

# Pearls and Pitfalls of Hypoglossal Nerve Stimulation

---

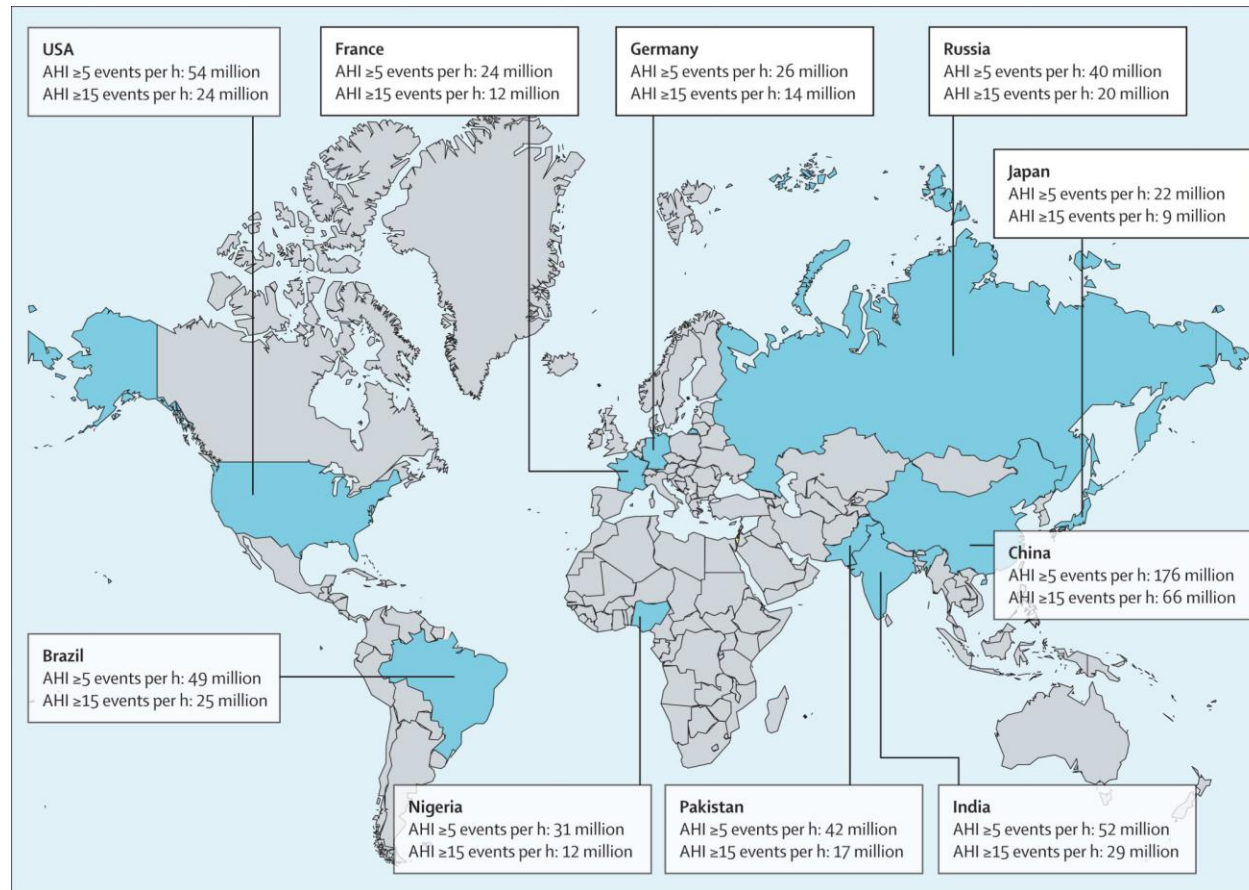
Ryan Nord, MD  
Associate Professor of Otolaryngology  
Director of Sleep Surgery  
VCU Health

# Disclosures

- Inspire Medical Systems – Consultant
- Nyxoah – Safety monitoring
- Siesta Medical – Consultant
- Avivomed – Consultant

# Topics of Discussion

- Lightning Overview of Hypoglossal Nerve Stimulation
- Patient Selection Pearl – DISE Patterns that lead to successful outcomes
- Intraoperative Pearls – Nerve anatomy and dissections tips
- Post-operative Pathway Pearls— Programming for comfort and airway opening



Worldwide prevalence of OSA is 1 billion!!

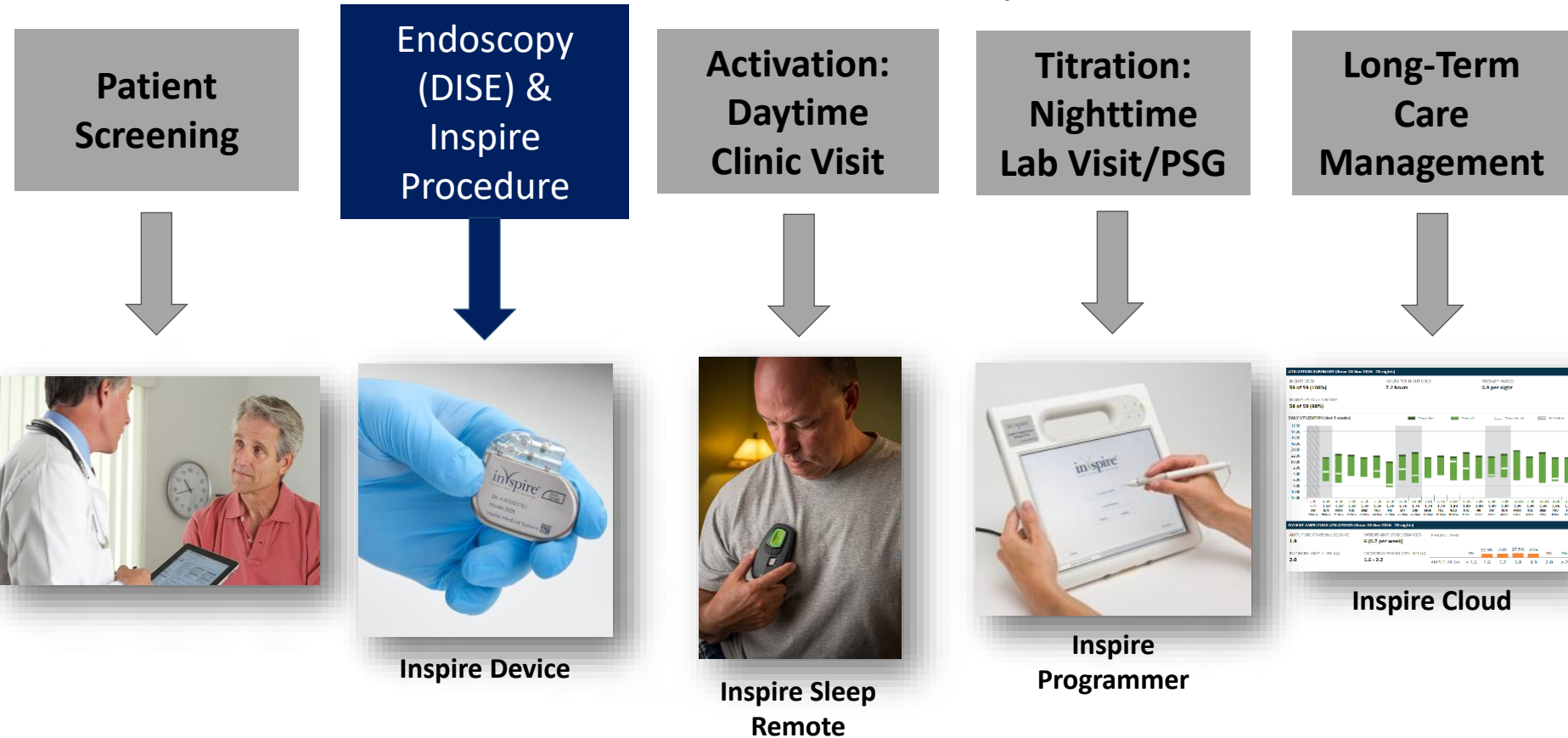
# What if CPAP fails?

---

- 40-60% of patients cannot tolerate or fail CPAP
- No accepted second line treatment for CPAP failures
- What about the other 12.5 million?

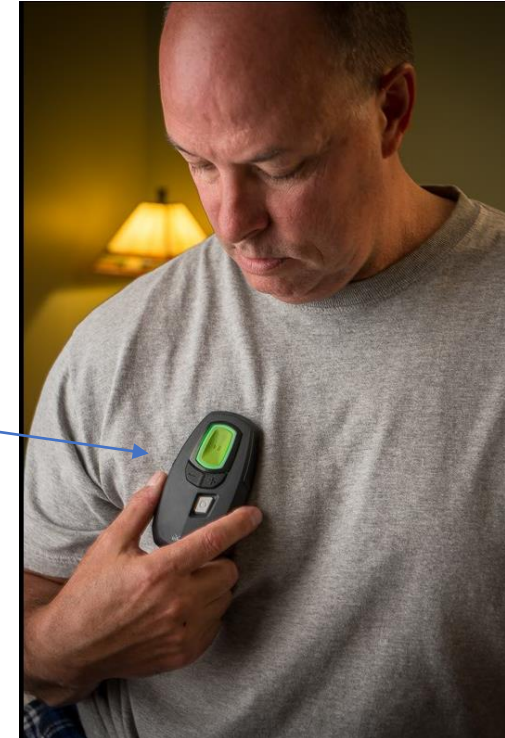
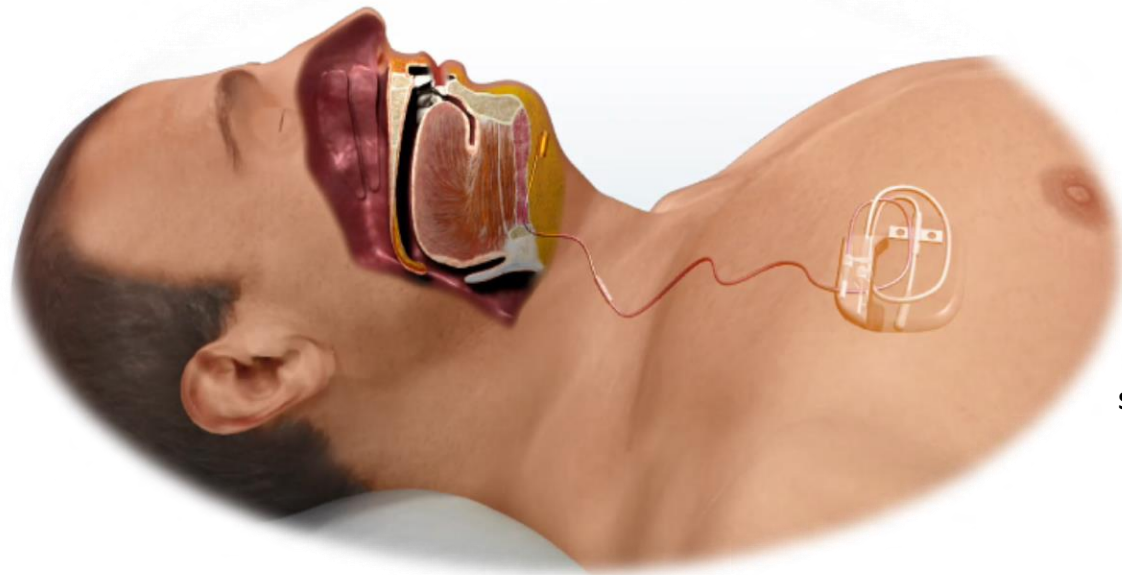


