Review Article

EFFECTS OF ORTHOGNATHIC SURGERY ON AIRWAY DIMENSION AND SLEEP APNEA OUTCOME: A SYSTEMATIC REVIEW

Hajar Aljarboua[1], Yousef Alomran[2], Jasem Alkandari[3], Hessah Alzamanan[4]*

[1]*Bnaid Algar Specialist Center, Ministry of Health, Kuwait City, Kuwait*
[2]*Abdulrahman Al-Abdulmoghni Health Center, Ministry of Health, Kuwait City, Kuwait. Yousef.alomran12@gmail.com*
[3]*Alshuhada Health Center, Ministry of Health, Kuwait City, Kuwait*
[4]*Bader AlNafisi Health Center, Ministry of Health, Kuwait City, Kuwait*.

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ABSTRACT

This systematic review was done to determine the effects of orthognathic surgery on upper airway dimensions and clinical outcomes in patients with obstructive sleep apnea. The electronic databases, PubMed, Scopus, Web of Science, and Google Scholar, were searched in a systematic manner to find the relevant studies. The selection of the study was conducted according to PRISMA, and specific criteria of inclusion and exclusion were used. The review involved fifteen studies whose content was published in 2019 and 2026 after the screening and full-text assessment. The chosen articles were systematic reviews, meta-analyses, clinical studies, and observational studies assessing the outcomes of the orthognathic surgical procedures on airway dimensions and the severity of sleep apnea. The results suggest that orthognathic surgery, especially maxillomandibular advancement surgery, leads to a significant increase in upper airway dimensions, and airway patency is enhanced. Some of the studies indicated a tremendous decrease in apnea-hypopnea index (AHI) and an increase in oxygen saturation and sleep quality after surgery. All in all, the current evidence indicates that orthognathic surgery can be a good treatment modality in patients with obstructive sleep apnea and craniofacial anomalies. Additional large-scale clinical trials are needed to establish long-term results and to maximize the effectiveness of treatment.

Key words: Orthognathic surgery, Obstructive sleep apnea, Airway dimensions, Maxillomandibular advancement, Apnea-hypopnea index.

Introduction

Obstructive sleep apnea (OSA) is a widespread sleep-related breathing disorder, which is manifested by intermittent blockage of the upper airway by parts or all of it during sleeping. Such pauses in respiration cause periodical hypoxia, disrupted sleep, and several complications on a systemic level, such as cardiovascular disease, metabolic disorders, and low quality of life. The intensity of OSA is normally determined by the apnea-hypopnea index (AHI), which is the proportion of apnea and hypopnea instances per hour of rest [1]. OSA is developed due to a few causes, which are obesity, neuromuscular control, and anatomical variability of the craniofacial structures that affect the airway patency.

The morphology of the craniofacial features is an important factor that is related to the size and stability of the upper airway. Metabolic imbalances (like mandibular retrognathia, maxillary deficiency, and loss of pharyngeal airway space) are often linked with spurred airway collapse during sleep. Such anatomical features may cause airway constriction, thus exposing the person to the risk of breathing difficulties [2]. Developments in the method of diagnostic imaging, especially the cone-beam computed tomography (CBCT), have enabled researchers to assess airway structures with greater accuracy. These types of imaging can offer specific three-dimensional measurements of airway volume and architecture, which can then be used to understand how the craniofacial structures can affect respiratory performance [3].

Continuous positive airway pressure (CPAP) therapy and mandibular advancement devices are the most commonly used conservative management strategies of OSA as the first-line treatments. Though such therapies are important in symptom control, patients may not adhere to them because they are uncomfortable, inconvenient, and cause long-term dependence on the device [4]. Surgical interventions have therefore been considered as another line of treatment for patients not responding sufficiently to conservative therapy or those who show severe craniofacial malformation that has an impact on the size of the airways.

