2026 SEC Sleep Education Consortium

# From the Nose to Tongue-Base

## *Beyond DISE for Inspire Candidacy*

**Stanley Y.C. Liu, MD, DDS, FACS**

Associate Professor and Chair of OMS
Assistant Dean of Hospital Affairs
Nova Southeastern University
Director, NSU Breathe and Sleep Wellness Center

*Co-author, Updated Stanford (Riley-Powell) Sleep Surgery Algorithm*

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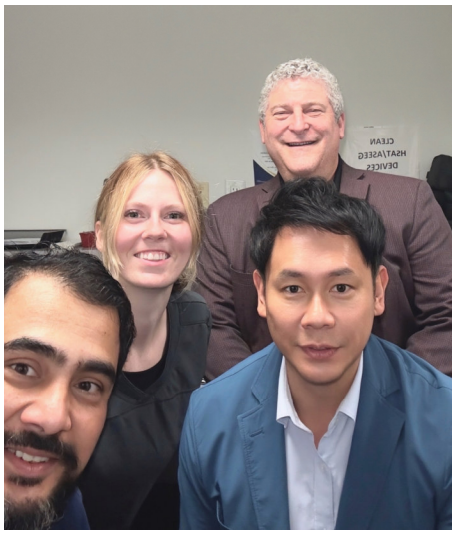
ACKNOWLEDGMENT



*With the CSMA sleep technology team, Sleepless in Houston*

## Jerald H. Simmons, MD

*Host, Sleep Education Consortium*
*Founding Director, Comprehensive Sleep Medicine Associates*

With gratitude to Dr. Simmons for hosting SEC 2026 and for welcoming this overnight visit to the Comprehensive Sleep Medicine Associates sleep lab in Houston.

A SHARED STANFORD LINEAGE

Both trained at Stanford under William C. Dement and Christian Guilleminault. The continuity of that mentorship now carries forward through collaborative education for the next generation of sleep clinicians and technologists.



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# Stanley Liu

MD · DDS · FACS

## Surgeon · Innovator · Educator

Restoring sleep breathing health as the gateway to wellness

**EDUCATION**

**Stanford University**
B.S., Biology

**UCSF**
D.D.S. & M.D.

**NIH / HHMI**
Medical Scholar, Cloister

**UCSF**
Residency
General Surgery & OMFS

**Stanford University**
Fellowship, ENT Sleep Surgery
Biodesign Faculty Fellow

**POSITIONS**

*Former*

**Stanford University**
Assoc. Professor, ENT
Sleep Surgery Fellowship Dir.

*Current*

**Nova Southeastern University**
Chair & Assoc. Professor, OMFS
Director, Breathe & Sleep Wellness Ctr

**LEADERSHIP**

**Global Initiative for OSA**
Deputy President

**World Dentofacial Sleep Society**
Founding Secretary

**ADVISORY**

**World Sleep Society**
Scientific Committee

**HelloSmile H.K. NGO**
Co-Director

**Children's Airway First Foundation**
Advisor

**CONNECT**

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www.drstanleyliu.com

**120+**
Peer-Reviewed Publications

**Keynote**
APSS 2019 · CSSM 2019 · World Sleep 2023

**FACS**
Fellow, American College of Surgeons

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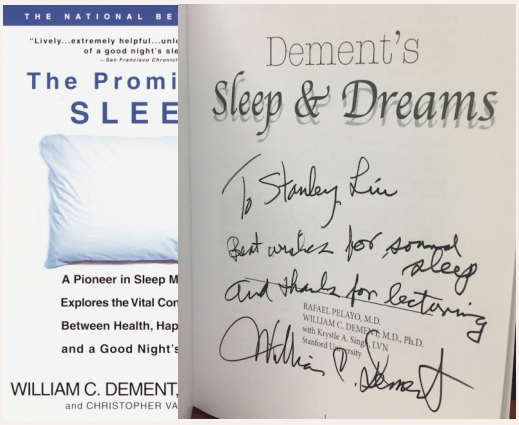
## As Late As 1970, the Practice of Medicine Ended When the Patient Fell Asleep

Dr. William C. Dement (1928-2020) and Dr. Christian Guilleminault (1938-2019)





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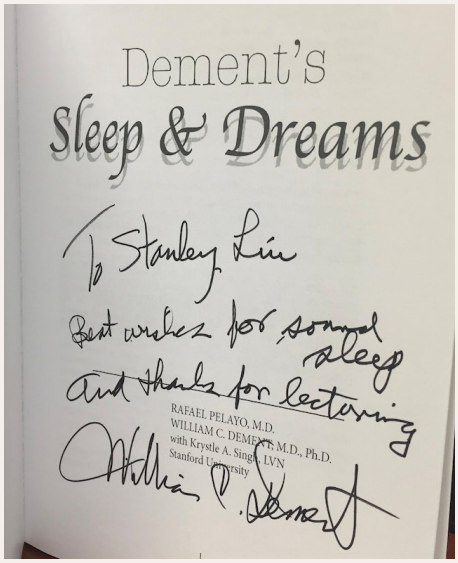
## Sleep and Dreams: A Personal Connection

"To Stanley Liu, best wishes for sound sleep and thanks for lecturing" — William C. Dement, MD, PhD





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## How Did We Fit In With OSA at Stanford?

The origins of sleep surgery, 1979

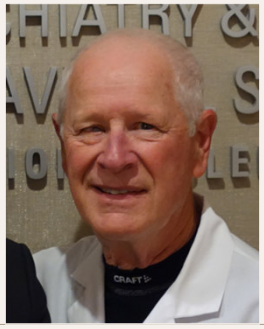
The sleep center in 1979 was on the second story and the Otolaryngology Clinic was below.

**Dr. Guilleminault** and **Dr. Dement** were interested in Bob Riley and I since we both had Maxillofacial and Dental experience. They were convinced that children and adults needed a more aggressive approach OSAS than **weight loss** or a **tracheotomy**.

Christian Guilleminault, MD, DPhil

Robert W. Riley, DDS, MD

Nelson Powell, DDS, MD



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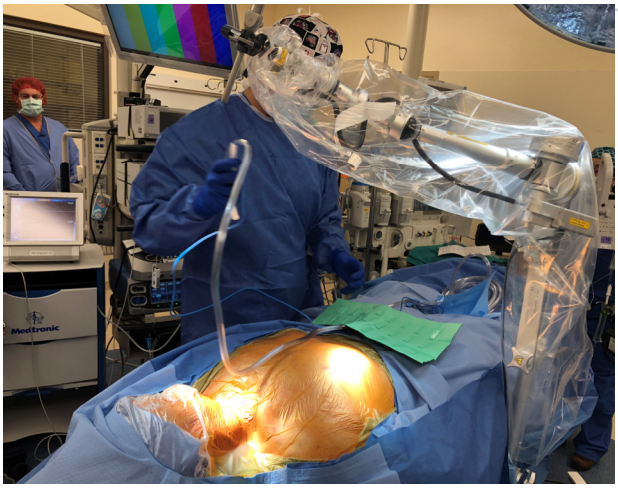
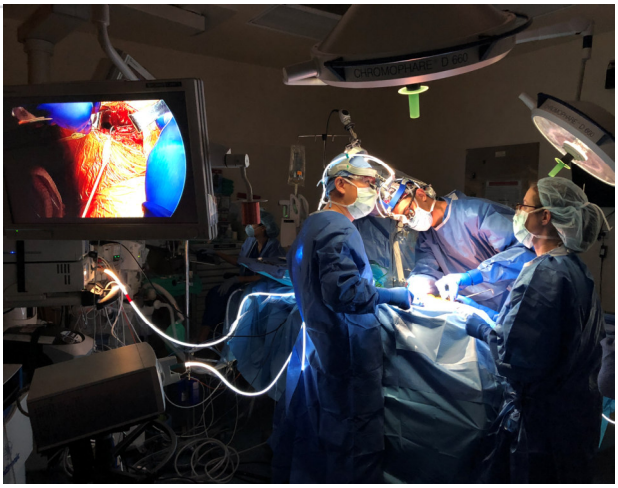
OPERATIVE EXPERIENCE

## Hypoglossal Nerve Stimulation

*Microsurgical exposure and team-based implant workflow*




*Microsurgical exposure under loupe magnification*



*Team approach with intraoperative video monitoring*

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UPPER AIRWAY STIMULATION · INSPIRE

## Inspire™ Upper Airway Stimulation

*U.S. indications expanded to AHI ≤100 and BMI ≤40*

FDA PMA P130008 / S090 · **APPROVED JUNE 8, 2023**

| CRITERION | REQUIREMENT | NOTE |
|---|---|---|
| **AHI** | 15 ≤ AHI ≤ 100 | Moderate to severe OSA (expanded from ≤65) |
| **BMI** | ≤ 40 kg/m² | Expanded from ≤32 with S090 approval |
| **Age** | ≥ 22 years | Ages 18-21 eligible with same AHI range |
| **Central apneas** | < 25% of AHI | Predominantly obstructive events required |
| **PAP status** | Failed or intolerant | Per CPAP / BiPAP clinical criteria |
| **DISE** | No CCC at velum | Complete concentric collapse contraindicated |
| **Pediatric (Down syn.)** | Ages 13-18, 10 ≤ AHI ≤ 50 | Adenotonsillectomy not an option |

**Inspire V (August 2024):** next-gen system with respiratory sensing integrated into the pulse generator. Same clinical indications. No separate sensing lead.

FDA, Inspire Upper Airway Stimulation P130008/S090, June 8, 2023. Accessed April 19, 2026. · *Inspire Medical Systems*

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INSPIRE™ · MECHANISM

# How Inspire™ Works

*Three defining design choices*

**01**

### Unilateral Stimulation

Cuff electrode wraps the right hypoglossal nerve. Stimulation advances the tongue anteriorly with each inspiratory pulse, opening the retroglossal and retropalatal airway.

**02**

### Inspiratory Sensing

Pressure-sensing lead in the intercostal space detects each inhalation. Stimulation fires in sync with breathing, reducing habituation and preserving physiologic drive.