# HNS Patient Care Pathway

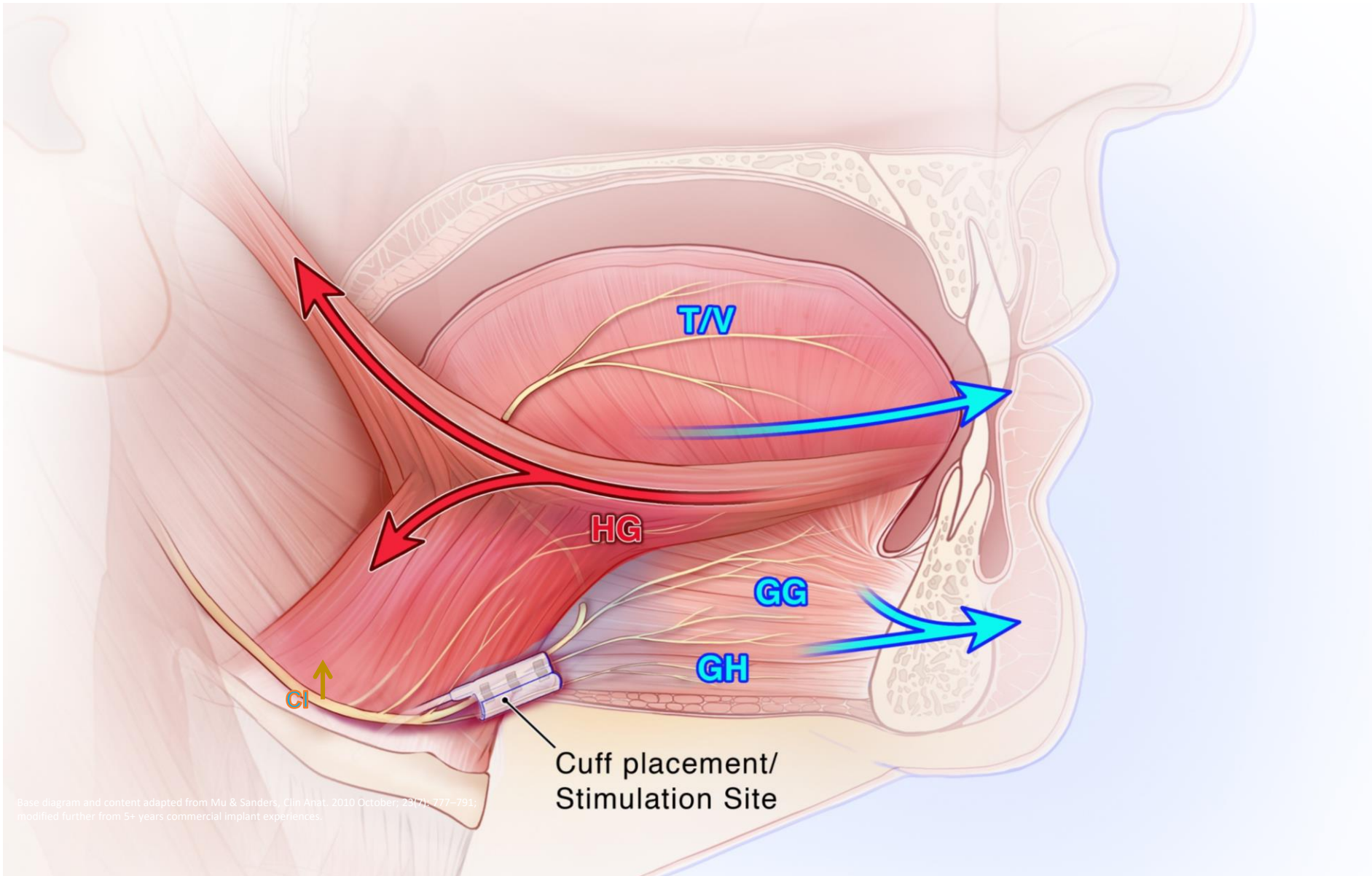


# Hypoglossal Nerve Stimulation

(Adjustable, Titratable, Adherence Monitoring)

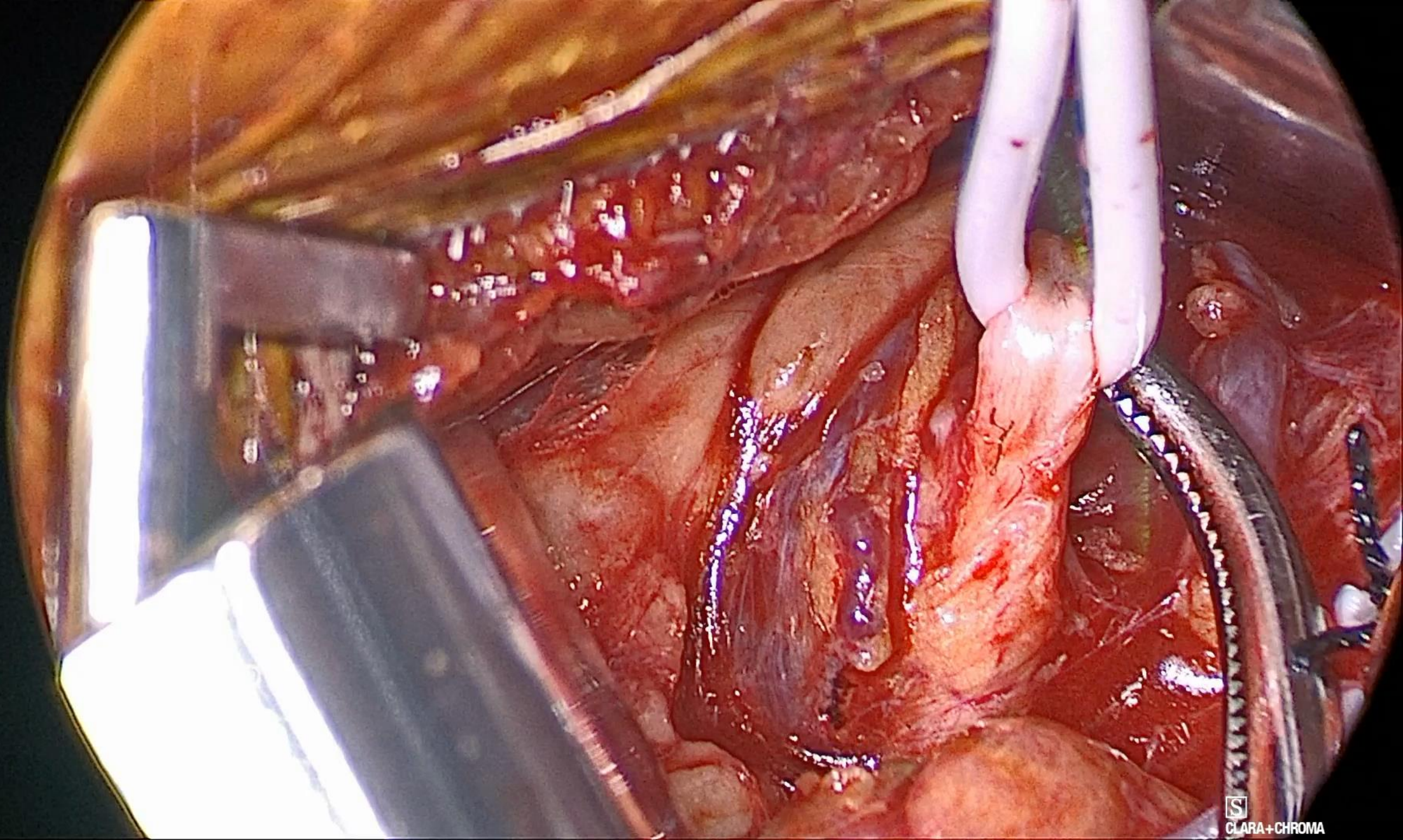


- FDA approved in 2014
- 2 small incisions
- 60-90 minute outpatient surgery with minimal downtime



