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Review Article

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REVIEW ARTICLE

What Are We Missing in Adult Obstructive Sleep Apnea Clinical Evaluation? Review of Official Guidelines

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Purpose: This article presents a narrative review of current recommendations for the clinical evaluation and management of adult patients with obstructive sleep apnea (OSA) to identify points missing from a myofunctional perspective.

Methods: The authors reviewed current official guidelines for adult patients with OSA, searching clinical evaluation and treatment recommendations for myofunctional therapy.

Results: None of the current guidelines for evaluation of adult OSA recommend performing a myofunctional evaluation. Only two guidelines consider myofunctional therapy (MFT) as a treatment modality for adult patients with OSA.

Conclusion: Despite the role of the pharyngeal dilator muscles as an essential contributor to the pathogenesis of OSA, this review has shown that myofunctional assessment is still not a standard recommendation in current guidelines for adult OSA. Recent guidelines occasionally include MFT as a therapeutic tool for OSA. To strengthen the knowledge base and evidence for including MFT treatment for adult patients with OSA, the authors encourage physicians to incorporate myofunctional evaluation into their regular clinical practice.

Keywords: *obstructive sleep apnea, myofunctional therapy, clinical practice guideline, narrative review, evaluation, recommendations*

INTRODUCTION

Obstructive sleep apnea (OSA) has a global prevalence between 4 to 30% (Benjafield et al., 2019) with heterogeneous pathophysiology (Subramani et al., 2017). Patients with OSA may have severe impairment in the quality of life and cardiovascular (Javaheri et al., 2017; Salman et al., 2020), neurological (Bassetti et al., 2020), and metabolic consequences (Li et al., 2018; Reutrakul & Mokhlesi, 2017). The pathogenesis of OSA involves several underlying mechanisms and components, such as the upper airway anatomy and its dynamic changes, the effectiveness of dilator muscle function to maintain airway patency, instability in the control of breathing including respiratory excitation threshold (arousals), and respiratory drive (loop gain) (Malhotra et al., 2020; Owens et al., 2008; Rizzatti et al., 2020). Given this complexity, OSA is a challenge for the clinicians involved in its evaluation and management.

Several consensus statements and guidelines addressing the evaluation and management of the adult patient with OSA have been published in the last 30 years throughout the world (Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine, 2009; American Academy of Otolaryngology-Head and Neck Surgery, 2021; Cuesta et al., 2005; Esteller Moré et al., 2018; Haddad et al., 2013; Irish Sleep Society, 2015; Levine et al., 2018; Lloberes et al.,

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2011; MacKay et al., 2020; Marín Trigo et al., 1993; Mayer et al., 2017; Mediano et al., 2022; NICE, 2021; Randerath et al., 2021; Sharma et al., 2014; Position Statement: Treatment of Obstructive Sleep Apnea – American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS), 2022). These guidelines consider different aspects such as pathophysiology, clinical evaluation, subjective and objective diagnostic tests, and diverse treatment modalities.

Since Eckert et al. (2013) described the OSA endotype, scientific evidence has advanced in this area, and considerations on precision medicine (Light et al., 2019) are directing efforts to identify the OSA phenotype for each patient through sleep studies and clinical assessment (Bamagoos et al., 2019; Dutta et al., 2021). For example, the hypotonic endotype is characterized by ineffective dilator muscle function. This endotype reduces the chance of successful surgical outcomes (Wong et al., 2022) and should thus be recognized prior to offering treatment, so that the clinician can offer a combined therapeutic modality.

Despite a consensus within the literature that functioning of the pharyngeal dilator muscles is an essential contributor to the pathogenesis of OSA (Koka et al., 2021), it is notable that myofunctional assessment is not a standard recommendation in the current guidelines. Furthermore, only a few research groups have examined this as a protocolized diagnostic procedure (de Castro Corrêa et al., 2020; Rodriguez-Alcalá et al., 2022).

