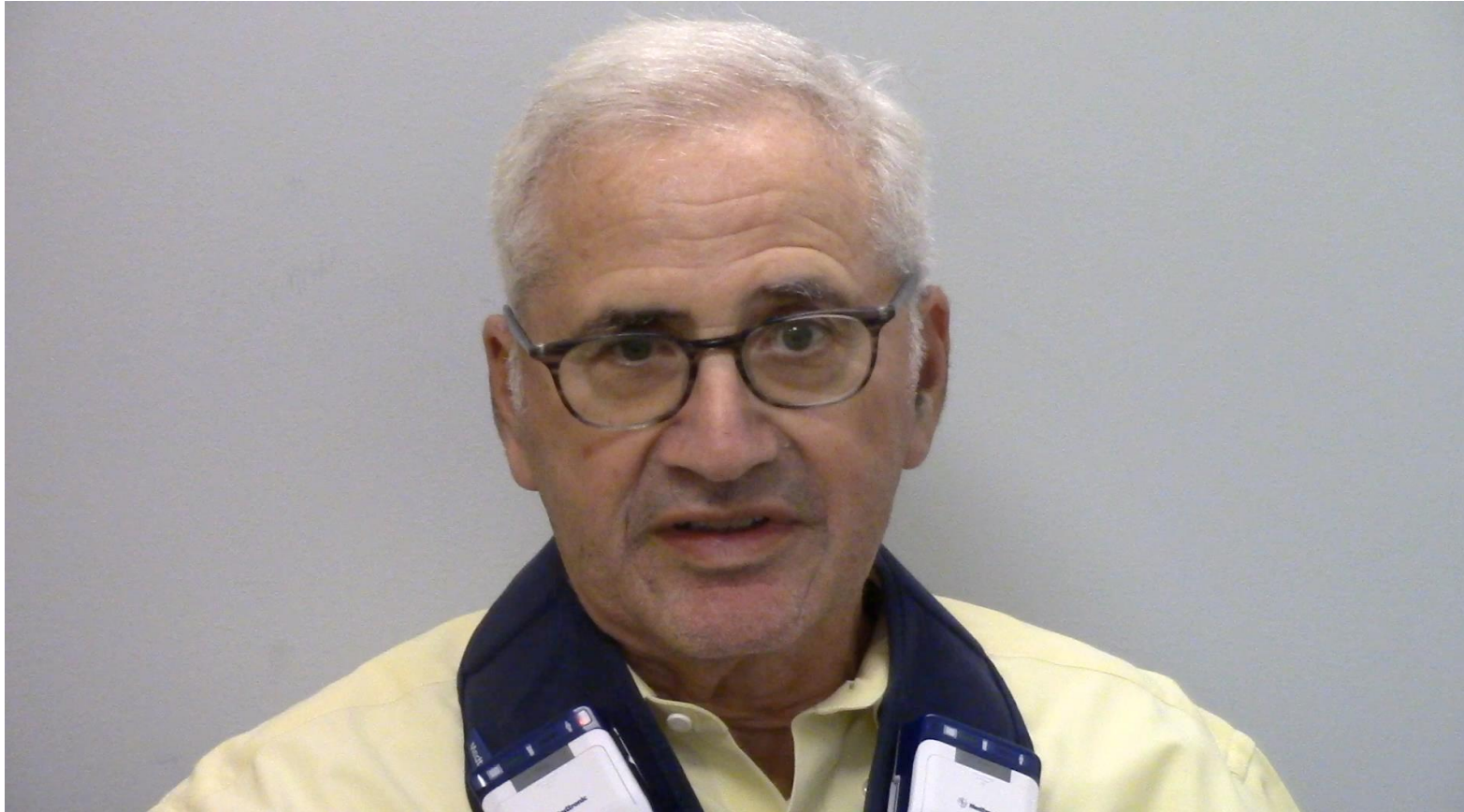
L STN: C+ 1- 2-, 3.0V, 60 us, 180hz

R STN: C+ 1-, 3.0V, 60us, 150hz

PD1 - Case 1- Part 2: Discussion

1. What is the problem now?
2. What can you do to troubleshoot the situation?
3. How would you adjust programming settings?

PD1 - Case 1 - Post Adjustment



Neurostimulation parameters (Medtronic 3389 leads - Activa SC IPG)

L STN: C+ 1- 2-, 3.0V, 60 us, 180hz – Range 1.0-3.2V

R STN: C+ 1-, 3.0V, 60us, 150hz – Range 1.0- 3.2V

PD1- Case 2

- 68 yo, Male, PD for 13 years
- Bilateral STN-DBS due to disabling motor complications at age 64 with more severe symptoms on the right side of his body.
- Has an excellent outcome for the first 2 years after DBS with no off time, no dyskinesia. Also reports no falls or balance issues.
- One day develops episodic (50/day) shock-like/tingling sensation in the right side of the scalp lasting for a few seconds.
- He is very concerned and calls the clinic to be seen by the DBS team.

PD1- Case 2

Neurostimulation regimen (Activa PC, 2.98V):

- Left STN C+ 1-, 2.7 V, 60 mcs, 130 Hz; range: 2.2-3.0
- Right STN C+ 10-, 2.7 V, 60 mcs, 130 Hz; range: 2.2-3.0

High Impedance (R STN only):

- C & 8/9/10/11 - 10000- 12000
- Bipolar combinations: between 2465 and 4091

PD1- Case2- Discussion points

1. How would you manage the patient?
2. Why is the patient not clinically worse?
3. What other surgical steps might you take in this case?

PD1 –Case 2



PD2

- Emily Levin
- Renato Munhoz

PD2- Case 1

- 67 yo man, PD x 17 years
- s/p BL STN DBS 7 years ago (Medtronic Activa RC)
- Referred for second opinion on DBS and medication management

PD2- Case1 - Prior DBS programming

- DBS initially with good benefit to medication refractory tremor
- No dose reduction of Sinemet pre- to post-DBS
 - (Sinemet 25/100 3.5 tabs five times daily)
- More recently falling 3-4 times daily
 - Frequent dyskinesia may contribute
 - Sometimes impulsive movements lead to falls
 - Freezing at times

PD2- Case 1- Prior DBS Programming

- Bipolar settings BL. Had been unable to tolerate monopolar settings and higher current with worsened dyskinesia and speech impairment
- Had 2 main groups – 60 Hz and 90 Hz. No improvement at lower frequency in falls/freezing

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PD 2 – Case 1 - Discussion

- Repeat MRI of the brain shows leads in good location.
- What would you do next to manage this patient?