Date







# Hypoglossal Nerve Stimulation Effect

## No Stimulation



Base of Tongue



Palate



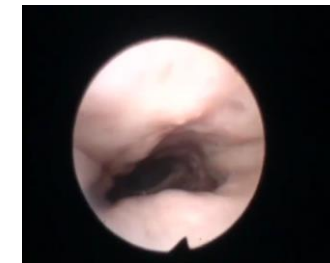
## Stimulation On



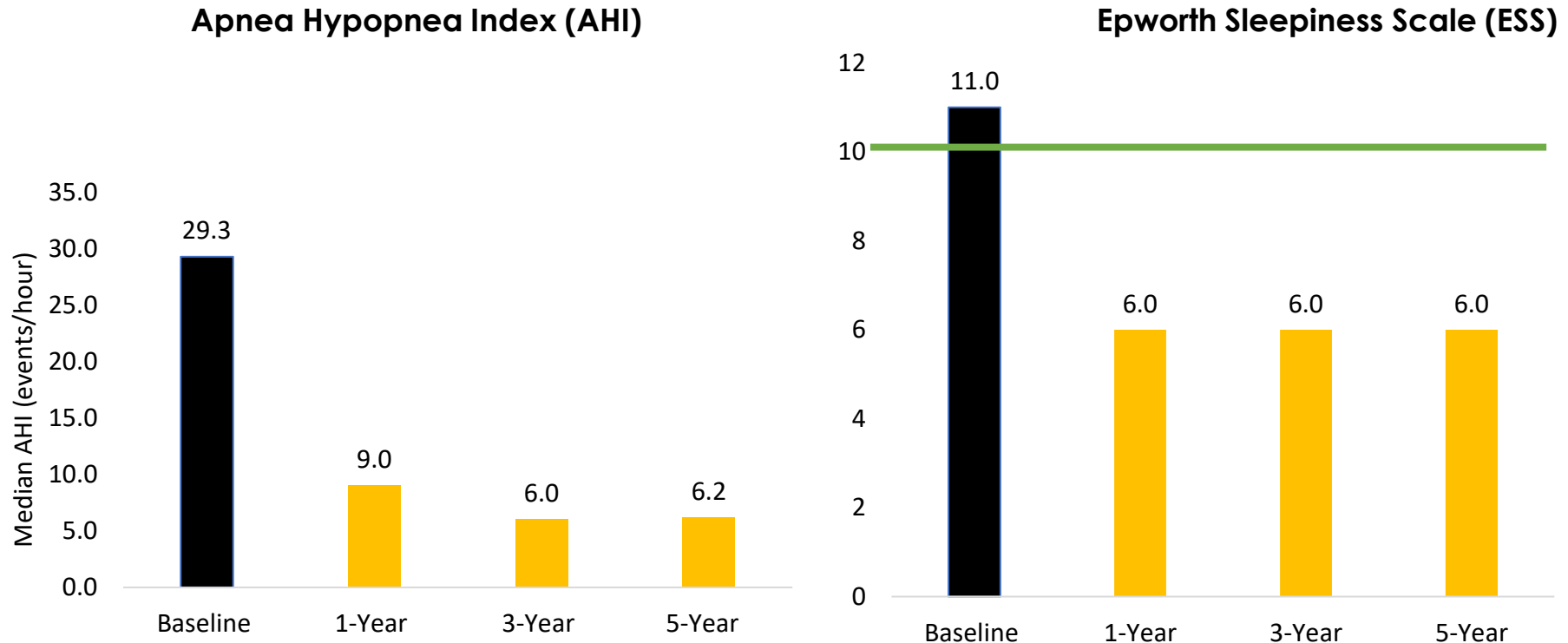
Base of Tongue



Palate



# STAR Trial Overview



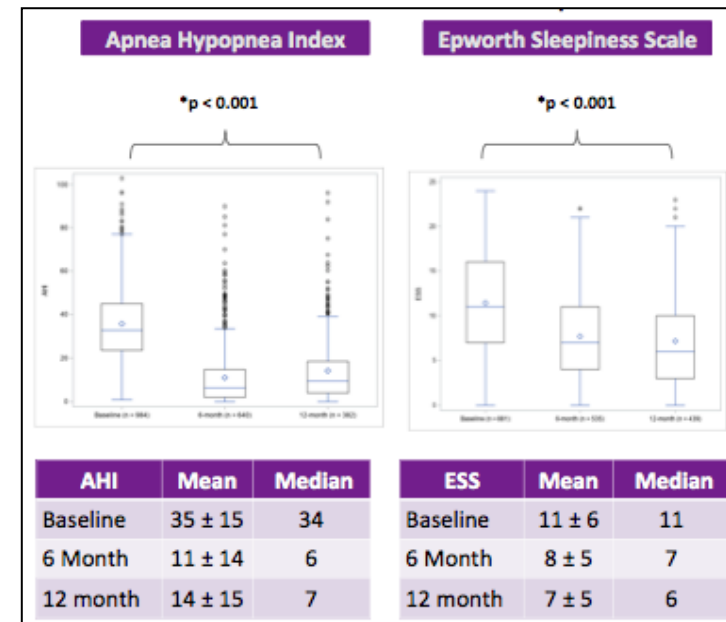
Strollo et al NEJM 2014; Woodson et al  
Heise et al ERJ 2019  
Pietzsch et Marin; 2018;

# ADHERE Registry

- Age (y): 60 ± 11 (22-86)
- BMI (kg/m<sup>2</sup>): 29.3 ± 3.9
- Gender: 26% female
- Multivariate analysis: female gender and lower BMI were predictors of therapy success
- Long-term adherence: 5.7h/night

## AHI response rate at 12mo


AHI <5	41%
AHI <10	65%
AHI <15	78%
AHI <20 + >50% reduction	81%




Boon M, Huntley C, Steffen A, et al. UAS for OSA: results from the ADHERE registry. *Otolaryngol Head Neck Surg* 2018.

Thaler E, Schwab R, Maurer J, Soose R, et al. Results of the ADHERE UAS registry and predictors of therapy efficacy. *Laryngoscope* 2019

Soose RJ, Boon M, Larsen C, et al. Phenotypic predictors of Long-Term Upper Airway Neurostimulation Responsiveness in the ADHERE International Registry. Abstract AAO-HNS, New Orleans, 2019.

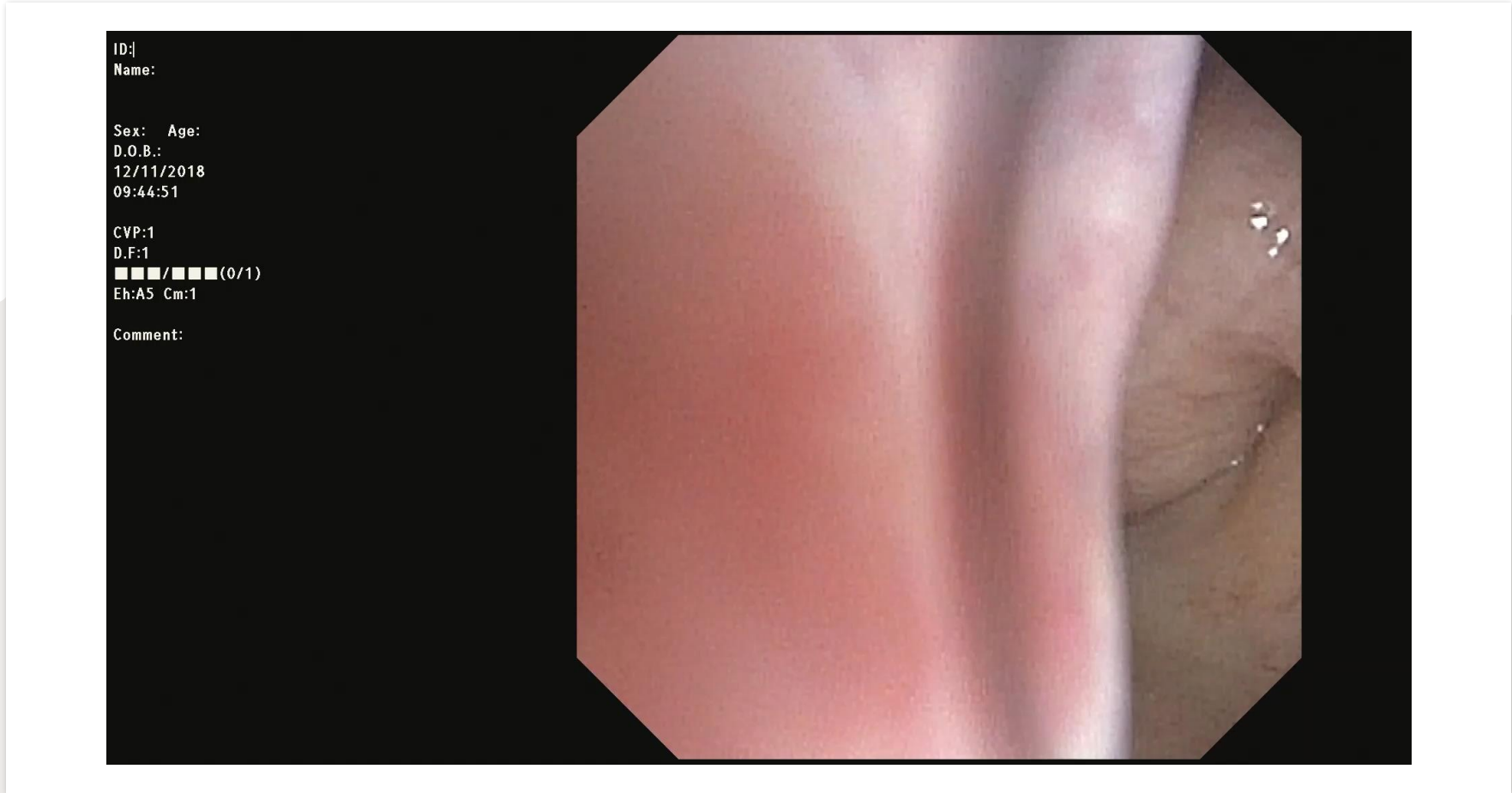


*Hypoglossal Nerve Stimulation is a safe, effective and efficient outpatient procedure to treat OSA BUT who is a good candidate?*



# Patient Selection – Candidacy Criteria

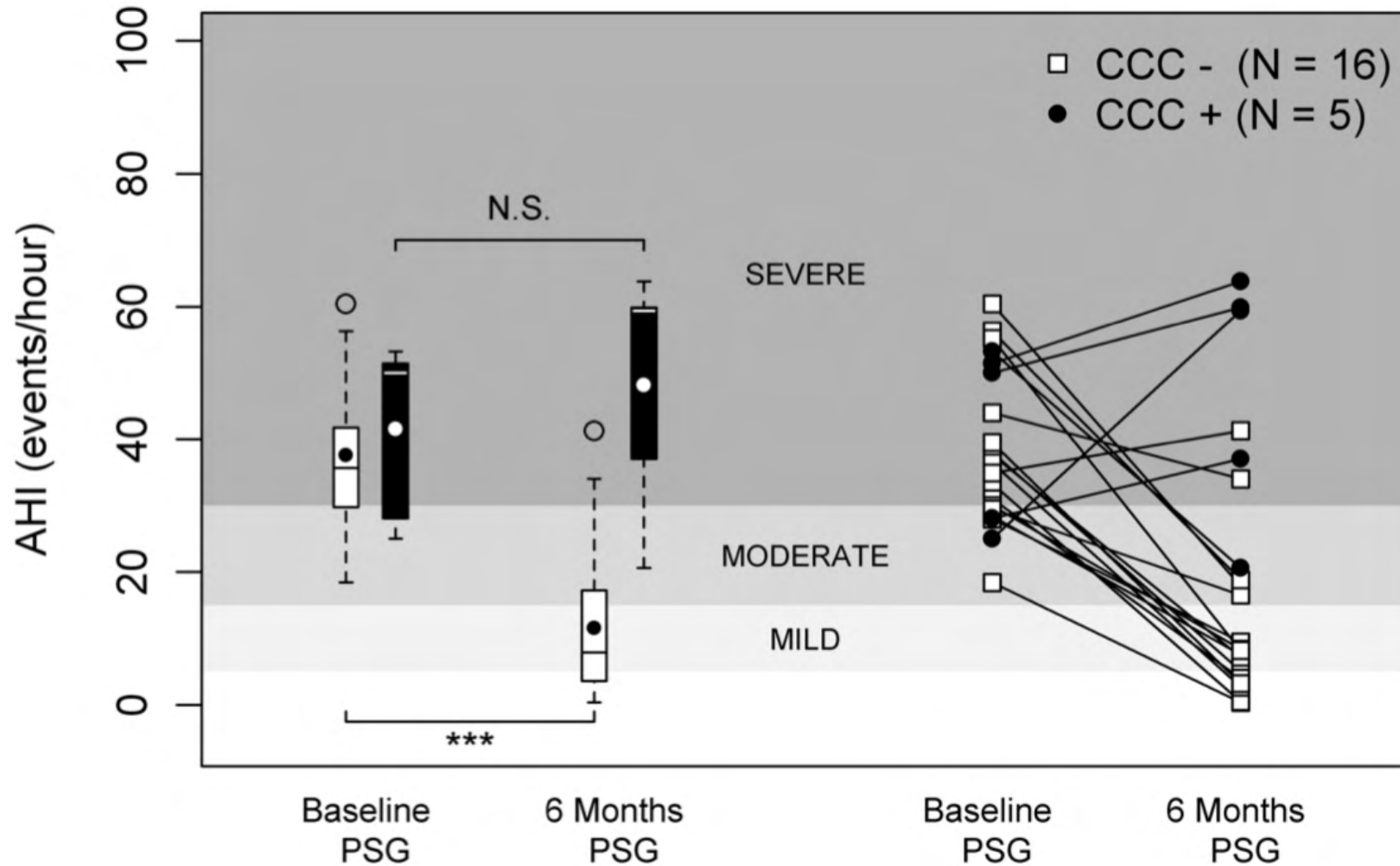
- AHI 15-65 with less than 25% central apneas
- Are unable to use or get consistent benefit from CPAP
- BMI under 32 (up to 35 or even higher possible if medically necessary)
- Age 18+
- No complete concentric collapse on DISE
- **UPDATE from the FDA: AHI<100 and BMI<40 BUT payers have not followed suit**