**03**

### Implanted Battery

Non-rechargeable pulse generator in the right subclavicular pocket. Patient activates the device via handheld remote before sleep. Battery lasts 7-11 years, then replaced.

KEY INSIGHT *Inspire established HGNS as a viable pathway for CPAP-failure OSA, built on respiration-synchronized unilateral stimulation.*

Strollo et al. *NEJM* 2014; 370: 139-149 (STAR trial). · *Inspire Medical Systems*

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UPPER AIRWAY STIMULATION · GENIO

# Genio™ Hypoglossal Nerve Stimulation

*Bilateral stimulation · leadless implant · externally powered by a wearable*

FDA PMA P240024 · **APPROVED AUGUST 8, 2025**

| CRITERION | REQUIREMENT | NOTE |
|---|---|---|
| **AHI** | 15 ≤ AHI ≤ 65 | Moderate to severe OSA |
| **BMI** | ≤ 32 kg/m² | Per DREAM trial inclusion criteria |
| **Age** | Adult | DREAM enrolled adults only |
| **PAP status** | Failed / refused / intolerant | CPAP or equivalent |
| **DISE** | No CCC at soft palate | CCC not formally contraindicated in U.S. label |
| **MRI** | Full-body 1.5T and 3T | Leadless, battery-free implant |

FDA, Genio System PMA P240024, August 8, 2025. Accessed April 19, 2026. · *Nyxoah SA* · DREAM pivotal trial (NCT03868618)

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GENIO™ SYSTEM · MECHANISM

# How the Genio™ System Works

*Three defining design choices*

**01**

### Bilateral Stimulation

Paddle electrodes straddle both left and right distal hypoglossal nerve branches at the genioglossus insertion. Symmetric tongue protrusion improves airway patency.

**02**

### Minimal Implant

Single battery-free stimulation unit implanted via one submental incision. No leads, no tunneling, no implanted battery. External activation unit worn under chin during sleep.

**03**

### No Sensing Leads

Predetermined adjustable rate and duty cycle. Stimulation at ~70% of respiratory cycle. No inspiratory synchronization required. Simplifies implant and reduces failure points.

KEY INSIGHT *Genio eliminates what Inspire requires: sensing lead, implanted battery, and inspiratory synchronization.*

Eastwood et al. *Eur Respir J* 2020; 55: 1901320 (BLAST OSA). · *Nyxoah SA*

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GENIO™ SYSTEM · SURGICAL APPROACH

# Surgical & Patient Considerations

*BLAST OSA eligibility criteria and operative technique*

ELIGIBILITY · BLAST OSA

- Age 21-75 years
- BMI ≤ 32 kg/m²
- AHI 20-60 events/h (obstructive)
- Central + mixed AHI < 10
- No positional OSA
- No concentric collapse (DISE)
- Failed / refused PAP therapy

SURGICAL PROCEDURE

- Single midline submental incision
- Dissect platysma, mylohyoid, geniohyoid to genioglossus
- Identify bilateral hypoglossal nerve branches
- Nerve integrity monitor for positioning
- Stimulator sutured in place over both nerves
- Activated 4-6 weeks post-implant
- Titration over 2-4 months

Eastwood et al. *Eur Respir J* 2020; 55: 1901320 (BLAST OSA)

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GENIO™ SYSTEM · CLINICAL EVIDENCE

# BLAST OSA: 6-Month Outcomes

*Prospective, open-label · 8 centers, 3 countries · n = 22*

| 23.7 → 12.9 | 19.1 → 9.8 | 11.0 → 8.0 | 50% |
|---|---|---|---|
| AHI (events/h) | ODI (events/h) | ESS | Responder rate |
| *p < 0.0001* | *p < 0.0001* | *p = 0.01* | *AHI ≥50% ↓ and <20* |

**ADDITIONAL OUTCOMES**

- Sleep efficiency improved (84% → 87%)
- Arousal index decreased (28.7 → 16.0 events/h, p < 0.001)
- Bed partners reporting loud snoring: 96% → 35%
- 91% used device >5 days/week, 77% used >5 h/night
- No device-related serious adverse events

Eastwood et al. *Eur Respir J* 2020; 55: 1901320

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GENIO™ SYSTEM · PIVOTAL TRIAL

# DREAM Pivotal Trial

*n = 115 · basis for U.S. FDA PMA approval (August 2025)*

| 70.8% | 63.5% | 66.6% | 82% |
|---|---|---|---|
| Median AHI reduction | AHI responder rate (Sher criteria) | Supine AHI reduction | Reached final AHI < 15 |

**WHY IT MATTERS**

DREAM is the largest prospective trial of bilateral HGN stimulation to date and the basis for the Genio™ System's U.S. PMA approval (P240024).

*Unlike Inspire, Genio achieves these outcomes without a sensing lead, an implanted battery, or inspiratory synchronization.*

DREAM pivotal trial (NCT03868618). · *Nyxoah SA* · FDA PMA P240024 (August 2025)

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HYPOGLOSSAL NERVE STIMULATION · DEVICE COMPARISON

# Inspire vs Genio™: Head-to-Head

*Design, surgical footprint, and clinical outcomes*

| FEATURE | INSPIRE (STIMULATION THERAPY) | GENIO™ (NYXOAH) |
|---|---|---|
| **Stimulation** | Unilateral | Bilateral |
| **Electrode type** | Cuff electrode around HN | Paddle electrode over HN branches |
| **Sensing lead** | Yes (intercostal) | No |
| **Implanted battery** | Yes (non-rechargeable) | No (external activation) |
| **Incisions** | 3 (submandibular, chest x2) | 1 (submental) |
| **Synchronization** | Inspiratory-triggered | Preset rate & duty cycle |
| **CCC exclusion** | Yes | Yes |
| **BMI limit** | ≤ 40 kg/m² (S090) | ≤ 32 kg/m² |
| **AHI reduction** | ~68% (STAR trial) | ~47% (BLAST OSA) · 70.8% (DREAM) |

Sources: Strollo et al. *NEJM* 2014 (STAR) · Eastwood et al. *Eur Respir J* 2020 (BLAST OSA) · DREAM pivotal trial (2025)

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CLINICAL TAKEAWAYS

# The Bottom Line

*Hypoglossal nerve stimulation in 2026*

**01** **Two FDA-approved pathways**

Inspire since 2014 (expanded 2023: AHI ≤100, BMI ≤40). Genio since August 2025 (AHI ≤65, BMI ≤32, bilateral).

**02** **Design philosophies diverge**

Genio eliminates what Inspire requires: sensing lead, implanted battery, inspiratory synchronization. One submental incision vs three.

**03** **Efficacy is comparable**

STAR ~68% AHI reduction, DREAM 70.8% median reduction. Both require no CCC on DISE. Both deliver responder rates ~60-66%.

**04** **Selection over substitution**

Choose by anatomy, BMI, MRI need, surgical experience, and patient preference. Head-to-head trial data will refine selection.

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## Hypoglossal Nerve Stimulation: Surgical Technique

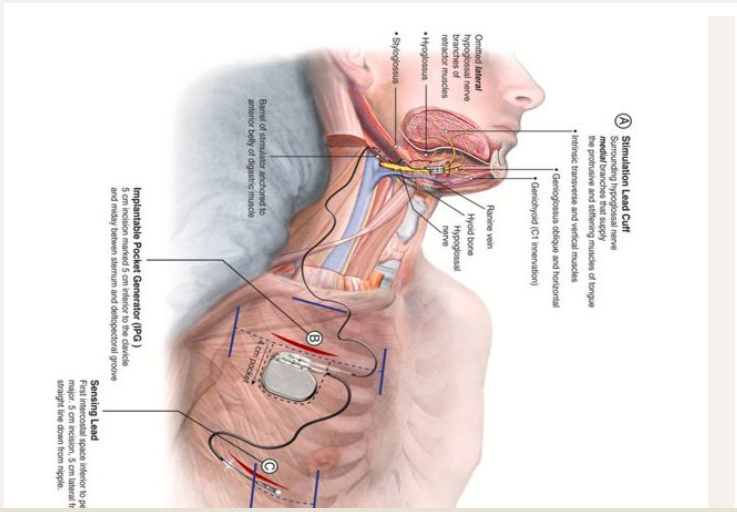
**A** **Stimulation Lead Cuff**
Surrounds hypoglossal nerve medial branches supplying tongue protrusors

**B** **Implantable Pulse Generator**
Infraclavicular pocket, 5 cm incision anchored to pectoralis fascia

**C** **Sensing Lead**
Intercostal placement detecting respiratory effort for synchronized stimulation


Chapter Source

*Atlas of Oral and Maxillofacial Surgery*
Kademani D, Tiwana P.
Saunders; 2015.




Liu SY. Hypoglossal Nerve Stimulation. In Kademani D, Tiwana P. *Atlas of Oral and Maxillofacial Surgery.* Saunders; 2015.