PD2- Case 1- Programming Steps

- Brought in for new monopolar review, off meds x 12 hours
- On Entry DBS settings, off meds:
 - Severe ongoing rest tremor, bradykinesia, rigidity
 - Very short stride length and slow steps
 - Freezing on turns

L STN:

- 2 contact with poor benefit to bradykinesia
 - Very low therapeutic window – feels “woozy” and speech effects at low voltages
- 1 contact with best effect on tremor and bradykinesia and good therapeutic window

R STN:

- 9 contact best therapeutic window
 - Much better control of tremor, rigidity, bradykinesia in monopolar setting

PD2- Case - 1Final DBS Settings

L STN: C+1-, 2.5V, 60mcsec, 130Hz

R STN: C+9-, 2.8V, 70mcsec, 130Hz

- Exam on-stim, off-meds:
 - Significantly improved bradykinesia, tremor, rigidity
 - Gait much improved with longer stride length and more fluid gait
 - Reduced Sinemet from 3.5 tabs to 2 tabs five times daily

2 months later

- Continued to have dyskinesia with Sinemet, so reduced from 2 to 1.5 tabs five times daily and they resolved
- No falls
- Some breakthrough tremor, improved with increase of 0.3V on both sides

PD2- Case 1- Take home points

- Suboptimal contact selection on L STN had previously hampered DBS optimization
 - Unable to increase current due to side effects
 - High dose of Sinemet required to help with tremor, rigidity, bradykinesia
 - High dose of Sinemet contributed to dyskinesia and impulsive gait, both contributing to falls
- Simple monopolar settings with better contact selection and higher frequency led to much better control of bradykinesia and gait and enabled Sinemet reduction

PD2- Case 2

- 58 yr old M with PD and STN DBS surgery 3 weeks ago, presents to Friday clinic for initial DBS programming.
- After a monopolar review, contact 1 and 9 are most helpful in reducing tremor and rigidity acutely.
- DBS settings:
 - Left hemisphere: C+1- 2.0mA, 60us, 130 hz
 - Right hemisphere: C+9- 2.0mA, 60us, 130 hz
- Pt leaves feeling better. He forgets his pt programmer in Uber on way home.

PD2- Case 2

- He takes his usual PD medications and by 6:00pm has severe dyskinesia.
- He calls clinic but office is closed and is referred to on-call neurology resident who is unfamiliar with DBS and tells patient to come to ER.
- In ER patient exhausted, terrified, with severe dyskinesia. No one can find a physician programmer. The programming neurologist is paged and agrees to come to the ER with the clinician programmer.
- Finally, after turning off the DBS his dyskinesia subsides.



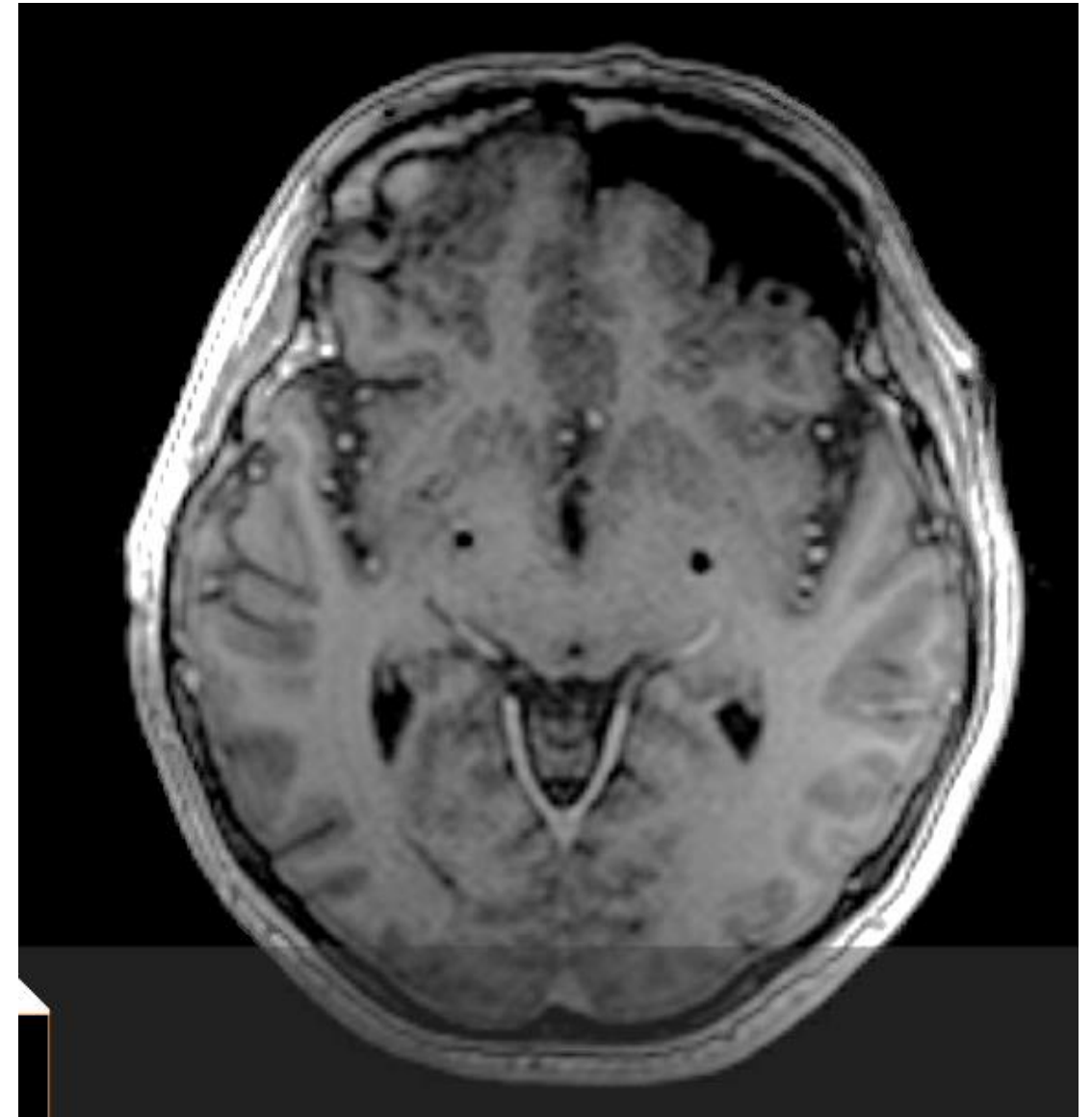
Watch out for delayed
dyskinesia with STN DBS!

