

Programming DBS: Trouble Shooting Strategies

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Common Problems Encountered in DBS Therapy

Lead location → suboptimal placement?

Programming suboptimal?

Device-related issues or malfunction?

Has there been an over zealous medication
reduction?

(pt under-medicated?) Or unrealistic expectations?

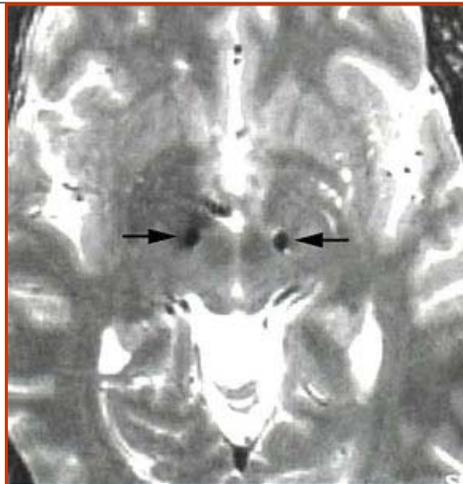
Is it a Lead Location Problem?

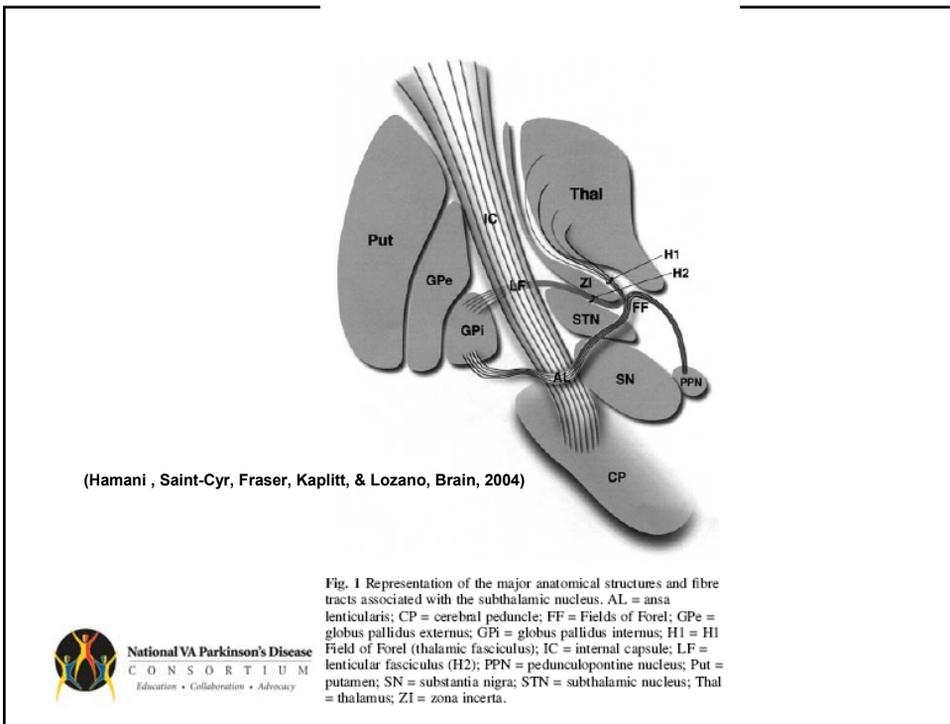
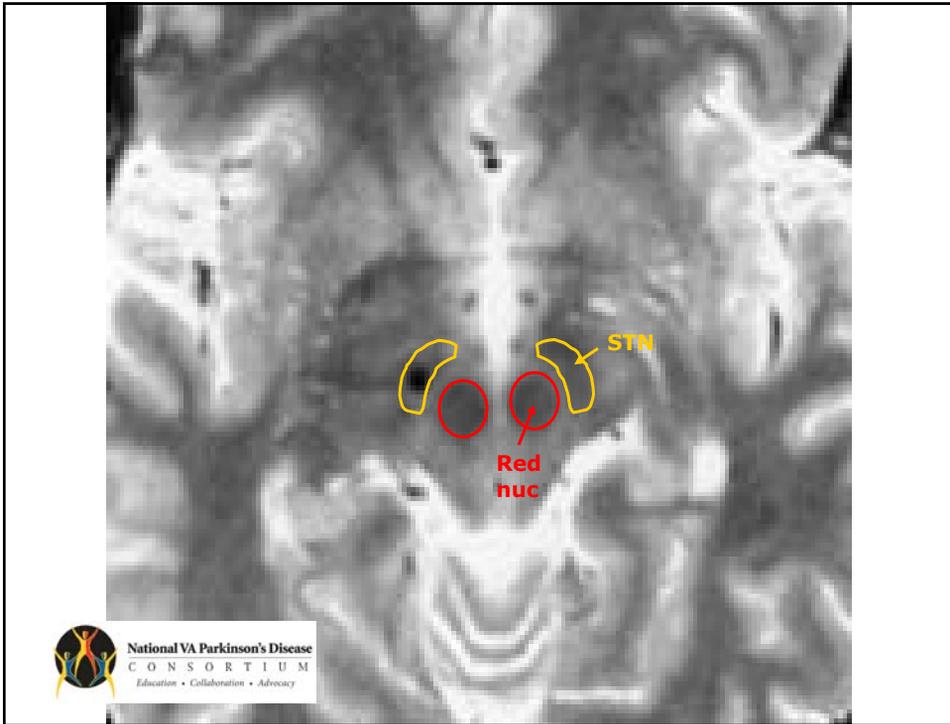
- What does the post-op MRI show?
- 1.5 tesla magnet only