To identify a myofunctional disorder, different approaches have been published using validated questionnaires (de Felício & Ferreira, 2008) and instruments to assess muscular strength and endurance by assigning it an objective value, such as the Iowa Oral Performance Instrument (IOPI®) (Adams et al., 2013), or the Tongue Digital Spoon as an alternative device (Rodriguez-Alcalá et al., 2021). An international group is working towards standardizing guidelines for a myofunctional assessment protocol for patients with suspected OSA (Moeller et al., 2021). Through an anatomical evaluation, the physician may consider the length of the lingual frenulum (Drazin, 1994; Marchesan, 2012), the presence of an arched hard palate, or changes in dental occlusion (Hariri et al., 2010), not necessarily because of their potential roles in upper airway obstruction, but as indirect signs of oral breathing and myofunctional disorders (Fraga et al., 2018; Knösel et al., 2012).

The therapies currently recommended for this complex disease include continuous positive airway pressure (CPAP), mandibular advancement devices (MAD), and surgical procedures (Gottlieb et al., 2021; Patil et al., 2019; Rabie et al., 2021; Venema et at., 2021). However, these are not always as effective as anticipated, and inadequate patient adherence and potential complications limit their overall effectiveness and results (Beydoun et al., 2018; Lorenzi-Filho et al., 2017; Rabie et al., 2021; Sawyer et al., 2022; Schwartz et al., 2018).

In recent years, myofunctional therapy (MFT) has emerged as another potential treatment modality, showing acceptable adherence and promising outcomes among adults with mild-to-severe OSA, including reduced snoring, apnea/hypopnea index (AHI), oxygen desaturation, and daytime sleepiness, and improved quality of life and CPAP adherence (Aiello et al., 2016; de Felício et al., 2018; Guimarães et al., 2009; O'Connor-Reina et al., 2020; Mediano et al., 2019).

This review provides a comprehensive reading of current recommendations for the clinical evaluation and management of adult patients with OSA to identify the presence or absence of information from the myofunctional perspective.

METHODS

This narrative review evaluates current management guidelines for adult patients with OSA. The process followed the Scale for the Assessment of Narrative Review Articles (SANRA) as a scale for the quality assessment of narrative review articles (Baethge et al., 2019).

Inclusion criteria were defined as multidisciplinary guidelines that addressed the clinical evaluation and/or management of the adult patient with OSA issued by recognized national or international sleep organizations. Exclusion criteria were guidelines not issued by official organizations or those targeted at specific populations.

The search strategy was designed using keywords as referenced in Pubmed Medical Subject Headings: Obstructive sleep apnea; Sleep apnea; Guideline; Consensus; Position; Statement; Systematic review; Assessment; Evaluation; Recommendations.

The search was performed in May 2022 by reviewing official international and national sleep organizations' online guidelines databases, according to World Sleep Society (WSS) current associate members and European Sleep Research Society (ESRS) Affiliated National Sleep Societies. Additional research was conducted during the same period in PubMed, Scopus, SciELO, and Google Scholar databases.

Three researchers independently reviewed the titles and abstracts and discarded guidelines that did not meet the inclusion criteria (guidelines on specific populations: eight for drivers, five for pediatrics, and

Table 1. Systematic questionnaire to evaluate OSA guidelines

Pathophysiology	
	Does it consider the muscular factor as a contributor?
Anatomical	
Nose	Septum; Turbinates; Rhinitis; Polyps
Anthropometric Measures	Height; Weight; Body Mass Index (BMI); Neck circumference
Maxillo-Mandibular Profile	Convex; Concave; Retrusive; Protrusive; Retrognathia; Prognathia
Occlusal	Augmented; Crossed overbite
Lingual Frenulum	Tongue-tie
Hard Palate	High arched hard palate
Soft Palate	Elongated soft palate; Uvula; Anterior pillars
Pharyngeal Tonsils	Hypertrophic
Tongue	Macroglossia; Mallampati score; Friedman score
Functional	
Breathing habit	Nasal; Oral
Tongue Position / Mobility	Tongue position with mouth close; Mobility; Ability to reach hard palate
Muscular tone	Does it recommend instrumental evaluation for tongue muscle properties (strength, endurance, tone)?
Orofacial myofunctional evaluation with scores	Does it recommend orofacial myofunctional evaluation with scores?
Treatment	
	Is myofunctional therapy included in the treatment recommendations?

one each for adolescents, bariatric patients, and women with menopausal disorders).

