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REVIEW

Emerging monitoring techniques in oral appliance therapy for sleep apnea: a narrative review with a focus on mandibular jaw movement analysis

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ABSTRACT

Introduction: Oral appliance therapy (OAT) for obstructive sleep apnea (OSA) is a complex and dynamic intervention that requires efficient tools to evaluate treatment response and monitor therapeutic outcomes.

Area covered: This review aims to provide a structured overview of current techniques for OAT monitoring, with a particular focus on mandibular jaw movement (MJM) analysis – a promising yet underutilized approach. Literature searches were conducted in PubMed, Scopus, and the Cochrane Library databases up to February 2025. Fifty-six studies were examined, encompassing morphometric and physiological measurements applied at different stages of OAT management in OSA patients. A wide range of measurement techniques were identified and categorized into three groups based on clinical utility.

Expert opinion: The clinical relevance of any monitoring technique depends on its dynamic or static properties, the clinical setting (in sleep or wakefulness) and alignment with the specific clinical objectives within the OAT workflow. While static imaging and endoscopic-based methods offer anatomical and functional insights, only sleep-based assessments can capture treatment efficacy in clinically meaningful terms. Among alternative technologies for sleep testing, MJM analysis stands out as a promising approach for continuous and reliable monitoring, with ability to evaluate the dynamic, synchronized mechanisms underlying OAT efficacy.

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KEYWORDS
home sleep apnea testing; obstructive sleep apnea; oral appliance therapy; mandibular jaw movements; monitoring techniques; upper airway

1. Introduction

Oral appliance therapy (OAT) is currently recommended as an alternative for patients with obstructive sleep apnea (OSA) who cannot tolerate or refuse positive airway pressure (PAP) therapy [1]. The therapy involves a multi-stage protocol, requiring close collaboration between qualified dentists (QD) and sleep medicine physicians [2]. While OAT has demonstrated comparable effectiveness to PAP in improving OSA health outcomes [3], the clinical response in terms of apnea-hypopnea index (AHI) is highly variable among patients. Only 50% of patients achieve complete resolution (AHI <5 events·h^{-1}), approximately one-third of OSA patients are unresponsive to OAT [4], and individual treatment responses vary significantly [5]. These uncertainties underscore the need for personalized approaches to mitigate the risks of delayed appropriate interventions and inefficient allocation of healthcare resources [6].

Consequently, a critical challenge in clinical practice is to predict treatment response to OAT which involves predicting favorable outcomes or identifying non-responders [7]. OAT is a dynamic and non-deterministic process [8] with complex clinical response patterns, emphasizing the need for objective and continuous monitoring to determine the effective protrusion level early and identify non-responders to therapy. Comprehensive and precise monitoring methods are necessary to guide therapeutic decision-making effectively. Moreover, the monitoring techniques must be accessible for routine clinical practice, cost-effective, and practical for dental offices or sleep disorders centers.

Common strategies include evaluating the predictive values of baseline patient phenotypes, such as craniofacial structures [9], OSA endotypes [10], upper airway (UA) morphology and collapsibility [11]. More advanced strategies involve modeling [12] or experimentally evaluating the effect of a mandibular advancement device (MAD) on UA morphology and collapsibility [13], either prior to therapy or during the initial phase of treatment. Others evaluate incremental MAD protrusion levels to determine the effective mandibular position [14].

While diverse measurement techniques have been employed in clinical studies to investigate the OAT mechanisms [15], each study typically employs a distinct method with its own capabilities and constraints, allowing only partial

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Article highlights

- This review provides a structured overview of potential monitoring techniques applicable to oral appliance therapy (OAT).
- Static imaging and endoscopic methods provide valuable anatomical and functional insights but are limited in their ability to capture treatment efficacy. By contrast, sleep-based assessments yield more clinically meaningful evaluations.
- Mandibular jaw movement analysis emerges as a promising approach for continuous and reliable monitoring in OAT, with ability to capture the dynamic and synchronized interplay among factors underlying the therapeutic mechanisms of oral appliances.

insights into OAT efficacy [7]. The lack of a structured classification of these monitoring methods – with respect to their mechanisms, strengths, limitations and clinical utilities – complicates their practical use. The diversity and fragmentation of available measurement techniques pose challenges to selecting effective and clinically appropriate methods, ultimately restricting the research, interdisciplinary collaboration, and clinical outcomes.

Recent advances in biosensor technologies and data analytics have introduced novel sleep monitoring techniques, yet their application in dental sleep medicine remains limited [15]. A pertinent example is the mandibular jaw movement (MJM) analysis, a dentistry-derived method that efficiently explores the dynamic interplay of mandibular jaw movements, UA muscle activity, and respiratory drive during sleep [16]. Although clinically validated in real-life OAT [17–19], the MJM analysis is not yet widely used within the dental sleep medicine community.

Given the lack of a structured classification of monitoring techniques for OAT and under-recognition of emerging methods like MJM analysis, this review aims to: (1) Provide a structured overview of potential measurement techniques, with a particular focus on MJM analysis, and (2) Critically evaluate the strengths, limitations, and clinical utilities of these techniques for assessing and monitoring the effectiveness of OAT in patients with OSA.

2. Methods

Our review employed a narrative synthesis approach. This method was adopted to balance factual data with critical insights derived from the reviewers' experiences, and to address the clinical complexity and methodological diversity in the field.

2.1. Search strategy and database

A non-exhaustive search was performed on PubMed, Cochrane Library and Scopus databases, covering publications from January-1st, 2017, to February-15th, 2025. Search terms included 'oral appliance,' 'mandibular advancement device,' 'obstructive sleep apnea' and 'sleep disordered breathing' combined using logical operators (AND/OR). Initial screening based on titles, abstracts, and keywords focused on three predefined main review questions. Search results were exported into a reference management tool (Endnote X9.3.3, Clarivate, Philadelphia, U.S.A.). Duplicate results were excluded based on matching authors, title, and journal. Full-text screening was conducted independently by four reviewers to assess eligibility according to predefined inclusion and exclusion criteria. The identification and selection procedures are summarized in Figure 1.

2.2. Inclusion/Exclusion criteria

Studies were included for literature analysis and data extraction if they were peer-reviewed, published in English, involved adult patients with OSA undergoing OAT, employing any suitable design, including randomized or observational, retrospective or prospective, repeated measures or single-point assessments. Eligible studies had to address objectives such as validating new measurement techniques, evaluating oral appliance (OA) impacts on UA anatomical structure and ventilatory function, predicting clinical response, guiding the titration process or monitoring adherence to treatment. Clinical outcomes were required to include at least one conventional sleep study method (polysomnography (PSG) or polygraphy (PG)), combined with additional assessments such as imaging, nasopharyngoscopy, airflow dynamics, or biosignal monitoring.

Studies were excluded if they were non-original studies (e.g. reviews, meta-analyses), studies with insufficient content, non-English language publications, purely technical or physiological studies lacking a clinical context.

Only studies meeting the inclusion criteria were included for further analysis, with additional relevant articles identified through reference list examination.

2.3. Literature synthesis

During the initial appraisal, a taxonomy (Annex, Table S1) was developed to classify eligible articles according to the clinical problem, evaluated parameters, and other technical attributes. A structured data extraction was performed, focusing on both clinical and technical aspects. Key elements included the clinical context, targeted outcomes, technical aspects of the measurement methods, clinical significance and applicability. Findings from clinical and technical analyses were integrated to create a coherent narrative addressing the review questions, providing an overview of potential techniques and their clinical applications in OA treatment.

Comprehensive details on the literature search, screening and selection criteria, and the literature review framework are available in the supplemental document (Annex, Section I).

3. Clinical context of OAT

3.1. Integrated mechanisms of action of OAT

To accurately understand the role of anatomical and physiological measurement techniques in OAT, it is important to recognize that the effectiveness of OA in mitigating OSA symptoms is achieved through multifaceted mechanisms of action [7,20].

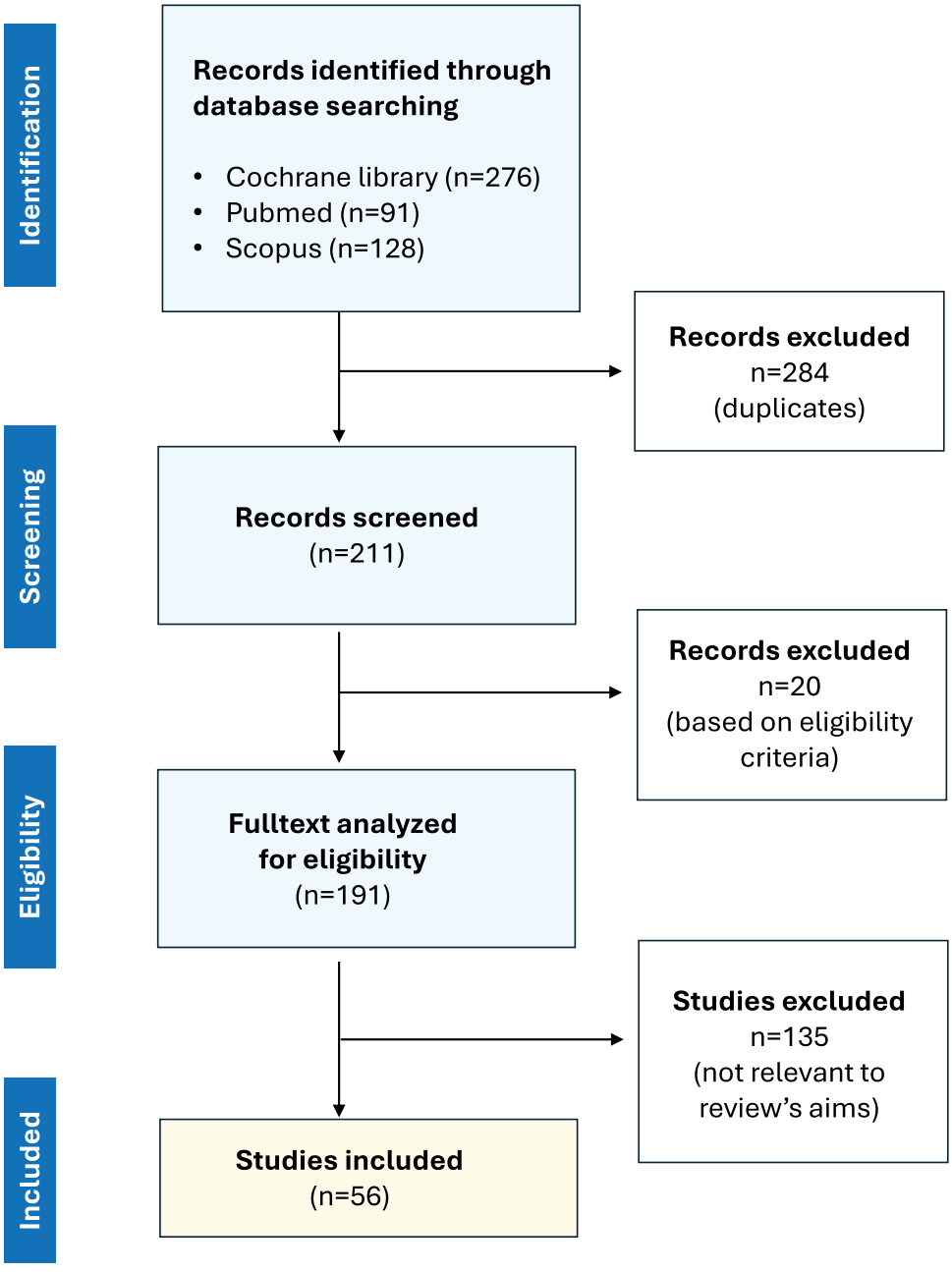

Figure 1. PRISMA flowchart summarizing the process of identification, screening and selection of articles.

