Minimally Invasive 3-Hz Sequential Electrical Nerve Stimuli for Percutaneous Electrode Placement near Protrusive Branches of the Hypoglossal Nerve

David Herron[1], Joel McCabe[1], Kevin Meng[1], Scott Russell[1], Guillaume Raux[1], Tim Fayram[1]

[1] Restera (previously Invicta Medical)
Contact: dherron@invictamedical.com

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Introduction

- Hypoglossal nerve (HGN) stimulation is a treatment option for obstructive sleep apnea (OSA).
- Percutaneous electrode delivery near distal arborizing branches of the HGN under ultrasound guidance reduces surgical invasiveness.
- Here, we describe a novel systematic method to facilitate HGN localization and to confirm **selective activation of its protrusive branches** prior to electrode placement.

1. Needle Insertion

- 18 patients with moderate-to-severe OSA undergoing drug-induced sleep endoscopy (DISE) were included in this case series.
- Following sedation, ultrasound was used to guide a 20-gauge needle inserted into a 5-French introducer toward the HGN (**Figures 1+4**).

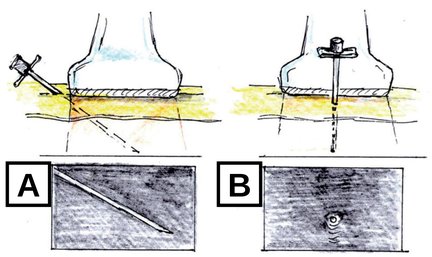


Figure 1. **(A)** In-plane and **(B)** out-of-plane needle placement. Adapted from [1].

2. Needle-based Stimulation → Electrode Placement at HGN Target

- 3-Hz monopolar stimulation (**Figure 2**) was delivered to the needle tip while observing tongue base responses under nasoendoscopy.
- As the needle approached the HGN, the longer pulse activated the nerve from further away, eliciting a visible 1-Hz twitch response. Closer to the target, the shorter pulse also activated the nerve, causing a 3-Hz response (**Figure 3**).

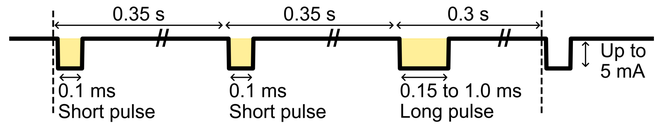
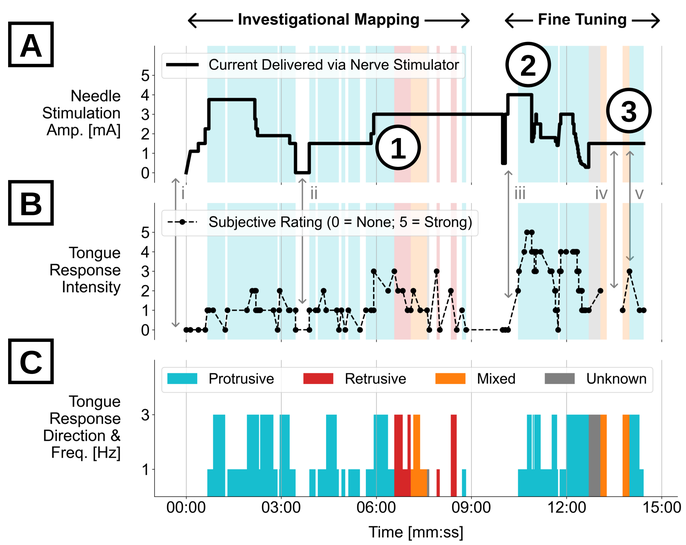


Figure 2. Repeated sequence of 3 pulses per second at adjustable amplitudes. Based on initial research described in [2].

3. Educational Case Example



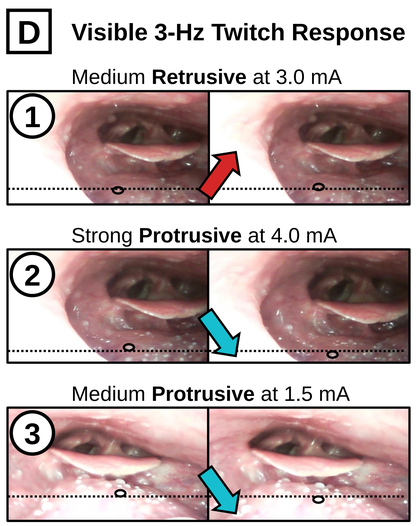
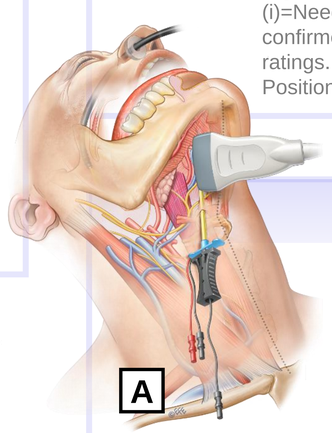


Figure 3. **(A)** Needle stimulation amplitude over time with annotations. (1-3)=Nasoendoscopy example times; (i)=Needle insertion; (ii)=Doppler; (iii)=Needle trajectory adjusted; (iv)=Scope adjusted; (v)=Desired response confirmed. **(B)** Tongue response intensity and **(C)** direction (color) and frequency (y-axis) based on subjective ratings. **(D)** Nasoendoscopy example frames during undesired retrusive versus desired protrusive responses. Position of a taste bud (circle) relative to a fixed reference (line) before (left) and during (right) stimulation.

4. Ultrasound Navigation



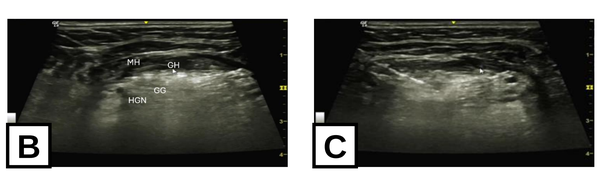
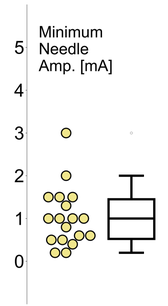


Figure 4. **(A)** Introducer and ultrasound probe. © Levant Efe. **(B)** Sonogram with annotations. MH=Mylohyoid; GH=Geniohyoid; GG=Genioglossus. **(C)** Sonogram with needle targeting HGN in view

5. Results



- Mean minimum needle amplitude maintaining 3-Hz responses was 1.03 ± 0.70 mA.
- A modified Seldinger technique was used to place electrode arrays at the HGN.

Figure 5. Boxplot of minimum needle amplitudes for all 18 patients included in this case series.

Conclusion

- This method advances sleep surgery by optimizing HGN localization and percutaneous electrode placement.
- Future studies will examine whether minimum needle amplitude predicts flow improvement, upper airway opening and OSA severity reduction during electrode-based stimulation.

Scan the QR codes to learn about related clinical studies supported by Restera

[1] Ihnatsenka, B., & Boezaart, A. P. (2010). Ultrasound: Basic understanding and learning the language. International journal of shoulder surgery, 4(3), 55.

[2] Urmey, W. F., & Grossi, P. (2006). Use of sequential electrical nerve stimuli (SENS) for location of the sciatic nerve and lumbar plexus. Regional Anesthesia & Pain Medicine, 31(5), 463-469.