PD2- Case 2- Discussion

1. When can dyskinesia occur after STN DBS?
2. Who is most at risk?
3. What are strategies to reduce risk and improve dyskinesia (medications and DBS settings)?

PD2- Case 3

- 65 yo female with PD treated for motor fluctuations and refractory right upper extremity tremor.
- Has successful bilateral GPi DBS in 2016 which increased on time and improved tremor.
- In May 2017 reported worsening of right sided tremor, more stiffness, and slower walking.
- See by DBS team for evaluation.

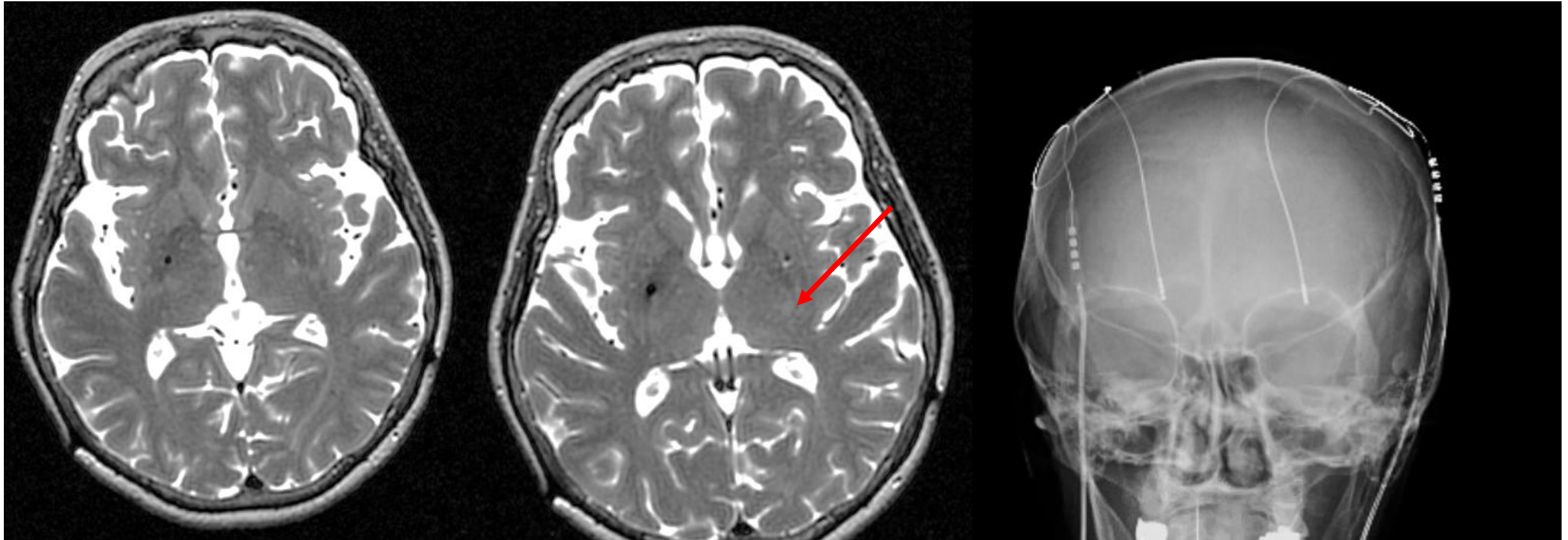


Initial lead location 2016 postop MRI

PD2- Case 3- Discussion

1. What would you do to troubleshoot?
2. When would you order brain imaging?

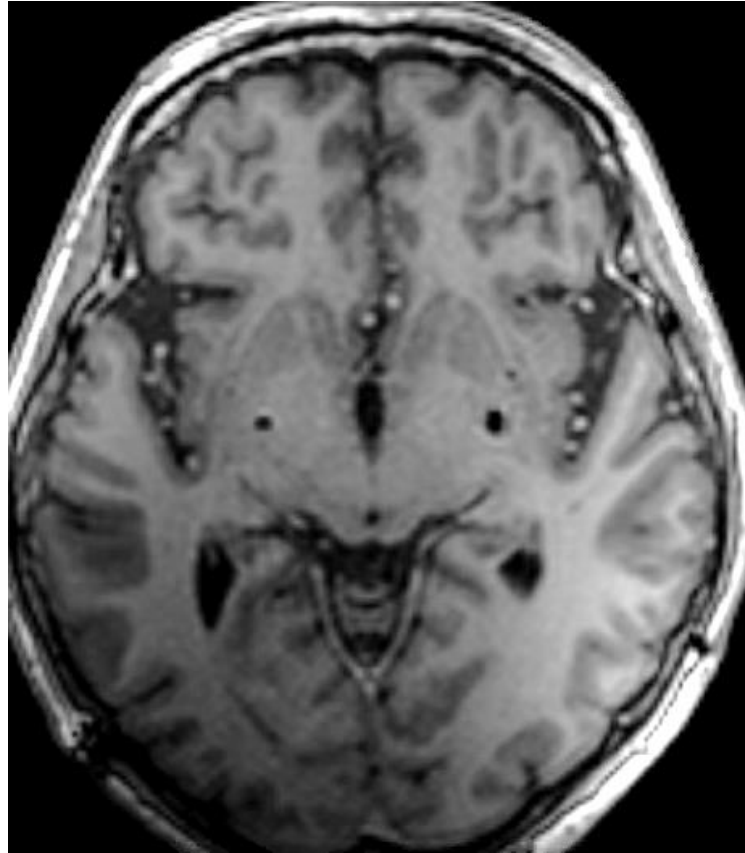
PD2- Case 3



May 2017 workup of worsening PD symptoms

Left lead tip had migrated 11 mm superiorly to the putamen-GPe junction

PD2- Case 3



Sept 2017

After pushing lead down 11 mm

Tremor

- Doris Wang
- Tiago Mestre

Tremor- Case 1

- 76 yo ambidextrous man – writes with LH, eats with RH
- Several decades of postural and action tremor c/w ET
- Had bilateral VIM DBS with Boston Scientific directional leads and IPG