Typically, OAT implies two main types of mandibular advancement devices (MAD): non-custom made and custom-made MADs, with varying efficacy between them. A higher treatment success rate [21] and better adherence could be achieved with custom MADs [22], while non-custom MADs could be similarly effective in reducing AHI but with more side effects [23]. Custom MADs are categorized into monobloc and duo-bloc designs, with studies showing mixed results: while some reported better patient preference and fewer side effects with duo-bloc MADs [24,25], others found higher treatment success with monobloc MADs [26]. Overall, non-custom MADs remain a cost-effective option for initiating therapy but custom MADs are preferable for long-term OSA management [22].

Custom MADs incorporate midline traction or bilateral thrust titration mechanisms to gradually advance the mandible. While midline traction MADs show better short-term outcomes and treatment success rates [27], other studies reported similar efficacy for both types [28]. Midline traction MADs might be associated with higher dropout rates and potentially greater anterior teeth stress [27]. Novel MADs, digitally designed and manufactured with interchangeable advancement straps, have shown improved AHI reduction and treatment success compared to traditional bilateral thrust devices [29].

The primary mechanism involves repositioning the mandible forward, thereby increasing the UA volume, especially in the velopharyngeal and oropharyngeal regions [30,31]. MADs also generate tension on surrounding soft tissues (tongue base, soft palate, and palatoglossal arch) [7,32], further stabilizing the pharyngeal walls and reducing UA collapsibility [33]. The mandibular advancement also repositions the hyoid bone and tongue [32], enhancing airway patency by decreasing the risk of airway collapse.

In addition to direct anatomical changes, muscle activation and neuromuscular coordination are also central to the mechanism of action of OAT. By advancing the mandible, the device optimizes the length, orientation and tone of muscle fibers such as genioglossus and geniohyoid, thereby reducing the effort required to maintain airway patency during sleep [31]. This leads to decreased activity of the genioglossus and other peri-pharyngeal muscles, which in turn lowers the critical UA closing pressure and enhances airflow dynamics [5,34]. Furthermore, prolonged forward positioning induces adaptive changes in the muscle-tendon units and ligaments, promoting long-term stability and resistance to airway collapse through tissue remodeling [30].

Beyond beneficial anatomical and neuromuscular effects, concerns have been raised regarding potential side effects of MADs on the temporomandibular system. However, systematic evidence indicates that MADs do not exacerbate temporomandibular disorder (TMD) symptoms, and preexisting TMD should not be considered a routine contraindication to OAT, particularly when careful and individualized titration strategies are applied [35].

Moreover, OAT has been shown to modulate not only respiratory events but also sleep bruxism intensity [36]. This observation further supports the concept of a close functional interaction between respiratory drive, mandibular motor activities, and upper airway stability during sleep, suggesting that OAT acts on an integrated physiological system rather than on isolated anatomical structures.

Based on these mechanisms, we recognize that each measurement technique has distinct application value, depending on the targeted elements – whether anatomical, mechanical or physiological. Furthermore, an ideal and clinically meaningful evaluation method must assess the dynamic, integrated effects of OAT within the interactions among various elements, rather than being confined to a single element.

3.2. OAT workflow and potential measurements

An OAT protocol can be initiated through two distinct pathways [6]. In the most common scenario, a patient with a confirmed OSA diagnosis is referred by a respirologist or sleep physician to a QD for OAT as a first-line treatment option or following failure or refusal of PAP therapy. In the second pathway, the patient initially consults with a QD through a screening consultation. This involves assessing the patient's primary complaints, utilizing validated questionnaires, and performing a clinical examination to evaluate oral and UA risk factors. These assessments include evaluating the maxillomandibular relationship, tongue size, posterior pharyngeal crowding, UA morphometry, and collapsibility. However, it is important to note that screening tools cannot replace a diagnostic sleep apnea test. Depending on the circumstances and in compliance with applicable regulations, the QD may prescribe a home sleep apnea test (HSAT) using a reliable method, ranging from level 2 to 4 devices (e.g. pulse oximetry, respiratory PG, or wearable sleep testing devices) [2]. Alternatively, the patient may be referred to a sleep laboratory for standard PSG.

In both cases, prior to initiating OAT, it is recommended to conduct a comprehensive dental sleep medicine (DSM) examination for determining the suitability for OAT and selecting the appropriate appliance [2]. QDs are responsible for evaluating the patient's oral health, focusing on dentition stability, jaw alignment, temporo-mandibular joint (TMJ) function, and other relevant factors to confirm OAT suitability. Selecting the appropriate MAD involves considering craniofacial structures, specific anatomical and functional requirements necessary to maintain UA patency during sleep [34]. Before treatment initiation, consensus should be reached among the QD, patient and sleep physician regarding the treatment plan and measures of success [2,34]. In practice, mandibular positioning is exploratory with initial levels ranging from 25–75% [2]. At this stage, a key concern is determining the optimal initial mandibular position (IMP) to balance the time required to achieve an effective advancement level and side effects. It is generally accepted that the optimal therapeutic position is within the range of 50%-80%, but highly dependent on the individual characteristics and OSA severity [37].

Following the MAD insertion, the patient enters the titration process. Within 30 days and at regular intervals as needed, the patient's clinical status is reevaluated using the same methods as during the initial examination. The MAD can be advanced in increments of 0.25 to 1 mm upon persistence or worsening of OSA symptoms, until the targeted therapeutic position is achieved [2]. However, combining symptomatic data with objective measurements might lead to better clinical outcomes [38].

In both research and clinical practice, the definition of treatment success for OAT in OSA remains heterogeneous, as no standardized post-treatment AHI threshold has been well established. Instead, the practitioners have adopted several criteria which are driven by pragmatic clinical consensus. Commonly applied criteria include: (i) a complete response or resolution defined as a residual AHI <5 events·h^{-1}, reflecting a normalization of OSA; (ii) optimal relative response, typically defined as a ≥ 50% reduction in AHI from baseline, acknowledging clinically meaningful improvement despite residual OSA; (iii) a combined criterion, which is the most widely adopted, requiring both ≥50% reduction in AHI and achievement of a post-treatment AHI below a pre-defined absolute threshold (typically <5 or <10 events·h^{-1}) [39].

For long-term management, regular follow-up is essential to reinforce adherence, maintain effectiveness, and ensure ongoing treatment success. Patients are typically reevaluated

Table 1. Summary of the reviewed articles.

Author	Year	Sample size	Measurement technique	Monitoring points	Anatomy/ Geometry	Mechanical	Physiological	Static	Dynamic	Reference
Remmers JE et al	2017	131→48	Feedback-controlled mandibular positioner	Intermittent, 2 points	N	N	Y	N	Y	[40]
Sutherland K et al	2017	40	Feedback-controlled mandibular positioner	Intermittent, 2 points	N	N	Y	N	Y	[41]
Gjerde K et al	2018	80	Intra-oral sensor	Continuous (HSAT)	N	N	N	N	N	[42]
Sutherland K et al (A)	2018	80	Awake nasopharyngoscopy	Single point	Y	Y	N	Y	Y (awake)	[88]
Sutherland K et al (B)	2018	142	Nasopharyngoscopy	Intermittent, 2 points	Y	Y	Y	Y	N	[43]
Martinot JB et al	2018	56	MJM analysis (manual)	Intermittent, 2 points	N	N	Y	N	Y	[17]
Chen H et al	2019	64	CBCT scan, spirometry	Intermittent, 2 points	Y	N	N	Y	N	[44]
Op de Beeck S et al	2019	100	DISE	Intermittent, 2 points	Y	Y	N	N	Y	[11]
Marques M et al	2019	25	Nat sleep endoscopy, Pcrit (separated)	Single point	Y	Y	Y	Y	Y	[45]
de Vries GE et al	2019	40	Intra-oral sensor	Continuous, tele	N	N	N	N	N	[46]
Bamagoos A et al (A)	2019	12	Pcrit, genioglossus EMG, PEP	Intermittent, 2 points	N	Y	Y	N	Y	[5]
Bamagoos A et al (B)	2019	93	PSG endotypes	Intermittent, 2 points	N	N	Y	N	Y	[13]
Metz E et al	2019	101	HRPO	Intermittent, 3 points	N	N	Y	N	Y	[47]
Mostafiz WR et al	2019	33	CBCT scan	Single point	Y	N	N	Y	N	[48]
Song BL et al	2019	8	Functional CT, CFD	Intermittent, 2 points	Y	Y	Y	Y	Y (awake)	[49]
Opsahl UL et al	2020	120	Acoustic pharyngometry	Intermittent, 2 points	Y	N	N	Y	N	[50]
Van de Perck E et al	2020	100→65	Awake nasopharyngoscopy	Single point	Y	Y	N	Y	Y (awake)	[51]
Tong BK et al	2020	39	Awake nasal resistance	Intermittent, 2 points	N	Y	Y	Y	N	[14]
Martínez A et al	2020	6	MDCT, CFD	Single point	Y	Y	Y	Y	Y (sim)	[52]
Lu RJ et al	2020	30	CBCT scan	Intermittent, 2 points	Y	N	N	Y	N	[53]
Ma Y et al	2020	42→22	MRI, rhinospirometry, rhinomanometry	Intermittent, 3 points	Y	Y	Y	Y	N	[54]
Marco-Pitarch R et al	2020	41	CBCT scan	Intermittent, 2 points	Y	N	N	Y	N	[30]
Ishiyama H et al	2021	27	Cephalometric radiograph, IOS	Single point	Y	Y	Y	Y	N	[56]
Park JW et al	2021	48	Hypoxic burden (oximetry)	Intermittent, 2 points	N	N	Y	N	Y	[57]
Stern J et al	2021	28	Intra-oral sensor	Intermittent, 2 points	N	N	N	N	N	[58]
Sutherland K et al	2021	58	Intra-oral sensor	Continuous (HSAT)	N	N	N	N	Y	[30]
Xu L et al	2021	89→43	Intra-oral sensor	Continuous (HSAT)	N	N	N	N	N	[60]
Camañes-Gonzalvo S et al	2021	45	CBCT scan	Intermittent, 2 points	Y	N	N	Y	N	[61]
Op de Beeck S et al	2021	72	PSG endotypes	Intermittent, 2 points	N	N	Y	N	Y	[62]
Suga H et al	2021	15	CT scan, CFD	Intermittent, 2 points	Y	Y	N	Y	Y	[63]
Antonaglia C et al	2022	32	PSG endotypes	Intermittent, 3 points	N	N	Y	N	Y	[64]
Gjerde K et al	2022	77	Intra-oral sensor	Continuous (HSAT)	N	N	N	N	N	[65]
Gogou E et al	2022	50	DISE	Single point	N	Y	Y	Y	N	[30]
Kazemeini E et al	2022	10→7	DISE	Continuous, 4 points	Y	N	Y	Y	N	[30]
Kwon JS et al	2022	40	Intra-oral sensor	Continuous, tele	N	N	N	N	N	[30]
Van Gaver H et al	2022	71	CT scan, CFD	Intermittent, 2 points	Y	Y	Y	Y	Y (sim)	[30]
Vena D et al	2022	61	PSG derived surrogates	Intermittent, 2 points	Y	Y	Y	N	Y	[69]
Ferraz PD et al	2022	60	Teleradiography	Intermittent, 2 points	Y	N	N	Y	N	[70]
Ishida E et al	2022	15	Cephalometric radiograph	Intermittent, 2 points	Y	N	N	Y	N	[71]
Jugé L et al	2022	71	MRI	Intermittent, 2 points	Y	Y	N	Y	N	[72]
Mosca EV et al	2022	61	Mandibular repositioning during sleep	Intermittent, 2 points	N	Y	Y	N	Y	[30]
Venema J et al	2023	85→50	Orofacial examination	Single point	Y	Y	N	Y	N	[30]

(*Continued*)

Table 1. (Continued).

