Percutaneous Approaches to Hypoglossal Nerve Stimulation: A Pilot Study During Drug-Induced Sleep Endoscopy

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Rationale: Hypoglossal nerve stimulation (HNS) is a surgical treatment option for select patients with obstructive sleep apnea (OSA). HNS currently requires intraoperative dissection for implantation of associated hardware, including a stimulation electrode on select protrusor muscle branches of the hypoglossal nerve (HGN) with exclusion of undesirable retractor branches. We hypothesized that the target HGN branches could instead be selectively stimulated with a percutaneously delivered electrode array via several anatomic approaches.

Methods: Consenting patients with moderate-to-severe OSA were studied during drug-induced sleep endoscopy. A pneumotachometer was connected to a nasal mask with positive airway pressure to modulate airway collapsibility and document changes in airflow with HNS. The HGN was identified ultrasonically and approached with a needle electrode followed by delivery of a 4-6 contact electrode array by modified Seldinger technique. Five different anatomic approaches were evaluated: posterior, intraoral, anteromedial, anterolateral, and paracoronal. Pressure-flow curves were constructed to calculate changes in measures of airway collapsibility, including the critical closing (ΔP_{CRIT}) and opening (ΔP_{OPEN}) pressures.

Results: Fourteen participants were studied with 1-2 HGN anatomic approaches each (see Table 1). The HGN was positively identified with ultrasound and stimulated via needle electrode in all fourteen participants. Oral tongue protrusion was observed after electrode array delivery in all but one participant (posterior approach). Oral tongue protrusion without retrusor activation was observed endoscopy in 2/8 posterior, 0/3 intraoral, 0/2 anteromedial, 3/4 paracoronal, and 5/5 anterolateral approaches. Large decreases in airway collapsibility resulting in non-flow limited breathing prevented calculations of ΔP_{CRIT} and ΔP_{OPEN} in 1 posterior and 2 anteromedial approach participants, respectively. Mean ΔP_{CRIT} and ΔP_{OPEN} were -3.19 ± 2.2 and -4.5 ± 2.2 cmH_2O, respectively. No adverse events were observed.

Conclusions: HNS electrode array delivery via a percutaneous approach is feasible. The paracoronal and anterolateral approaches were the most successful, with comparable changes in measures of airway collapsibility. Percutaneous delivery of a stimulation electrode has the potential to significantly decrease the morbidity of HNS implantation. Further work is necessary to ascertain what anatomic approach is optimal for percutaneous electrode delivery.

Anatomic Approach	Participants (n)	Guide Needle Activation (n)	Tongue Protrusion with Electrode (n)	ΔP_{CRIT} (cmH2O)	ΔP_{OPEN} (cmH2O)
Posterior	8	8	2	-4.3	-7.7
Intraoral	3	3	0		
Anteromedial	2	2	0		
Anterolateral	5	5	5	-4.0 ± 2.0	-3.6 ± 2.4
Paracoronal	4	4	3	-3.3 ± 2.1	-5.9 ± 3.0

Table 1. Summary of tested anatomic approaches for percutaneous hypoglossal nerve stimulation. ΔP_{CRIT} = critical collapsing pressure of the pharynx; ΔP_{OPEN} = critical opening pressure of the pharynx.