Orthognathic surgery has become a significant surgical operation directed at the repair of the clavicle and airway obstruction by the involvement of craniofacial structural anomalies. Some of these procedures include the maxillomandibular advancement, which is aimed at repositioning the jaws forward, which in turn will increase the size of the upper airway and decrease the chances of airway blockage caused by sleeping. It has been shown by clinical research that these types of surgical procedures can bring remarkable changes in the airway sizes and decrease

the apnea-hypopnea index in patients with obstructive sleep apnea [5, 6]. Moreover, the systematic reviews indicated that the craniofacial development of the surgical nature could enhance the oxygen saturation rates and the overall outcomes of sleep [7, 8].

The latest trends in surgery planning and advanced methods have also facilitated a better treatment result. The methods are supposed to maximize airway expansion and maintain aesthetic facial features and functional stability [9]. Regardless of these encouraging results, the literature available is inconsistent in the study design, population of patients, and outcome measurements. That is why the synthesis of the existing evidence is required to better comprehend the impact of orthognathic to airway dimensions and sleep apnea results.

The proposed systematic review will assess and synthesize recent clinical evidence (published 2019-2026) on the topic of the effect of Orthognathic surgery on airways and the outcome of obstructive sleep apnea.

Types of orthognathic surgical treatments for osa

Mandibular advancement surgery

In Mandibular advancement surgery, the lower jaw is moved forward to increase the upper airway space and decrease the airway blockage during sleep. This is a process that enhances the flow of air in the oropharyngeal and hypopharyngeal cavities and may alleviate the degree of obstructive sleep apnea. Various research studies have seen a decrease in apnea-hypopnea index (AHI) after the mandibular advancement procedures.

Advantages

- Increases airway space
- Improves breathing during sleep
- Reduces apnea severity

Disadvantages

- The changes in the facial profiles.
- Surgical complications include edema or muscle neuralgia.
- Recovery period required

Mandibular setback surgery

Mandibular prognathism is normally treated using mandibular setback surgery **(Figure 1)**. This process could lead to a decrease in the airway area due to the shifting of the mandible. There are some studies that indicate that mandibular setback can cause the risk of airway obstruction and aggravation of the symptoms of obstructive sleep apnea in some patients.

Advantages

- Modifies severe mandibular prognathism.
- Enhances facial beauty in the chosen cases.

Disadvantages

- Can reduce airway volume
- May deteriorate the symptoms of sleep apnea.
- Contraindicated in the case of OSA-prone patients.

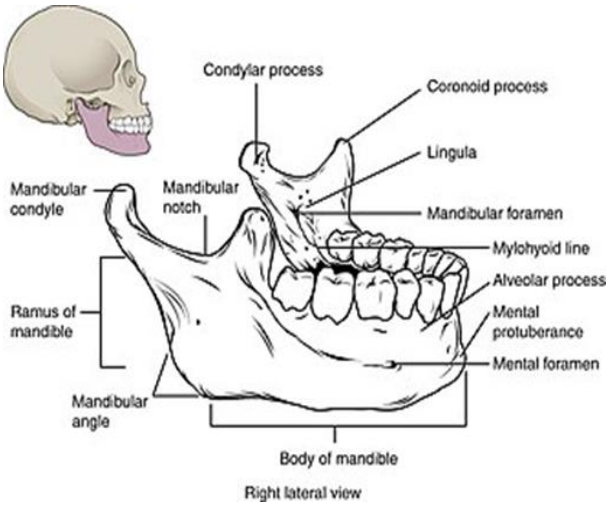

Figure 1. Mandibular setback surgery showing posterior repositioning of the mandible and its potential effect on upper airway space.

Bimaxillary surgery

Bimaxillary surgery is performed to reposition the maxilla and mandible to correct skeletal discrepancies and to amend pressure in the airways **(Figure 2)**. This is because this combined method provides the surgeons with an opportunity to allow them to alter various elements of the craniofacial structure, which can greatly enhance airway patency.

Advantages

- Enhances craniofacial allusion.
- Increases airway volume
- Makes it functional and aesthetically better.