Tremor – Case 1- Initial programming

Right VIM: C+ 2-, 2.1mA, 60mcsec, 136Hz

- Some slurring of speech noted during monopolar review

Left VIM: 1- 8+, 2.2mA, 50mcsec, 170Hz

- More difficult to get good control over R UE tremor without causing slurring of speech

3 weeks later

- Balance much worse → 2 falls
- Had reduced stim to 1.9mA bilaterally
- L UE tremor well controlled; R UE tremor poorly controlled
- Both sides at higher amplitudes worsened tandem gait and caused slurred speech

Tremor – Case 1- Lead Location

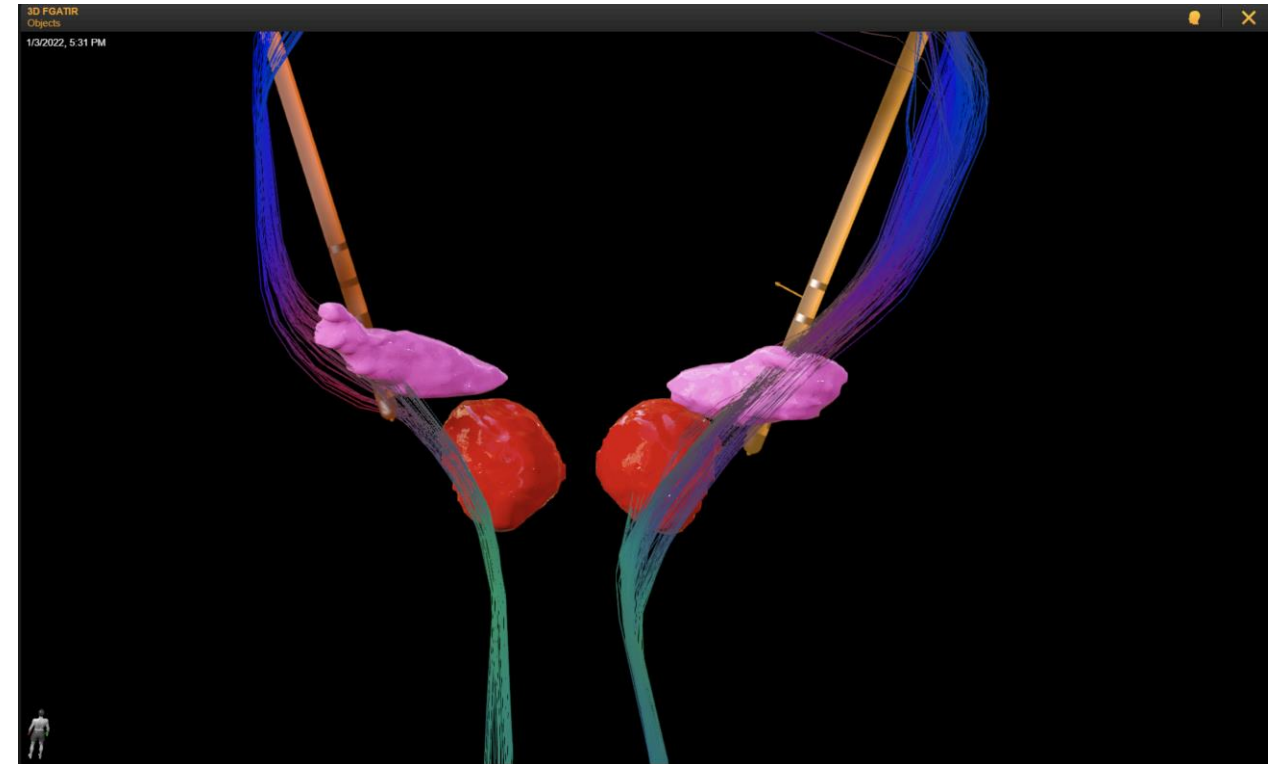
- Brainlab reconstructions showed leads in relatively anterior position within VIM

Left hemisphere:

- Current steered in posterior direction on more dorsal contact in L VIM
- Better RUE tremor, reduced slurring of speech, gait imbalance
- L VIM: C+ 6-(50%)7-(50%), 2mA, 90mcsec, 154Hz

Right hemisphere

- Some further improvement in LUE tremor with increased frequency 136Hz → 154Hz
- R VIM: C+ 2-, 1.3mA, 60mcsec, 154Hz



Tremor – Case 1- Part 2

2 mos later:

- LUE tremor 80% improved
- RUE tremor 75% improved
- Still would like better RUE tremor while eating
- Speech still slurred, but not as bad as on prior settings



DBS settings:

L VIM: C+ 6-(50%) 7-(50%), 2mA, 90mcsec, 154Hz

R VIM: C+ 2-, 1.7mA, 60mcsec, 154Hz

Tremor – Case 1- Discussion

- What would you do next to try and help this patient?