Paul S. Larson, R. Mark Richardson, Philip A. Starr, Alastair J. Martin (2008).
**Magnetic Resonance Imaging of Implanted Deep Brain Stimulators:
Experience in a Large Series.** Stereotactic Functional Neurosurgery;
86:92–100



Post-Operative MRI





Lead Location Directly Influences Programming: STN

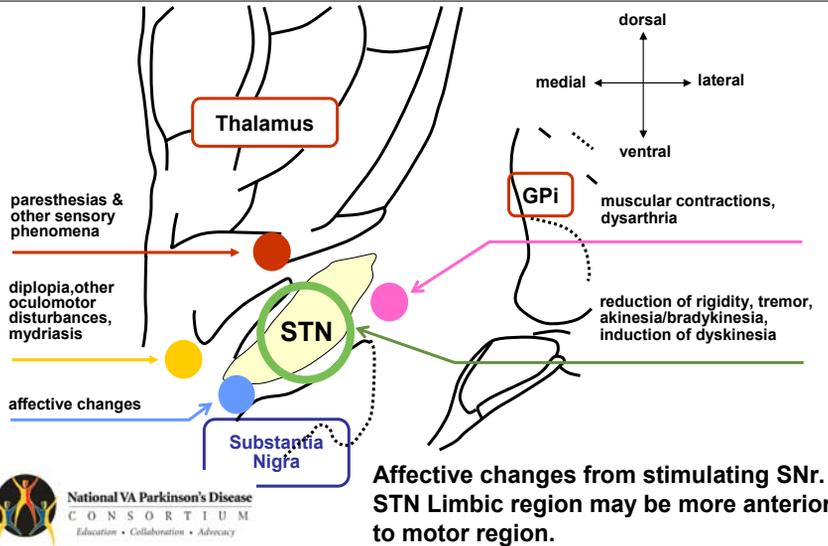
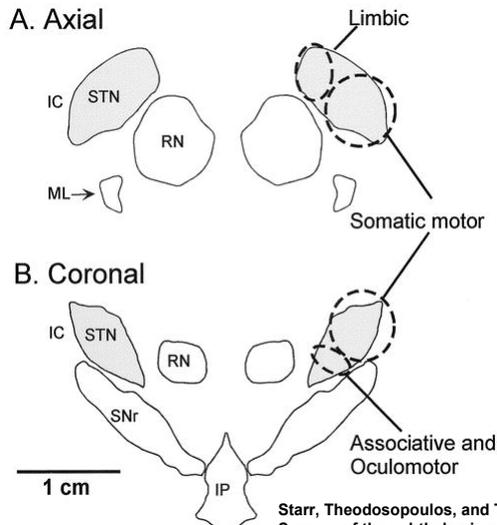
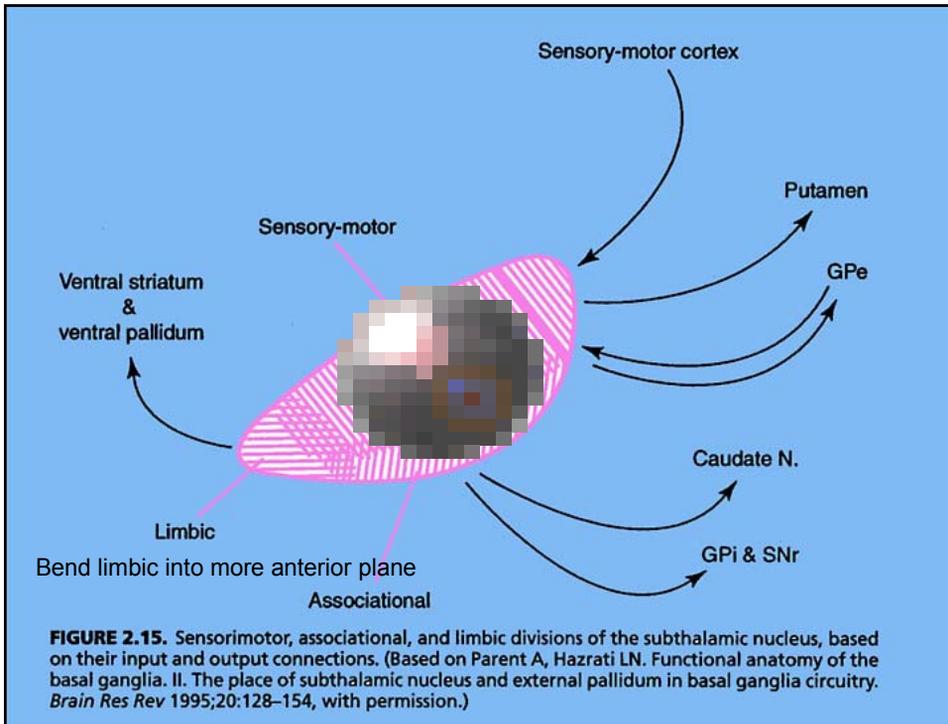


FIGURE 2



Starr, Theodosopoulos, and Turner.
Surgery of the subthalamic nucleus: use of movement-related neuronal activity for surgical navigation.
Neurosurgery. 2003 Nov;53(5):1146-9; discussion 1149



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Programming with Gusto

- Has each contact been screened using *maximum tolerated voltage* to assess ceiling threshold?
 - Determines therapeutic window
 - Titrate just below maximum tolerated voltage
- Kinetra batteries require higher voltages



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Three Dimensional STN Anatomy

- Medial and posterior = leminscal fibers
- Lateral and anterior = capsular fibers
- Anterior to motor = limbic pathways ?
- Deep and medial = SNr = limbic
- Medial and deep = IIIrd nerve
- Lateral to STN, genu of capsule =
conjugate gaze eye signs



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STN Side Effects at Low Thresholds

Expected side effects from lead location:

- Persistent Paresthesias → Too posterior or medial (Lemniscal fibers)
- Dysarthria, pulling/contractions → Too lateral (Capsule)
- Diplopia → Too deep, **anteromedial**
- Dyskinesias → In optimal location
- Mood changes → Too anterior and medial
- **No effect at high voltages** → Too superior or anterior

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Is Problem a Device Malfunction?

