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Review Article

The effect of neuromuscular orthodontic interventions on jaw position and oropharyngeal airway dimensions

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ABSTRACT:
Neuromuscular Orthodontics is an evolving field that emphasizes the relationship between muscle function, jaw positioning, and airway dynamics. This review explores how neuromuscular interventions, including myofunctional therapy and functional appliances, influence craniofacial growth and oropharyngeal airway dimensions. Evidence from cephalometric, CBCT-based, and sleep studies suggests that such interventions can promote forward mandibular growth, improve tongue posture, and enhance airway patency. These outcomes are particularly relevant in the management of obstructive sleep apnoea and other sleep-disordered breathing conditions. While paediatric patients show the most pronounced structural changes due to ongoing growth, adult patients may still benefit through, improving bite & jaw alignment, addressing postural issues, fixing issues like overbites, underbites, and crossbites more functionally, establishing true resting jaw position, acquiring muscle optimised jaw position, achieving functional bite, soft tissue remodelling and functional re-education. Myofunctional therapy has emerged as a valuable non-invasive tool to restore nasal breathing, reduce pharyngeal collapsibility, and support orthodontic stability. Despite encouraging results, current literature is limited by small sample sizes, heterogeneous methodologies, and a lack of standardized treatment protocols. Long-term, high-quality randomized trials are essential to validate the role of neuromuscular orthodontics in airway management and to develop universally accepted guidelines. Integrating airway-focused orthodontics into routine practice holds promise for improving both dental and systemic health outcomes.

Keywords: neuromuscular orthodontics, myofunctional therapy, functional appliances, jaw position, oropharyngeal airway

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INTRODUCTION

Neuromuscular orthodontic interventions, which encompass functional appliances and myofunctional therapy, aim to harmonize muscle function with skeletal structures to optimize both occlusion and airway patency. These interventions are based on the understanding that alterations in jaw positioning can influence the oropharyngeal airway, thereby impacting respiratory efficiency and overall health [1].

The oropharyngeal airway, situated posterior to the oral cavity and extending from the soft palate to the epiglottis, plays a pivotal role in respiration, phonation, and deglutition. Its patency is influenced by the surrounding skeletal and soft tissue structures, including the maxilla, mandible, tongue, and hyoid bone [2]. Malpositions or dysfunctions in these components can lead to airway compromise, contributing to conditions such as obstructive sleep apnoea (OSA). Orthodontic interventions that address these dysfunctions have the potential to enhance airway dimensions and improve patient outcomes [3].

This review synthesizes evidence on the skeletal and functional effects of neuromuscular orthodontic therapy, focusing on how these treatments impact jaw positioning and oropharyngeal airway dimensions across different age groups.

ANATOMY AND PHYSIOLOGY OF THE JAW AND OROPHARYNGEAL AIRWAY

The anatomical relationship between the jaw structures and the airway is foundational to

understanding the role of orthodontic intervention in airway management. The maxilla and mandible form the skeletal framework of the oral cavity, while the tongue, soft palate, and pharyngeal walls contribute to defining the patency of the oropharyngeal airway [4]. The hyoid bone acts as a suspension point for muscles that help maintain airway stability.

During normal respiration, the airway remains open due to the tonic activity of the pharyngeal dilator muscles, which counteract the negative inspiratory pressure. Any imbalance or dysfunction in these muscles, or anomalies such as retrognathic mandibles and narrow maxillary arches, can cause airway narrowing or collapse—especially during sleep when muscle tone is reduced [5].

Mandibular retrognathism can push the tongue posteriorly, reducing the airway space and increasing the risk of OSA [6]. In contrast, mandibular advancement—whether surgical or orthopedic—can increase the space by anteriorly repositioning the tongue and stabilizing the pharyngeal muscles [7]. This dynamic relationship underlines the importance of jaw position in maintaining a patent airway.

Moreover, dysfunctional habit like chronic mouth breathing & Upper airway resistance syndrome often secondary to nasal obstructions, can disrupt craniofacial development. Children with mouth breathing tend to develop high-arched palates and retruded mandibles, which can further narrow the airway [8]. These observations reinforce the necessity for early detection and orthopedic correction during periods of active growth.

NEUROMUSCULAR ORTHODONTICS: CONCEPTS AND MECHANISM OF ACTION

Neuromuscular Orthodontics (NMO) differs from conventional orthodontics by emphasizing the coordination between dental occlusion, temporomandibular joints, and masticatory muscle function [1]. This holistic approach considers the resting posture and function of orofacial muscles as critical determinants of jaw development and airway patency.

