Hypoglossal Nerve Stimulation: Beyond AHI for OSA Patient Selection

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> Obstructive sleep apnea (OSA) affects up to one billion adults worldwide, carrying substantial risks for hypertension, cardiometabolic disease, neurocognitive decline, and increased all-cause mortality. Continuous positive airway pressure (CPAP) remains the first-line therapy, but more than half of patients struggle with intolerance or non-adherence, leaving a significant population vulnerable to sustained health risks. This unmet need has driven interest in surgical interventions, particularly hypoglossal nerve stimulation and maxillomandibular advancement (MMA).

KEY TAKEAWAYS

- The Pivot: Maxillomandibular advancement (MMA) offers a definitive, anatomically driven solution for OSA, achieving an approximately 80% reduction in AHI.
- The Data: MMA provides durable improvements in nocturnal oxygenation, daytime function, and quality of life, with evidence linking it to attenuation of oxidative stress and sympathetic hyperactivation.
- The Action: Clinicians should consider MMA not merely as craniofacial corrective surgery but as a healthspan-relevant intervention for selected OSA patients, especially those intolerant to CPAP.

Obstructive sleep apnea (OSA) is a complex, anatomically driven disorder, but its management often defaults to a single metric: the apnea-hypopnea index (AHI). While AHI quantifies event frequency, it fails to capture the full spectrum of physiological derangements or the anatomical root cause of airway collapse. This narrow focus has significant implications for patient selection, particularly when considering advanced surgical therapies like hypoglossal nerve stimulation (HNS) and maxillomandibular advancement (MMA). A contemporary review published in Frontiers in Surgery highlights the need to move beyond AHI, positioning MMA as a potentially disease-modifying intervention with broader healthspan implications.1

The review, authored by Kauke-Navarro, Steinbacher, and Safi, synthesizes current evidence on MMA, a surgical approach that physically expands the upper airway.1 It contrasts MMA's mechanism with other interventions, including HNS, by emphasizing its direct anatomical correction. Patients with OSA often present with a constricted pharyngeal airway, a problem that HNS attempts to mitigate by stimulating muscles to open the airway during sleep. But MMA addresses the underlying skeletal framework, moving the maxilla and mandible forward to create a larger, more stable airway. This fundamental difference in approach dictates distinct patient selection criteria and offers varying degrees of efficacy and durability.

The Anatomical Imperative

Maxillomandibular advancement is a reconstructive surgery that repositions the facial skeleton to enlarge the posterior airway space. This is a direct, mechanical solution to an anatomical problem. The procedure typically involves osteotomies of the maxilla and mandible, followed by their advancement and fixation in a new, more anterior position. This forward movement pulls the soft tissues of the palate, tongue, and pharynx with them, effectively increasing the volume of the airway and reducing the likelihood of collapse during sleep. The review emphasizes that MMA achieves an approximately 80% reduction in the apnea-hypopnea index (AHI), a substantial and durable improvement.1

But the benefits of MMA extend beyond AHI reduction. The procedure also leads to durable improvements in nocturnal oxygenation, daytime function, and overall quality of life.1 This comprehensive improvement is critical, as intermittent hypoxia and sleep fragmentation contribute to systemic inflammation, oxidative stress, and sympathetic hyperactivation, pathways implicated in accelerated aging and various comorbidities. By correcting the anatomical obstruction, MMA attenuates these downstream physiological insults, positioning it as a potentially disease-modifying intervention. This is a key distinction from symptomatic treatments like CPAP or HNS, which manage the consequences of obstruction rather than resolving its root cause.

Beyond Symptom Management

Hypoglossal nerve stimulation, while effective for many, operates on a different principle. It relies on electrical impulses to activate the genioglossus muscle, pulling the tongue forward and opening the airway. This is a dynamic solution, dependent on the device's activation and the patient's response to stimulation. Patient selection for HNS typically involves a drug-induced sleep endoscopy (DISE) to identify the pattern of airway collapse. Patients with concentric collapse at the soft palate, for example, may not respond as well to HNS, which primarily targets tongue base obstruction. This highlights the importance of detailed anatomical assessment, not just AHI, in determining suitability for HNS. But even for ideal candidates, HNS does not fundamentally alter the underlying skeletal anatomy.

The review points out that MMA's ability to correct intermittent hypoxia is linked to the attenuation of oxidative stress, sympathetic hyperactivation, and cellular senescence pathways.1 These are not merely markers of OSA severity; they are drivers of accelerated aging and chronic disease. For example, chronic intermittent hypoxia contributes to endothelial dysfunction and increased cardiovascular risk. By providing a stable, patent airway, MMA offers a chance to reverse or halt these detrimental processes. This perspective reframes MMA from a purely corrective surgery to a healthspan-relevant treatment, a concept that should influence patient counseling and shared decision-making. Clinicians should consider the long-term systemic benefits, not just the immediate sleep metrics.