Disadvantages

- More complex surgery
- Longer recovery time
- Higher surgical cost

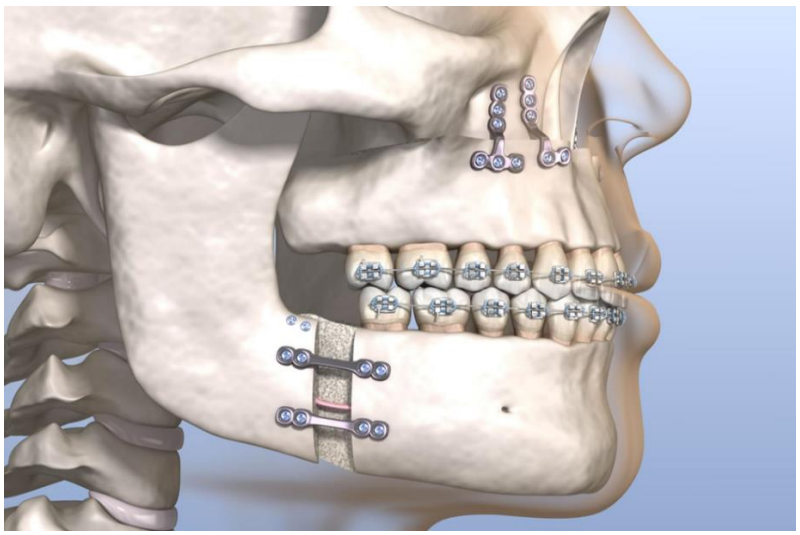

Figure 2. Bimaxillary surgery involving repositioning of both the maxilla and mandible to improve craniofacial alignment and airway dimensions.

Maxillomandibular advancement (MMA)

Maxillomandibular advancement surgery is regarded as the most effective orthognathic surgery treatment as far as obstructive sleep apnea is concerned **(Figure 3)**. The process causes a forward movement of both the maxilla and mandible and expansion of the upper airway, and decreases airway collapse during sleep. Many studies have reported a major decrease in the apnea-hypopnea index and an increase in oxygen saturation after MMA surgery.

Advantages

- The airways are considerably enlarged.
- Huge decrease in apnea-hypopnea index (AHI)
- Sleep quality improvement on a long-term basis.

Disadvantages

- Major surgical procedure
- Pain and edema after surgery.
- Demonstrates special needs in surgical planning.

Figure 3. Maxillomandibular advancement surgery showing forward repositioning of both jaws, resulting in enlargement of the upper airway and reduction of airway obstruction.

PICO question

This systematic review used the PICO framework to design the research question. The sample size (P) consists of patients with obstructive sleep apnea (OSA). The intervention (I) is orthognathic surgery to correct craniofacial structural abnormalities, especially those that can move the jaws forward to enlarge the airway space. The comparison (C) is between pre-surgical airway diseases or other non-surgical interventions employed in the management of OSA. The assessed outcomes (O) would be improvements in airway size and the decrease in the apnea-hypopnea index (AHI), better oxygen saturation, and the

general reduction of the sleep apnea symptoms. Thus, this review aims to identify whether or not orthognathic surgery causes significant changes in airway structure and clinical outcomes in patients with obstructive sleep apnea.

Aim of the study

This systematic review is expected to examine and summarize the available evidence on the impact of orthognathic surgery on upper airway dimensions and clinical outcomes in patients with obstructive sleep apnea. This paper aims to establish the contribution of orthognathic surgery therapies in enhancing airway structure and parameters associated with sleep breathing.

Materials and Methods

Study design and protocol

This paper was done as a systematic review to assess the outcome of orthognathic surgery on airway size and sleep apnea outcomes. To achieve transparency, methodological rigor, and reproducibility in the study selection and reporting process, the review was conducted through Preferred Reporting Items that are based on Systematic Reviews and Meta-Analyses guidelines (PRISMA). The systematic review methodology was chosen to detect, appraise, and integrate current evidence regarding surgical interventions to influence the airway dimension and the outcome of obstructive sleep apnea.