Author	Year	Sample size	Measurement technique	Monitoring points	Anatomy/ Geometry	Mechanical	Physiological	Static	Dynamic	Reference
Chand P et al	2023	29	CT scan	Intermittent, 2 points	Y	Y	N	Y	N	[30]
Ma Y et al	2023	29	MRI, CT	Continuous, multiple	Y	N	N	Y	N	[30]
Gurgel M et al	2023	17	CBCT scan	Intermittent, 2 points	Y	Y	N	Y	Y (awake)	[77]
Shi X et al	2023	31	CBCT scan	Intermittent, 2 points	Y	N	N	Y	N	[30]
Venza N et al	2023	22	CBCT scan	Intermittent, 2 points	Y	N	N	Y	N	[28]
Van den Bossche K et al	2023	56	DISE	Intermittent, 3 points	Y	Y	N	Y	N	[30]
Attia AAMM et al	2024	39	MRI	Intermittent, 2 points	Y	N	N	Y	N	[30]
Fernández-Sanjuán P et al	2024	104	DISE, VOTE scale	Single point	Y	Y	N	Y	N	[81]
Navarro RE et al	2024	46	Cephalometric radiograph	Single point	Y	N	N	Y	N	[9]
Pépin JL et al	2024	135→93	MJM analysis (automated)	Continuous (2 in-lab /4 HSAT)	N	N	Y	N	Y	[30]
Papenfuß GS et al	2024	20	HSAT	Continuous, 3 points	N	N	Y	N	Y	[82]
Özköylü G et al	2024	25	CBCT scan	Intermittent, 2 points	Y	Y	N	Y	N	[83]
Gogou ES et al	2024	59	DISE	Single point	Y	Y	N	N	Y	[84]
Pépin JL et al	2025	93	MJM analysis (automated)	Continuous, 4 points	N	N	Y	N	Y	[19]

Sample size: number of patients (n1→n2) corresponding to the sample at baseline and at protocol completion.
Measurement techniques: CBCT for cone-beam computed tomography; DISE for drug-induced sleep endoscopy; HRPO for high resolution pulse oximetry; IOS for impulse oscillometry; ldCT for low-dose computed tomography scan; MJM for mandibular jaw movements; MDCT for multidetector helicoidal computed tomography; Pcrit for upper airway critical pressure.
Monitoring points: type of monitoring (single point, intermittent/continuous) with number of evaluation points.
Anatomy/Geometry: specifies whether the technique provides measurement of anatomical/geometrical features.
Mechanical: specifies whether the technique provides measurement of mechanical features of airflow.
Physiological: specifies whether the technique provides measurement of physiological functions.
Static: specifies whether the technique provides a static measurement.
Dynamic: specifies whether the technique provides a dynamic assessment (sim means generated by simulation).

every six months during the first year and annually thereafter to monitor treatment efficacy, adherence, structural integrity, and side effects [2]. Therefore, the subsequent stages of the OAT protocol require the use of monitoring techniques which can provide clinically relevant data, while also allowing for repeated measures over time.

Although conclusive evidence of effectiveness has yet to be established, the concepts of identifying responders or predicting treatment success may be implemented at this stage. Such procedure relies on anatomical and physiological parameters derived from various measurement techniques.

4. A structured overview of measurement techniques

Out of 211 records initially identified, 191 studies were screened and evaluated in full-text for eligibility. Ultimately, 56 studies were included for literature review. Relevant information addressing the review's objective was extracted and summarized in Table 1.

Through the literature synthesis, we have identified a wide range of measurement techniques that have been employed across various stages during OAT protocols [5,8,9,11–14,17–19,28,40–84]. These techniques exhibit a considerable diversity in technical mechanisms while being specialized in their functionalities and the parameters investigated. A summary of the reviewed studies and techniques is presented in Table 1, with comprehensive details provided in the Annex.

Within the scope of this review, we concentrated on analyzing several principal techniques, including imaging, nasopharyngoscopy, and sleep apnea testing with a focus on MJM analysis. A detailed description of the operating mechanisms, implementation process, measured parameters, and a synthesis of relevant findings for each technique are provided in the Annex (Section II).

For a structured and hierarchical overview, the measurement methods can be categorized into three groups, each representing an ascending level of clinical utility and comprising methods with similar technical features and clinical significance. Figure 2 provides a schematic overview of how those three groups of monitoring techniques could be applied across the different stages of the OAT workflow.

Group 1 comprises various imaging modalities, such as cephalometric radiography [9,56,70,71], computed tomography (CT) [75], cone-beam CT (CBCT) [17,28,48,53,55,61,77,78,83] and magnetic resonance imaging (MRI) [54,72,75,80]. These techniques are primarily intended to quantify changes in UA dimensions induced by OAT. Each modality has its own advantages in terms of resolution, soft tissue contrast or ability in 3D reconstruction.

Although these imaging-based measurements have improved our understanding of the anatomical mechanisms by which OAT enhances UA patency in OSA, their overall clinical relevance remains limited.

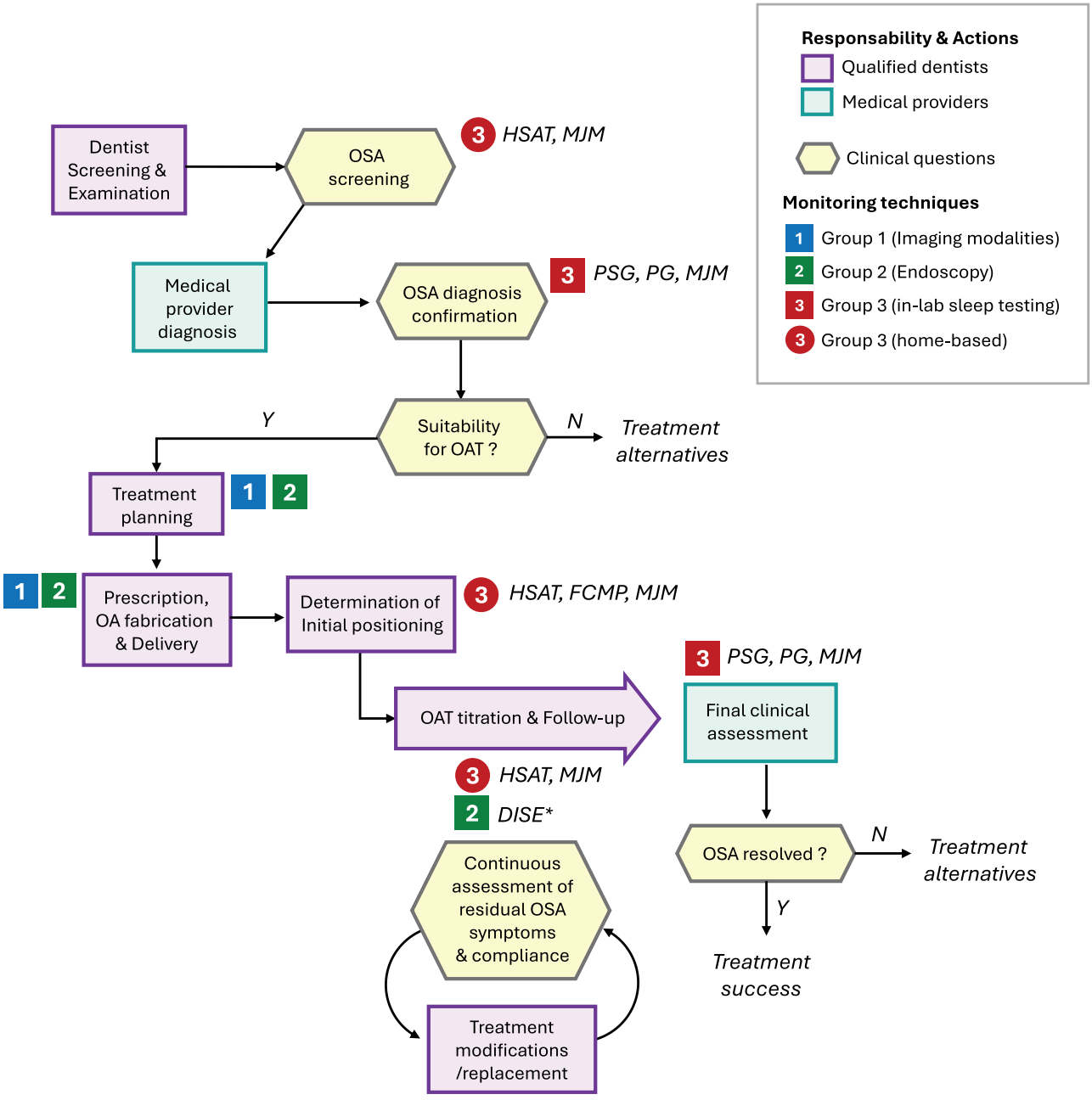

Figure 2. Positioning of the three groups of monitoring techniques across the different stages of the OAT workflow. HSAT: home sleep apnea testing, OA: oral appliance, OAT: oral appliance therapy, PSG: polysomnography, PG: polygraphy, FCMP: feedback-controlled mandibular positioner, MJM: mandibular jaw movement analysis, DISE: drug-induced sleep endoscopy, *: selective use.

Despite being a standard and cost-effective imaging modality in dentistry, cephalometric radiography shows limited utility at the screening stage due to its poor discriminatory performance. Indeed, case-control analyses have reported no significant differences in lateral cephalometric indices between habitual snorers and non-snoring individuals [85].

MRI-based research has consistently demonstrated that mandibular advancement results in notable UA expansion, particularly in the oropharyngeal region, with the magnitude of expansion correlating with the degree of mandibular protrusion, suggesting a dose-dependent effect [72,75]. Similarly, multiple studies using CT and CBCT have reported increases in UA volume, cross-sectional area, and diameter after OAT [28,53,55,61,75,77], usually accompanied by improvements in the AHI and oxygen saturation levels [53,61]. Nevertheless, not all findings are concordant, as several studies failed to identify significant differences in UA morphology between responders and non-responders to OAT [44,78], and one study reported no statistically significant association between anatomical airway changes and AHI reduction [55].

Beyond these inconsistencies, CBCT-derived volumetric and cross-sectional airway measurements are sensitive to post-processing workflow. Heterogeneity in segmentation software and thresholding method can lead to systematically different results, even under standardized acquisition protocol [86].

The variability in treatment response across individuals further complicates the interpretation [76]. Baseline craniofacial phenotype and sex represent a potential source of inter-individual variability [87,88]. Patients with lower or average mandibular plane angles appear to experience more favorable UA enlargement and achieve better AHI reduction, while those with a higher mandibular plane angle would require greater mandibular protrusion to achieve a satisfactory response [76]. The hyoid-mandibular plane distance may also be clinically informative by reflecting sex-specific associations with OSA severity [88], though this metric may not necessarily correlate with airway volume [87]. Airway constriction due to maxillofacial disproportions, rather than solely soft tissue obstruction, may also predict better treatment outcomes [48].

Longitudinal radiographic studies further indicate that although OAT induces beneficial airway expansion, prolonged use is associated with mild but progressive dental and alveolar bone remodeling. However, these skeletal changes were considered clinically negligible [71].

In summary, the reviewed studies have predominantly focused on evaluating the direct anatomical effect of oral appliances and were restricted to the initiation phase. Furthermore, these techniques are limited to static measurements taken during wakefulness and therefore fail to capture dynamic UA behaviors during sleep or to establish connections between anatomical and neuromuscular factors. Most studies attempted to establish a correlation between anatomical metrics and treatment success, without proving the benefit of those techniques, such as determining whether the oral appliance titration time could be reduced. No study showed that imaging examinations could help identify the appropriate therapeutic position.