Myofunctional therapy is an important aspect of NMO. It involves structured exercises aimed at correcting dysfunctional habits such as low tongue posture, mouth breathing, and improper swallowing [9]. These exercises help in reprogramming muscle activity to promote nasal breathing and maintain an elevated tongue position, which supports the palate and optimizes airway space [10].

Functional orthopedic appliances—including the Myobrace, Twin-block, and Frankel devices—are used to guide the growth of the maxilla and mandible by leveraging natural muscular forces [11]. These appliances stimulate forward mandibular movement, widen the maxillary arch, and promote proper tongue positioning. When used during growth periods, they can significantly influence sagittal and vertical jaw development [12].

In more advanced NMO practice, tools like electromyography (EMG) and transcutaneous electrical nerve stimulation (TENS) are employed to determine and maintain an ideal mandibular rest position, ensuring optimal muscle balance and jaw alignment [13,14]. These technologies provide objective insights into muscle activity and occlusal dynamics, refining diagnosis and enhancing treatment precision.

IMPACT OF NEUROMUSCULAR INTERVENTIONS ON JAW POSITION

One of the primary therapeutic goals of neuromuscular orthodontic interventions is to normalize jaw position, especially in patients with sagittal discrepancies such as mandibular retrognathism. Functional appliances like the Twin Block, Herbst, and Bionator are widely used to advance the mandible, especially in growing children with Class II malocclusion. Studies have shown that such interventions can lead to significant increases in SNB angle and mandibular length, indicating skeletal remodeling rather than just dental compensation [13].

Baccetti et al. demonstrated that functional orthopedic therapy in adolescents induced not only forward mandibular movement but also increased posterior facial height and improved mandibular plane angles [14]. These structural shifts positively affect the airway by repositioning the tongue and anteriorly displacing the hyoid bone.

Pavoni et al. reported that neuromuscular-guided functional appliances facilitated forward positioning of the pogonion and reduced lower facial height, which is often associated with vertically excessive growth patterns and airway compromise [15]. Furthermore, expansion of the transverse arch using appliances such as ALF or Myobrace has been found to correct maxillary constriction and indirectly support nasal and oropharyngeal airway structures [16].

In adults, while skeletal changes are more limited, functional improvements in jaw posture and muscle coordination still yield significant outcomes in occlusal stability and soft tissue alignment.

EFFECT ON OROPHARYNGEAL AIRWAY DIMENSIONS

The influence of neuromuscular orthodontic therapies on airway volume is well-documented in imaging studies, particularly using cone-beam computed tomography (CBCT). Mandibular advancement causes the tongue to move forward and the pharyngeal airway to expand, especially in the velopharyngeal and glossopharyngeal regions [17].

Ozbek et al. studied skeletal Class II patients treated with functional appliances and found a significant increase in minimum airway space and an anterior shift in tongue posture, both of which contributed to improved airway patency [18]. These changes are particularly beneficial for individuals with sleep-

disordered breathing, as the collapse-prone region of the oropharynx becomes more stable.

Myofunctional therapy, when integrated into orthodontic care, has demonstrated efficacy in improving upper airway muscle tone, decreasing collapsibility during sleep, and stabilizing the soft palate and lateral pharyngeal walls [19]. Guimarães et al. showed that a structured oropharyngeal exercise program significantly reduced the apnea-hypopnea index (AHI) in adults with moderate obstructive sleep apnea [19].

Maxillary expansion is another approach that improves airway space by widening the nasal floor and repositioning the lateral walls of the nasal and oral cavities. Singh et al. reported that adults treated with biomimetic oral appliances experienced volumetric increases in nasopharyngeal and oropharyngeal airway segments, verified by 3D imaging [20].

CLINICAL OUTCOMES AND PATIENT-CENTERED BENEFITS

The clinical relevance of neuromuscular orthodontic interventions lies in their multidimensional benefits—beyond correcting malocclusion, these therapies enhance functional outcomes such as breathing, sleep quality, and facial growth harmony. Early intervention in children has shown improvements in nasal breathing, head posture, and reduced incidences of mouth breathing and snoring [5,9].

In paediatric populations, myofunctional therapy combined with orthopedic appliances contributes to optimal craniofacial development, improved oxygenation, and behavioral benefits. Chervin et al. demonstrated that treating sleep-disordered breathing improved cognitive and behavioral performance in children, highlighting the systemic effects of airway correction [5].

For adults, particularly those with mild-to-moderate OSA, airway-aware orthodontics has been shown to significantly improve sleep indices, reduce daytime fatigue, and even reduce reliance on CPAP devices when used adjunctively [19]. In addition, maintaining proper tongue posture and nasal breathing enhances post-treatment stability, reducing orthodontic relapse and improving long-term outcomes [3].