Eligibility criteria

The PICO framework was used to define the eligibility criteria to maintain the similarity in the selection of relevant studies. The patients with obstructive sleep apnea were included in the population. Articles that examined orthognathic surgery procedures to alter craniofacial features and enhance airway clearance were selected. The qualitative results were alterations in the airway dimensions on the upper surfaces, apnea-hypopnea index (AHI), the level of oxygenation in the blood, and other clinical signs of sleep apnea. Peer-reviewed journals (i.e., systematic reviews and meta-analyses, clinical trials, and observational studies) were considered [10-15]. Articles whose contents were unrelated to airway outcomes, abstracts of a conference that lacked the full text, animal research, and those that were not in English were not included.

Information sources

Multiple electronic databases were searched to find relevant studies through a thorough literature search. The main databases that were searched were PubMed, Scopus, and Web of Science because these databases have a vast amount of biomedical and clinical research data. Besides searching databases, reference lists of the appropriate articles were also carefully calculated to determine derivative studies, which fulfilled the inclusion criterion. Review articles and grey literature sources were also filtered to make sure that no relevant evidence was missed [16-20].

Search strategy

A search strategy was designed in a structured way based on the combination of keywords and controlled vocabulary items connected with orthognathic surgery, airway dimensions, and obstructive sleep apnea. Search terms were also combined and results refined using the operators AND and OR. The search terms used comprised the search terms orthognathic surgery, maxillomandibular advancement, airway dimension, upper airway volume, and obstructive sleep apnea. These terms were translated to match the needs of each database in order to have all the relevant studies.

Study selection process

The selection of the study was done in a number of steps. The titles and abstracts of the studies retrieved in the first step were filtered to identify the potentially relevant articles. At this point, studies that failed to pass the inclusion criteria were eliminated. The rest of the articles were then checked on the basis of their eligibility. The screening was conducted on an ad hoc basis in order to enhance less bias, and any differences in terms of inclusion in the study were sorted out via discussion and consensus.

Data extraction

A structured data extraction form was used to extract data from the included studies. The variables that were extracted were author names, year of publication, study design, population characteristics, type of orthognathic surgical intervention, measures taken to determine airway dimensions, and the results of sleep apnea. Other details, including sample size, imaging methods, and follow-up time, were also included with the aim of comparing studies.

Risk of bias

The quality of methodologies of the studies used was evaluated to determine the possible sources of bias. Proper quality assessment tools were used depending on the study design. Observational studies were critically assessed with standard quality appraisal methods like the Newcastle - Ottawa Scale, whereas randomized or controlled studies were critically assessed with conventional risk-of-bias methods. This analysis allowed us to conclude on the reliability and validity of the results presented in the chosen studies.

Data synthesis

The results of the included studies were synthesized based on the narrative approach because of the differences in the study design, the population of the patients, and the outcome measures. The synthesis aimed at determining trends in the reported alterations in airway dimensions and better outcomes of obstructive sleep apnea as a result of orthognathic surgical procedures. Where feasible, the findings were contrasted among the studies to determine similar patterns and variations in the effectiveness of the treatments [21-30].

Results and Discussion

Study selection

The electronic databases such as PubMed, Scopus, Web of Science, and Google Scholar were thoroughly searched to gather information on the topic of orthognathic surgery and its impact on the airway dimensions and results of obstructive sleep apnea. The search first came up with several potentially relevant records. Once the duplicate articles were eliminated, the titles and abstracts of the rest of the studies were filtered, and the relevance of these studies to the research topic was determined. At the screening phase, the research papers that had no direct correlation to the orthognathic surgical procedures and airway dimension alterations or obstructive sleep apnea outcomes were filtered out. Articles that emphasized orthodontic treatment but did not include airway assessment, those that had animal models as subjects, and those that had no comprehensive clinical information were also eliminated. The rest of the articles were assessed using full-text evaluation based on the inclusion and exclusion criteria developed. They included studies that investigated the association between orthognathic surgery, airway structural changes, and the results of sleep apnea among human subjects. Articles that failed to provide measurable airways parameters or clinical sleep apnea results were excluded.