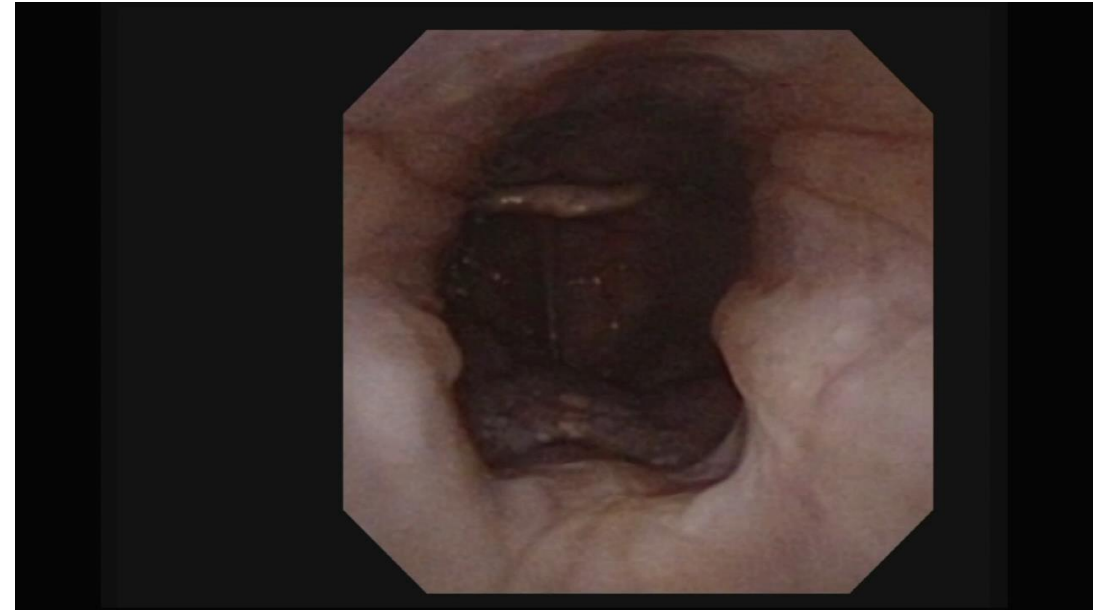
Complete Concentric Collapse



# Complete Concentric Collapse Predicts Poor HNS Outcomes



Vanderveken OM, Maurer JT, Hohenhorst W, et al. Evaluation of drug-induced sleep endoscopy as a patient selection tool for implanted upper airway stimulation for obstructive sleep apnea. *J Clin Sleep Med.* 2013;9(5):433-438.



# Drug-Induced Sleep Endoscopy and Hypoglossal Nerve Stimulation Outcomes: A Multicenter Cohort Study










Phillip Huyett, MD ; David T. Kent, MD; Mark A. D'Agostino, MD ; Katherine K. Green, MD, MS; Ryan J. Soose, MD; Thomas M. Kaffenberger, MD ; B Tucker Woodson, MD ; Colin Huntley, MD ; Maurits S. Boon, MD; Clemens Heiser, MD ; Amelie Birk, MD; Maria V. Suurna, MD ; Ho-Sheng Lin, MD; Jonathan A. Waxman, MD, PhD ; Eric J. Kezirian, MD, MPH 

TABLE VI.  
Surgical Response ( $\geq 50\%$  Decrease in Apnea-Hypopnea Index to  $< 15$  Events/Hour) on tPSG and Association With DISE Findings.

DISE Finding	N (%)	P Value	
V	None vs. partial vs. complete	19 (79.2%) vs. 116 (68.6%) vs. 114 (76.0%)	.29
	Complete vs. partial/none	114 (76.0%) vs. 135 (69.9%)	.22
	Complete vs. partial*	114 (76.0%) vs. 116 (68.6%)	.17
	Any vs. none	230 (72.1%) vs. 19 (79.2%)	.64
	Complete vs. none	114 (78.0%) vs. 19 (79.2%)	1.00
	<b>Complete concentric collapse: presence vs. absence</b>	<b>8 (57.6%) vs. 241 (73.0%)</b>	.22
O	None vs. partial vs. complete	163 (74.1%) vs. 67 (74.4%) vs. 19 (57.6%)	.13
	<b>Complete vs. partial/none</b>	<b>19 (57.8%) vs. 230 (74.2%)</b>	<b>.042</b>
	Any vs. none	86 (69.9%) vs. 163 (74.1%)	.41
	<b>Complete vs. none</b>	<b>19 (57.8%) vs. 163 (74.1%)</b>	<b>.049</b>
T	None vs. partial vs. complete	48 (64.9%) vs. 86 (70.5%) vs. 115 (78.2%)	.09
	<b>Complete vs. partial/none</b>	<b>115 (78.2%) vs. 134 (68.4%)</b>	<b>.043</b>
	Any vs. none	201 (74.7%) vs. 48 (64.9%)	.09
	<b>Complete vs. none</b>	<b>115 (78.2%) vs. 48 (64.9%)</b>	<b>.033</b>
E	None vs. partial vs. complete	216 (73.5%) vs. 24 (72.7%) vs. 9 (56.3%)	.32
	Complete vs. partial/none	9 (56.3%) vs. 240 (73.4%)	.13
	Any vs. none	33 (67.3%) vs. 216 (73.5%)	.37
	Complete vs. none	9 (56.3%) vs. 216 (73.5%)	.13

# Should lateral wall collapse be a contraindication for hypoglossal nerve stimulation? ☆,☆☆

Ryan S. Nord <sup>a,\*</sup>, Thomas Fitzpatrick IV <sup>a</sup>, Graham Pingree <sup>b</sup>, Albina Islam <sup>a</sup>, Andrew Chafin <sup>b</sup>

**Table 2**

Treatment response.

Lateral wall collapse	Overall	Complete	Partial	None
Post-Op AHI	10.44 ± 12.82	12.06 ± 13.86	8.51 ± 9.38	10.03 ± 13.99
Post-Op ESS	6.3 ± 4.7	6.6 ± 4.8	7.3 ± 5.0	5.2 ± 4.1
Voltage (V)	1.85 ± 0.65	1.88 ± 0.73	1.89 ± 0.57	1.78 ± 0.62
Alt configuration	22.52 % (25)	17.78 % (8)	23.33 % (7)	27.78 % (10)
Awake endoscopy	32.53 % (35)	40.00 % (18)	20.00 % (6)	30.56 % (11)
Adherence (h)	6.42 ± 2.07	6.30 ± 2.04	6.71 ± 1.82	6.32 ± 2.30
Surgical success	77.47 % (86)	66.67 % (30)	90.00 % (27)	80.56 % (29)

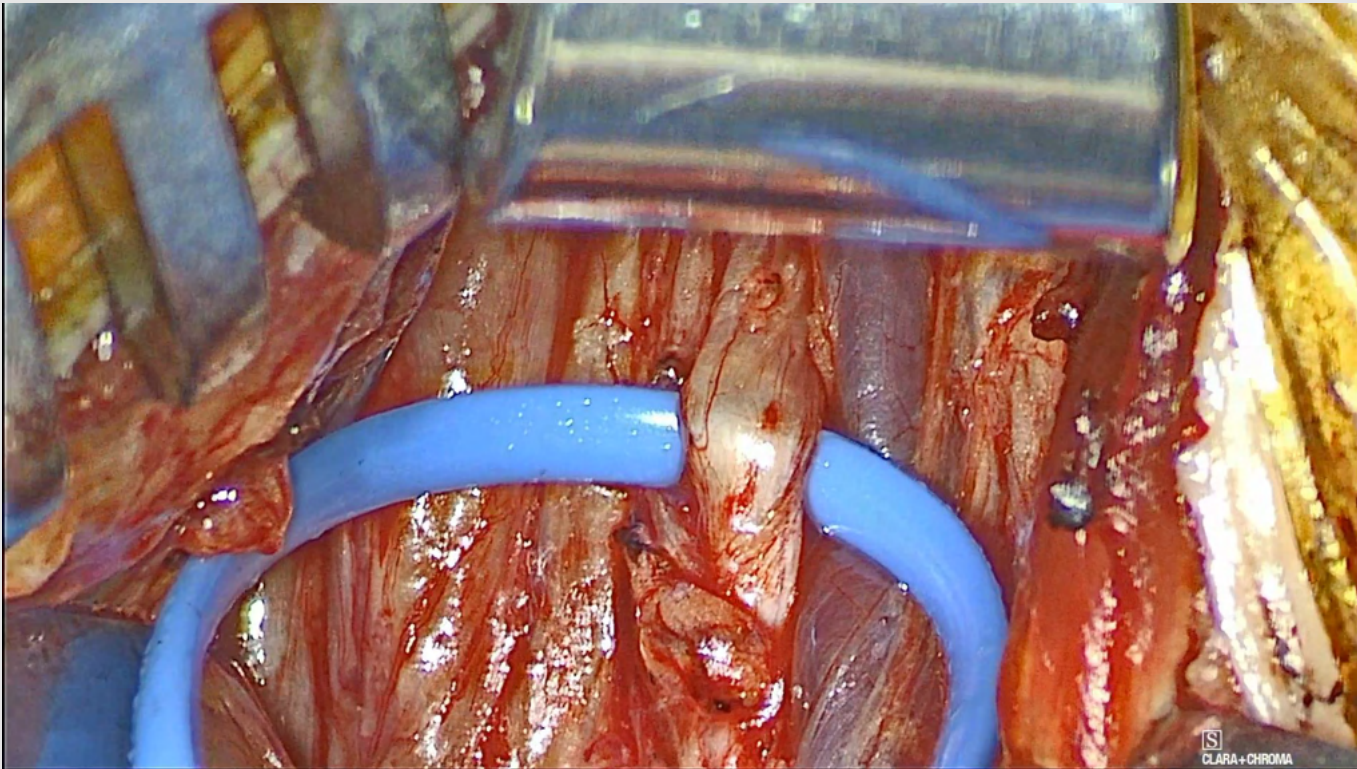
**PEARL:** Patients with tongue base collapse and without complete lateral wall collapse do best

Nord RS, Fitzpatrick T, Pingree G, Islam A, Chafin A. Should lateral wall collapse be a contraindication for hypoglossal nerve stimulation? Am J Otolaryngol. 2023;45(1):104053.