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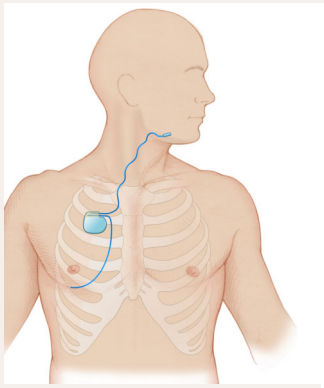
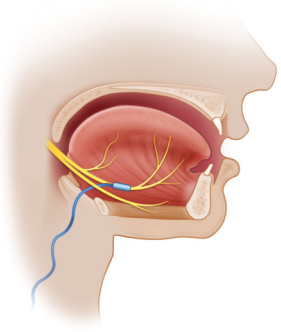
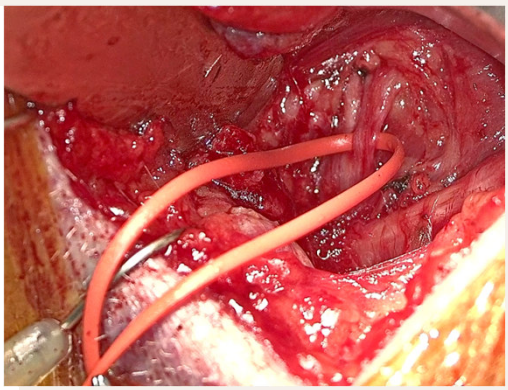
## Hypoglossal Nerve Stimulation: Device & Surgical Anatomy







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## Coupling of Tongue & Upper Airway Muscles

*Yu MS, Ibrahim B, Riley RW, Liu SY. Maxillomandibular Advancement and Upper Airway Stimulation: Extrapharyngeal Surgery for Obstructive Sleep Apnea. Clin Exp Otorhinolaryngol. 2020 Aug;13(3):225-233.*

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## 1987 Powell-Riley (Stanford) Sleep Surgery Approach

**Presurgical Evaluation**

Physical Exam, Cephalometric Analysis, Fiberoptic Pharyngoscopy

**Phase I** Sites of Obstruction

| UPPP | UPPP + GAHM | GAHM |
|---|---|---|
| Type 1: Oropharynx | Type 2: Oropharynx + Hypopharynx | Type 3: Hypopharynx |

**Post-Operative Polysomnogram (6 months)**

If failure → Phase II

**Phase II**

**Maxillomandibular Osteotomies (MMO)**

Riley RW, Powell N, Guilleminault C. *Current surgical concepts for treating obstructive sleep apnea syndrome.* J Oral Maxillofac Surg. 1987 Feb;45(2):149-57.

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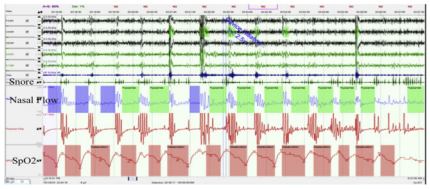
STANFORD PROTOCOL · FIRST CONTINUATION

# When Phase 2 Relapses

*A 16-year clinical pathway: from maxillomandibular advancement to hypoglossal stimulation*

*Stanford team, protocol era*




*Pre-UAS PSG: snoring, hypopneas, $SpO_2$ desaturations (Fig 3)*

THE PATIENT JOURNEY

**2001** *age 49*

**GGA + MMA at Stanford** — AHI 4.5 events/h

Counterclockwise rotation, single-splint, maxilla-first approach (Riley)

**2015** *age 60*

**OSA relapse** — AHI 19 → 21.8 events/h

Septoplasty, UPF, and tongue base RF brought only temporary relief

**2016** *age 65*

**UAS evaluation** — UAS candidate

DISE: no CCC at velum. VOTE V=0, O=0, T=2, E=1. CPAP intolerant

KEY INSIGHT *MMA stabilizes the velum and lateral pharyngeal wall, preserving the exact anatomy UAS requires 15 years later.*

**Liu SY, Riley RW.** *J Oral Maxillofac Surg* 2017;75(7):1514-1518. · Continuing the Stanford Sleep Surgery Protocol from Upper Airway Reconstruction to Upper Airway Stimulation.

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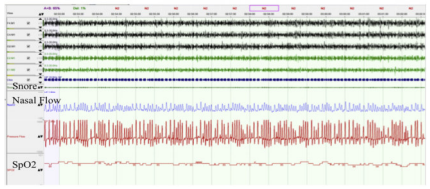
STANFORD PROTOCOL · FIRST CONTINUATION

# From MMA to Hypoglossal Stimulation

*Liu with Riley, his Stanford mentor*




*Post-UAS PSG: resolution of events, stable $SpO_2$ (Fig 4)*

POST-UAS TITRATION

| 1 | 0 | 6 | 3.2V |
|---|---|---|---|
| AHI lateral (events/h) | AHI other positions | ESS (from ≥10) | Final titrated amplitude |

SURGICAL TECHNIQUE

- 3 incisions: neck (stimulation lead), upper chest (IPG), intercostal (sensor lead)
- Modified Risdon approach, anterior to submandibular gland
- NIM-guided selection of medial protrusor branches only; C1 retrusor branch excluded
- Respiratory coupling confirmed intraoperatively with tongue protrusion

PIVOTAL *First published case continuing the Riley-Powell Stanford protocol into the UAS era. Phase 1 → Phase 2 → Hypoglossal Stimulation.*

**Liu SY, Riley RW.** *J Oral Maxillofac Surg* 2017;75(7):1514-1518.

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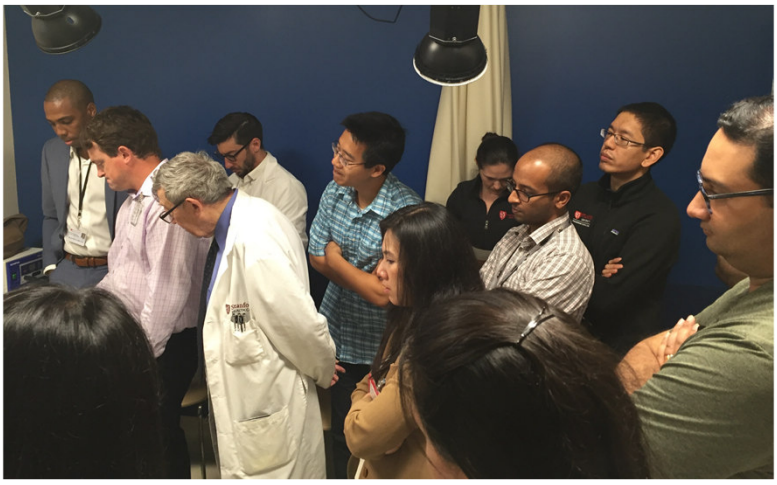
A MEMORABLE MOMENT

STANFORD SLEEP SURGERY CLINIC · CIRCA 2015

# The First Activation

Dr. Christian Guilleminault brings the Stanford sleep medicine fellows to the bedside for the first upper airway stimulation activation.



A quiet moment marking the integration of hypoglossal nerve stimulation into the Stanford Sleep Surgery Algorithm.

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STANFORD PROTOCOL · CLINICAL CASE

# MMA Outcomes in Severe OSA

*Clinical case: 65-year-old man, BMI 29.6, baseline AHI 145*

*3D CBCT after MMA, fixation hardware visible*

PATIENT PROFILE

| 65 | 29.6 | 145 | 83% |
|---|---|---|---|
| years | BMI | AHI (pre) | nadir $SpO_2$ |

PHASE 2 · MMA OUTCOME

**AHI 145 → 28**

**80.7% reduction** · still moderate residual OSA

KEY INSIGHT *MMA delivered 80% AHI reduction in extraordinarily severe OSA. Residual moderate disease remained: the stage for continuation.*

Unpublished clinical case · Stanford protocol continuation · *De-ID: STAN 0045*

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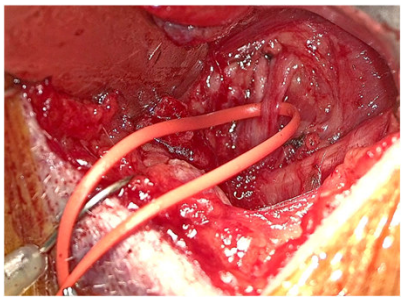
STANFORD PROTOCOL · CLINICAL CASE (CONT.)

# Adjunctive HGNS After MMA

*Long-term therapy outcomes and stimulation parameters*



*Stimulator cuff on hypoglossal nerve, post-MMA*

UAS OUTCOME

## AHI 28 → 4

**86% UAS-stage reduction** · final AHI approaches cure

LONG-TERM COMPLIANCE

**6,703+**

hours of documented therapy

SETTINGS (STABLE)

Amplitude **2.2 V**
Rate **33 Hz**
Pulse width **90 µs**
Duration **8 h/night**

PIVOTAL *Phase 2 + Hypoglossal Stimulation: AHI 145 → 4. A 97% total reduction in AHI.*

Unpublished clinical case · Stanford protocol continuation · *De-ID: STAN 0045*

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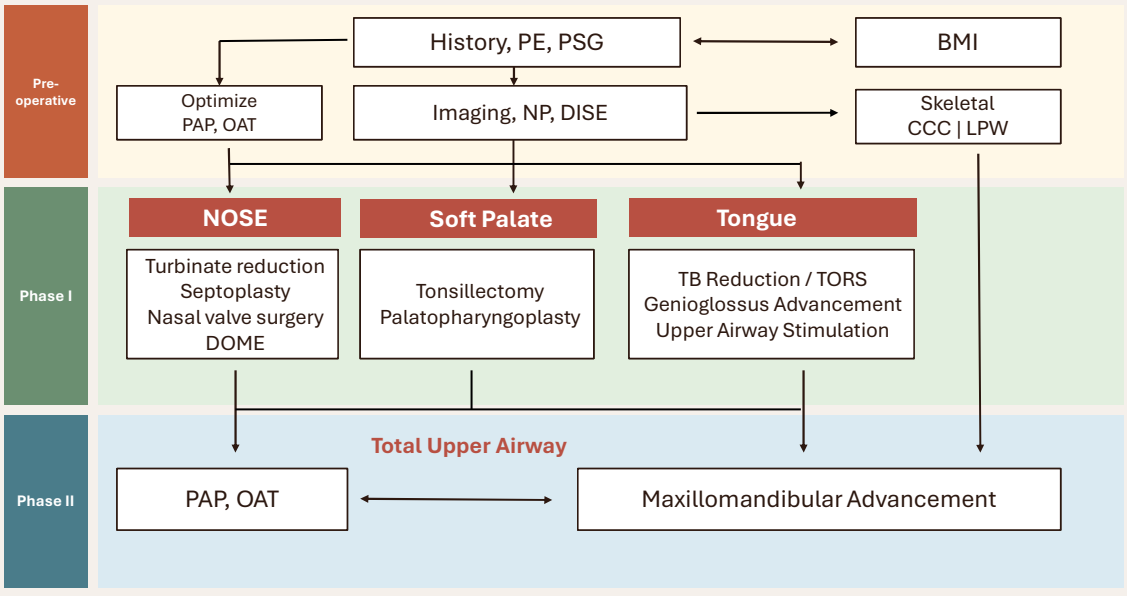
## Updated Stanford (Riley-Powell) Sleep Surgery Algorithm




*Liu, Riley et al*

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## Liu, et al. Updated Stanford (Riley-Powell) Sleep Surgery Algorithm


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LANDMARK STUDY · STANFORD SLEEP SURGERY · LARYNGOSCOPE 2020

## Palatopharyngoplasty resolves concentric collapse in patients ineligible for upper airway stimulation

*A prospective single-blinded cohort study evaluating conversion of complete concentric collapse at the velum following tissue-preserving modified UPPP.*

| 12/12 | 54 → 33 | 25% | 100% |
|---|---|---|---|
| CCC CONVERTED | MEAN AHI (events/h) | RESOLVED COMPLETELY | UAS ELIGIBLE |
| 100% of the cohort | Paired t-test significant | No velum collapse post-op | Every patient qualified after PPP |

**Clinical significance:** complete concentric collapse at the velum is a contraindication to upper airway stimulation. This study demonstrated that tissue-preserving modified palatopharyngoplasty can convert the collapse pattern and restore candidacy in this subgroup.