Group 2 encompasses a diverse array of techniques integrating anatomical and physiological measurements. These include the computational fluid dynamics (CFD) simulations [8,12,15,52,63], awake nasopharyngoscopy [8,51] and drug-induced sleep endoscopy (DISE) [11,66,67,79,81,84], as well as measurements of UA critical pressure – defined as the intraluminal pressure at which the UA (e.g. velopharynx or oropharynx) collapses during sleep – resulting in flow limitation or complete cessation of airflow [13,45,69].

The CFD technique overcomes limitations of static imaging by creating virtual models of the UA based on imaging data, then performing numerical simulations of the airflow dynamics through this reconstructed geometry. Such approach allows to quantify both anatomical and aerodynamic parameters. Across the reviewed studies, the consistent finding is that OAT significantly improves the total UA volume, often with specific emphasis on the velopharyngeal or palatopharyngeal region [12,49]. Other insights gained from CFD studies include modifications in airflow velocity [52] and pressure drop within the UA [49,63] under OAT. However, Gaver et al. emphasized that improvement in total UA volume expansion is instrumental, but this factor alone may not entirely predict the clinical success of OAT [12]. Some patients demonstrated increased velopharyngeal volume yet showed limited improvement in AHI, suggesting that in addition to volume expansion, other physiological factors such as tissue compliance, muscle tone, or neuromuscular reflexes may modulate OAT efficacy.

Data from studies using awake nasopharyngoscopy, natural sleep endoscopy, and DISE converge on several key points. Anatomical features such as soft palate, or tongue base position, and pharyngeal crowding have emerged as potential predictors of OAT success or deterioration [11,13,51]. Certain collapse patterns observed during DISE may be indicative of different treatment responses.

While fixed protrusion levels (70–75% of maximal comfortable advancement) are frequently used in clinical practice, emerging evidence underscores the non-uniform nature of the dose-response effect on pharyngeal collapsibility among different patient subgroups. The study by Bamagoos et al. (2019) demonstrated that mandibular advancement can improve pharyngeal collapsibility in a dose-responsive manner, though this improvement pattern differed notably between MAD responders and non-responders [13]. Another study showed that patients with posteriorly located tongues and less severe collapsibility gained more significant reductions in AHI [45]. Some studies also revealed residual collapses at different levels of the airway, even after achieving maximal mandibular protrusion [81]. Such heterogeneity in clinical response suggests that combined interventions and/or more sophisticated titration approaches should be considered for specific anatomical subtypes. Recent development of quantitative scoring and phenotyping methods has shown promise in providing objective measurement of airway collapsibility and better predictive ability [8,79].

Overall, these findings underscore that baseline anatomical positioning and collapsibility greatly influence therapeutic success. However, DISE-guided titration has shown no clear advantage in comparison with subjective or PSG-based approaches [67].

Instead of capturing only anatomical aspects, Group 2 offers a significant enhancement in physiological relevance and extended capability to conduct more specialized and complex investigations. These include a real-time assessment of UA function during sleep, a direct observation of UA collapse and obstruction, as well as localized access to specific muscles. These approaches provide more insights into physiological mechanisms like muscular function and mechanical ventilation. However, it remains uncertain whether observations from nasopharyngoscopy can be translated into physiological outcomes measured by PSG or HSAT. The complexity and invasiveness of DISE limit its applicability in routine practice.

Group 3 represents the highest level of clinical significance, encompassing techniques that enable the assessment of the true efficacy of OAT on the clinical manifestations of OSA. This group comprises standard PSG [13,62,69], HSAT with PG [40,56,58] or any alternative methods [12,18,19,47,82] that allow for dynamic monitoring of sleep quality, oxygen desaturation and sleep-disordered breathing (SDB) events.

Only the measurements within this group provide practical and effective solutions to the clinical challenges in OAT, including initial mandibular positioning [2,10,15], predicting responsiveness [5,11], and long-term follow-up [18,19,82].

PSG remains the standard method for diagnosing OSA, classifying its severity, and guiding therapeutic decisions

[1,89]. At the conclusion of the MAD titration process, the PSG also served as the benchmark tool for objectively assessing treatment outcomes. Beyond its conventional role, PSG provides a comprehensive range of physiological parameters for an in-depth assessment of clinical outcomes. Non-pharyngeal endotypic features derived from PSG such as loop gain, arousal threshold, ventilatory response to arousal [13,62] or hypoxic burden [51] can independently or mutually contribute to OSA pathogenesis at varying degrees. These markers have shown potential for guiding personalized titration of oral

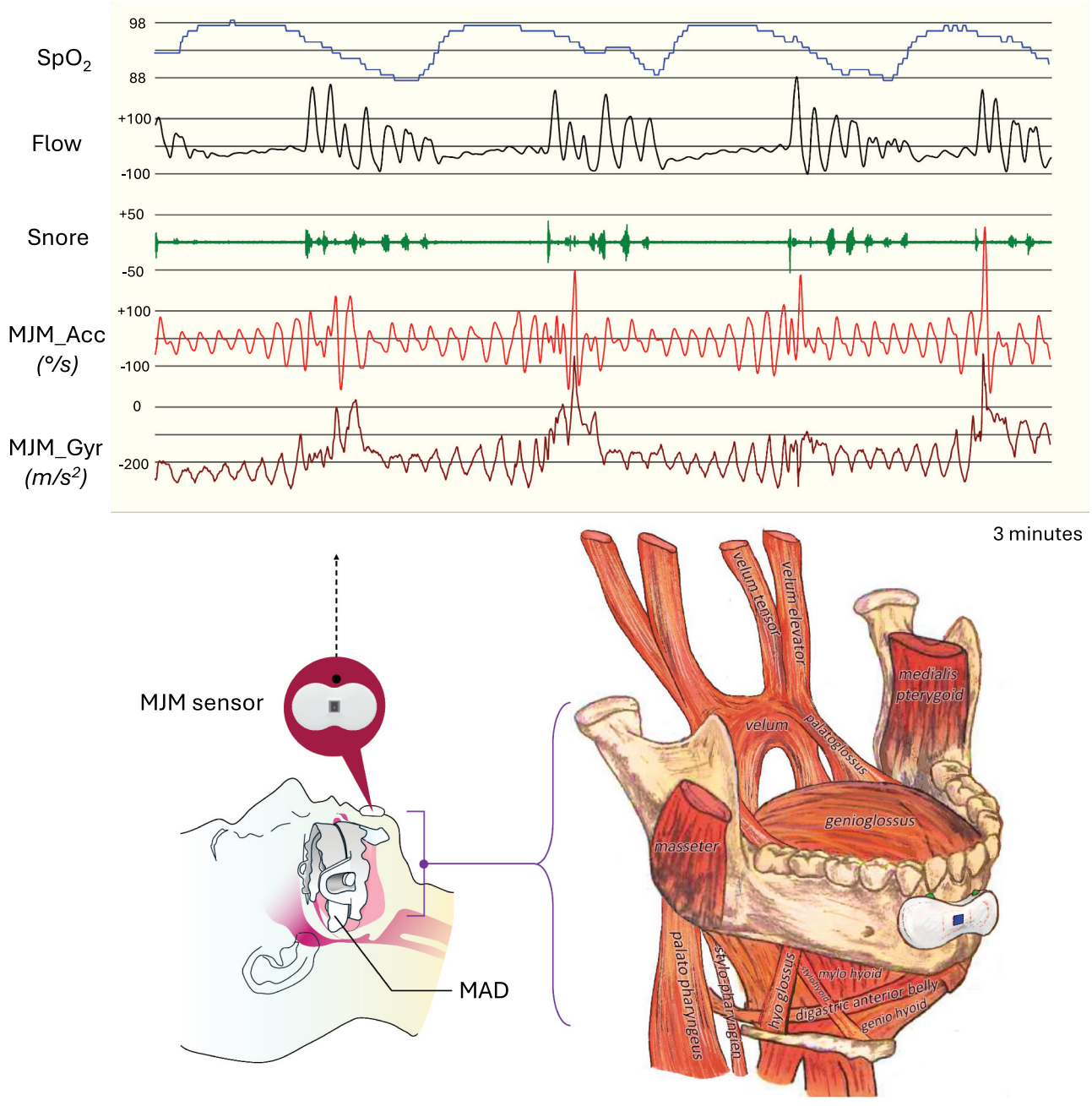

Figure 3. MJM signal recording and its anatomical aspects. Upper: A 3-minute fragment of the SpO_2, snore, thermal flow, and MJM signals recorded by the Sunrise technology (Sunrise, Namur, Belgium), showing episodes of apneas/hypopneas accompanied by desaturations, during which the trigeminal drive increases (as evidenced by an increase in the rotational speed of the mandible(MJM_Gyr)), and the accelerometric position of the mandibular jaw (MJM_Acc) changes (the mouth opens) until an arousal occurs, leading to mouth closure and a peak in airflow.

Lower/Left: The integrated sensor unit affixed to the chin.

Lower/Right: In humans, the pharyngeal airway is surrounded by soft, highly compliant tissues, requiring active forces from pharyngeal dilator muscles to maintain openness during breathing. During wakefulness, reflex activation of these muscles prevents pharyngeal collapse, a process disrupted in sleep, resulting in obstructive sleep apnea (OSA) due to reduced dilator muscle tone. Four key muscles originating from the jaw – genioglossus, geniohyoid, mylohyoid, and the anterior belly of the digastric – insert onto the hyoid bone. These muscles contribute significantly to maintaining pharyngeal stability during sleep by exerting a leveraging effect on the pharyngeal tissues. Their activation is associated with neural drive to the jaw musculature, as confirmed through electromyography (EMG) studies, which show these muscles' impact on airway patency. Jaw positioning influences the effect of these muscles on the pharyngeal airway. For example, closing the jaw with muscles like the masseter, which exerts tension on these dilator muscles, stabilizes or expands the pharyngeal airway. However, if the jaw opens excessively due to activation of the chin depressor muscles, it might move the jaw downward rather than stabilize the airway.