*A pre-operative DISE exam is essential to rule out CCC however, complete lateral wall collapse is also an important factor.*

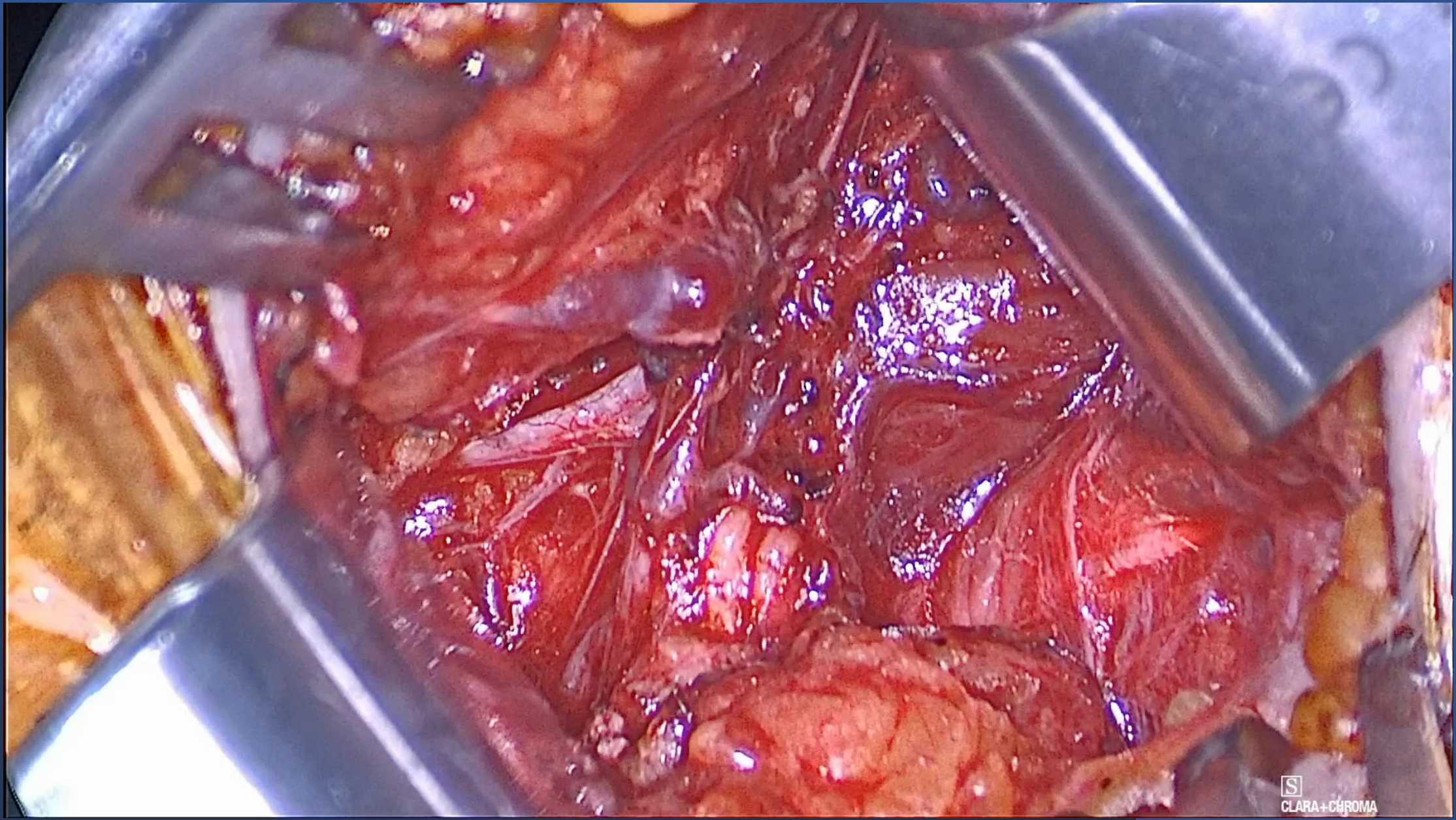
# 5 Pearls to Optimize Nerve Dissection

1. Avoid the nerve to the mylohyoid and the lingual nerve
2. Efficient dissection by using venous landmarks
3. Divide crossing venous branches
4. Locate the free edge of the hyoglossus
5. Test tongue motion using bipolar and unipolar settings



## Lingual Nerve

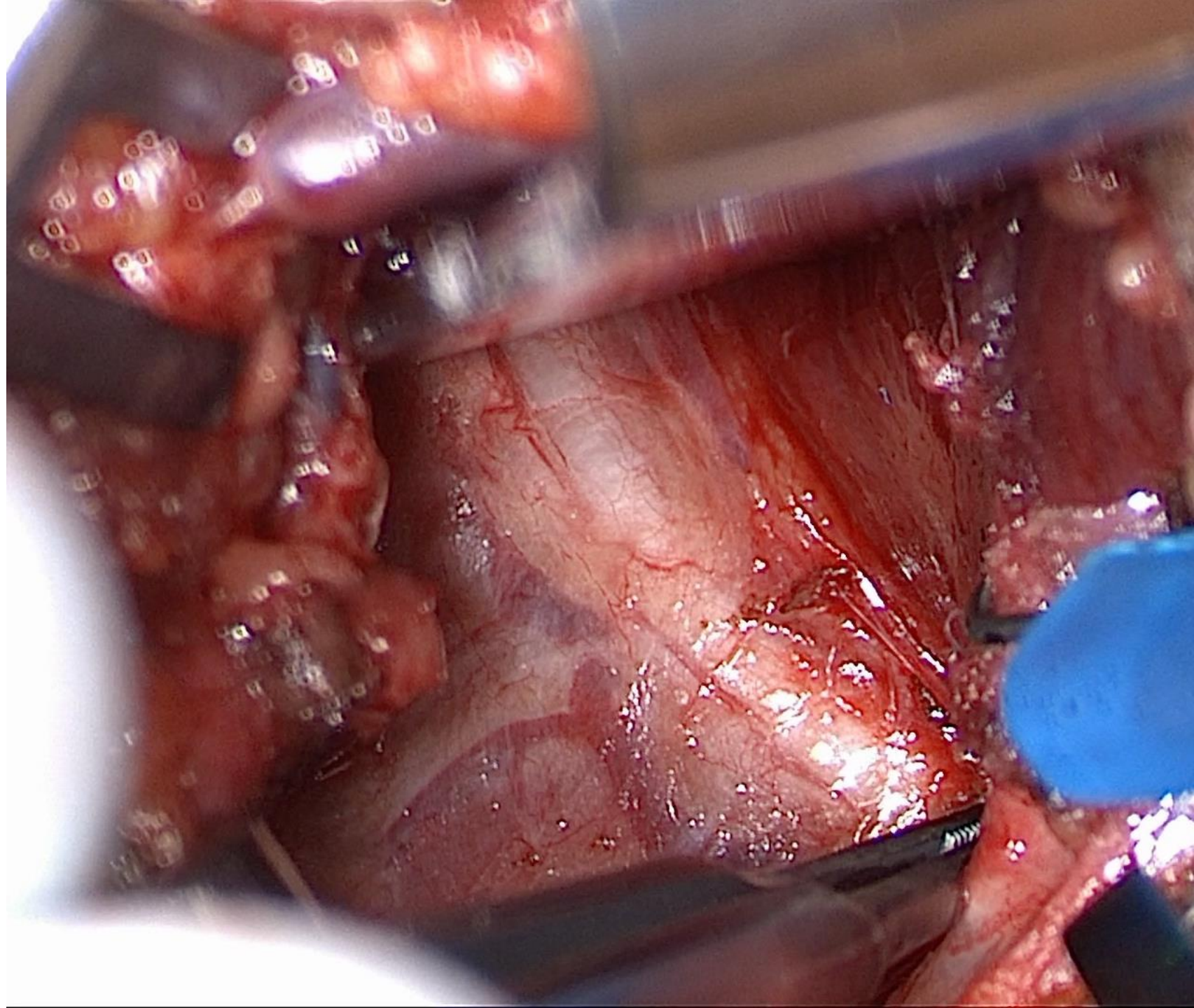
- May be ptotic in older individuals
- No stim on NIM