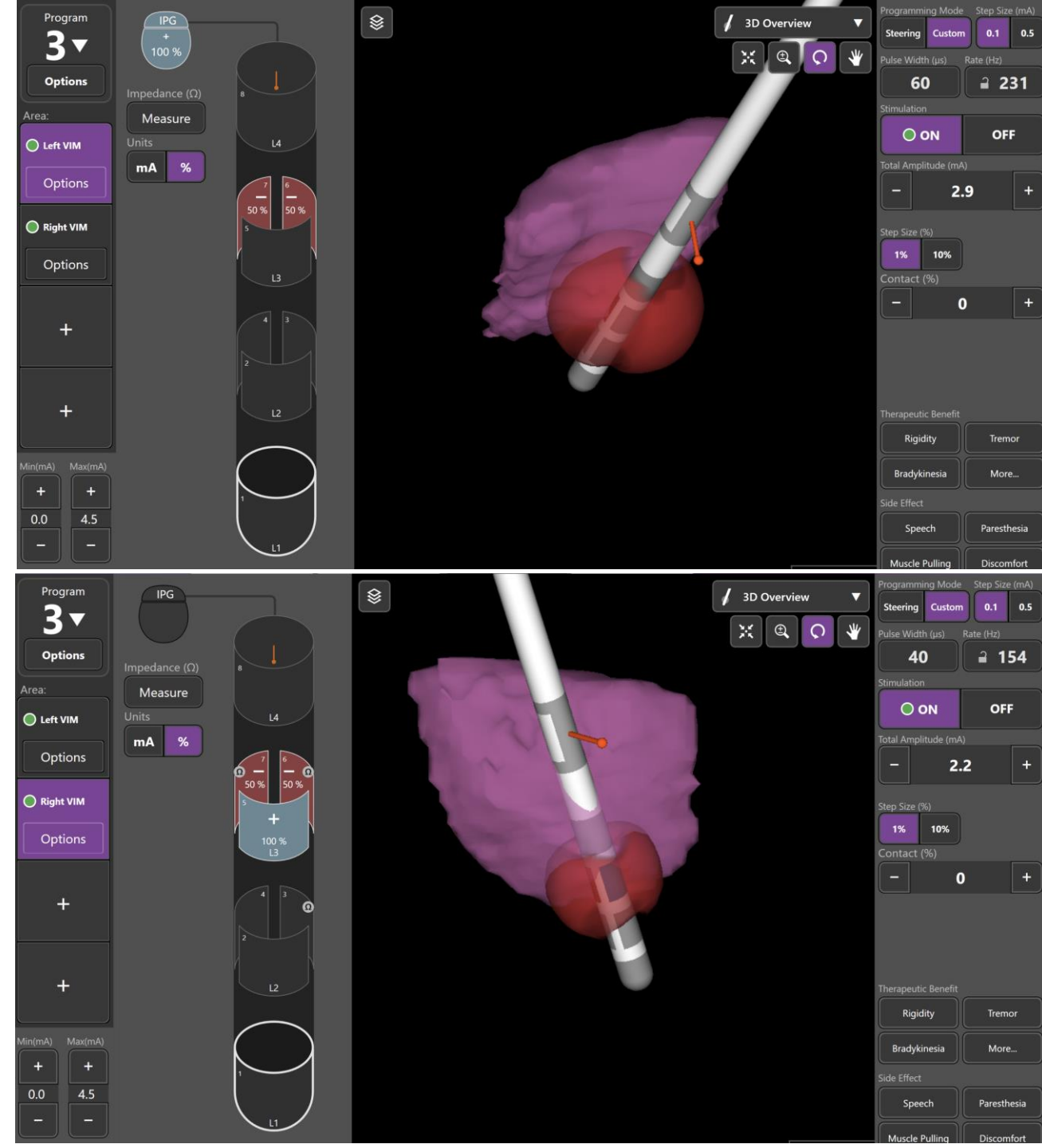
Tremor – Case 1- Part 3

L VIM

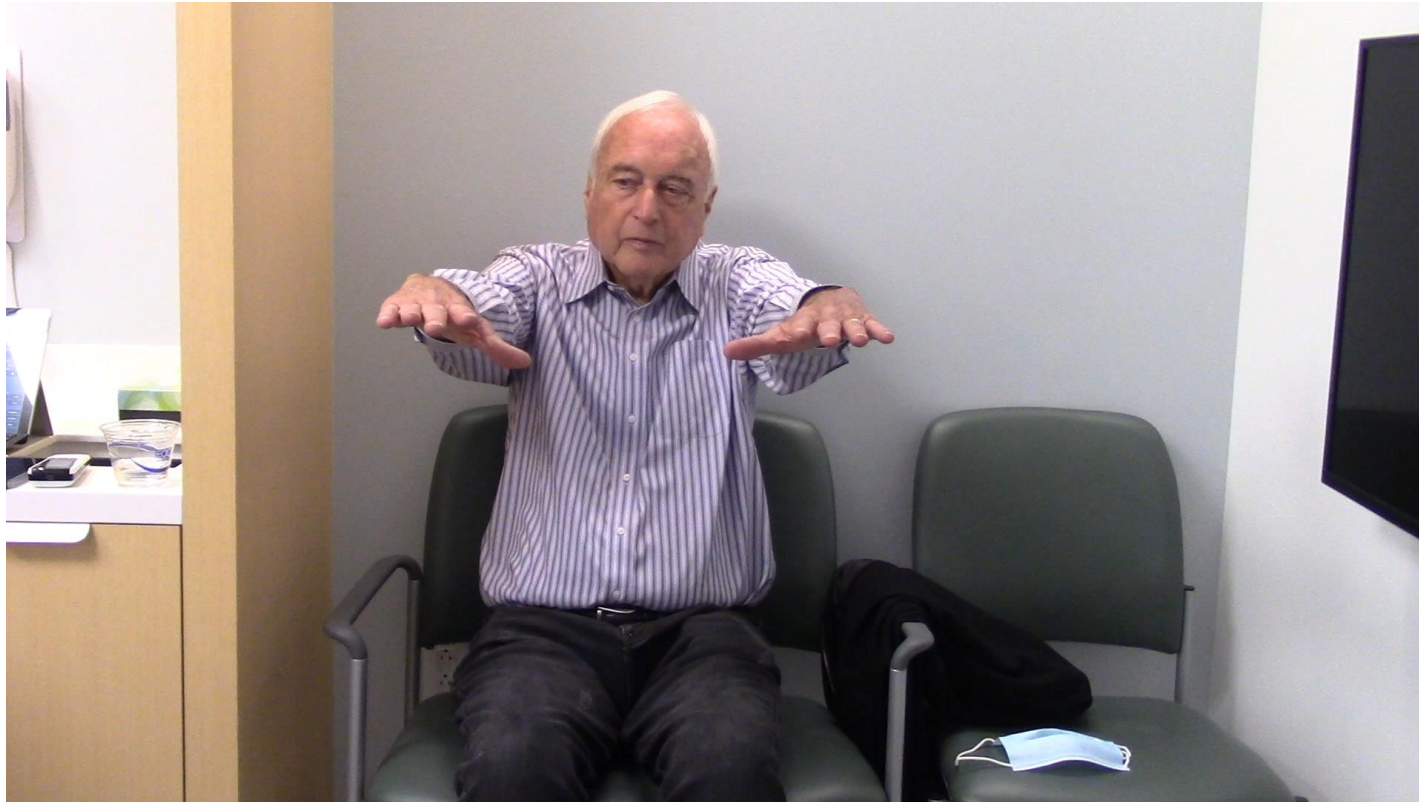
- Could not achieve adequate tremor control with bipolar config
- Reduced pw from 90→60; increased frequency 154 → 231Hz
 - Combination much **better tremor control with less speech impairment**
 - Able to tolerate higher amplitude which led to better tremor control
- Final: C+ 6-(50%)7- (50%); 2.9mA, 60mcsec, 231Hz