After the eligibility check, 15 studies were included in this systematic review to satisfy the inclusion criteria. These were systematic reviews, meta-analyses, clinical studies, and observational research studies of the consequences of orthognathic surgeries on airway size and severity of obstructive sleep apnea. The PRISMA principles were used for study selection, and the general screening procedure is provided in **Figure 4** (PRISMA flow diagram).

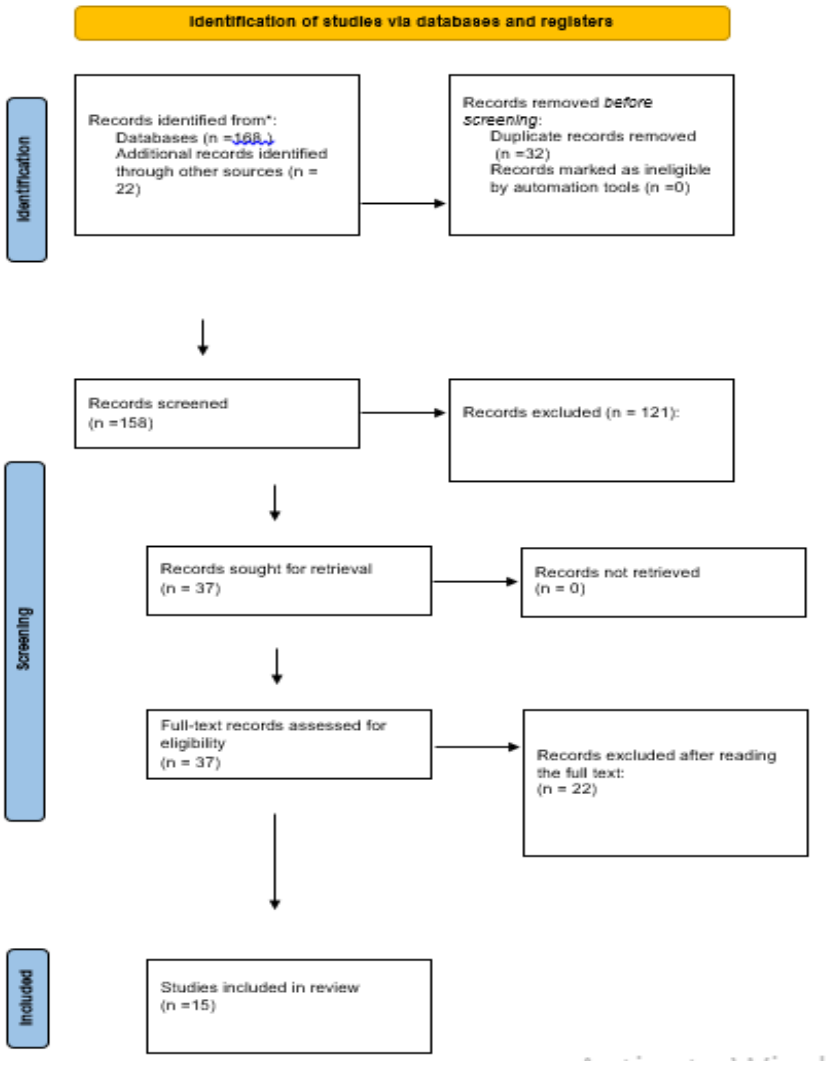

Figure 4. PRISMA flow diagram showing the study selection process.

Study characteristics

The articles included in the review were published from 2019 to 2026 and represented the research in different areas such as North America, Europe, and Asia. The studies that

were selected involved patients with obstructive sleep apnea who had orthognathic surgical complications that were intended to enhance airway patency **(Table 1)**. A number of studies were directed at maxillomandibular advancement surgery, which is commonly regarded as one of the most efficient surgical procedures that help in the treatment of obstructive sleep apnea. There were other studies that looked at orthodontic/craniofacial treatments that impact the airway size and breathing capacity [3, 31]. The studies included various research designs that included systematic reviews, meta-analyses, prospective clinical trials, and observational studies. Airway changes were measured using different imaging techniques such as cone-beam computed tomography (CBCT) and three-dimensional radiographic imaging. These methods enabled scientists to determine the volume and structural variation of the airways accurately pre- and post-surgical surgeries [21, 32-36].