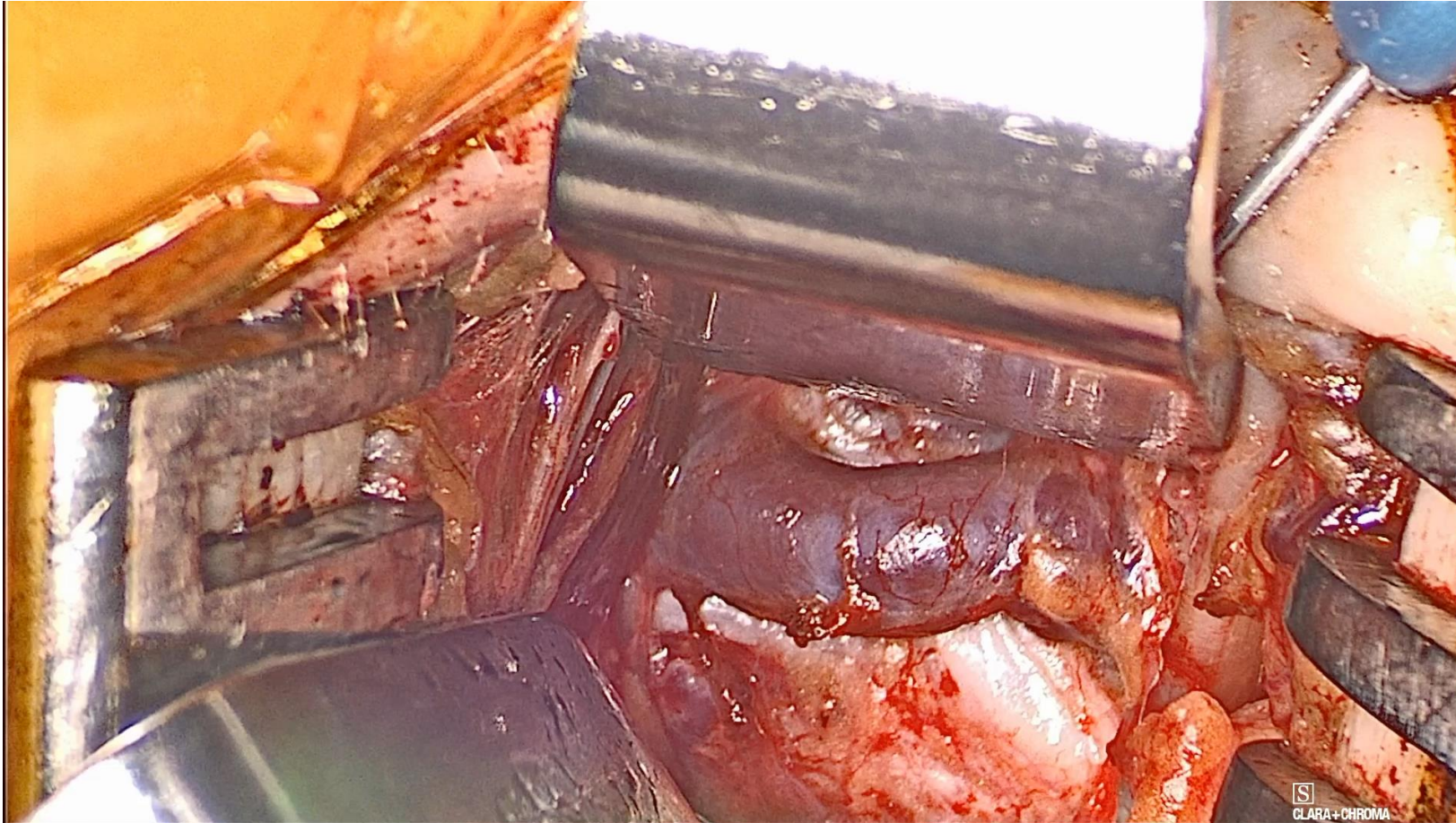


# Breakpoint

- Before doing any dissection, try to estimate location of the breakpoint.

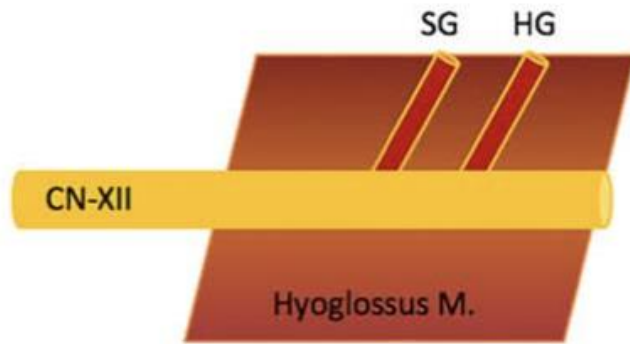


# Crossing branch of the Ranine Vein

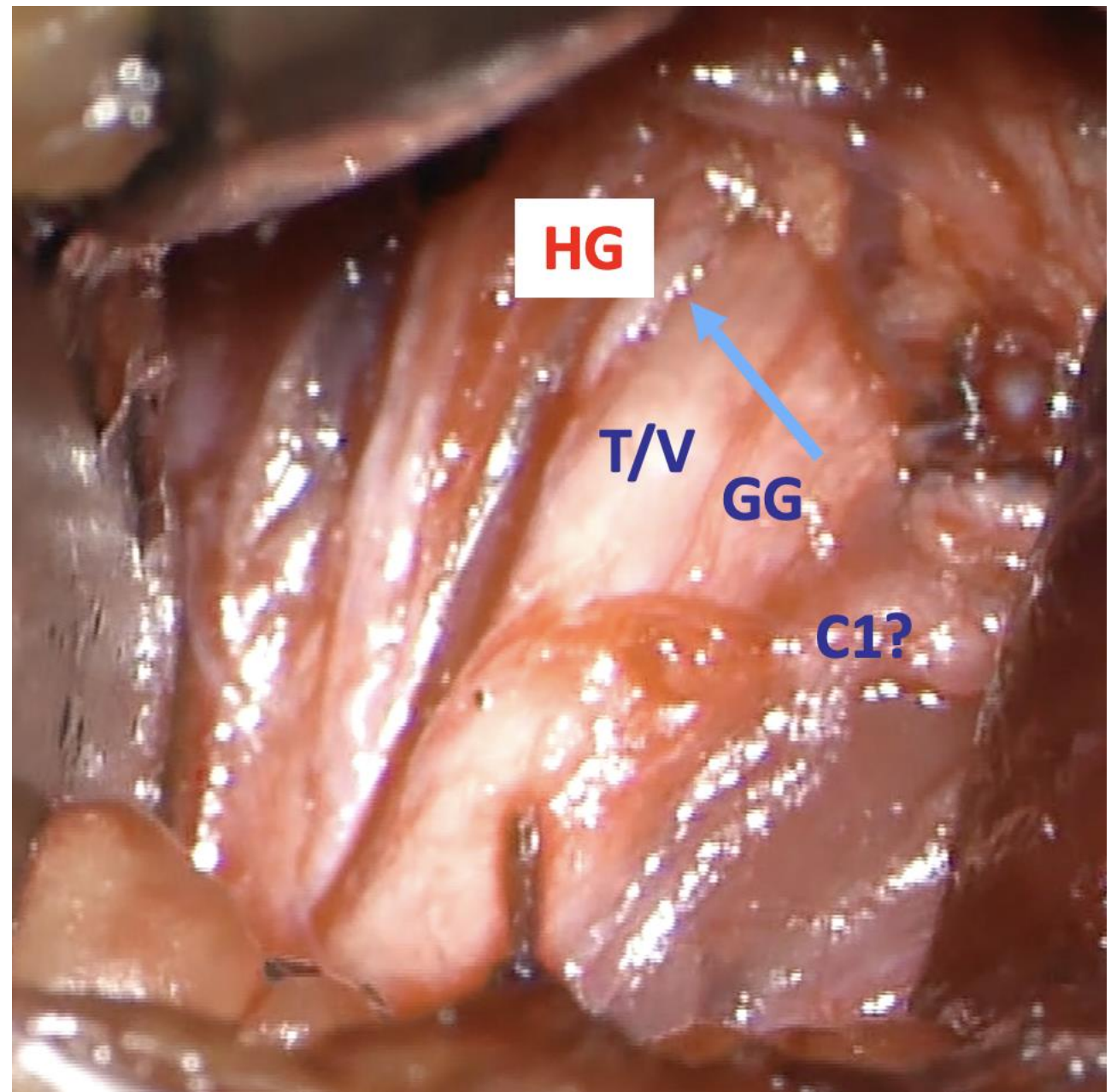
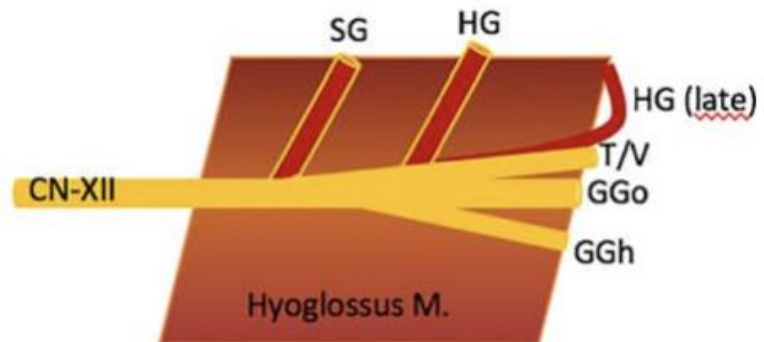


- Ligate any branch of the Ranine vein that crosses the nerve to improve visualization and confidence in dissection