Liu SY, Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.

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BACKGROUND

## Prevalence and clinical significance of CCC

**~25%**

OF UAS CANDIDATES

demonstrate complete concentric collapse at the velum on preoperative DISE

*Hasselbacher 2018 · Ong 2016 · Steffen 2015*

MECHANISTIC CONSIDERATIONS

**Tongue protrusion cannot solve a 360° collapse.**
UAS stiffens and advances the tongue in the anteroposterior plane. CCC collapses the velum circumferentially. The forces do not align.

**Vanderveken 2013: no significant AHI reduction**
in CCC patients who received UAS, establishing CCC as an exclusion criterion in the FDA label.

**The path forward was unclear.**
Hasselbacher (2018) observed conversion after classical UPPP in a retrospective cohort, but no prospective data validated the approach, and no study had tested it on patients specifically excluded from UAS.

Liu SY, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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METHODS

## Study design and inclusion criteria

*Primary outcome: conversion of concentric collapse at the velum on post-operative DISE. Secondary outcome: change in AHI.*

METHODS

| | |
|---|---|
| **Design** | Prospective, single-blinded cohort |
| **Setting** | Stanford, October 2015 to February 2018 |
| **Surgeons** | Two sleep surgeons (SYL, RC) |
| **DISE review** | Third blinded sleep surgeon |
| **Scoring** | VOTE classification |
| **Level of evidence** | 1B |

INCLUSION CRITERIA

| | |
|---|---|
| **Age** | Adult (> 18 years) |
| **Diagnosis** | OSA with AHI > 15 |
| **BMI** | < 32 kg/m² (STAR trial criteria) |
| **Central apneas** | < 25% of AHI |
| **DISE finding** | Complete concentric collapse at velum |

COHORT SNAPSHOT

| | |
|---|---|
| **N enrolled** | 12 (9 male, 3 female) |
| **Mean age** | 68.2 years (range 42 to 71) |
| **Mean BMI** | 30.5 kg/m² |
| **Mean baseline AHI** | 54.0 events/h (28 to 89) |

Liu SY, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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METHODS · INTERVENTION

## Surgical technique

*Tissue-preserving modified palatopharyngoplasty, as described by Awad et al., 2019.*

**SUTURE PLACEMENT**

Three to four 3-0 Vicryl sutures placed to tension palatopharyngeus, tensor veli palatini, and levator veli palatini.

**TISSUE HANDLING**

Muscle tissue is preserved. Uvula trimmed to approximately 1 cm only where appropriate, not routinely amputated.

**RATIONALE**

Preserves velopharyngeal function and reduces VPI risk. Converts collapse vector without ablating tissue that contributes to speech and swallow.

**Perioperative course.**
All patients received concurrent tonsillectomy when indicated. Overnight airway monitoring. Discharge next day. Follow-up polysomnogram at a mean of 119 days (17 weeks). Patients with incomplete response returned for repeat DISE to confirm the new collapse pattern.

**Liu SY**, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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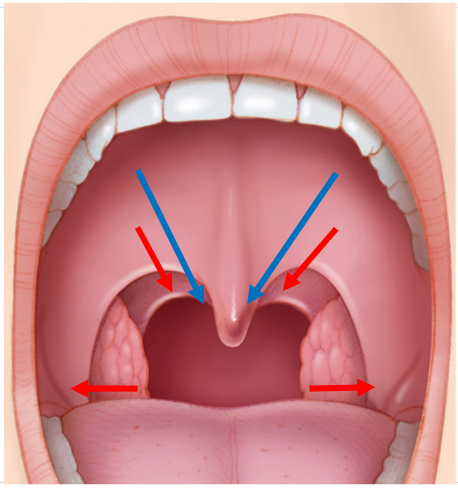
SOFT PALATE & PHARYNGEAL SURGERY

## Preservation Pharyngoplasty

*Rationale & Anatomic Target*



**WHY PRESERVATION?**

OSA airway narrows in the **lateral dimension** at the retropalatal region.
*Schwab et al, 1995.*

Resective UPPP risks **VPI, scar, bleeding**.
UPF (Powell, 1996) preserves palatal muscles and uses oral-surface incisions.

**TARGET**

*Expand the lateral wall. Suspend the levator veli palatini. Preserve function.*

Awad M, ..., **Liu SY**. Tonsillectomy and Pharyngoplasty: Tissue-Preserving Techniques. *Atlas Oral Maxillofac Surg Clin North Am* 2019;27(1):17-22.

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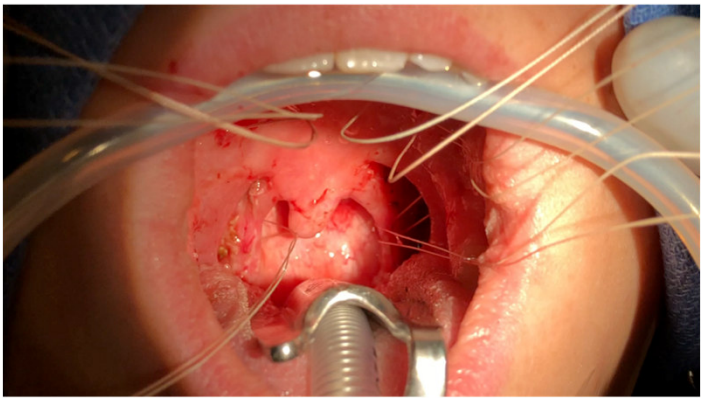
SOFT PALATE & PHARYNGEAL SURGERY

# Preservation Pharyngoplasty



TECHNIQUE HIGHLIGHTS

3-0 Vicryl horizontal mattress x 3-4 per fossa at 45°
2-0 Vicryl hamulus-to-uvula stitch for A-P expansion

OUTCOMES

**2/3** meet surgical success criteria
ODI 4% reduction ≥50%, AHI <20

**Preservation over resection.** *Converts CCC to AP collapse for UAS eligibility.*

Awad M, ..., **Liu SY**. Tonsillectomy and Pharyngoplasty: Tissue-Preserving Techniques. *Atlas Oral Maxillofac Surg Clin North Am* 2019;27(1):17-22.

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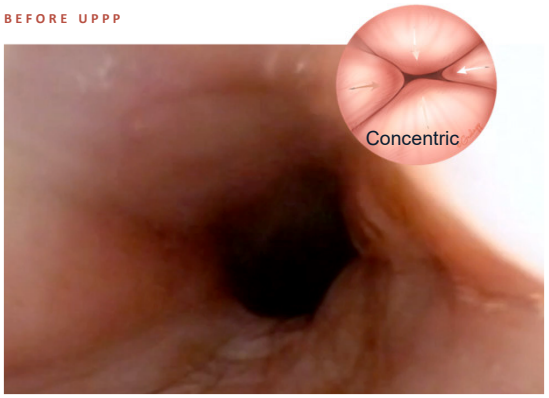
RESULTS · DISE FINDINGS

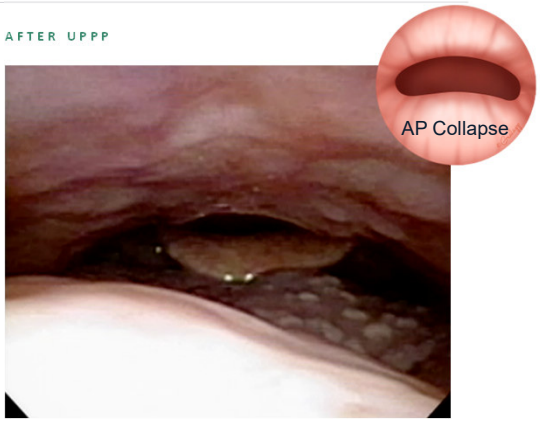
# Conversion of collapse pattern on post-operative DISE

*Representative drug-induced sleep endoscopy images from the study cohort. Concentric pattern pre-operatively, anteroposterior or no collapse post-operatively.*

BEFORE UPPP




AFTER UPPP




**Conversion rate: 12 of 12 (100%).** Three patients showed no velum collapse post-operatively; nine showed anteroposterior collapse.

**Liu SY**, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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RESULTS · OUTCOMES

## Quantitative outcomes

CONVERSION BREAKDOWN (n = 12)

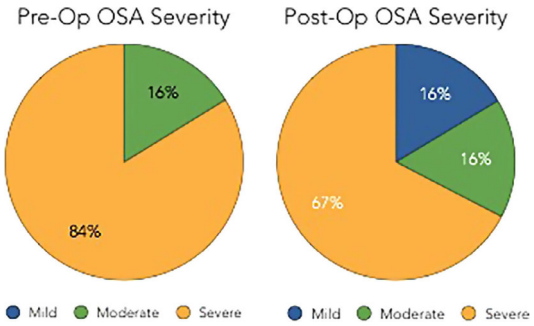
| | | |
|---|---|---|
| Complete A-P collapse | 7 pts | 58% |
| Partial A-P collapse | 2 pts | 17% |
| No collapse at velum | 3 pts | 25% |

MEAN AHI

**54.0** → **33.1** events / hour

*Paired measurements, n = 12*

OSA SEVERITY SHIFT




*Pre-op: 84% severe, 16% moderate, 0% mild. Post-op: 67% severe, 16% moderate, 16% mild.*

Liu SY, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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DISCUSSION

## Clinical implications

*A 12-patient prospective cohort study that informed subsequent research on surgical sequencing and UAS eligibility.*

PATIENT SELECTION

### Modifiability of CCC

Finding of CCC on pre-operative DISE may be reframed as a modifiable anatomic pattern rather than a categorical contraindication. Tissue-preserving PPP restores candidacy in approximately one in four otherwise-ineligible patients.