Before evaluating each guideline, we had custom designed a questionnaire focusing on the pathophysiological aspects described and the recommendations for the clinical evaluation and treatment modalities, Reviewers identified whether each item was assessed and assigned them to four groups: Pathophysiology, Anatomical findings, Functional assessment, and Treatment consideration (Table 1).

RESULTS

The search strategy identified 37 adult OSA guidelines. Once 6 duplicates were removed, all abstracts were screened. Ultimately, 15 guidelines were selected for review (Figure 1). These were read thoroughly and rated using our questionnaire. The overall results are shown in Table 2.

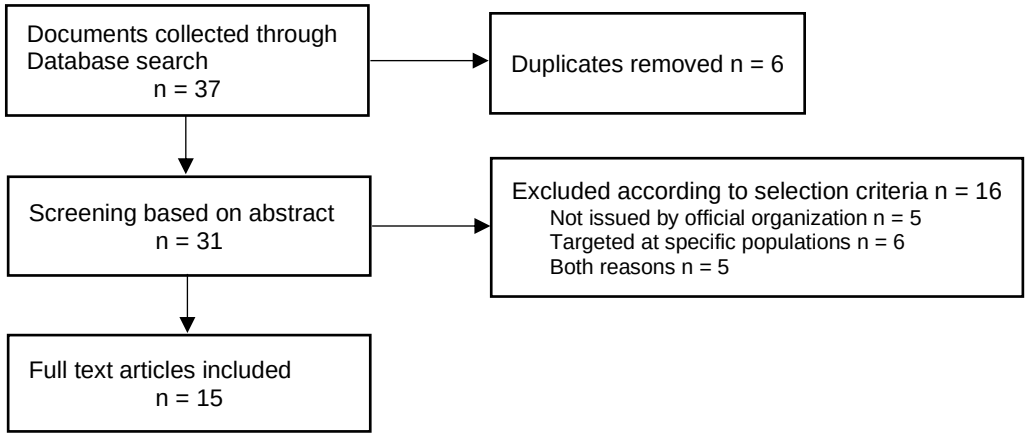

Figure 1. Study search flowchart.

Table 2. Questionnaire results

Guideline	Reference	Patho-physiology	Anatomical									Functional				Treatment
Organization	First Author (year)	Hypotonia / Muscular	Nose	Anthropo-metric measures	Maxillo-mandibular profile	Occlussal	Lingual Frenulum	Hard Palate	Soft Palate	Pharyngeal Tonsils	Tongue	Breathing Habit	Tongue position/ mobility	Instrumen-tal assess-ment	OMES	MFT
SEPAR	Marín Trigo (1993)	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No	No	No
GES	Cuesta (2005)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No
AASM	Epstein (2009)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	No
SEPAR	Lloberes (2011)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No
ABS	Haddad (2013)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No	No	No
INOSA	Sharma (2014)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No
ISS	ISS (2015)	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No	No	No
GERMAN S3	Mayer (2017)	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
AADSM	Levine (2018)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No
SES	Esteller Moré (2018)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	No
ASA	Mackay (2020)	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No
AAO-HNS	AAO-HNS (2021)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
ERS	Randerath (2021)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
NICE	NICE (2021)	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
SEPAR	Mediano (2022)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes

SEPAR: Sociedad Española de Neumología y Cirugía Torácica; GES: Grupo Español de Sueño; SES: Sociedad Española de Sueño; AASM: American Academy of Sleep Medicine; ABS: Associacao Brasileira do Sono; INoSA: Indian Iniciative on OSA; ISS: Irish Sleep Society NICE: National Institute for Health and Care Excellence; AADSM: American Academy of Dental Sleep Medicine; ASA: Australasian Sleep Association; ERS: European Respiratory Society; AAO-HNS: American Academy of Otolaryngology - Head and Neck Surgery; OMES: Orofacial myofunctional evaluation with scores; MFT: Myofunctional therapy