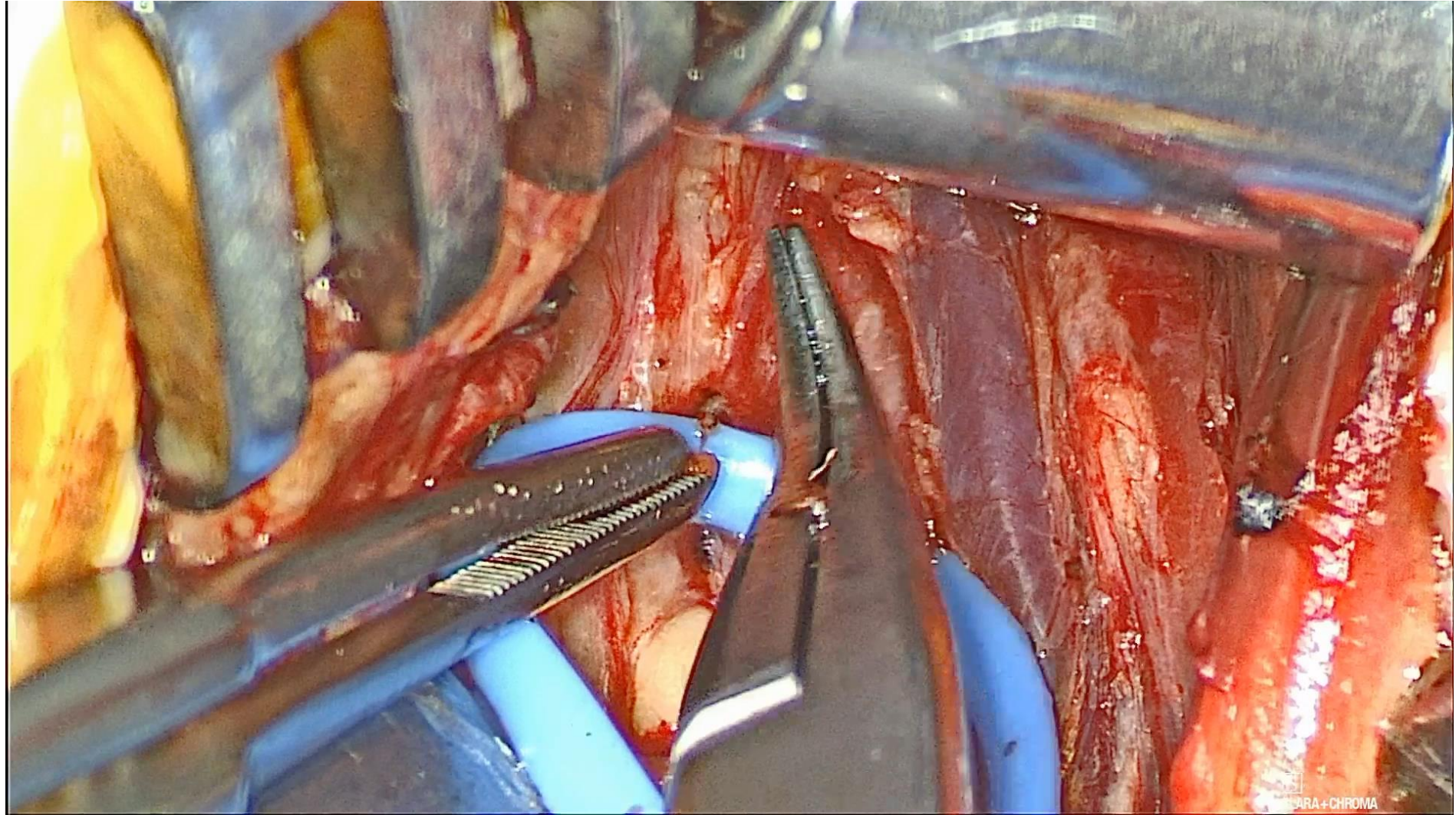
type 1: 33%



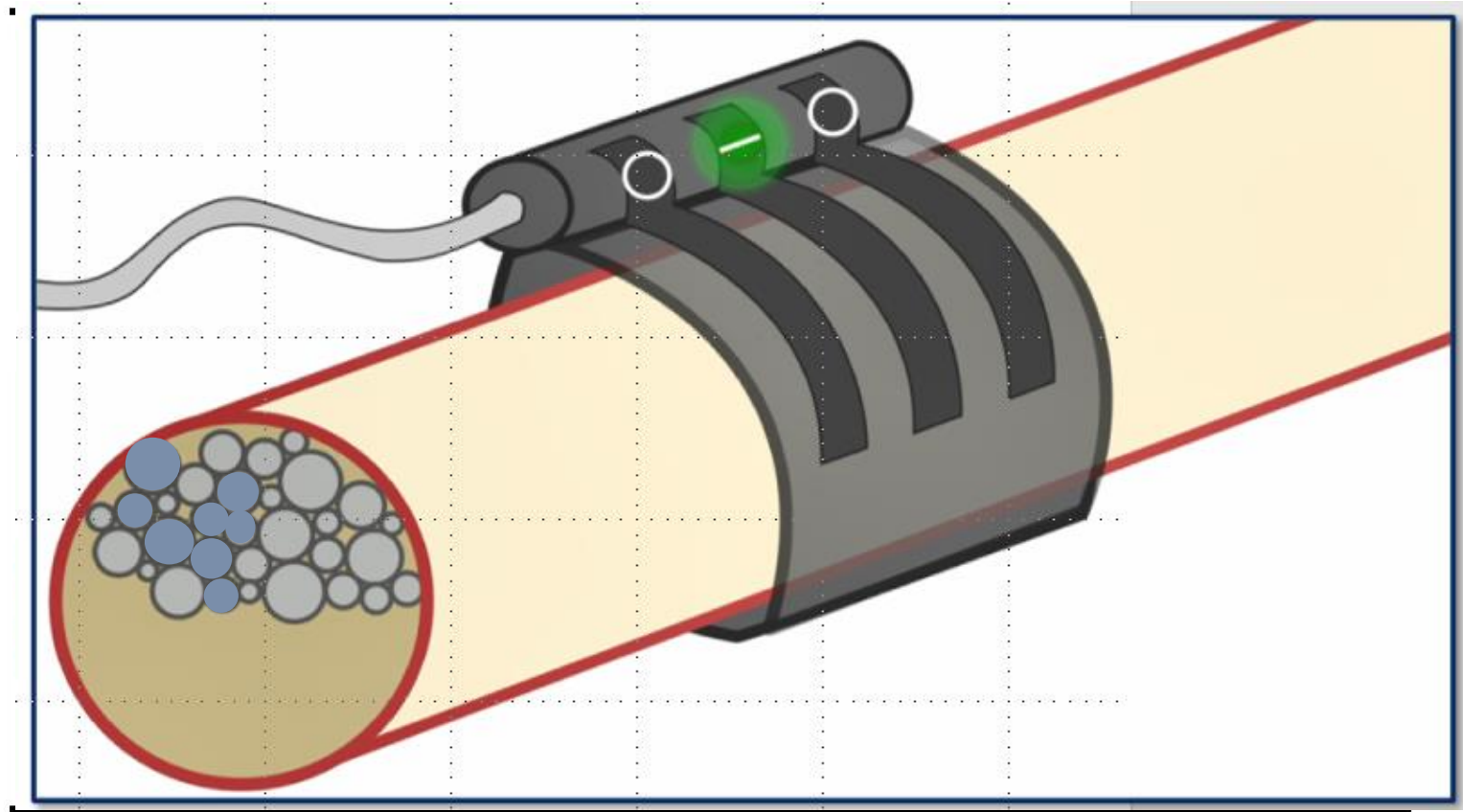
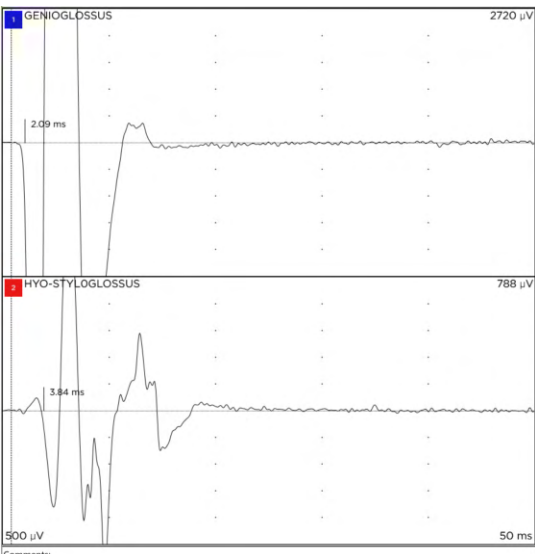
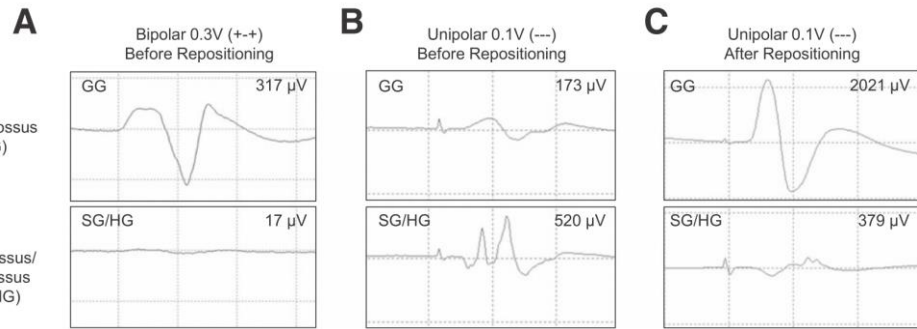
type 2: 67%



Heiser C, Knopf A, Hofauer B. Surgical anatomy of the hypoglossal nerve: A new classification system for selective upper airway stimulation. *Head Neck*. 2017;39(12):2371-2380.



# Check bipolar AND unipolar settings



Sturm JJ, Lee CH, Modik O, Suurna MV. Intraoperative identification of mixed activation profiles during hypoglossal nerve stimulation. *J Clin Sleep Med.* 2020;16(10):1769-1774.

# Achieve Success in the Care Pathway

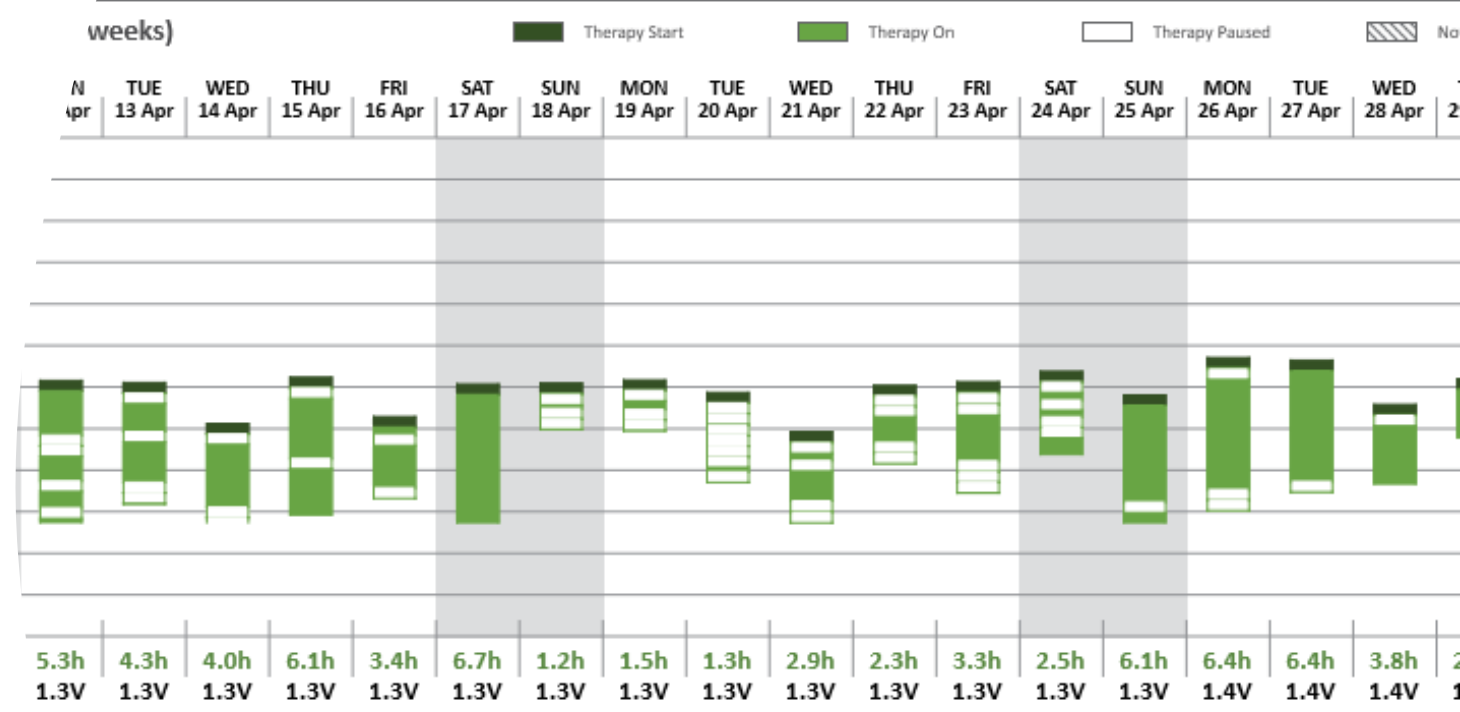
- Achieve comfort
- Find the best tongue motion
- Find the best palate motion

HOURS PER NIGHT USED  
**3.2 hours**

THERAPY PAUSES  
**4.3 per night**

# Case #1

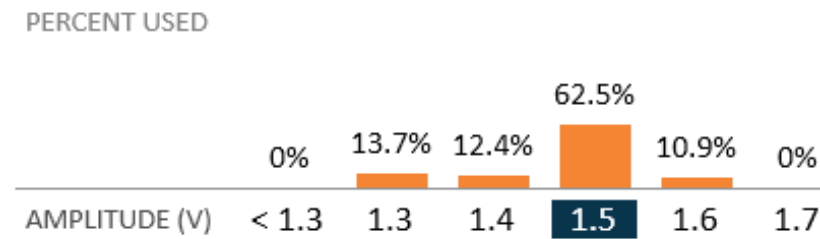
- Patient has advanced to level 10 but finds stimulation wakes him up at night and is uncomfortable