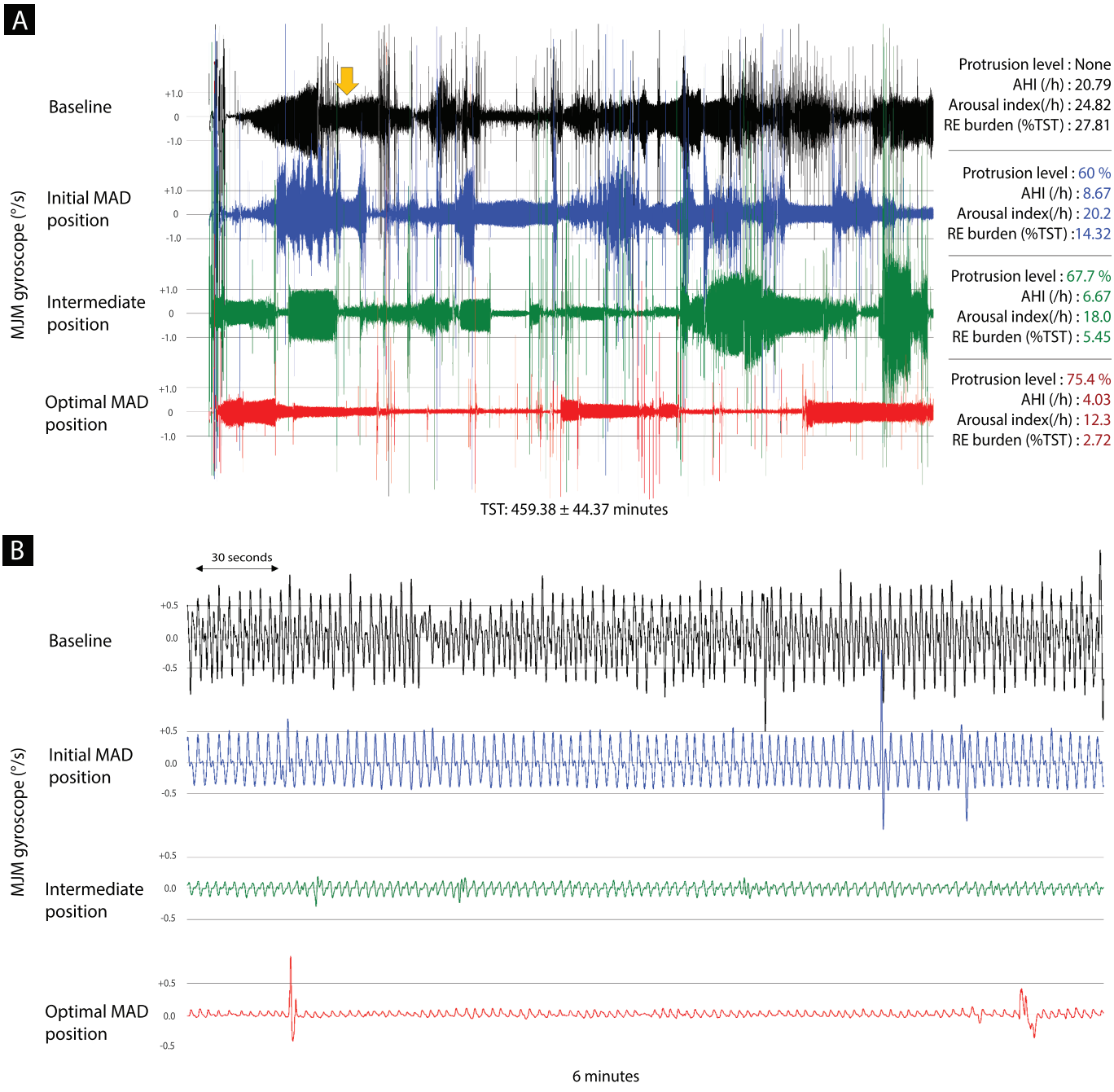

Figure 4. Impact of MAD protrusion on MJM signal patterns and clinical outcomes. A) Overnight trends of MJM signals acquired from the same patient across four levels of MAD protrusion. From top to bottom: baseline (without MAD), initial MAD position (60% maximal protrusive range (MPR)), intermediate MAD position (67.7% MPR), and final MAD position (75.4% MPR). These positions highlight the temporal relationship between mandibular displacements, derived from the mandibular rotational speed recorded by the gyroscope, and the scored events, including residual respiratory disturbances, arousals, and awakenings. Additionally, periods of persistent respiratory effort, such as respiratory effort-related arousals (RERAs), are marked by a sustained increase in respiratory drive, as evidenced by MJM signals. A progressive improvement in AHI, arousal index, and respiratory effort burden was observed. The titration was guided by self-reported OSA symptoms and patient comfort. B) A 6-minute fragment of the MJM signal captured at the basal level of respiration during sleep (located by the yellow arrow in A), showing a significant reduction in MJM amplitude as the MAD protrusion level increased.

appliances and for predicting responsiveness to OAT [13,62]. However, the high cost and complexity of PSG limit its accessibility and practicality for continuous monitoring or guiding oral appliance titration. HSAT with PG also has drawbacks, including the missing or altered sleep data, underestimation of OSA severity due to overestimated sleep time, and limited reliability in patients with sleep disorders or cardiovascular comorbidities.

While evidence-based evaluation has not yet been conducted, the American Academy of Dental Sleep Medicine (AADSM) task force acknowledges the emerging trend of new technologies and highlights their potential for applications in OAT [15]. Among the most prominent technologies is the concept of integrating various biosensors and/or a feedback-control mechanism into the MAD to provide both therapeutic and telemonitoring features [90]. While appealing, miniaturizing and

Table 2. Summary of key studies on MJM-based analysis applied to OAT.

Information	Martinot et al. 2018 [17]	Pépin et al. 2024 [18]	Pépin et al. 2025 [19]
Study design	Prospective cohort	Prospective cohort	Prospective cohort
Sample size	n = 56	n = 135 (105 completed follow-up)	n = 93
Targeted study question	Mandibular movement analysis for assessing OAT clinical response	Agreement of MJM analysis with PSG and PG for AHI measurement; efficacy for OAT response evaluation	Dose-response effect on AHI and respiratory effort (RE) burden
Primary outcome(s)	Respiratory event index	AHI	AHI and respiratory effort (RE) burden
Oral appliance type & titration	Herbst appliance; 1 mm incremental advancement; 16 weeks	Bi-bloc custom-made MAD; 60% MPR initial position; 1–2 mm incremental advancement; 4–6 months	Bi-bloc custom-made MAD; 60% MPR initial position; 1–2 mm incremental advancement; 4–6 months
Clinical settings	In-lab (baseline), HSAT (post)	In-lab & HSAT	HSAT
Monitoring schedule	Pre/post single evaluations: Baseline (in-lab PSG); endpoint (HSAT with PG +MJM)	Multiple testing: Pre-treatment (1 in-lab PSG+MJM, 1 HSAT by MJM); end of titration (1 in-lab PG+MJM, 1 HSAT by MJM)	Continuous: 4 HSATs by MJM at 4 protrusion levels
Reference method	PSG & PG	PSG & PG	N/A
Sensor technology	Magnetometry	Inertial sensors	Inertial sensors
Interpretation	Manual (blinded), based on specific signal patterns	Automated (blinded)	Automated (blinded)
Overall quality (NIH criteria)*	Low to moderate risk of bias	Low risk of bias	Low risk of bias
Key findings	MJM provides comprehensive evaluation of clinical response to OAT; consistent OAT effects on respiratory event-related indices	MJM analysis demonstrates strong agreement with PSG and PG for AHI measurement; consistent AHI improvement across different settings	Dose-response relationship between oral appliance protrusion level and improvements in RE burden and AHI

AHI: Apnea-Hypopnea Index; HSAT: Home Sleep Apnea Test; MAD: Mandibular Advancement Device; MPR: Maximal Protrusion Range; PG: Polygraphy; PSG: Polysomnography; ODI: Oxygen Desaturation Index. (*): The results and rationale of the quality assessment are detailed in Table S3 (Annex).

incorporating multiple sensors within the constrained space and fixed OA structure pose significant technical challenges and potentially compromise the flexibility and robustness of OAs. Currently, only two applications – adherence monitoring by intra-oral thermosensor [46,58,60,65,68] and initial mandibular positioning using feedback-controlled mandibular positioner (FCMP) [40,41,73] – are supported by evidence from clinical validations. Most other concepts remain in the research and development phase [90].

5. MJM analysis as a promising monitoring tool in OAT

Among the alternative technologies within Group 3, MJM analysis has emerged as a promising tool for monitoring OAT efficacy in OSA patients. MJM represents a distinct physiological signal that captures the dynamic interplay among mandibular motion, UA muscle activity, and respiratory drive. Respiratory MJM, although subtle in amplitude, plays a crucial role in maintaining pharyngeal stability during sleep. Functioning as an instrumental mobile structure, the mandible fine-tunes the oropharyngeal structures by recruiting pharyngeal and genioglossus muscles, thereby maintaining UA patency and reducing airway collapsibility (Figure 3). Additionally, the mandibular jaw acts as a sensitive instrument, synchronizing with respiratory movements under the regulation of respiratory centers. Variations in MJM amplitude and frequency reflect subtle changes in the tempo and rhythm of neural activities across different sleep stages and episodes of respiratory disturbance. As a peripheral signal, MJM provides insights into central respiratory drive and UA muscle dynamics, functioning like an internal brainstem sensor.

Initially studied in dentistry since 1990s, the MJM signal was used to assess anatomical and motor functions during sleep [91]. Over the following decades, clinical relevance of MJM has been established through extensive research [16]. Key milestones include the significant correlation between MJM patterns and SDB events [92], the causal relationship between mandibular motion and UA ventilation regulation during sleep [93], the strong association between MJM and sleep respiratory effort (RE) [94], and validation of MJM analysis as an alternative to PSG for diagnosing OSA [95,96].

Since 2012, the MJM signal has been incorporated into PSG as a surrogate respiratory measure for OSA diagnosis and therapeutic assessment [97]. Initially, the magnetometric technology (Nomics, Liège, Belgium) was employed to capture mandible position and vertical displacement via paired resonant circuits placed on the forehead and chin [92,97]. In 2019, a more advanced technology was introduced: a system integrating a tri-axial accelerometer and gyroscope into a single-point contact sensor (Sunrise, Namur, Belgium), allowing a comprehensive analysis of mandibular motion, encompassing its acceleration and rotational speed. Supported by machine-learning-based automated analysis, the system provides a full range of conventional clinical metrics, including TST, sleep stage proportions, AHI and arousal index.

In addition to these advantages, MJM-based monitoring exhibits other benefits, including a straightforward interpretation and the preservation of signal validity in the presence of cardiovascular comorbidities [16]. The primary drawbacks of this approach are that it does not provide morphometric and anatomical information, and that research data on neuromuscular pathological conditions affecting the mandibular muscles remain limited.

At present, MJM analysis using this inertial sensor technology (Sunrise, Namur, Belgium) is recommended by the National Institute for Health and Care Excellence (NICE, UK) as a cost-effective HSAT option for diagnosing and assessing OSA severity in individuals aged 16 years and older [98].

Several studies have explored the benefits of MJM for assessing OAT efficacy in real-world clinical settings [17–19]. A study by Martinot et al. first utilized the MJM technology alongside PSG to assess OAT outcomes in 56 patients, introducing specific MJM-derived patterns linked to RE and a surrogate respiratory event index comparable to PSG-based AHI. This approach also offers clinical insights beyond PSG-based metrics, validating OAT efficacy and laying the foundation for AI-supported MJM analysis [17].

In 2024, Pépin et al. conducted a prospective study on 135 patients [18], employing advanced technology featuring integrated inertial sensors and AI-supported analysis. MJM monitoring showed a high level of agreement with PSG/PG for AHI measurement. Study data also demonstrated high reliability of MJM monitoring in unsupervised settings, with no technical failures recorded, consistent improvements in AHI in both sleep lab and home conditions, and high patient compliance. Figure 4 illustrates how MJM signals capture the improvement in RE following OAT. A subsequent analysis [19] further revealed a dose-dependent response in both AHI and RE burden with increasing MAD protrusion, highlighting MJM's utility in continuous monitoring at home.

Key details of these studies [17–19], including methodology, technical aspects and overall quality assessment, are summarized in Table 2.

From a clinical perspective, MJM analysis provides physiological indices that are functionally equivalent to those obtained from conventional PSG, including the residual AHI which is the key therapeutic target. As such, MJM-derived post-treatment AHI can be interpreted using the same criteria commonly applied in PSG-guided clinical practice. However, the heterogeneity in AHI thresholds emphasizes the need to interpret OAT efficacy within a broader clinical context, integrating residual AHI, symptom improvement, and patient-centered outcomes.

Beyond AHI, the MJM analysis also enables quantification of respiratory effort burden (REMOV), a pathologically meaningful parameter that captures the cumulative impact of residual upper airway instability under OAT and responds to mandibular advancement in a dose-dependent manner [19]. A preliminary threshold for treatment success, defined as a residual REMOV <14%TST, has been proposed, suggesting potential utility as a supplemental outcome to refine therapeutic assessment [19]. While promising, this cutoff requires further validation for routine clinical adoption.