All guidelines (100%) recommended performing a clinical evaluation of the anatomical factors (nasal septum, turbinates, polyps, allergies, soft palate and uvula, pharyngeal tonsils, Friedman scores (Friedman, 2009), and Mallampati scores. However, only one (6.7%) recommended including an assessment of the lingual frenulum and tongue position and mobility (Mediano et al., 2022) and four (26.7%) urged addressing the hard palate.

Only two (13.3%) guidelines: SEPAR 2022 (Mediano et al., 2022) and the European Respiratory Society (ERS) (Randerath et al., 2021) considered MFT as a treatment modality. However, neither of them included a recommendation for myofunctional evaluation or explained this lack of recommendation, nor did they explain which endotype is indicated for this treatment modality.

DISCUSSION

This review considered all currently available sleep-organization guidelines for the clinical evaluation and/or management of adults with OSA, and revealed that myofunctional assessment is still not a standard recommendation in the current guidelines for adult OSA.

According to the current scientific literature, physicians involved in OSA care are encouraged to consider other phenotypes rather than Anatomical, such as those involving loop gain, arousals threshold, and upper airway muscular function. However, phenotypes such as loop gain and arousal threshold are challenging to assess in daily practice, but researchers are encouraged to expand their application (Bamagoos et al., 2019; Dutta et al., 2021). Instead, myofunctional evaluation may be easily performed in the office and does not require expensive equipment, as reported by several authors (de Castro Corrêa et al., 2020; Rodriguez-Alcalá et al., 2022).

However, as shown in this review, although the role of myofunctional disorders in OSA pathogenesis has been reported in the literature for some time, myofunctional evaluation is not included yet in the routine clinical evaluation of patients with OSA. None of the current guidelines on clinical evaluation addresses the requirement to assess precisely the myofunctional components in patients with OSA, although various groups have validated and protocolized their methods (Folha et al., 2015; Rodriguez-Alcalá et al., 2022).

The findings of our review raise the following question*: If OSA is a breathing disorder, why is it that physicians do not address the indirect signs of breathing disorders, such as open-mouth breathing, lack of lip sealing, abnormal resting tongue position and tongue mobility, and the length of the lingual frenulum?* Assessing these features is inexpensive, quick, and risk free.

However, our review concluded that only the American Academy of Dental Sleep Medicine (AADSM) Standards of Practice (MacKay et al., 2020) recommends the evaluation of tongue position and mobility, and the length of the lingual frenulum. On the contrary, when otolaryngologists or pneumologist were primarily involved, guidelines failed to consider signs of oral breathing or poor nasal function, although an open mouth implies jaw dropping and glossoptosis, both recognized in the pathogenesis of OSA (Isono et al., 2004). In addition to their own examination, specialists such as otolaryngologists or pneumologists should also enlist the support of speech therapists with training in orofacial myology when assessing OSA patients.

All guidelines reviewed here recommend these treatments for OSA: CPAP therapy, MADs, and surgical options. Instead, although MFT has been shown to benefit patients with OSA by improving the quality of life and objective sleep study findings, only two OSA guidelines: SEPAR 2022 (Mediano et al., 2022) and ERS (Randerath et al., 2021) considered MFT as a treatment modality.