Table 1. Characteristics of Included Studies

Author (Year)	Study Design	Population	Intervention	Outcome Measures	Key Findings
Behrents *et al.* (2019) [2]	Clinical guideline	OSA patients	Orthodontic considerations	Airway structure	Craniofacial structure influences OSA severity
Sutherland *et al.* (2019) [1]	Clinical comparative study	Adults with OSA	Anatomical risk assessment	Airway structure	Craniofacial risk factors related to OSA
Giralt-Hernando *et al.* (2019) [5]	Systematic review & meta-analysis	OSA patients	Maxillomandibular advancement	AHI, airway volume	Significant airway expansion and AHI reduction
Liu *et al.* (2019) [37]	Review article	OSA patients	Surgical protocol	Treatment outcomes	Stanford protocol improves surgical planning
Templier *et al.* (2020) [38]	Systematic review	Pediatric OSA	Surgical & orthodontic treatment	Airway improvement	Combined treatment improves airway function
Lai *et al.* (2022) [4]	Prospective clinical trial	Severe OSA	CPAP vs mandibular advancement	AHI	Both treatments improved symptoms
Zhou *et al.* (2022) [8]	Systematic review	OSA patients	MMA & airway stimulation	AHI, oxygen saturation	MMA significantly improved airway patency
Bucci *et al.* (2023) [31]	Systematic review	Pediatric OSA	Orthodontic appliances	Airway volume	Functional appliances improved airway dimensions
Quah *et al.* (2023) [7]	Review	OSA patients	Orthographic surgery	AHI	Surgical treatment improved OSA outcomes
Ahmed *et al.* (2024) [3]	Clinical imaging study	Class II patients	Orthodontic appliance	Airway volume	CBCT showed airway enlargement
Yong *et al.* (2024) [9]	Scoping review	OSA patients	Modified MMA surgery	AHI, airway volume	Modified techniques improved outcomes
Diemer *et al.* (2025) [6]	Meta-analysis	Obese OSA patients	Maxillomandibular advancement	AHI	Significant improvement after surgery
Ali *et al.* (2025) [39]	Systematic review	OSA patients	Orthographic surgery	AHI	Surgical treatment improved sleep apnea
Shaw *et al.* (2026) [40]	Systematic review & meta-analysis	OSA patients	MMA surgery	AHI	Strong evidence for surgical effectiveness
Patel *et al.* (2026) [41]	Systematic review	OSA patients	Sleep apnea surgery	Airway collapse	Surgery reduced airway obstruction

Risk of Bias Assessment

The quality of the methodology of the used studies was assessed to determine possible sources of bias. The majority of systematic reviews and meta-analyses had a low risk of

bias, whereas other observational and pilot clinical studies had a moderate risk as they had smaller sample sizes and differences in study designs. **Figure 5** shows the risk of bias of the included studies in general.

Figure 5. Risk of bias assessment summary of the included studies

Airway dimension changes

The majority of the studied articles found that there was a significant change in the airway sizes after performing orthognathic surgery. Maxillofacial growth of the maxilla and mandible was linked to the expansion of the pharyngeal airways (especially the retropalatal and retroglossal areas), where airway blockage is one of the most frequent problems in OSA patients. The systematic reviews and meta-analyses showed that maxillomandibular advancement surgery significantly enhances the volume of the upper airway and alleviates airway collapse during sleep [5, 8] Other studies also documented positive changes in the airway space with the use of CBCT imaging after surgical intervention [3].