While the body of research continues to grow, the convergence of findings from current studies provides robust evidence supporting MJM analysis as a reliable and clinically effective alternative to PSG/PG for monitoring OAT outcomes. Importantly, MJM analysis offers a distinct advantage over standard PSG by enabling repeated, unsupervised home-based assessments, which aligns closely with current recommendations emphasizing the need for continuous monitoring during OAT. This capability supports earlier identification of treatment success or failure and facilitates timely adjustment of MADs. Nevertheless, the current evidence base needs to be expanded to define validated MJM-AHI or REMOV change thresholds for titration guidance. Establishing such decision thresholds and demonstrating the cost-effectiveness of MJM-guided workflows compared with PSG-centered pathways represent a clear priority for future research.

Looking ahead, a more comprehensive research pathway on the extended applications of MJM analysis in OAT is anticipated, exploring its role in initial MAD positioning and titration guidance, ultimately promoting a broader integration of MJM technology in dental sleep medicine.

6. Limitations and mitigation measures

This review has several limitations that should be acknowledged. First, as a narrative review, it does not follow a systematic or quantitative synthesis and is therefore inherently exposed to risks of selection bias and subjective interpretation. The literature search was non-exhaustive and restricted to the most recent publications, which may have led to the omission of older relevant data. Second, the available literature is unevenly distributed across techniques, with limited high-quality evidence for several emerging technologies, and heterogeneity in monitoring protocols, which restricts a direct comparability among those techniques. Finally, interpretation of findings may be influenced by differences between experimental and real-world clinical settings.

To mitigate these potential risks, several methodological measures were implemented. The review was guided by clearly defined clinical questions, broad inclusion criteria, structured taxonomy and a transparent, predefined screening strategy across multiple databases. Literature analysis and synthesis were performed independently by multiple reviewers, integrating both clinical- and technical-oriented approaches to reduce individual interpretative bias. Rather than prioritizing positive findings, techniques were critically appraised with explicit discussion of their strengths, limitations, and clinical applicability within the OAT workflow. A detailed analysis of the strengths, weaknesses, and potential applications of all techniques including MJM analysis is presented in Table S3 (Annex).

Together, these measures aimed to ensure a balanced, structured and clinically meaningful overview that supports both clinical decision-making and future research directions.

7. Conclusion

In this review, we provide a structured overview of potential measurement techniques applicable to a standard OAT protocol and emphasize the need for objective and continuous monitoring techniques with high clinical relevance. The

central message is that monitoring methods for OAT should be considered by their physiological relevance – aligning with the integrated mechanisms of action of MADs, feasibility for repeated use, and ability to provide actionable information across the entire care pathway – from screening and titration to long-term follow-up.

Our review has also facilitated the rediscovery of MJM – an original physiological signal, closely tied to the field of dentistry while offering the ability to capture the dynamic and synchronized interplay among factors underlying the therapeutic mechanisms of MADs. Findings from the reviewed studies on MJM analysis highlight its promise as an innovative solution for continuous monitoring in OAT-related procedures.

8. Expert opinion

Drawing on practical experience and a synthesis of current literature, we argue that the clinical significance and utility of any OAT monitoring technique depend on following considerations: (i) its technical properties – including the anatomical, biomechanical, or physiological relevance of the measured parameters, and whether the assessment is static or dynamic; (ii) the implementation context (e.g. awake vs. asleep; with vs. without the MAD in place; in-laboratory vs. home-based); (iii) its position within the OAT workflow (screening, baseline assessment, treatment initiation, titration, or long-term follow-up); and (iv) the specific clinical question being addressed (e.g. upper airway morphometry, physiological function, the integrated effect of the MAD, or outcomes related to sleep quality and SDB events). Recognizing the strengths and limitations of each technique enables clinicians and researchers to select the most effective approach for specific clinical objectives or research questions in OAT.

Supported by a solid physiological foundation and artificial intelligence-supported analysis, MJM monitoring is straightforward to implement and reduces staffing demands. The MJM analysis is therefore a promising tool for optimizing OAT outcomes and enabling personalized treatment strategies in clinical practice. Despite validation in specific sensor-based implementations [17–19], MJM should be understood as a physiological signal and an analytical framework rather than a device-dependent feature. Its physiological relevance and clinical value extend across a range of analytical approaches, including manual, visually comprehensive human analysis. At scale, MJM-based monitoring could shorten time to effective protrusion, reduce non-responder drift, and allow earlier confirmation of treatment success or failure – each with downstream benefits for clinical outcomes, safety, and resource utilization.

Nevertheless, we do not dismiss the practical value of Group 1 and Group 2 techniques. Although these techniques may not, on their own, provide direct and decisive clinical benefits, they retain complementary roles in research and specific phenotypes. For example, geometric parameters from static imaging can inform MAD design and fabrication, computational fluid dynamics can advance physiological research, and thermosensor-based adherence monitoring can support behavioral interventions. In this context, MJM analysis and endoscopy-based exploration (such as DISE) should not be viewed as competing or isolated tools, but rather as complementary steps within an adaptive MAD titration process. While the MJM analysis is valuable for multiple clinical objectives, particularly the home-based longitudinal follow-up, DISE could be selectively applied to patients who present persistent UA obstruction despite good adherence and maximal mandibular advancement, to identify complex, site-specific UA collapse patterns or not remediable patterns with OAT. Such complementary approach can bridge the gap between anatomical/mechanistic phenotypes and clinically meaningful sleep outcomes, inform the needs for adjunctive or alternative interventions, therefore enhancing both personalization and efficiency of OAT management.

Despite the growing interest in novel HSAT technologies, including the MJM analysis, their integration into the OAT workflow should be regarded as a complementary refinement for longitudinal monitoring and iterative clinical decision-making, rather than a universal substitute for PSG. The choice between PSG- and HSATbased monitoring should be guided by the clinical context, including the specific diagnostic or follow-up objectives and patient access to the technique. PSG remains essential for diagnosis confirmation and comprehensive phenotyping in complex clinical cases (e.g. patients with neuromuscular or cardiovascular comorbidities) where the clinical question extends beyond the assessment of obstructive respiratory events alone.

In a near future, we anticipate that the current OAT workflow will evolve from a slow, prolonged titration process to an accelerated, continuous and adaptive monitoring. This transition would be enabled by home sleep testing with alternative technologies – such as MJM analysis that support real-time decision-making, shorten iteration cycles, and ultimately improve efficiency and patient outcomes.

However, achieving these benefits requires overcoming several pragmatic barriers to the widespread adoption of modern sleep-monitoring technologies, including MJM analysis. These include under-recognition among clinicians and insufficient training in MJM signal interpretation; the lack of standardized MJM-guided titration protocols and decision-making algorithms; legacy reliance on PSG-driven AHI as primary endpoint; heterogeneous reimbursement for novel home sleep-testing modalities; and finally, an incomplete evidence base on the comparative cost-effectiveness of new strategies.

A coordinated, multisector effort is essential to address these challenges, engaging QDs, sleep physicians, medical device providers, and health-insurance policy makers. This collaboration should align the research,development, implementation, and clinical validation to ensure efficient translation of evidence into practice. Priority actions include: (i) conducting optimally designed clinical trials on a large scale to evaluate the effectiveness of an initial home-based assessment pathway and the cost-effectiveness of MJM-guided titration process compared with the standard PSGbased pathway; and (ii) establishing standardized protocols and decision algorithms for case selection and titration that flexibly integrate in-laboratory, symptoms and home-based

assessments, formally recognize validated alternatives such as MJM-based sleep testing, and imply continuous monitoring.

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References

Papers of special note have been highlighted as either of interest (•) or of considerable interest (••) to readers.

1. Ramar K, Dort LC, Katz SG, et al. Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: an update for 2015. J Clin Sleep Med. 2015;11(7):773–827. doi: 10.5664/jcsm.4858
2. Levine M, Cantwell MK, Postol K, et al. Dental sleep medicine standards for screening, treatment, and management of sleep-related breathing disorders in adults using oral appliance therapy: an update. J Dent Sleep Med. 2022;9(4):1–13. doi: 10.15331/jdsm.7266

•• **A clinical guideline by the American Academy of Dental Sleep Medicine (AASM).**

3. Phillips CL, Grunstein RR, Darendeliler MA, et al. Health outcomes of continuous positive airway pressure versus oral appliance treatment for obstructive sleep apnea: a randomized controlled trial. Am J Respir Crit Care Med. 2013;187:879–887. doi: 10.1164/rccm.201212-2223OC
4. Sutherland K, Vanderveken OM, Tsuda H. Oral appliance treatment for obstructive sleep apnea: an update. J Clin Sleep Med. 2014;10(2):215–227. doi: 10.5664/jcsm.3460
5. Bamagoos A, Cistulli PA, Sutherland K. Polysomnographic endotyping to select patients with obstructive sleep apnea for oral appliances. Ann Am Thorac Soc. 2019;16(11):1422–1431. doi: 10.1513/AnnalsATS.201903-190OC
6. Lavigne GJ, Babiloni AH, Beetz G, et al. Critical issues in dental and medical management of obstructive sleep apnea. J Dent Res. 2020;99(1):26–35. doi: 10.1177/0022034519885644 PMID: 31702942.
7. Haskell BS, Voor MJ, Roberts AM. A consideration of factors affecting palliative oral appliance effectiveness for obstructive sleep apnea: a scoping review. J Clin Sleep Med. 2021;17(4):833–848. doi: 10.5664/jcsm.9018 PMID: 33196434.
8. Sutherland K, Chan ASL, Ngiam J. Awake multimodal phenotyping for prediction of oral appliance treatment outcome. J Clin Sleep Med. 2018;14(11):1879–1887. doi: 10.5664/jcsm.7484 PMID: 30373687.
9. Navarro RE, Karadede B, Ünal BK, et al. Predictive factors of therapeutic response according to craniofacial skeletal biotype in patients with sleep apnea syndrome using mandibular advancement devices: a pilot study. Angle Orthod. 2024;94(2):216–223. doi: 10.2319/092822-670.1 PMID: 37788163.
10. Vena D, Azarbarzin A, Marques M, et al. Predicting sleep apnea responses to oral appliance therapy using polysomnographic airflow. Sleep (Basel). 2020;43(7):zsaa004. doi: 10.1093/sleep/zsaa004
11. de Beeck SO, Dieltjens M, Verbruggen AE, et al. Phenotypic labelling using drug-induced sleep endoscopy improves patient selection for mandibular advancement device outcome: a prospective study. J Clin Sleep Med. 2019;15(8):1089–1099. doi: 10.5664/jcsm.7796
12. Van Gaver H, de Beeck SO, Dieltjens M, et al. Functional imaging improves patient selection for mandibular advancement device treatment outcome in sleep-disordered breathing: a prospective study. J Clin Sleep Med. 2022;18(3):739–750. doi: 10.5664/jcsm.9694 PMID: 34608859.
13. Bamagoos A, Cistulli PA, Sutherland K. Dose-dependent effects of mandibular advancement on upper airway collapsibility and muscle function in obstructive sleep apnea. Sleep. 2019;42(6):zsz049. doi: 10.1093/sleep/zsz049

• **Important clinical study on dose-dependent effects of MAD on UA collasibility.**