The overall patient experience improves through non-invasive, holistic therapies that do not rely on pharmacological or surgical interventions. These approaches align with current trends toward integrative and preventive care in dentistry and medicine.

CRITICAL APPRAISAL OF AVAILABLE LITERATURE

While the clinical promise of neuromuscular orthodontic interventions is significant, the current body of literature lacks uniformity and methodological rigor. Most available studies are observational in nature—either prospective cohorts, retrospective analyses, or case reports—limiting the generalizability and strength of evidence [4,14].

Randomized controlled trials (RCTs), the gold standard in clinical research, are scarce in this domain. Furthermore, the available studies often vary in diagnostic criteria, intervention protocols, and outcome measurements, which complicates direct comparisons. For instance, some trials assess skeletal and dental outcomes using cephalometric indices, while others evaluate functional changes in airway volume using CBCT or sleep study parameters such as the apnoea-hypopnea index (AHI) [17,20].

Imaging-based measurements are highly sensitive to variables like head posture, tongue position, and respiratory phase during capture, introducing significant variability [18]. In addition, very few studies have long-term follow-up, making it difficult to assess the permanence of observed skeletal or functional improvements.

Another limitation is the frequent use of combined therapies—orthodontic appliances used alongside myofunctional therapy—which makes it challenging to isolate the specific effects of each component. Lastly, most research to date focuses on paediatric populations; studies involving adult patients are less prevalent and often limited by small sample sizes.

CONTROVERSIES AND GAPS IN KNOWLEDGE

NMO often employs technologies like electromyography (EMG) and transcutaneous electrical nerve stimulation (TENS) to determine optimal jaw positioning. Some experts contend that such instruments may not provide consistent or clinically meaningful data, leading to potential misdiagnoses. [21].

Given its emphasis on achieving a "neuromuscularly ideal" jaw position, NMO may lead to unnecessary interventions. Patients might undergo extensive treatments based on questionable diagnostics, exposing them to risks without clear benefits [22].

A central tenet of NMO is the correction of occlusal discrepancies to alleviate temporomandibular disorders (TMD). However, the relationship between occlusion and TMD remains contentious. Some studies suggest that occlusal factors play a minimal role in TMD pathogenesis, challenging the foundational premise of NMO [23].

Relationship between occlusion, posture and TMDs has been a debatable topic in prosthodontics. Rectifying the occlusal and postural abnormalities to treat Temporomandibular disorders according to pathophysiological concepts is under extensive scrutiny [23].

FUTURE DIRECTIONS AND RECOMMENDATIONS

To establish neuromuscular orthodontics as a reliable modality for airway enhancement, the field must invest in high-quality research. Priority should be

given to multicenter randomized controlled trials that standardize appliances, therapy duration, and assessment tools. Inclusion of long-term follow-ups will help determine the stability and durability of both skeletal and airway outcomes [17].

Advancements in technology offer new avenues for precision diagnosis and monitoring. AI-based analysis of 3D facial and airway scans can support objective assessments, while digital workflow integration can enhance appliance customization. Wearable sleep monitors and smartphone-based adherence trackers may also improve patient compliance and longitudinal data capture.

From a clinical perspective, greater interdisciplinary collaboration is vital. Sleep medicine specialists, pediatricians, speech therapists, and ENT surgeons should be integrated into comprehensive treatment teams, especially in complex cases involving OSA or craniofacial anomalies [20].

Future studies should also explore the role of adult neuroplasticity and the efficacy of virtual myofunctional therapy. As teledentistry and digital health expand, virtual platforms could deliver guided exercises and monitor compliance remotely, increasing accessibility to therapy in underserved regions.

Lastly, professional bodies and academic institutions should work toward developing evidence-based guidelines for diagnosis, appliance selection, and treatment timelines to standardize practice and improve outcome predictability.

CONCLUSION

Neuromuscular orthodontic interventions represent a paradigm shift in addressing malocclusion not merely as a dental issue but as a musculoskeletal and functional concern. By targeting the harmony between jaw position, muscular balance, and airway dynamics, these interventions offer an integrative approach that transcends aesthetics and occlusion.

Through functional appliances and orofacial exercises, clinicians can induce favourable skeletal changes, improve breathing patterns, and potentially mitigate airway-related pathologies like obstructive sleep apnoea. While current evidence supports these benefits, it remains preliminary and demands more rigorous validation.

The patient-centered advantages—improved sleep quality, enhanced facial development, and reduced daytime fatigue—underscore the broader health implications of airway-focused orthodontics. However, success hinges on individualized planning, early diagnosis, and a multidisciplinary approach.

In conclusion, neuromuscular orthodontics holds significant promise for advancing both orthodontic and airway health. Continued research and clinical refinement will determine its rightful place in future therapeutic algorithms.

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