R VIM

- Switched to bipolar setting; placed anode on 5 contact, further directing stim posteriorly to 6 and 7 contacts
- Reduced pulse width to 40 mcsec → **less speech impairment**
- Final: 5+ 6-(50%)7-(50%), 2.2mA, 40 mcsec, 154Hz



Tremor – Case 1- Part 3



Tandem gait still intact

Tremor- Case 1- Discussion

- Common side effects are from over stimulation
- Postural instability/ataxia may occur in 3-7% of patients with VIM DBS, particularly bilateral stimulation
 - May improve with reductions in amplitude or pulse width, changing to bipolar configuration
 - Changing stimulation directionality is also sometimes helpful
- Dysarthria may occur in 5-25% of pts with BL VIM DBS
 - May be caused by spread to internal capsule/corticobulbar fibers
 - May improve with various reprogramming efforts including reductions in pulse width, bipolar configurations, or current steering

Tremor – Case 2

- 70yo F with long-standing ET who had failed multiple medications underwent bilat ViM DBS
- Right hand: expected improvement at minimal settings of the left ViM electrode in monopolar configuration.
- Left hand: initial good tremor suppression, also in monopolar configuration
- During subsequent sessions, the patient started noticing loss of sufficient tremor control in the left hand along with side effects from higher stimulation settings.
- What would you do?

Tremor – Case 2

Repeated adjustments to Right ViM stimulation parameters

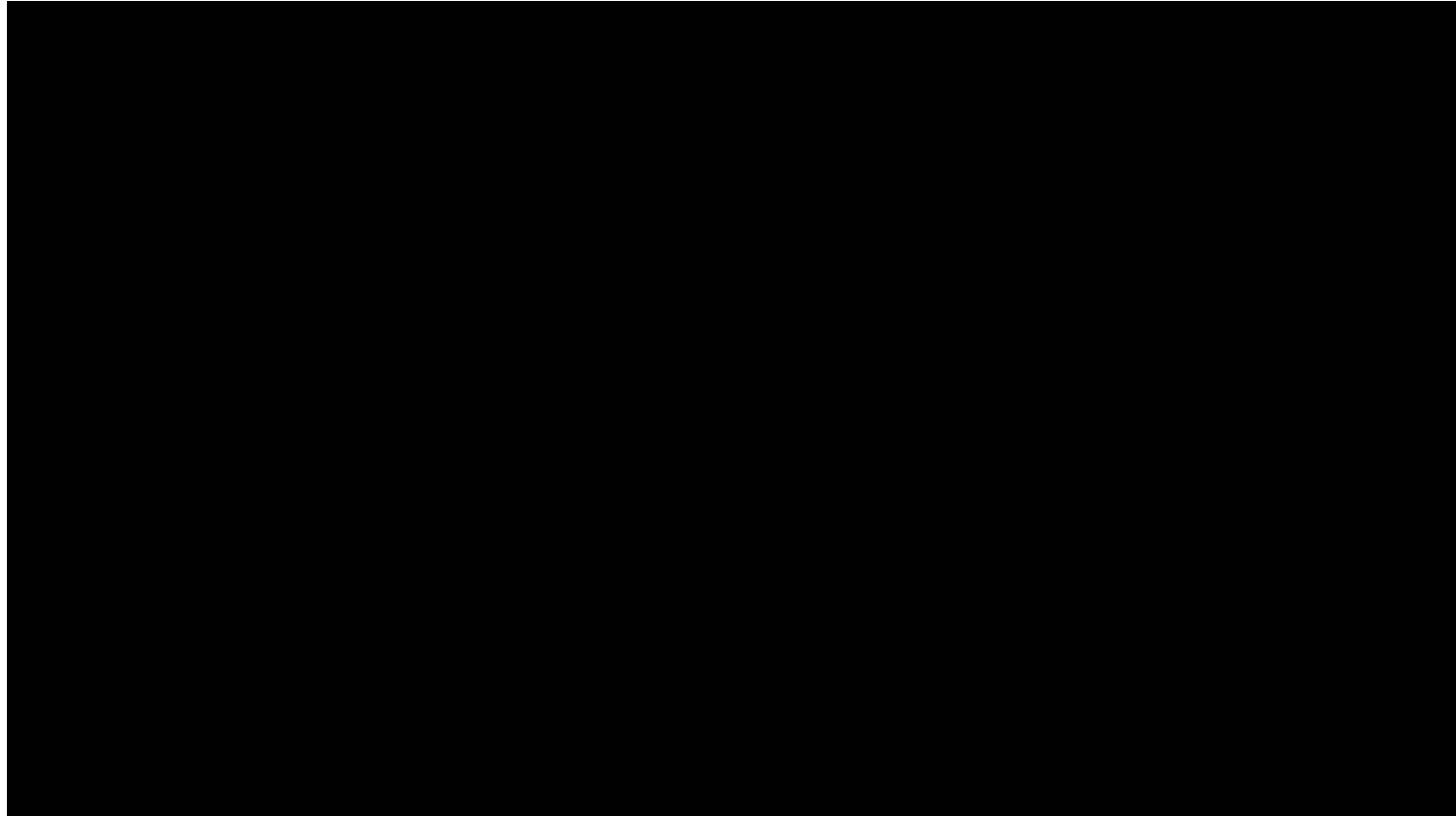
- Monopolar, bipolar, interleaved configurations
- Could not tolerate turning stimulator off at night due to marked rebound
- → Transient benefit only, followed by return of symptoms to their previous severity within days or weeks.

Rt ViM settings	Polarity	Amplitude (V)	Pulse width (μsec)	Frequency (Hz)
1 st programming session	C+10-	1.0	60	130
Maximum monopolar settings	C+10-	2.2	60	150
Maximum bipolar configuration	9+10-	2.5	60	150
Maximum interleaved configuration	ViM1 C+10-	3.0	60	125
	ViM2 C+9-	2.6	60	125
OFF	Marked left hand rebound tremor with a rest component, which then subsided and was followed by prominent left hand postural and kinetic tremor with almost the same severity as her pre-op tremor.			