SUBSEQUENT RESEARCH

### Multilevel sequencing

The Chang et al. 2023 cohort study (JOMS, AAOMS Stanton Award) extended these findings, demonstrating an 18-event adjusted AHI benefit with multilevel surgery followed by UAS compared to isolated UAS.

REGULATORY LANDSCAPE

### CCC label considerations

FDA-approved HGNS therapy currently contraindicates CCC at the velum. Emerging device platforms (e.g., Nyxoah Genio) are pursuing CCC label expansion based in part on conversion-pathway evidence.

Liu SY, *Hutz MJ, Poomkonsarn S, Chang CP, Awad M, Capasso R. Laryngoscope. 2020;130(12):E958-E962.*

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CASE REPORT

# $CO_2$ laser lingual tonsil reduction for tongue discomfort during hypoglossal nerve stimulation

*A case report demonstrating restoration of HGNS therapy response following adjunctive lingual tonsil reduction in a patient with Grade 4 lingual tonsil hypertrophy.*

**37.7 → 15.1**
**AHI events/h**
60% reduction, Sher criteria met

**50%**
**Lingual tonsil reduction**
$CO_2$ laser, direct laryngoscopy

**3.2V → 2.0V**
**Max tolerable amplitude**
Effective stimulation threshold

**Clinical significance:** upper airway obstruction often involves multiple anatomic levels. When stimulation amplitude required for airway patency exceeds the arousal threshold, adjunctive surgical reduction of identified obstruction may restore device tolerance and therapeutic response.

*Fontenot A, **Liu SYC**, Dewan K. J Clin Sleep Med. 2024;20(11):1857-1861.*

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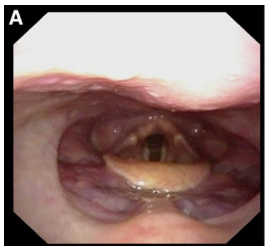
CASE PRESENTATION

# Patient history and initial HGNS trial

**BASELINE**

| | |
|---|---|
| **Age / Sex** | 74 years, male |
| **BMI** | 24.96 (non-obese) |
| **AHI** | 37.7 events/h (moderate-severe) |
| **O2 Nadir** | 82% |
| **Prior Surgery** | Tonsillectomy |
| **CPAP Status** | Intolerant after 3 years |
| **DISE** | AP velar collapse, no CCC |
| **Lingual Tonsil** | Grade 4 hypertrophy |

**PREOPERATIVE**




*Grade 4 lingual tonsil pushes the epiglottis anteriorly at rest.*

**INITIAL HGNS COURSE**

**Eligibility met.**
AHI in range, no CCC, BMI < 32.

**At 2.2–3.2 V:**
Adequate tongue protrusion but stimulation produced arousal from sleep.

**Reduced to 0.5 V:**
Tolerable but therapeutically inadequate. Symptoms persisted.

*Fontenot A, **Liu SYC**, Dewan K. J Clin Sleep Med. 2024;20(11):1857-1861.*

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INTERVENTION

# Surgical technique

*$CO_2$ laser reduction of the lingual tonsil under direct laryngoscopy with DISE and on-table HGNS re-titration.*

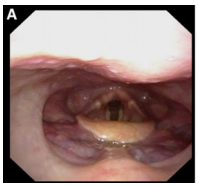
TECHNICAL RATIONALE

**Anatomic target.**
Hypertrophic lingual tonsil contributed bulk superior to the BOT musculature. Moderate tongue protrusion was insufficient to expand oropharyngeal cross-sectional area in this configuration.

**Choice of $CO_2$ laser.**
Lingual tonsil reduction has historically been associated with postoperative pain, hemorrhage, dysphagia, and dysgeusia. $CO_2$ laser offers precise tissue ablation with reduced morbidity.

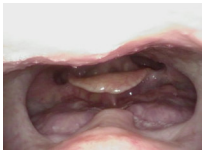
**Intraoperative re-titration.**
DISE with electrical analysis under anesthesia confirmed revised stimulation parameters prior to extubation.

BEFORE




Grade 4 lingual tonsil. Epiglottis pushed anteriorly. Midline and lateral space obscured.

AFTER · 1 MONTH



50% reduction. Well-healed base. Epiglottic frenulum and lingual surface now visible. No pain, bleeding, or dysphagia.

*Fontenot A, **Liu SYC**, Dewan K. J Clin Sleep Med. 2024;20(11):1857-1861.*

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OUTCOMES

# Post-operative polysomnography and device performance

POLYSOMNOGRAPHY & DEVICE PERFORMANCE

| METRIC | BASELINE | POST-INTERVENTION | CHANGE |
|---|---|---|---|
| **AHI (events/h)** | 37.7 | 15.1 | **–60%** |
| **O2 Nadir** | 82% | 87% | **+5 pts** |
| **Tolerable Amplitude** | >2.0 V awakened pt | 0.8–2.0 V effective | **Usable range** |
| **Nightly Device Use** | <1 hour | All night | **Restored** |
| **Sher Response** | No | Yes | **≥50% AHI drop** |

**Finding.** Tolerable stimulation amplitude decreased from >2.0 V (above arousal threshold) to 0.8–2.0 V. AHI fell from 37.7 to 15.1 events/h, meeting Sher criteria for surgical response.

*Fontenot A, **Liu SYC**, Dewan K. J Clin Sleep Med. 2024;20(11):1857-1861.*

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DISCUSSION

## Clinical implications

*Considerations for management of HGNS non-responders with identifiable residual obstruction on repeat DISE.*

**REPEAT DISE**

Repeat drug-induced sleep endoscopy identifies residual anatomic obstruction in HGNS non-responders. In this case, lingual tonsil hypertrophy remained the limiting factor despite adequate tongue protrusion.

**PATIENT SELECTION**

$CO_2$ laser lingual tonsil reduction may be considered in patients with Grade 4 lingual tonsil hypertrophy and normal swallow function. Preoperative swallow evaluation is recommended.

**COMBINED THERAPY**

HGNS remains the primary therapy. Adjunctive surgical reduction addresses identified residual obstruction. This aligns with multilevel treatment principles described in the updated Stanford sleep surgery algorithm.

**First reported case** of lingual tonsil reduction enabling HGNS therapy response. Further investigation is warranted to define patient selection criteria and durability of outcomes.

*Fontenot A, Liu SYC, Dewan K. J Clin Sleep Med. 2024;20(11):1857-1861. · Updated Stanford Algorithm: Liu65, 2020.*

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LANDMARK STUDY STANFORD SLEEP SURGERY · JOMS 2023

## Comparative efficacy of multilevel surgery followed by UAS versus isolated UAS

*A retrospective single-center cohort study of 35 adults with moderate-to-severe OSA undergoing UAS implantation from 2016 to 2019.*

| 37.6 | 31.5 | −18 | 1.8V |
|---|---|---|---|
| AHI REDUCTION | AHI REDUCTION | ADJUSTED BENEFIT | MEAN AMPLITUDE |
| Multilevel + UAS (events/h) | UAS only (events/h) | Multilevel group, p < .001 | Multilevel group at follow-up |

**Clinical significance:** the first direct comparison of isolated UAS and multilevel surgery followed by UAS in patients with moderate-to-severe OSA, informing sequencing decisions for initially ineligible candidates.

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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BACKGROUND

# Background and rationale

ESTABLISHED EVIDENCE

**UAS works for the right patient.**
STAR trial: ~75% response. FDA criteria: AHI 15–65, BMI ≤ 32, no complete concentric collapse (CCC) at the velum.

**MMA is the most efficacious skeletal operation.**
~86% surgical success, ~43% cure at single-surgeon centers.

**Palatopharyngoplasty can convert CCC.**
Previously CCC-ineligible patients can become UAS candidates.

RESEARCH GAP

**Does preparing the airway first change the UAS result?**
No study had directly compared patients who reached UAS through the multilevel door against patients who went straight to UAS.

**Hypothesis.**
Patients initially ineligible who undergo multilevel surgery to earn eligibility would see a greater net AHI reduction than patients who meet UAS criteria from the start.

**Why it was worth asking.**
If true, the field stops treating UAS and skeletal surgery as competitors and starts treating them as a sequence.

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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METHODS

# Study design and cohort snapshots

*Retrospective single-center cohort, Stanford Sleep Surgery Clinic, July 2016 to February 2019. n = 35 after exclusion.*

GROUP 1

## Multilevel surgery → UAS

*Initially ineligible · n = 18*

| | |
|---|---|
| **Ineligibility reason** | AHI > 65, BMI > 32, or CCC |
| **Surgery types** | UPPP, DOME, MMA, GGA |
| **Soft tissue only** | 61% |
| **Skeletal only** | 22% |
| **Both soft tissue + skeletal** | 17% |

GROUP 2

## UAS only

*FDA eligible from start · n = 17*

| | |
|---|---|
| **Eligibility criteria** | AHI 15–65, BMI < 32 |
| **DISE requirement** | No CCC at velum |
| **PAP status** | Intolerant / failed |
| **Central apneas** | < 25% of AHI |
| **Prior surgery** | None |

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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METHODS · DEMOGRAPHICS

## Baseline demographic and clinical characteristics

| VARIABLE | GROUP 1 · MULTILEVEL → UAS (n=18) | GROUP 2 · UAS ONLY (n=17) | p |
|---|---|---|---|
| **Age, years** | 62.4 ± 9 | 62.9 ± 14 | .90 |
| **Male, %** | 72% | 88% | .24 |
| **BMI, kg/m²** | 29.1 ± 4 | 26.7 ± 4 | .07 |
| **Mallampati IV, %** | 69% | 50% | .70 |
| **Skeletal Class II, %** | 50% | 43% | .80 |
| **Baseline AHI, events/h** | 49.3 ± 30 | 33.4 ± 14 | .076 |
| **Baseline ESS** | 7.1 ± 4 | 9.0 ± 6 | .40 |
| **Baseline FSS** | 30.0 ± 14 | 32.9 ± 17 | .65 |

***No significant demographic differences between groups at baseline.***

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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METHODS

## Multilevel surgical profile in Group 1

*Lateral cephalogram: MMA plates, genioglossus advancement (GGA) screws, and the HGNS lead. A single airway, three complementary operations.*

PRIOR PROCEDURES IN GROUP 1 (n = 18)

**Soft tissue only** — 61%
UPPP, tonsillectomy, septoplasty

**Skeletal only** — 22%
MMA, DOME, maxillary advancement, GGA

**Both** — 17%
Combined soft tissue + skeletal

**Baseline severity.**
Group 1 baseline AHI averaged 49 events/h, with several patients exceeding 100 and demonstrating CCC on DISE. Multilevel surgery was the pathway to eligibility for UAS implantation.