**UTILIZATION (30 Oct 2020 12:00 to 30 Apr 2021 12:00 - 182 nights)**

PATIENT AMPLITUDE CHANGES  
**18 (0.7 per week)**

INCOMING PATIENT CONTROL (V)  
**1.1 - 2.0**







Improved tolerance with decreased voltage

**UTILIZATION SUMMARY (30 Apr 2021 12:00 to 19 May 2021 12:00 - 19 nights)**

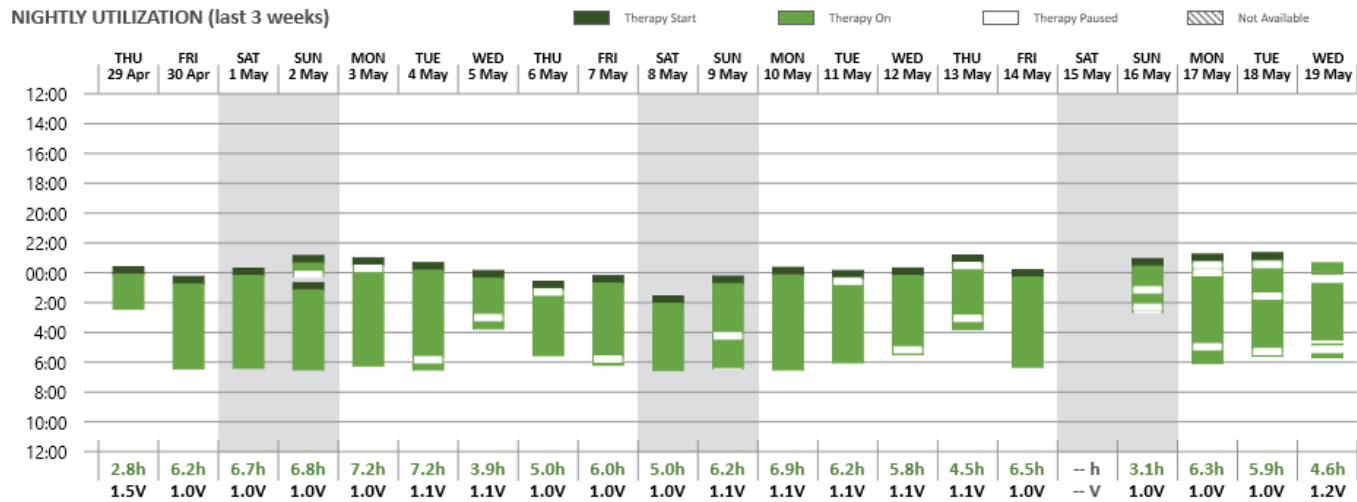
NIGHTS USED  
**18 of 19 (95%)**

HOURS PER NIGHT USED  
**5.8 hours**

THERAPY PAUSES  
**1.2 per night**

NIGHTS USED >= 4 HOURS  
**16 of 19 (84%)**

**NIGHTLY UTILIZATION (last 3 weeks)**



**PATIENT AMPLITUDE UTILIZATION (30 Apr 2021 12:00 to 19 May 2021 12:00 - 19 nights)**

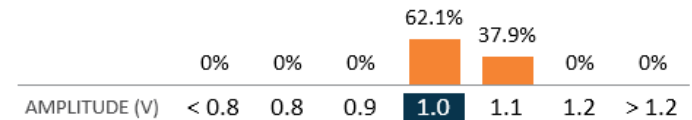
AMPLITUDE ON 30 Apr 2021 (V)  
**1.5**

PATIENT AMPLITUDE CHANGES  
**4 (1.5 per week)**

PERCENT USED

INCOMING AMPLITUDE (V)  
**1.0**

INCOMING PATIENT CONTROL (V)  
**0.8 - 1.9**



Patient  
returns  
after non-  
therapeutic  
study

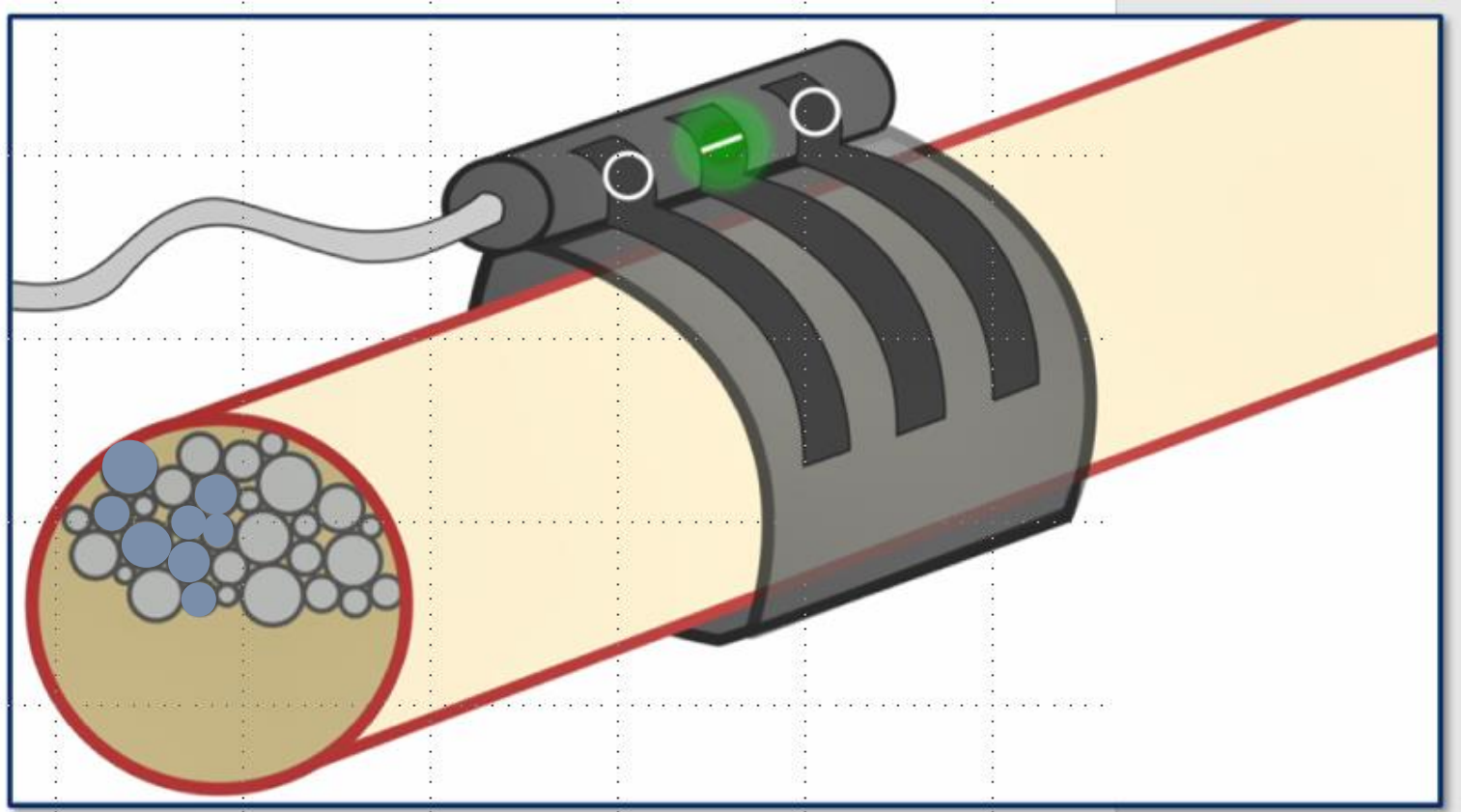
**Bipolar (+-+)**



AHI 20.8

# Changing the Electrode Configuration can improve comfort and efficacy

- Changing the electrode configuration can result in improved tongue motion.



# Improved Tongue Motion with Electrode Change

Unipolar (o-o)



AHI 2.5

+

o

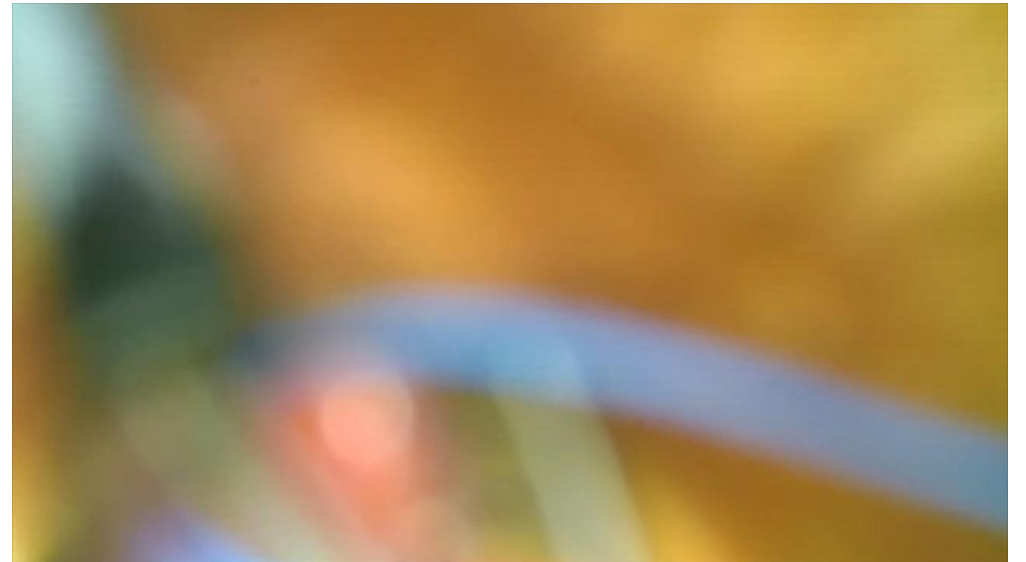
# Retraction on all settings

- 60 y/o man comes from outside physician as a consult to help troubleshoot his inspire device.
- Underwent uncomplicated implant approximately 1 year ago and despite multiple setting changes and awake endoscopy, an acceptable tongue motion phenotype was unable to be identified on any setting.



# Revision

- Place loop under cuff and remove cuff
- Divided two branches or Ranine vein as I worked more distally on the nerve
- Found clear exclusion branch



Pre-op: AHI 46.5

Post-op: AHI 1.7  
(full night)



# Awake Endoscopy to find the best palate opening

- If the tongue motion does not provide an answer, look at the palate.
- Cycle through voltages, electrode configurations, neck positions etc to find the optimal settings.





# Conclusions

- Hypoglossal nerve stimulation is an effective treatment for moderate to severe OSA after CPAP failure or intolerance
- Patient selection is key to success – tongue base collapse without complete lateral wall collapse
- Knowledge of the relevant nerve anatomy allows a successful outcome
- Simple office-based adjustments can often help the struggling patient

Thank you! 404-434-0257 /  
ryan.nord@vcuhealth.org