Tremor – Case 2

- What would you do?
- Head CT with thin cuts to check for electrode placement, which was merged back to the pre-op MRI using the StealthStation Surgical Navigation System
 - → Suboptimal right VIM lead positioning
 - Right VIM electrode position approximately 2 mm anteromedial from the optimal location
 - Left VIM accurately placed
- Recommendation?
 - Revision of the right VIM electrode
 - Other options

Tremor – Case 2



	AFTER REVISION of left ViM			
1 st programming session	C+10-	2.0	60	130
9 months	C+10-	2.8	60	170

Tremor Room -Case 3

- 55 yo M with PD for 8 years had bilateral STN DBS at outside center to improve motor fluctuations and dyskinesia.
- When neurostimulators turned on - developed diplopia sensitive to adjustment of the right STN stimulation amplitude.
- An MRI was performed to confirm lead location which confirmed a medial and deep placement of his right lead leading to spread of stimulation to oculomotor fibers.
- He returned for surgical revision and original lead was removed and a new lead was implanted lateral to the prior lead.
- Despite revision, stimulation settings still resulted in side effects -dyskinesia, instability, and mild diplopia. For several years, a therapeutic programming setting could not be found, and patient usually kept the stimulation turned off.

Tremor Room- Case 3

- His parkinsonism worsened with medication alone due to severe impulse control behaviors and dyskinesia.
- He transferred care to our center where his DBS system was evaluated and reprogrammed.
- MRI was reviewed, and the leads did appear slightly more medial than usual
- DBS settings:
 - Left C+, 3- 2.1 volts, 90 μ sec and 180Hz
 - Right 7+, 6- 2.5 volts, 60 μ sec and 180Hz
- New DBS setting:
 - Left (3+, 2-, 1+) 3.0 volts, 80 μ sec and 100 Hz
 - Right (7+, 6-, 4+) 3.7 volts, 80 μ sec and 100 Hz - eliminated diplopia and improved his PD symptoms substantially.
- He reported improvement in medication-induced dyskinesia and freezing-of-gait as well as rigidity (~60%-70%), and his bradykinesia and gait improved on exam. He was able to slowly titrate down his PD medications.

Tremor Room- Case 3

- He subsequently developed scalp irritation over his right DBS lead. Over the course of several months, the lead eroded through the skin and was exposed. The DBS system was still electrically intact with normal impedances, and the area surrounding the lead did not appear infected.



Discussion Points

1. How would you manage this patient?

Dystonia

- Suneil Kalia
- Jill Ostrem

Dystonia- Case 1

- 69 yo female
- History of isolated cervical dystonia since ~2004 (onset at age 50-51)
- Received botulinum toxin injections from 2009-2015 by outside neurologist (500u Dysport)
- First appointment with us in June 2015 after transferring care
- Neurological exam notable only for right torticollis (~90 degrees when distracted), right laterocollis (~10 degrees) and right shoulder elevation, rare head tremor, right splenius and left SCM hypertrophy.
- MRI brain notable for small left superior frontal meningioma
- Injected with 400-500 units of Botox at our center every 3 months from June 2015 until December 2017

Dystonia Case 1

- She underwent bilateral GPI DBS in January 2018. Medtronic PC+S participant (right GPI + right cortical paddle).
- Over the following 3 months, she experienced improvement in pain and discomfort and head turning. She reported sleeping better, no longer needing sensory tricks, but persistent right head turn particularly bothersome still while driving.
- Six months after surgery, she felt improved compared to preoperatively, but still had 15-20 degrees of right torticollis (right shoulder elevation and head tremor had resolved). Patient is still hoping for more improvement.
- Increase in PW was particularly helpful.

Neurostimulation parameters (Medtronic 3387 leads- Activa PC +S IPG)

L GPI: C+ 2-, 4.0V, 90 us, 145hz Max 185/ Min 130

R Gpi: C+ 2-, 4.0V, 90us, 145hz

Dystonia Case 1- Follow-up

- From 2019-2021 she had persistent residual right head turn and tilt.
- Stimulation on left GPI lead was limited by capsular side effects (tightness in leg and tongue).
- She underwent battery replacements into Percept in April 2021.
- Last settings as of November 2022

Neurostimulation parameters (Medtronic 3387 leads- Percept)

L Gpi: C+ 1-, 2.7mA, 60 us, 185hz Max 185/ Min 130

R Gpi: C+ 1-, 2.95mA, 80us, 90hz

Dystonia Case 1- Discussion

- How to you manage a dystonia patient with suboptimal benefit?

Disease related factors

- Primary vs secondary dystonia
- Duration of dystonia at time of surgery
- Presence of contractures or other orthopedic complications
- Fixed skeletal deformities
- Secondary disabilities (e.g., cervical myelopathy)
- Other issues:
 - Poor lead positioning
 - Non-isolated dystonia
 - Functional dystonia
 - May just takes some time

Dystonia- Case 2

- 62 y.o. RH male with history of cervical dystonia for over 20 years.
- Initially dystonia pulled head to right.
- Oral therapy no help. Botox helped about 60%.
- After three years, dystonia went into remission for 15 years, aside from a stiff neck, but no movement.
- Five years later dystonia returned with LEFT torticollis. For another 1-2 years, he had only 50% improvement with neurotoxin injections.
- Had bilateral GPi DBS surgery 9/2021. He did well with no complications and had great CD benefit.
- Two months after surgery, began noticing increased slowness, trouble moving legs as easily when walking, walking more slowly, worse handwriting, some trouble getting put of a chair.

Dystonia- Case 2 -Discussion

- What is causing this symptoms?
- How would you manage this patients programming?
- Some strategies?