An updated review of current literature on MFT in OSA should be included in future guidelines for adult OSA. de Felício et al. (2018) reviewed 11 articles showing that the benefits of MFT include reduced AHI and arousal index, and improved daytime sleepiness and sleep quality. In their randomized trial, Ieto et al. (2015) showed that patients diagnosed with primary snoring and mild-to-moderate OSA who underwent daily oropharyngeal exercises for 3 months had a decreased snore index compared with the control group. Guimarães et al. (2009) showed significant improvement in OSA severity and symptoms (i.e., snoring frequency and intensity, daytime sleepiness, AHI) after 3 months of oropharyngeal exercise therapy in patients with moderate OSA. Camacho et al. (2015) published a meta-analysis addressing post-MFT results based on polysomnographic, snoring, and sleepiness data, showing that this therapy decreases AHI by approximately 50% in adults and 62% in children. It also improves oxygen saturation, snoring, and sleepiness in adults. These investigators concluded that MFT could serve as an adjunct OSA treatment. This is consistent with the meta-analysis by Aiello et al. (2016) demonstrating that oropharyngeal exercises in patients with OSA decreases AHI and reduces Epworth sleepiness scale scores.

Although the specific mechanisms are not yet identified, it is known that MFT improves muscle responsiveness, muscle gain, and coordinated recruitment of different compartments of the tongue

and other pharyngeal muscles. Rodriguez-Alcalá et al. (2021) showed that the mHealth AirwayGym® app improved sensorimotor tongue function via proprioceptive training, when used by patients with moderate-to-severe OSA and primary snoring, and a healthy control group.

In summary, current evidence shows that MFT is a safe, inexpensive, home-based treatment, without reported complications or adverse effects (Camacho et al., 2015; Rodriguez-Alcalá et al., 2021; Rueda et al., 2020). Despite this, only the latest SEPAR 2022 guideline (Mediano et al., 2022) recommends MFT as beneficial for patients with OSA, in three contexts: as an alternative treatment for mild-to-moderate OSA; as an adjunctive to CPAP to improve efficacy and tolerance; and complementary to MAD. Although SEPAR makes this recommendation, an explanation for their lack of advice regarding assessing muscular endurance or tone is not provided.

Even if MFT may benefit some patients with OSA, it would be better for the physicians to first define which patients are good candidates for this therapy. Endotyping is considered to be essential in the management of every patient with OSA, to allow precisely targeted treatments. It is thus necessary to implement myofunctional assessment in daily practice.

In 2021, the ERS published their guideline for non-CPAP OSA therapies (Randerath et al. 2021). Although they did not focus on clinical evaluation, the guideline does consider MFT to be an alternative treatment for patients reluctant to undergo surgical procedures or CPAP. The ERS also recommends using CPAP instead of MFT for adult patients, although MFT has shown a similar effect size for treating sleepiness, and no significant side effects.

Although MFT cannot replace all benefits of CPAP therapy, which continues to be the gold-standard OSA treatment, we do recommend MFT as a complementary treatment modality (as are weight loss and habit modifications) for all the reasons described above. The ERS notes that MFT "is limited by cost" and that "health insurance might not cover this type of treatment," suggesting that they likely did not consider available mHealth applications, which currently show good outcomes and increasing adherence rates (Mediano et al., 2019; O'Connor-Reina et al., 2021), which are inexpensive and easily accessible.

To date, we lack a clear understanding of the most beneficial types, frequencies, and durations of MFT exercises. Although growing evidence suggests that MFT should be considered a complementary treatment, it is not always conclusive, encouraging further research. As such, we currently consider MFT a valuable complement for appropriately selected patients and have implemented it in our standard of practice. In addition to the benefits of precise endotyping and personalized therapeutics, we encourage the scientific community to further investigate this area, and to produce more robust scientific evidence via randomized clinical trials that will refine evaluation and therapeutic protocols.

CONCLUSION

Despite functioning of the pharyngeal dilator muscles as an essential contributor to the pathogenesis of OSA, this review has shown that myofunctional assessment is still not a standard recommendation in the current guidelines for adult OSA. Based on the current empirical knowledge of the pathogenesis of OSA, and considering that MFT is a safe, inexpensive, home-based therapy without complications or adverse effects, recent guidelines have started to include MFT as a therapeutic tool for OSA. To strengthen our understanding of MFT treatment for adult patients with OSA, we encourage physicians to incorporate myofunctional evaluation into their regular clinical practice.

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