Sleep apnea outcomes

Other than positive airway dimension improvements, various studies have recorded tremendous positive improvements in clinical outcomes related to obstructive sleep apnea. The apnea-hypopnea index (AHI) was also reduced, and the oxygen saturation levels had also improved in patients who underwent orthognathic surgery as a result of surgical interventions. The meta-analyses and systematic reviews revealed that the maxillomandibular advancement surgery could considerably decrease the severity of sleep apnea and enhance breathing during sleeping hours [6, 40]. Orthognathic surgery is linked to a better quality of sleep and fewer symptoms in the daytime among patients with moderate and severe OSA [7, 39]. The results of the studies included in this review show that orthognathic surgical procedures could be effective in the correction of airway structure and the results of sleep apnea in patients with craniofacial and anatomical defects affecting airway obstruction.

This is a systematic review of the available evidence on the impact of orthognathic surgery on the upper airway dimensions and clinical outcomes in patients with obstructive sleep apnea (OSA). The overall results of the studies included in the review point to the idea that surgical repair of craniofacial formations can be used to enhance patency of the airways and decrease the intensity of breathing disorders in sleep. Most of the studies that were incorporated in this review stated that orthognathic surgical intervention, and especially maxillomandibular advancement, produced quantifiable increases in upper airway dimensions. Increase in the retropalatal and retroglossal airway spaces was common after the surgical repositioning of the maxilla and mandible. Such structural changes are the cause of the lessening airway collapse during sleep, among the main mechanisms of OSA. The same was found in earlier systematic reviews, which showed that craniofacial surgical development has a significant effect on the pharyngeal airway space, which can be expanded and airway stability enhanced [5, 8]. Besides structural improvements, some of the studies also reported significant improvement in clinical outcomes regarding sleep apnea. The number of patients who had undergone orthognathic surgery witnessed a major improvement in the apnea-hypopnea index (AHI), which is one of the major parameters that are used to gauge the severity of OSA. Among other studies, there were also reports of improvement in the levels of oxygen saturation and the overall quality of sleep. It has been demonstrated by meta-analyses that with maxillomandibular advancement, it is

possible to achieve significant AHI improvements and respiratory function improvement during sleep [6, 40]. Such findings indicate that orthognathic surgery can be a viable treatment method, especially for moderate to severe OSA patients who do not respond to conservative therapies. Although these positive results were observed, the evidence in the studies had some variation in the study design, the population of patients, and outcome measures. There were some studies that had a small sample size or observational designs that might be a restriction to the generalization of the findings. Also, the varying imaging modalities and periods of subsequent follow-ups across studies would affect the reported results. However, the general pattern of the literature is that the orthognathic surgical interventions result in both anatomical and functional improvements of OSA patients. The imaging technology, such as cone-beam computed tomography (CBCT), has also made it easier to assess the modification in airways accurately after surgical procedures. All these imaging methods enable clinicians to measure three-dimensional airway volume and airway structural alterations with greater accuracy, which aids in making treatment choices and measuring surgical outcomes [3]. The results of this review suggest that orthognathic surgery is rather helpful in the management of the airway structure and the decrease in the severity of the obstruction of the airway during sleep. Additional and high-quality clinical studies utilizing bigger samples of studies and more standard outcome measures are required to enhance the existing evidence base.

Conclusion

The current systematic review has assessed the existing evidence on the impact of orthognathic surgery on airway sizes and clinical measures in patients with obstructive sleep apnea. The results of the studies included in the paper show that orthognathic surgeries, especially those that consist of maxillomandibular advancement, may actually have a substantial positive effect in enhancing upper airway dimensions and airway obstruction during sleep. Most of the studies indicated a large drop in the levels of the apnea-hypopnea index (AHI) alongside advancements in the oxygenation level and sleep quality level on the whole after surgery. These findings indicate that orthognathic surgery may be a good treatment alternative for a patient of moderate to severe obstructive sleep apnea when the less invasive measures have not worked, or the patient is poorly tolerant to them. Although these positive results were obtained, differences in the study design and sample size point to the necessity of additional high-quality clinical studies to get a clearer picture of the long-term efficiency and clinical performance of orthognathic surgical procedures in the management of OSA.

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