Activate different contacts (maybe dorsal)

Bipolar stimulation

Directional stimulation

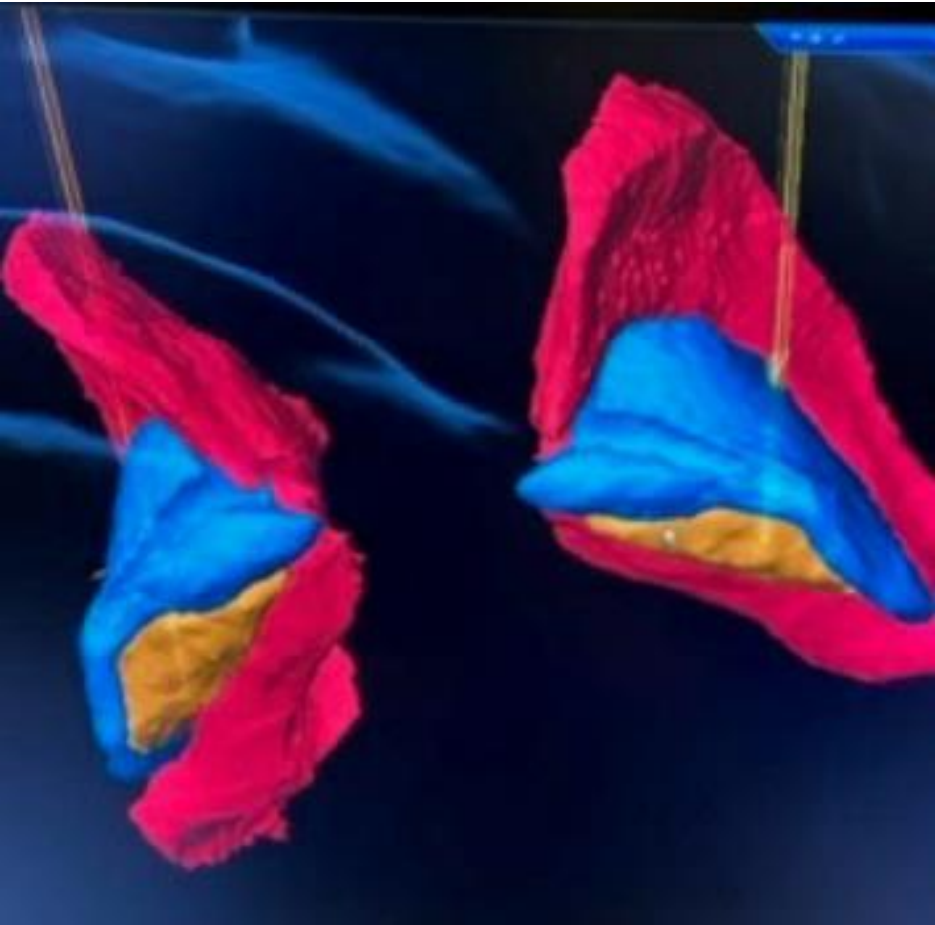
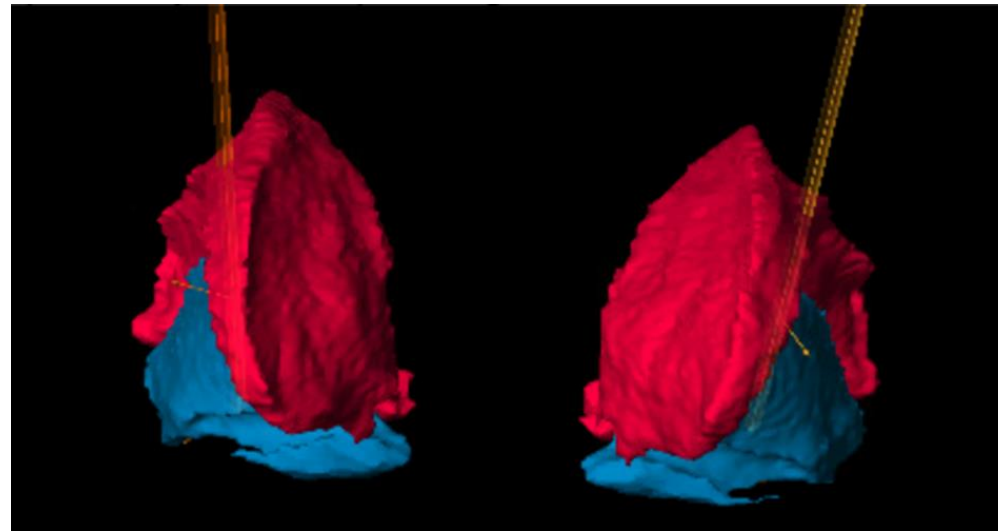
Lower amplitude

Lower frequency

Dystonia - Case 2 – Lead Location

Yellow- GPi
Blue- GPe
Red- Internal Capsule

Level 2 and level 3
electrodes in GP
bilaterally
Right a little more
ventral



Dsytonia – Case2 - Programming Options

Program	Left Hemisphere lead	Amp	Pulse Width	Freq	Right Hemisphere lead (deeper)	Amp	Pulse Width	Freq	Comments
1	C+ 2,3,4 (60%) C+ 5,6,7 (40%)	5.4	90	149	C+2,3,4 (60%) C+ 5,6,7 (40%)	5.5	90	149	Ring mode – 2 levels
2	C+ 2 (30%) 3 (30%) 5 (20%) 6 (20%)	5.4	90	149	C+ 2 (10%) 4 (30%) 5 (15%) 6 (45%)	5.0	90	149	Directional mode-lateral
3	C+ 2 (30%) 3 (30%) 5 (20%) 6 (20%)	5.4	60	149	C+ 2 (10%) 4 (30%) 5 (15%) 6 (45%)	5.0	60	149	Directional mode-lower pw
4	C+ 2,3,4 (60%) C+ 5,6,7 (40%)	5.4	90	119	C+2,3,4 (60%) C+ 5,6,7 (40%)	5.5	90	119	Ring mode- lower frequency

Dystonia Case 3

- 7 yr old boy (DYT1-negative) primary/isolated generalized dystonia referred to UCSF after a month ICU stay requiring IV sedation to suppress severe dystonic spasms.
- Hospital course complicated by rhabdomyolysis, CHF, electrolyte abnormalities, aspiration pneumonia from status dystonicus.
- Failed oral and IV therapy, as well as ITB.
- Underwent emergent bilateral GPi DBS.
- One week after DBS, BFMDRS-M dramatic improved. Eventually able to returned to school with moderate disability.



Dystonia - Case- 3 – Many Years Later

- Patient was lost to follow-up but then the DBS center gets an emergency call the patient is significantly worse.
- He is evaluated urgently in the emergency room.
- Diagnosis with status dystonicus -potentially life-threatening complication of dystonia.
- His DBS neurostimulator can not be interrogated.
- He is admitted to the hospital and started on medications (benzodiazepine).
- Emergency battery replacement surgery performed, and patient recovered fully



Postoperative MRI DBS electrode tip locations (yellow arrows) in the ventroposterolateral GPi

Dystonia Case 3 - Discussion

- What is status dystonicus?
- What are serious complications of severe pediatric dystonia treated with DBS?