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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RESULTS · PRIMARY OUTCOME

## Apnea-hypopnea index: pre- and post-treatment

GROUP 1 · MULTILEVEL → UAS

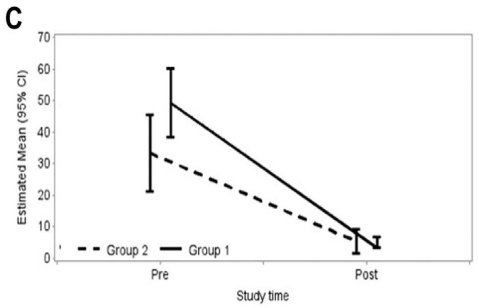
**49·3 → 3·5**

Δ −37.6 ± 21.2 · p < .001 · mean amplitude 1.8 V

GROUP 2 · UAS ONLY

**33·4 → 5·3**

Δ −31.5 ± 13.2 · p < .001 · mean amplitude 1.9 V




Group 1: Multilevel surgery followed by UAS due to initial ineligibility
Group 2: UAS only

*Estimated mean AHI (95% CI) pre vs post. Solid: Multilevel + UAS. Dashed: UAS only.*

**Finding.** Despite higher baseline severity in Group 1, post-treatment AHI converged. Within-group reductions were significant in both cohorts (p = .0002 and .0003).

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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RESULTS · ADJUSTED MODEL

## Adjusted analysis and secondary outcomes

**−18.0**

ADDITIONAL AHI REDUCTION

Multilevel + UAS vs UAS alone, adjusted for age, BMI, and sex

*95% CI −35.68 to −0.35 · p = .046*

SECONDARY OUTCOMES

**ESS (Epworth Sleepiness Scale)**

Group 1: **7.1 → 4.9** · Group 2: **9.0 → 8.2**

*Multilevel reached below-threshold sleepiness; UAS-only did not.*

**FSS (Fatigue Severity Scale)**

Group 1: **30.0 → 19.3** · Group 2: **32.9 → 28.7**

*Clinically meaningful 11.2-point greater improvement in Group 1.*

**LSAT (Lowest $O_2$ Saturation)**

Group 1: **80.4% → 85.5%** · Group 2: **80.9% → 87.5%**

*Both groups recovered meaningful saturation floor.*

**Interpretation.** After adjustment for age, BMI, and sex, Group 1 demonstrated a statistically significant 18-event additional reduction in AHI compared to Group 2 (95% CI −35.68 to −0.35, p = .046). Secondary outcomes showed clinically meaningful improvements favoring the multilevel group.

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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CONCLUSIONS

# Clinical implications and recognition

### UAS ELIGIBILITY CAN BE EARNED

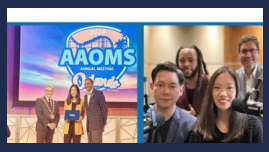
Patients initially ineligible due to AHI > 65, BMI > 32, or CCC on DISE can be converted to candidacy through staged multilevel surgery, including palatopharyngoplasty, DOME, and MMA.

### MULTILEVEL + UAS IS SUPERIOR

Adjusted for demographics, Group 1 achieved an 18-event additional AHI reduction compared to Group 2 (p < .001). Both groups reached near-cure AHI levels post-treatment.

### ALGORITHMIC ROLE OF UAS

Within the updated Stanford protocol, UAS serves patients who decline skeletal surgery, relapse after MMA, or require combined approaches for severe disease burden.




AAOMS STANTON AWARD

*JOMS paper of the year, 2024*

*Scan for article + podcast*

*Chang CP, Poomkonsarn S, Giannakopoulos H, Ma Y, Riley RW, Liu SY. J Oral Maxillofac Surg. 2023;81(5):557-565. · AAOMS Stanton Award.*

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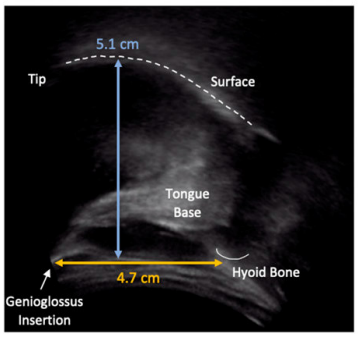
PHYSIOLOGY OF HYPOGLOSSAL STIMULATION

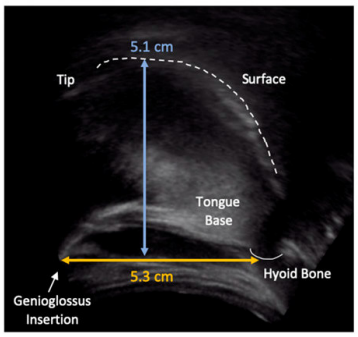
# Tongue Morphologic Response to HNS

*Midsagittal ultrasound in 12 patients with multi-contact stimulation (Aura6000)*

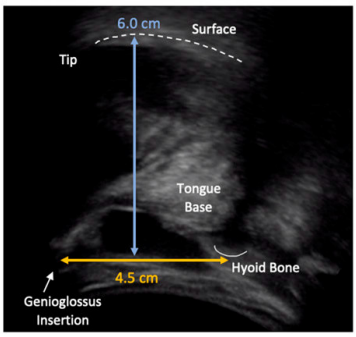
**Opening Response**




**Baseline**




**Closing Response**




KEY FINDING *Selective HNS produced two distinct responses. Similar degrees of tongue protrusion; opposite airway outcomes.*

Fleury Curado T, ..., **Liu SY**, ..., Schwartz A. *J Clin Sleep Med* 2023;19(5):947-955.

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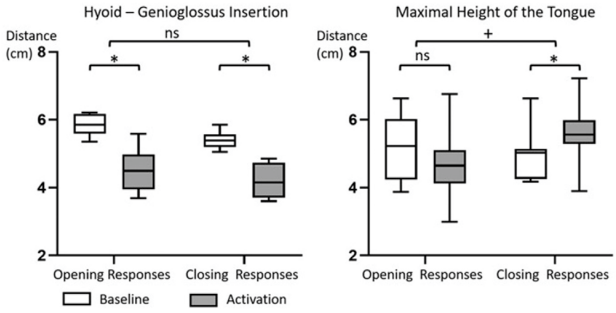
PHYSIOLOGY OF HYPOGLOSSAL STIMULATION (CONT.)

# Tongue Height and Pharyngeal Patency

*Hyoid-genioglossus distance versus tongue height during stimulation*




*Hyoid-genioglossus distance (left) and tongue height (right). Figure 5.*

MEASUREMENTS ON STIMULATION

| | OPENING | CLOSING |
|---|---|---|
| n | 8 | 7 |
| **Hyoid-GG Δ** | -1.3 cm | -1.1 cm |
| **Tongue height Δ** | *no change* | **+0.6 cm*** |

** p < 0.001 between groups*

INTERPRETATION

Equal tongue protrusion, different outcomes. Unopposed protrusor activation raises tongue height and paradoxically reduces airflow.

MECHANISM *Airway patency is best maintained when protrusion preserves tongue shape, requiring coactivation of intrinsic and retractor lingual muscles.*

Fleury Curado T, ..., **Liu SY**, ..., Schwartz A. *J Clin Sleep Med* 2023;19(5):947-955.

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# Breathing: Route and State

THE 2x2 BREATHING MATRIX

| | |
|---|---|
| NASAL | AWAKE |
| MOUTH | **ASLEEP** |

*sleep-disordered breathing*

**Physiologic breathing is nasal.**
**The problem begins when the mouth opens during sleep.**

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# Nasal vs Oral Breathing During Sleep

UAR AND OSA SEVERITY ARE SIGNIFICANTLY LOWER WITH NASAL BREATHING

**Upper Airway Resistance** #: p = 0.012

*UAR cmH₂O·L⁻¹·s⁻¹*

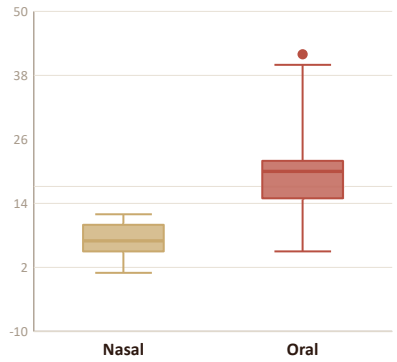


Fig. 3: Effect of breathing route on UAR during supine stage 2 sleep.

**AHI by Breathing Route** **: p < 0.01

*Apnea/Hypopnea Index*

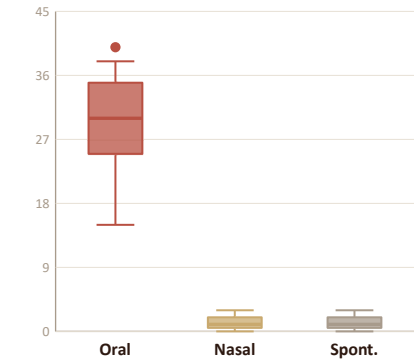


Fig. 5: Effect of breathing route on sleep apnea severity in lateral position.