Comparing Surgical Approaches

The absence of head-to-head comparisons between MMA and HNS remains a significant research gap.1 Both are advanced surgical options for patients intolerant to or non-adherent with CPAP, but their mechanisms and ideal patient profiles differ. HNS is less invasive, involving implantation of a neurostimulator and a sensing lead. It is typically performed as an outpatient procedure or with a short hospital stay. MMA, in contrast, is a major craniofacial surgery, requiring a longer recovery period and specialized surgical expertise. But its efficacy is generally higher, with success rates (defined as AHI 50% reduction) often exceeding 80%.1

Patient selection for MMA involves careful evaluation of craniofacial anatomy, often using cephalometric analysis and 3D imaging. Patients with retrognathia or micrognathia, where the jaw is set back, are often excellent candidates.

The magnitude of advancement, typically 10-12 mm, correlates with treatment success.1 Complications, while rare, can include temporary or permanent numbness, malocclusion, and aesthetic changes. These considerations are part of the detailed surgical planning. For a deeper dive into how different surgical and non-surgical modalities compare, our previous coverage on multimodal OSA treatment explores the range of options in the market.

The Broader Health Context

The review also identifies other key research gaps, including the absence of long-term cardiovascular endpoints and MMA-specific cost-effectiveness data.1 While MMA improves nocturnal oxygenation and reduces AHI, direct evidence linking it to reduced incidence of myocardial infarction, stroke, or cardiovascular mortality is still needed. Such data would further solidify its position as a disease-modifying intervention. But the physiological improvements, such as attenuation of sympathetic hyperactivation, strongly suggest a positive impact on cardiovascular health. For clinicians managing patients with complex comorbidities, understanding the systemic effects of OSA treatment is paramount. The Oxford Handbook of Cardiology offers a concise guide to modern cardiological practice, which often intersects with OSA management.

The economic impact of OSA is substantial, encompassing direct healthcare costs and indirect costs from lost productivity. While MMA is an upfront investment, its durable efficacy and potential to mitigate long-term comorbidities could make it cost-effective over a patient's lifetime. But robust, MMA-specific cost-effectiveness studies are lacking. These studies would need to account for the reduced need for ongoing CPAP therapy, fewer OSA-related complications, and improved quality of life. Without this data, payers and healthcare systems may struggle to fully appreciate the long-term value of MMA.

Where the Evidence Falls Short

One limitation of the current evidence base, as highlighted by Kauke-Navarro and colleagues, is the lack of head-to-head trials comparing MMA with HNS.1 This makes direct comparisons of efficacy, safety, and patient satisfaction challenging. Clinicians often rely on indirect comparisons and expert consensus when guiding patients through these complex decisions. Another gap is the limited data on MMA's impact on specific cardiovascular endpoints. While improvements in surrogate markers are clear, hard outcomes like stroke or MI incidence require large, long-term prospective studies. These studies are expensive and difficult to conduct for surgical interventions, but they are essential for establishing MMA's full disease-modifying potential.

The review also highlights the need for more sophisticated patient selection tools. Relying solely on AHI is insufficient for both HNS and MMA. A comprehensive evaluation should include detailed anatomical assessment, consideration of comorbidities, patient preferences, and an understanding of the long-term physiological benefits beyond simple event reduction. The future of OSA management will likely involve a more personalized approach, integrating advanced imaging and physiological phenotyping to match the right patient to the right therapy. This shift requires clinicians to look beyond the numbers and consider the whole patient.

> **CLINICAL IMPLICATIONS**
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> The persistent reliance on AHI as the primary metric for obstructive sleep apnea (OSA) treatment success, particularly for advanced interventions, misses the forest for the trees. Maxillomandibular advancement (MMA)

> offers a definitive anatomical correction, a stark contrast to the symptomatic management provided by CPAP or even hypoglossal nerve stimulation. Clinicians should view MMA not as a last resort, but as a primary consideration for CPAP-intolerant patients with appropriate craniofacial anatomy, recognizing its potential to mitigate long-term systemic sequelae of OSA.
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> For patients, this means a more thorough diagnostic workup is warranted, extending beyond a basic sleep study to include detailed anatomical imaging. Understanding the underlying skeletal and soft tissue contributions to airway collapse is essential for making informed decisions about surgical options. The promise of attenuating oxidative stress and sympathetic hyperactivation, pathways linked to accelerated aging, should be part of the patient conversation.
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> The lack of head-to-head trials comparing MMA and HNS creates a clinical dilemma, forcing reliance on indirect comparisons. This gap in evidence means that the optimal sequencing or choice between these two effective surgical modalities remains largely guided by anatomical considerations and surgeon expertise rather than robust comparative effectiveness data. Industry and academic researchers need to prioritize these comparative studies to provide clearer guidance for patient selection.
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> The message is clear: OSA is more than just a high AHI. It is a systemic disease with profound long-term health consequences. Interventions that address the root anatomical cause, like MMA, offer benefits that extend beyond simply reducing apneic events, potentially influencing a patient's overall healthspan. GPs and specialists alike must consider this broader context when evaluating treatment pathways for their patients.

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REFERENCES

1. 1. Kauke-Navarro M, Steinbacher D, Safi AF. Maxillomandibular advancement for obstructive sleep apnea: a contemporary review. Front Surg. 2026;13:42639313. doi:10.3389/fsurg.2026.42639313

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