14. Tong BK, Tran C, Ricciardiello A, et al. Efficacy of a novel oral appliance and the role of posture on nasal resistance in obstructive sleep apnea. J Clin Sleep Med. 2020;16(4):483–492. doi: 10.5664/jcsm.8244 PMID: 32003735.
15. Sheats R, Essick G, Grosdidier J, et al. Identifying the appropriate therapeutic position of an oral appliance. J Dent Sleep Med. 2020;7(4). doi: 10.15331/jdsm.7158
16. Martinot JB, Le-Dong NN, Malhotra A. Pépin JL.Enhancing artificial intelligence-driven sleep apnea diagnosis: the critical importance of input signal proficiency with a focus on mandibular jaw movements. J Prosthodont. 2024. doi: 10.1111/jopr.14003 Online ahead of print. PMID: 39676388.
17. Martinot JB, Le-Dong NN, Crespeigne E, et al. Mandibular movement analysis to assess efficacy of oral appliance therapy in OSA. Chest. 2018;154(6):1340–1347. doi: 10.1016/j.chest.2018.08.1027 PMID: 30413243.
18. Pépin JL, Cistulli PA, Crespeigne E, et al. Mandibular jaw movement automated analysis for oral appliance monitoring in obstructive sleep apnea: a prospective cohort study. Ann Am Thorac Soc. 2024;21(5):814–822. doi: 10.1513/AnnalsATS.202312-1077OC

•• **Important clinical study on MJM monitoring applied to OAT.**

19. Pépin JL, Martinot JB, Le-Dong NN, et al. Exploring the dose-response relationship between mandibular protrusion and respiratory effort burden in oral appliance therapy for OSA. Ann Am Thorac Soc. 2025;22(6):915–924. doi: 10.1513/AnnalsATS.202408-889OC

• **Important clinical study on MJM monitoring applied to OAT.**

20. Johal A, Hamoda MM, Almeida FR, et al. The role of oral appliance therapy in obstructive sleep apnoea. Eur Respir Rev. 2023;32:220257. doi: 10.1183/16000617.0257-2022
21. Johal A, Haria P, Manek S, et al. Ready-made versus custom-made mandibular repositioning devices in sleep apnea: a randomized clinical trial. J Clin Sleep Med. 2017;13(2):175–182. doi: 10.5664/jcsm.6440
22. Bortolotti F, Corazza G, Bartolucci ML, et al. Dropout and adherence of obstructive sleep apnoea patients to mandibular advancement device therapy: a systematic review of randomised controlled trials

with meta-analysis and meta-regression. J Oral Rehabil. 2022;49 (5):553–572. doi: 10.1111/joor.13290
23. Pépin JL, Raymond N, Lacaze O, et al. Heat-moulded versus custom-made mandibular advancement devices for obstructive sleep apnoea: a randomised non-inferiority trial. Thorax. 2019;74 (7):667–674. doi: 10.1136/thoraxjnl-2018-212726
24. Yanamoto S. Semi-fixed versus fixed oral appliance therapy for obstructive sleep apnea: a randomized crossover pilot study. J Dent Sci. 2021;16(1):404–409. doi: 10.1016/j.jds.2020.08.005
25. Abd-Ellah ME, Mohamed FS, Khamis MM, et al. Modified biblock versus monoblock mandibular advancement appliances for treatment of obstructive sleep apnea: a randomized controlled trial. J Prosthet Dent. 2024;131(4):633–642. doi: 10.1016/j.prosdent.2022.02.019
26. Umemoto G, Toyoshima H, Yamaguchi Y, et al. Therapeutic efficacy of twin-block and fixed oral appliances in patients with obstructive sleep apnea syndrome. J Prosthodontics. 2019;28(2):e830–e836. doi: 10.1111/jopr.12619
27. Venema J, Rosenmöller B, de Vries N, et al. Mandibular advancement device design: a systematic review on outcomes in obstructive sleep apnea treatment. Sleep Med Rev. 2021;60:101557. doi: 10.1016/j.smrv.2021.101557
28. Venza N, Malara A, Liguori C, et al. Upper airway characteristics and morphological changes by different MADs in OSA adult subjects assessed by CBCT 3D imaging. J Clin Med. 2023;12(16):5315. doi: 10.3390/jcm12165315 PMID: 37629359.
29. Vanderveken OM, Van Daele M, Verbraecken J, et al. Comparative analysis of two custom-made mandibular advancement devices with varied designs for treating moderate to severe obstructive sleep apnea. Sleep Med. 2024;117:95–98. doi: 10.1016/j.sleep.2024.02.035
30. Chan AS, Sutherland K, Schwab RJ. The effect of mandibular advancement on upper airway structure in obstructive sleep apnoea. Thorax. 2010;65(8):726–732. doi: 10.1136/thx.2009.131094
31. Johal A, Gill G, Ferman A, et al. The effect of mandibular advancement appliances on awake upper airway and masticatory muscle activity in patients with obstructive sleep apnoea. Clin Physiol Funct Imag. 2007;27:47–53.
32. Ogawa T, Long J, Sutherland K. Effect of mandibular advancement splint treatment on tongue shape in obstructive sleep apnea. Sleep Breath. 2015;19(3):857–863. doi: 10.1007/s11325-014-1101-y
33. Tsuiki S, Lowe AA, Almeida FR, et al. Effects of mandibular advancement on airway curvature and obstructive sleep apnoea severity. Eur Respir J. 2004;23(2):263–268. doi: 10.1183/09031936.04.00094304
34. Mogell K, Blumenstock N, Mason E, et al. Definition of an effective oral appliance for the treatment of obstructive sleep apnea and snoring: an update for 2019. J Dent Sleep Med. 2019;6(3):1–4.
35. Alessandri-Bonetti A, Bortolotti F, Moreno-Hay I, et al. Effects of mandibular advancement device for obstructive sleep apnea on temporomandibular disorders: a systematic review and meta-analysis. Sleep Med Rev. 2019;48:101211. doi: 10.1016/j.smrv.2019.101211
36. Martynowicz H, Wieczorek T, Macek P, et al. The effect of continuous positive airway pressure and mandibular advancement device on sleep bruxism intensity in obstructive sleep apnea patients. Chron Respir Dis. 2022;19:14799731211052301. doi: 10.1177/14799731211052301
37. Bartolucci ML, Bortolotti F, Corazza G, et al. Effectiveness of different mandibular advancement device designs in obstructive sleep apnoea therapy: a systematic review of randomised controlled trials with meta-analysis. J Oral Rehabil. 2021;48(4):469–486. doi: 10.1111/joor.13077
38. Attali V, Chaumereuil C, Arnulf I, et al. Predictors of long-term effectiveness to mandibular repositioning device treatment in obstructive sleep apnea patients after 1000 days. Sleep Med. 2016;27- 28:107–114. doi: 10.1016/j.sleep.2016.10.004
39. Sutherland K, Takaya H, Qian J. Oral appliance treatment response and polysomnographic phenotypes of obstructive sleep apnea. J Clin Sleep Med. 2015;11(8):861–868. doi: 10.5664/jcsm.4934
40. Remmers JE, Topor Z, Grosse J, et al. A feedback-controlled mandibular positioner identifies individuals with sleep apnea who will respond to oral appliance therapy. J Clin Sleep Med. 2017;13 (7):871–880. doi: 10.5664/jcsm.6656 PMID: 28502280.
41. Sutherland K, Ngiam J, Cistulli PA. Performance of remotely controlled mandibular protrusion sleep studies for prediction of oral appliance treatment response. J Clin Sleep Med. 2017;13 (3):411–417. doi: 10.5664/jcsm.6492 PMID: 27923436.
42. Gjerde K, Lehmann S, Naterstad IF, et al. Reliability of an adherence monitoring sensor embedded in an oral appliance used for treatment of obstructive sleep apnoea. J Oral Rehabil. 2018;45 (2):110–115. doi: 10.1111/joor.12584
43. Sutherland K, Chan ASL, Ngiam J. Qualitative assessment of awake nasopharyngoscopy for prediction of oral appliance treatment response in obstructive sleep apnoea. Sleep Breath. 2018;22 (4):1029–1036. doi: 10.1007/s11325-018-1624-8
44. Chen H, Aarab G, Lobbezoo F, et al. Differences in three-dimensional craniofacial anatomy between responders and non-responders to mandibular advancement splint treatment in obstructive sleep apnoea patients. Eur J Orthod. 2019;41 (3):308–315. doi: 10.1093/ejo/cjy085
45. Marques M, Genta PR, Azarbarzin A, et al. Structure and severity of pharyngeal obstruction determine oral appliance efficacy in sleep apnoea. J Physiol. 2019;597(22):5399–5410. doi: 10.1113/JP278164 PMID: 31503323.
46. de Vries GE, Hoekema A, Claessen J, et al. Long-term objective adherence to mandibular advancement device therapy versus continuous positive airway pressure in patients with moderate obstructive sleep apnea. J Clin Sleep Med. 2019;15(11):1655–1663. doi: 10.5664/jcsm.8034 PMID: 31739856.
47. Metz JE, Attarian HP, Harrison MC, et al. High-resolution pulse oximetry and titration of a mandibular advancement device for obstructive sleep apnea. Front Neurol. 2019;10:757. doi: 10.3389/fneur.2019.00757 eCollection 2019.
48. Mostafiz WR, Carley DW, Viana MGC, et al. Changes in sleep and airway variables in patients with obstructive sleep apnea after mandibular advancement splint treatment. Am J Orthod Dentofac Orthop. 2019;155(4):498–508. doi: 10.1016/j.ajodo.2018.05.022 PMID: 30935605.
49. Song B, Li Y, Sun J, et al. Computational fluid dynamics simulation of changes in the morphology and airflow dynamics of the upper airways in OSAHS patients after treatment with oral appliances. PLOS ONE. 2019;14(11):e0219642. doi: 10.1371/journal.pone.0219642 eCollection 2019.
50. Opsahl UL, Berge M, Lehmann S, et al. Acoustic pharyngometry - a new method to facilitate oral appliance therapy. J Oral Rehabil. 2021;48(5):601–613. doi: 10.1111/joor.13134
51. Van de Perck E, Op de Beeck S, Dieltjens M, et al. The relationship between specific nasopharyngoscopic features and treatment deterioration with mandibular advancement devices: a prospective study. J Clin Sleep Med. 2020;16(7):1189–1198. doi: 10.5664/jcsm.8474 PMID: 32267227.
52. Martínez A, Muñiz AL, Soudah E, et al. Physiological and geometrical effects in the upper airways with and without mandibular advance device for sleep apnea treatment. Sci Rep. 2020;10 (1):5322. doi: 10.1038/s41598-020-61467-4 PMID: 32210246.
53. Lu RJ, Tian N, Wang JZ, et al. The effectiveness of adjustable oral appliance for older adult patients with obstructive sleep apnea syndrome. Ann Palliat Med. 2020;9(4):2178–2186. doi: 10.21037/apm-20-1300 PMID: 32692246.
54. Ma Y, Yu M, Gao X. The effect of gradually increased mandibular advancement on the efficacy of an oral appliance in the treatment of obstructive sleep apnea. J Clin Sleep Med. 2020;16(8):1369–1376. doi: 10.5664/jcsm.8556 PMID: 32394888.
55. Marco-Pitarch R, García-Selva M, Plaza-Espín A, et al. Dimensional analysis of the upper airway in obstructive sleep apnoea syndrome patients treated with mandibular advancement device: a bi- and three-dimensional evaluation. J Oral Rehabil. 2021;48(8):927–936. doi: 10.1111/joor.13176 PMID: 33977548.