*Fitzpatrick MF, McLean H, Urton AM, Tan A, O'Donnell D, Driver HS. Effect of nasal or oral breathing route on upper airway resistance during sleep. Eur Respir J. 2003 Nov;22(5):827-32.*

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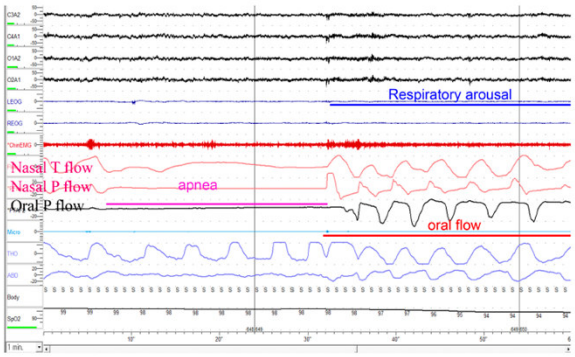
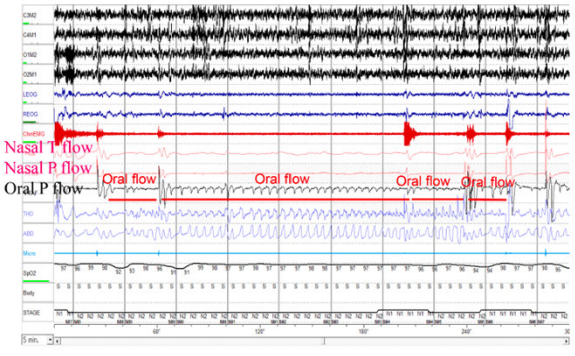
# Oral Flow Patterns & Nasal Obstruction

RELATIONSHIP WITH RESPIRATORY EVENTS DURING SLEEP




*Suzuki M, Furukawa T, Sugimoto A, et al. Relationship between Oral Flow Patterns, Nasal Obstruction, and Respiratory Events during Sleep. J Clin Sleep Med. 2015 Aug 15;11(8):855-60.*

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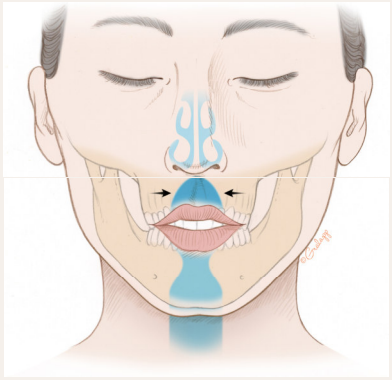
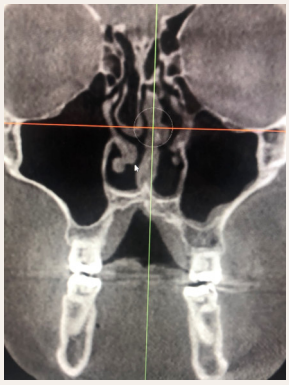
# The Upper Airway Nasal Complex

STRUCTURAL CONTRIBUTION TO PERSISTENT NASAL OBSTRUCTION





Coronal CT — narrow maxilla & compressed nasal floor

**Narrow maxilla (Nasal Floor & Palatal Vault)**

Intranasal surgery may not overcome a structurally narrow nasomaxillary complex. The Nasal Floor is part of the INV, most restricted part of the upper airway.

*Williams R, ... Liu SYC. The Upper Airway Nasal Complex: Structural Contribution to Persistent Nasal Obstruction. Otolaryngol Head Neck Surg. 2019 Jul;161(1):171-177.*

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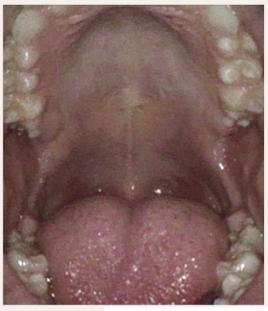
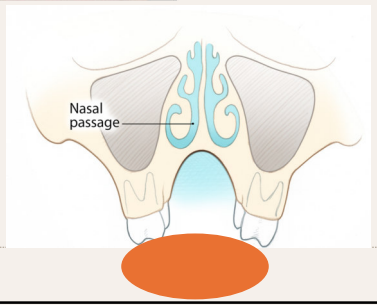
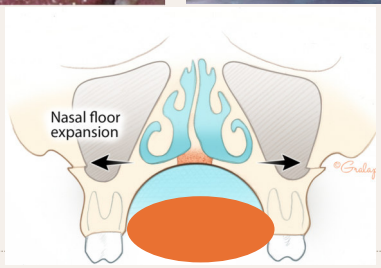
# Arch versus Dome

ARCH

DOME



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# DOME the Concept

WHAT IT IS

Naso-Maxillary Expansion by Distraction Osteogenesis Transforming a High-Arched to Dome-Shaped Palate, with Expansion of the Internal Nasal Valve.

WHY

To Optimize Nasal Breathing and Pharyngeal Stability across Wakefulness and Sleep.

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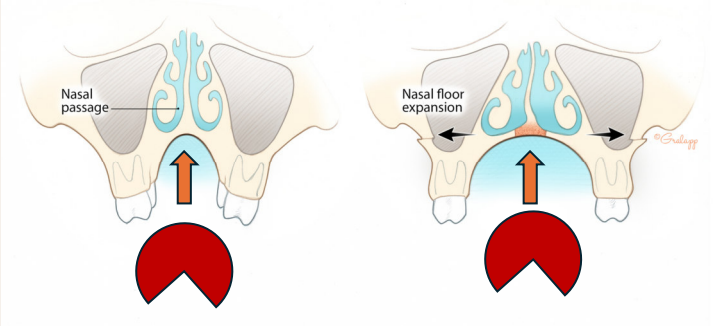
## DOME shaped maxilla and U.A. Stimulation

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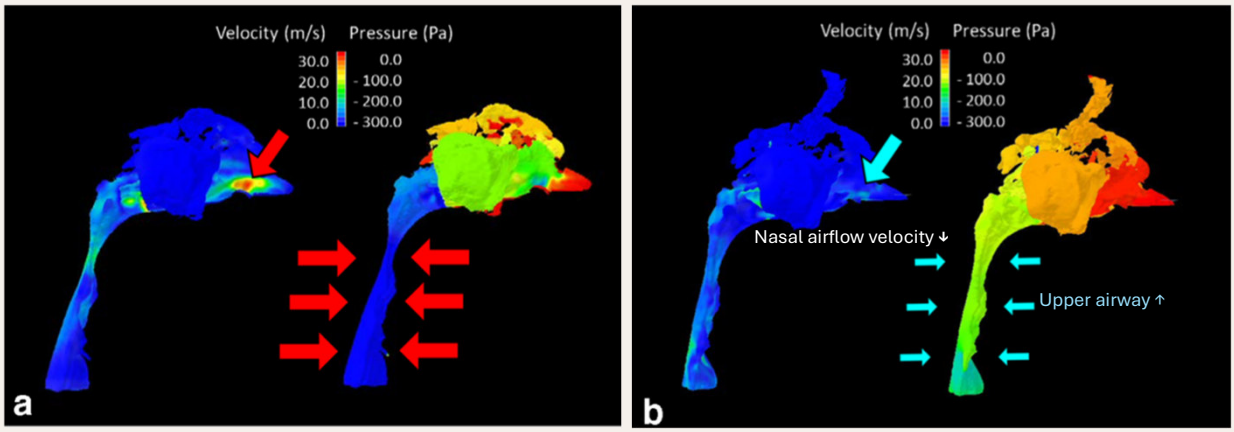
## DOME: CFD with Patient-Specific Rhinometry




Iwasaki T, Yoon A, Guilleminault C, Yamasaki Y, Liu SY. *How does DOME reduce severity of OSA?* Sleep Breath. 2020;24(1):287-296.

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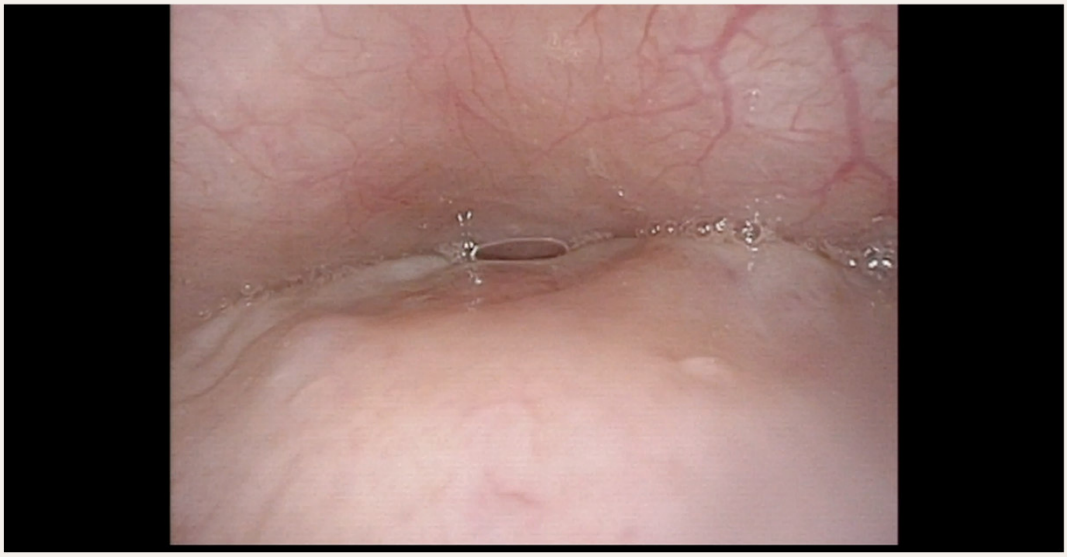
## Hypoglossal Nerve Stimulation | Nasal vs Mouth Breathing



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CLINICAL CASE · PRESENTATION