- Impedance checks – verify electrical integrity
- Kinetra (use 4.0V or 4.5V to run checks)
- Soletra (use std 1.5V to run checks)
- Short circuit = two contacts or wires connecting → rapid battery depletion
- Open Circuit = loss of one or more contacts with sudden loss of efficacy

Impedance Readings

– Impedance & current drain indicate status of system (applies to Soletra)

- *Normal:* impedance 600-1300 Ω ; current drain <12-30 μA
- *Open Circuit:*
 - Soletra impedance >2000 Ω ; current drain <7-9 μA
 - Kinetra impedance >4000 Ω ; current drain <7-9 μA
- *Short Circuit:* impedance <250 Ω ; current drain >500 μA

Open Circuit - loss of one or more contacts

Electrode Impedences (1.5 V, 210 μ s, 30 Hz)

Electrode Pair	Impedance (Ω)	Current (μ A)
0 & c	>2000	<7
1 & c	>2000	<7
2 & c	>2000	<7
3 & c	>2000	<7
0 & 1	1137	14
0 & 2	1480	12
0 & 3	1535	12
1 & 2	1159	14
1 & 3	1381	13
2 & 3	1217	13

**Wire Bond failure =
Loss of unipolar, but
preserved bipolar
function.**

**This pt
had loss of
efficacy in
Monopolar
setting, but,
preserved function
in bipolar setting**

Lead Fracture – Open Circuit



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Short Circuit

- Short Circuit: Two wires making contact
- Impedance $<250 \Omega$; current drain $>500 \mu\text{A}$
- Rapid depletion of battery life



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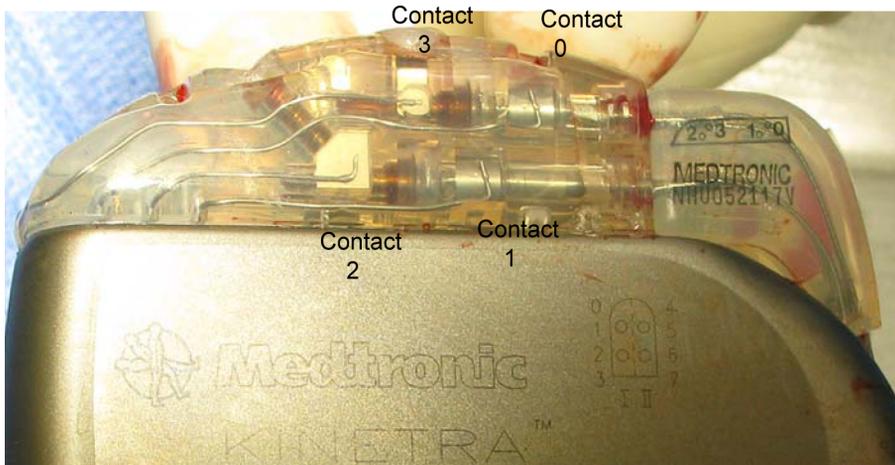
Kinetra Impedance Challenges

- Less reliable and harder to interpret
- Run 900's -1800's (wider range, and sometimes higher than Soletra)
- Often similar readings between many contacts/settings – unclear how to interpret



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Kinetra Battery with 'fluid in the boot'



Subjective loss of efficacy after routine Kinetra battery change – note fluid in contacts 3 and 2.
Impedances were high, but not as high as open circuit readings (> 4000, current drain <7)
(Post-op Readings = 1880's - 2121 imp with <15 current drain.)



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Low Battery Issues

- **Solettra** low battery = < **3.60V**, common for pts to want 'more juice' or feel less well
- **Kinetra** low battery = < **2.40V**, uncommon for pts to feel loss of efficacy (start surgical referral at 2.50V)
- Advanced PD patients have required inpatient admission due to severe PD sx's after battery failed
- Goal is to monitor battery and replace *before* battery fails
- Need 2-4 weeks to plan replacement surgery



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Lead location → suboptimal placement?

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Volts pushed up to just below side effects?

At high voltages, what are the side effects?

Device-related issues or malfunction?

- Hardware issues: wire fracture or crushed?
- Factory recall :‘wire bond’ disruption in battery

Has there been an over zealous medication reduction?
(pt under-medicated?)

Patient Education: Identify Secret Unrealistic Expectation(s)

- Managing Pt expectations “mantra”
 - DBS is not a cure for PD, can’t find ‘holy grail’ settings
 - Optimal results from stimulation different for each patient
- DBS settings and medications often need to be adjusted concurrently with STN (goes against rule to change one variable at a time)

Adjunctive therapies needed for advanced pts: physical therapy, occupational therapy and speech therapy often indicated

- Depression common after medication reduction