56. Ishiyama H, Hideshima M, Inukai S. Evaluation of respiratory resistance as a predictor for oral appliance treatment response in obstructive sleep apnea: a pilot study. J Clin Med. 2021;10(6):1255. doi: 10.3390/jcm10061255
57. Park JW, Almeida FR. Disparities in oxygen saturation and hypoxic burden levels in obstructive sleep apnoea patient's response to oral appliance treatment. J Oral Rehabil. 2022;49(6):633–643. doi: 10.1111/joor.13316 PMID: 35274338.
58. Stern J, Lee K, Kuhns D, et al. Efficacy and effectiveness of the ProSomnus® [IA] sleep device for the treatment of obstructive sleep apnea: EFFECTS study. Cureus. 2021;13(6):e15391. doi: 10.7759/cureus.15391 eCollection 2021. PMID: 34249542.
59. Sutherland K, Almeida FR, Kim T. Treatment usage patterns of oral appliances for obstructive sleep apnea over the first 60 days: a cluster analysis. J Clin Sleep Med. 2021;17(9):1785–1792. doi: 10.5664/jcsm.9288
60. Xu L, Xie D, Griffin KS, et al. Objective adherence to dental device versus positive airway pressure treatment in adults with obstructive sleep apnea. J Sleep Res. 2021;30(4):e13240. doi: 10.1111/jsr.13240
61. Camañes-Gonzalvo S, Marco-Pitarch R, Plaza-Espín A, et al. Correlation between polysomnographic parameters and tridimensional changes in the upper airway of obstructive sleep apnea patients treated with mandibular advancement devices. J Clin Med. 2021;10(22):5255. doi: 10.3390/jcm10225255
62. Op de Beeck S, Dieltjens M, Azarbarzin A, et al. Mandibular advancement device treatment efficacy is associated with polysomnographic endotypes. Ann Am Thorac Soc. 2021;18(3):511–518. doi: 10.1513/AnnalsATS.202003-220OC
63. Suga H, Iwasaki T, Mishima K, et al. Evaluation of the effect of oral appliance treatment on upper-airway ventilation conditions in obstructive sleep apnea using computational fluid dynamics. Cranio. 2021;39(3):209–217. doi: 10.1080/08869634.2019.1596554
64. Antonaglia C, Vidoni G, Contardo L, et al. Low arousal threshold estimation predicts failure of mandibular advancement devices in obstructive sleep apnea syndrome. Diagn (Basel). 2022;12(10):2548. doi: 10.3390/diagnostics12102548
65. Gjerde K, Lehmann S, Bjorvatn B, et al. Partner perceptions are associated with objective sensor-measured adherence to oral appliance therapy in obstructive sleep apnea. J Sleep Res. 2022;31(2):e13462. doi: 10.1111/jsr.13462 PMID: 34490690.
66. Gogou ES, Psarras V, Giannakopoulos NN, et al. Drug-induced sleep endoscopy improves intervention efficacy among patients treated for obstructive sleep apnea with a mandibular advancement device. Sleep Breath. 2022;26(4):1747–1758. doi: 10.1007/s11325-021-02561-3 PMID: 35015211.
67. Kazemeini E, Op de Beeck S, Vroegop A, et al. A pilot study on comparison of subjective titration versus remotely controlled mandibular positioning during polysomnography and drug-induced sleep endoscopy, to determine the effective protrusive position for mandibular advancement device therapy. Sleep Breath. 2022;26(4):1837–1845. doi: 10.1007/s11325-022-02569-3
68. Kwon JS, Jung HJ, Yu JH, et al. Effectiveness of remote monitoring and feedback on objective compliance with a mandibular advancement device for treatment of obstructive sleep apnea. J Sleep Res. 2022;31(3):e13508. doi: 10.1111/jsr.13508 PMID: 34693583.
69. Vena D, Taranto-Montemurro L, Azarbarzin A, et al. Clinical polysomnographic methods for estimating pharyngeal collapsibility in obstructive sleep apnea. Sleep. 2022;45(6):zsac050. doi: 10.1093/sleep/zsac050 PMID: 35238379.
70. Ferraz PD, Francisco I, Borges MI, et al. Pharyngeal airspace alterations after using the mandibular advancement device in the treatment of obstructive sleep apnea syndrome. Life (Basel). 2022;12(6):835. doi: 10.3390/life12060835 PMID: 35743866.
71. Ishida E, Kunimatsu R, Medina C, et al. Dental and occlusal changes during mandibular advancement device therapy in Japanese patients with obstructive sleep apnea: four years follow-up. J Clin Med. 2022;11(24):7539. doi: 10.3390/jcm11247539
72. Jugé L, Knapman FL, Humburg P, et al. The relationship between mandibular advancement, tongue movement, and treatment outcome in obstructive sleep apnea. Sleep. 2022;45(6):zsac044. doi: 10.1093/sleep/zsac044 PMID: 35218653.
73. Mosca EV, Bruehlmann S, Zouboules SM, et al. In-home mandibular repositioning during sleep using MATRx plus predicts outcome and efficacious positioning for oral appliance treatment of obstructive sleep apnea. J Clin Sleep Med. 2022;18(3):911–919. doi: 10.5664/jcsm.9758
74. Venema J, Bosschieter P, Hoekema A, et al. Do dental parameters predict severity of obstructive sleep apnea and mandibular advancement device therapy outcomes? A pilot study. J Oral Rehabil. 2023;50(3):203–209. doi: 10.1111/joor.13392
75. Chand P, Solanki N, Singh BP. A computed tomographic evaluation of effect of mandibular advancement device at two different horizontal jaw positions in patients with obstructive sleep apnea. J Oral Biol Craniofac Res. 2023;13(3):392–397. doi: 10.1016/j.jobcr.2023.03.014 PMID: 37124835.
76. Ma Y, Yu M, Gao X. Role of craniofacial phenotypes in the response to oral appliance therapy for obstructive sleep apnea. J Oral Rehabil. 2023;50(4):308–317. doi: 10.1111/joor.13418
77. Gurgel M, Cevidanes L, Costa F, et al. Three-dimensional comparison between the effects of mandibular advancement device and maxillomandibular advancement surgery on upper airway. BMC Oral Health. 2023;23(1):436. doi: 10.1186/s12903-023-03125-5
78. Shi X, Lobbezoo F, Chen H, et al. Comparisons of the effects of two types of titratable mandibular advancement devices on respiratory parameters and upper airway dimensions in patients with obstructive sleep apnea: a randomized controlled trial. Clin Oral Investig. 2023;27(5):2013–2025. doi: 10.1007/s00784-023-04945-z
79. Van den Bossche K, Van de Perck E, Vroegop AV, et al. Quantitative measurement of pharyngeal dimensions during drug-induced sleep endoscopy for oral appliance outcome. Laryngoscope. 2023;133(12):3619–3627. doi: 10.1002/lary.30823 PMID: 37366240.
80. Attia AAMM, Awad SS, Mansour M, et al. Effects of different treatments for obstructive sleep apnea on temporomandibular joint: a randomized clinical trial. BMC Oral Health. 2024;24(1):931. doi: 10.1186/s12903-024-04623-w PMID: 39129005.
81. Fernández-Sanjuán P, Alcaraz M, Gabriela B, et al. Modifications in upper airway collapsibility during sleep endoscopy with a mandibular positioner: study in snorers and obstructive sleep apnea patients. J Clin Med. 2024;13(5):1184. doi: 10.3390/jcm13051184 PMID: 38592035.
82. Papenfuß GS, König IR, Hagen C, et al. Mandibular device treatment in obstructive sleep apnea -A structured therapy adjustment considering night-to-night variability night-to-night variability in mandibular devices. Sleep Breath. 2024;28(6):2501–2508. doi: 10.1007/s11325-024-03134-w
83. Özköylü G, Saraç D, Sasany R, et al. Comparison of monoblock and twinblock mandibular advancement devices in patients with obstructive sleep apnea and temporomandibular disorder: effects on airway volume, polysomnography parameters, and sleepiness scale scores. BMC Oral Health. 2024;24(1):1026. doi: 10.1186/s12903-024-04653-4
84. Gogou ES, Psarras V, Giannakopoulos NN, et al. Comparing efficacy of the mandibular advancement device after drug-induced sleep endoscopy and continuous positive airway pressure in patients with obstructive sleep apnea. Sleep Breath. 2024;28(2):773–788. doi: 10.1007/s11325-023-02958-2 Epub 2023 Dec 12. PMID: 38085497.
85. Tofangchiha M, Esfehani M, Eftetahi L, et al. Comparison of the pharyngeal airway in snoring and non-snoring patients based on the lateral cephalometric study: a case–control study. Dent Med Probl. 2023;60(1):121–126. doi: 10.17219/dmp/154776
86. Vidal-Manyari PA, Arriola-Guillén LE, Jimenez-Valdivia LM, et al. Effect of the application of software on the volumetric and cross-sectional assessment of the oropharyngeal airway of patients with and without an open bite: a CBCT study. Dent Med Probl. 2022;59(3):397–405. doi: 10.17219/dmp/145287
87. Dastan F, Ghaffari H, Hamidi Shishvan H, et al. Correlation between the upper airway volume and the hyoid bone position, palatal depth, nasal septum deviation, and concha bullosa in different

types of malocclusion: a retrospective cone-beam computed tomography study. Dent Med Probl. 2021;58(4):509–514. doi: 10.17219/dmp/130099
88. Graizel-Armoni D, Greenbaum T, Brosh T, et al. Sex difference in the hyoid bone position in adults with obstructive sleep apnea: systematic review and meta-analysis. Dent Med Probl. 2025;62(6):1177–1187. doi: 10.17219/dmp/192096
89. Kapur V, Auckley DH, Chowdhuri S, et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an American Academy of sleep medicine clinical practice guideline. J Clin Sleep Med. 2017;13(3):479–504. doi: 10.5664/jcsm.6506
90. Yang J, Rosenmöller B, van Riet T, et al. Smart mandibular advancement devices for obstructive sleep apnea: a systematic literature review. Sleep Breath. 2024;28(5):1879–1887. doi: 10.1007/s11325-024-03068-3
• **A systematic review on smart mandibular advancement devices.**
91. Hollowell DE, Suratt PM. Mandible position and activation of submental and masseter muscles during sleep. J Appl Physiol. 1991;71(6):2267–2273. doi: 10.1152/jappl.1991.71.6.2267
92. Maury G, Senny F, Cambron F, et al. Mandible behaviour interpretation during wakefulness, sleep and sleep-disordered breathing. J Sleep Res. 2014;23(6):709–716. PMID: 25078069 DOI: 10.1111/jsr.12180
93. Martinot JB, Le-Dong NN, Cuthbert V, et al. The key role of the mandible in modulating airflow amplitude during sleep. Respir Physiol Neurobiol. 2020;279:103447. doi: 10.1016/j.resp.2020.103447
•• **Importantstudy on the physiological role of MJM signals in OSA.**
94. Pépin JL, Le-Dong NN, Cuthbert V, et al. Mandibular movements are a reliable noninvasive alternative to esophageal pressure for measuring respiratory effort in patients with sleep apnea syndrome. Nat Sci Sleep. 2022;14:635–644. doi: 10.2147/NSS.S346229
•• **Important study on the utility of MJM signals in OSA.**
95. Martinot JB, Borel JC, Cuthbert V, et al. Mandibular position and movements: suitability for diagnosis of sleep apnoea. Respirology. 2017;22(3):567–574. PMID: 28225162 DOI: 10.1111/resp.12929
96. Pépin JL, Letesson C, Le-Dong NN, et al. Assessment of mandibular movement monitoring with machine learning analysis for the diagnosis of obstructive sleep apnea. JAMA Netw Open. 2020;3(1):e1919657. doi: 10.1001/jamanetworkopen.2019.19657
97. Senny F, Maury G, Cambron L, et al. The sleep/wake state scoring from mandible movement signal. Sleep Breath. 2012;16(2):535–542.
98. NICE diagnostics guidance (DG-62). Home-testing devices for diagnosing obstructive sleep apnoea hypopnoea syndrome. 2024 [cited 2025 Aug 5th]. Available from: https://www.nice.org.uk/guidance/dg62