# Patient Presentation

*45-year-old man with severe obstructive sleep apnea*

DEMOGRAPHICS

| 45 | 30 | 19 | 70/100 |
|---|---|---|---|
| age (years) | BMI | ESS | NOSE |

## CLINICAL HISTORY

**Vital signs** BP 143/89, HR 118, Fatigue 40/60

**Medications** Beta-blocker, Metformin, Zoloft

**Surgical history** Cholecystectomy, tonsillectomy, third molar removal

**Social** Non-smoker, no alcohol

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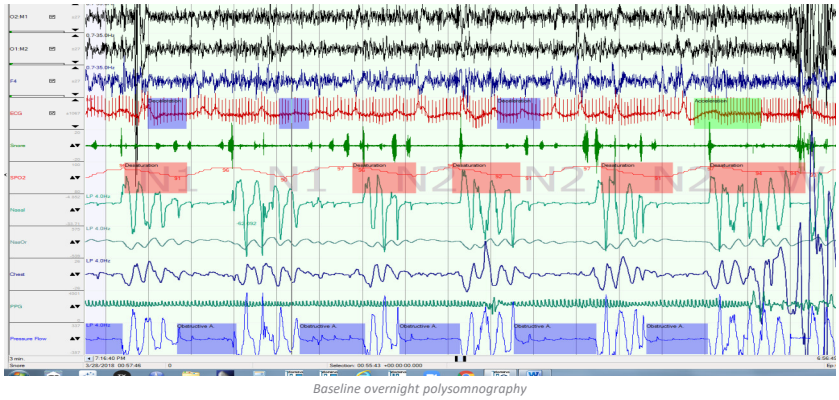
CLINICAL CASE · BASELINE

# Baseline Polysomnography

*Severe obstructive sleep apnea: frequent obstructive events with oxygen desaturation*




*Baseline overnight polysomnography*

SEVERITY

AHI

**50.8**

*events / hour*

**Severe OSA**

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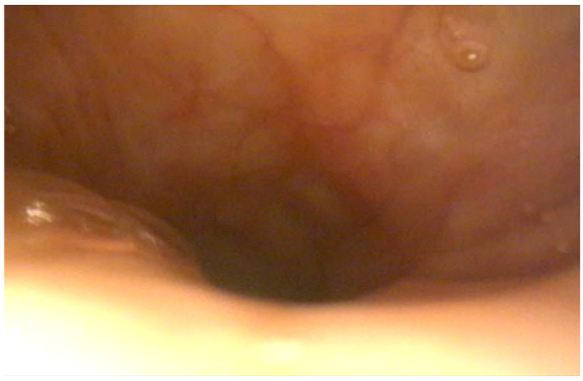
CLINICAL CASE · ORAL APPLIANCE THERAPY

# Oral Appliance Therapy Response

*Partial reduction in AHI with mandibular advancement device*



*Drug-induced endoscopy with mandibular advancement*

RESPONSE

## AHI 50.8 → 32.5

**36% reduction** · partial response

INTERPRETATION

Residual moderate OSA despite mandibular advancement. Mechanical repositioning alone did not fully restore airway patency.



CLINICAL CASE · PRE-HNS ASSESSMENT

# Drug-Induced Sleep Endoscopy

*Airway evaluation prior to hypoglossal nerve stimulation*

DISE FINDINGS

*Rules out CCC of Velum*

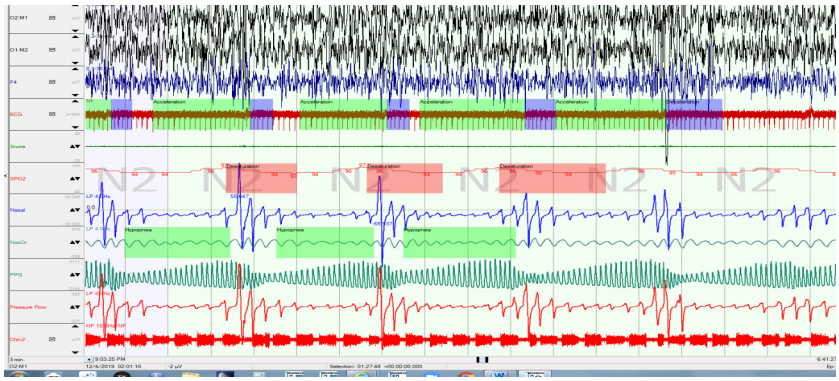
*Chin CCW Rotation*

PATTERN *Multi-level obstruction: anteroposterior velopharyngeal collapse and tongue base collapse during stimulation period.*

CLINICAL CASE · POST-HNS

# Polysomnography on HNS Therapy

*Persistent obstructive events despite active hypoglossal stimulation*



*Overnight PSG with HNS active throughout the study*

HNS OUTCOME

AHI

**35.1**

*events / hour*

vs. baseline 50.8
vs. OAT 32.5

***No improvement over oral appliance***



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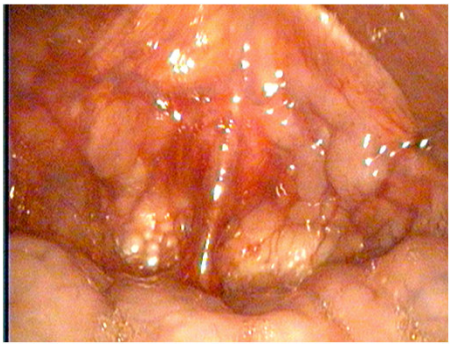
CLINICAL CASE · POST-HNS ASSESSMENT

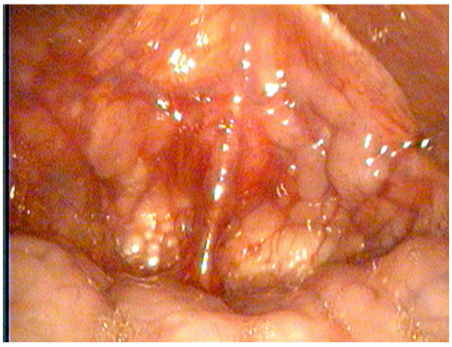
# Airway Closure during Activation

*Tongue shape not preserved during active stimulation*

POST-HNS DISE



*Epiglottis collapse with HNS active*



*Resolution of chin CCW rotation*

KEY FINDING *Epiglottis collapse during activation.*



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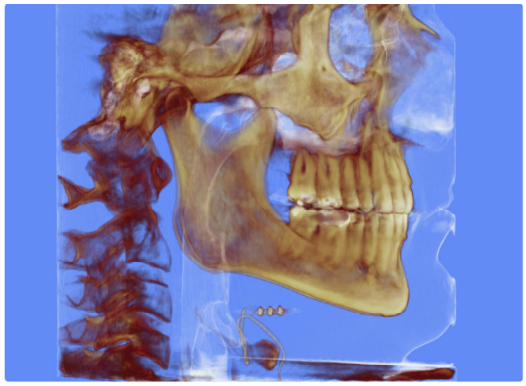
CLINICAL CASE · MMA

# Maxillomandibular Advancement



*Pre-MMA: HNS lead visible, no advancement*


*Post-MMA: advancement with fixation*

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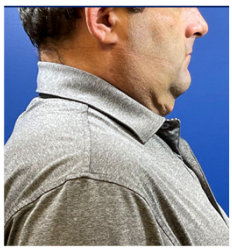
CLINICAL CASE · OUTCOME

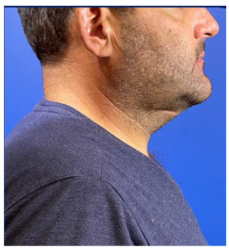
# Post-MMA Clinical Outcome

*Airway patency restored after skeletal advancement*

FACIAL PROFILE



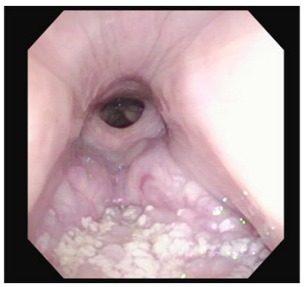
*Preop*



*Postop*

DISE

*Preop*



*Postop*

CLINICAL IMPLICATION *Tongue shape cannot be preserved without adequate oral cavity space. Skeletal assessment precedes HNS*

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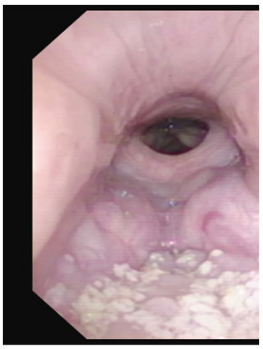
CLINICAL CASE · OUTCOME

# Post-MMA Clinical Outcome

*Airway patency restored after skeletal advancement*

PHOTO

*Pre- and post-MMA facial profile*



*Post-MMA endoscopy: open airway*

RESOLUTION

HNS
***failed***

MMA
**resolved**

*Clinical airway patency achieved through skeletal advancement after stimulation therapy failure.*

CLINICAL IMPLICATION *Tongue shape cannot be preserved without adequate oral cavity space. Skeletal assessment precedes HNS in the Stanford Revised Sleep Surgery Algorithm.*

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CONCLUSIONS

# Summary and Clinical Implications

*Comprehensive airway assessment for hypoglossal nerve stimulation candidacy*

**01** **Comprehensive airway evaluation**

DISE identifies concentric collapse at the velum but does not fully assess the airway. Evaluation spans the nose, palate, tongue base, and skeletal framework before candidacy is finalized.

**02** **Ineligibility is often modifiable**

Preservation palatopharyngoplasty converts CCC (12/12, Liu 2020). DOME widens the nasal floor in narrow high-arched palates. $CO_2$ laser lingual tonsil reduction restores HGNS response in non-responders.

**03** **Multilevel sequencing improves outcomes**

Multilevel surgery followed by UAS yielded an 18-event adjusted AHI advantage over isolated UAS (Chang, Liu 2023, AAOMS Stanton Award). UAS and skeletal surgery are complementary, not competitive.

**04** **Skeletal framework sets the ceiling**

When tongue shape cannot be preserved within available oral cavity space, maxillomandibular advancement precedes or replaces HGNS in the Stanford Revised Sleep Surgery Algorithm.

From the Nose to Tongue-Base · Beyond DISE for Inspire Candidacy · SEC 2026 Stanley Y.C. Liu, MD, DDS, FACS

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Step 1 of 4

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