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Major clinical results of orthognatic surgery in obstructive sleep apnea syndrome: a systematic review

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Abstract

Introduction: Obstructive sleep apnea involves obstruction or narrowing of an individual's airways during sleep and is associated with several comorbidities. Management can be surgical or non-surgical, and Phase II of the Stanford Protocol for surgical management involves maxillomandibular advancement. **Objective:** To conduct a concise systematic review to present the main considerations and clinical results of orthognathic surgery in obstructive sleep apnea syndrome. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from April to June 2024 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 110 articles were found, 41 articles were evaluated and 23 were included in this systematic review. Considering the Cochrane tool for risk of bias, the global assessment resulted in 28 studies with a high risk of bias and 28 studies that did not meet GRADE. Most studies showed homogeneity in their results, with X^2 =88.5% >50%. Maxillomandibular advancement surgery is a successful treatment for obstructive sleep apnea, but there are still concerns about cosmetic results due to the major advances involved. Bimaxillary advancement osteotomy significantly increases oropharyngeal volume and contracted superficial areas, which remain stable between 6 months and 1 year postoperatively.

Keywords: Obstructive sleep apnea syndrome. Orthognathic surgery. Maxillomandibular advancement.

Introduction

Obstructive Sleep Apnea Syndrome (OSAS) involves obstruction or narrowing of an individual's airways during sleep and is associated with several comorbidities. Patient evaluation includes a detailed history, clinical and radiographic examination, endoscopy, and polysomnography. Management can be surgical or non-surgical, and Phase II of the Stanford Protocol for surgical management involves maxillomandibular advancement. Surgical considerations (e.g., degree of movement, timing of surgery) and possible complications specific to maxillomandibular advancement need to be discussed as maxillomandibular advancement is effective in treating OSA [1].

In this sense, Orthognathic Surgery (OS) corrected the deformities of the maxillary and mandibular bones in OSAS [2,3]. The operating system has evolved a lot in the last two decades. The importance of airway dimensions is that they are related to respiratory disorders, since the narrow dimensions of the upper airways in the oropharynx region cause respiratory problems and can lead to reduced growth hormone levels in children [3].

Also, facial deformity with destructive psychological and social potential has a negative impact, which can influence not only the patient's self-confidence but also external relationships, resulting in social and psychological disadvantages [4-6]. The goals of the patient with dentofacial deformity, related to repair, are also psychosocial and this may express the expectation of resolving their personal and social difficulties with physical change [7].

Furthermore, OS treats patients with moderate and severe facial deformities, allowing the achievement of functional balance and harmony in facial aesthetics [8]. In this sense, as a consequence of functional imbalance, OSAS may occur, which is the arrest of the airways by the upper airways, in the presence of respiratory effort, lasting more than 10 seconds. Hypopnea constitutes a reduction in air passage in that area during the same period. These respiratory events occur countless times and exclusively during sleep, determining symptoms and signs that characterize OSAS [9].

Furthermore, OSAS is related to comorbidities such as systemic arterial hypertension or diabetes mellitus. The prevalence reaches 32% in the general population, varying from 1% to 20% when associated with chronic obstructive pulmonary disease (COPD) (overlap syndrome), and is described as higher than 60% in populations with COPD and obesity (COPD, OSAS, and obesity triad) [9]. Treatment methods are numerous and presented. Multidisciplinary participation and multidisciplinary development trends. In recent years, with the participation and deepening of oral medicine in the diagnosis and treatment of OSAS, the role of OS in OSAS has been increasingly recognized [9,10].

Therefore, the present study performed a systematic review to present the main considerations and clinical results of orthognathic surgery in obstructive sleep apnea syndrome.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 04/11/2024. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 04/110/2024.

Research Strategy and Search Sources

The literary search process was carried out from April to June 2024 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, covering scientific articles from various eras to the present. The descriptors (MeSH Terms) were used: "Obstructive sleep apnea syndrome. Orthognathic surgery. Maxillomandibular advancement", and using the Boolean "and" between the terms MeSH and "or" between historical discoveries.

Study Quality and Risk of Bias

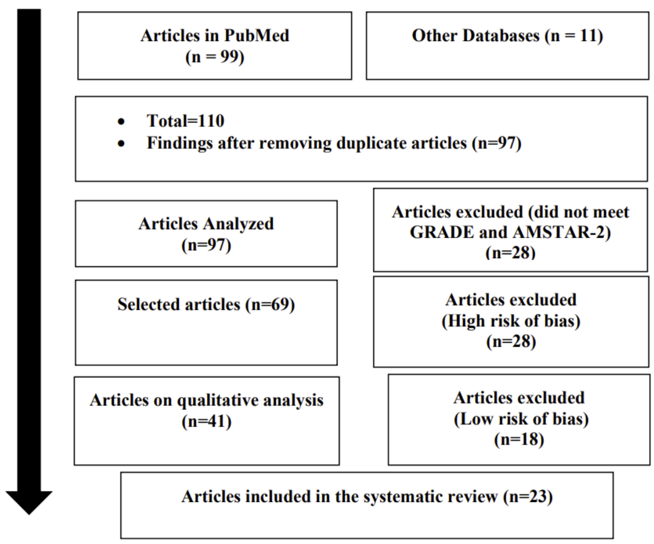
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

As a corollary of the literary search system, a total of 110 articles were found that were subjected to eligibility analysis and, subsequently, 23 of the 41 final studies were selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering in the first instance the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=88.5%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 28 studies with a high risk of bias and 28 studies that did not meet GRADE and AMSTAR-2.

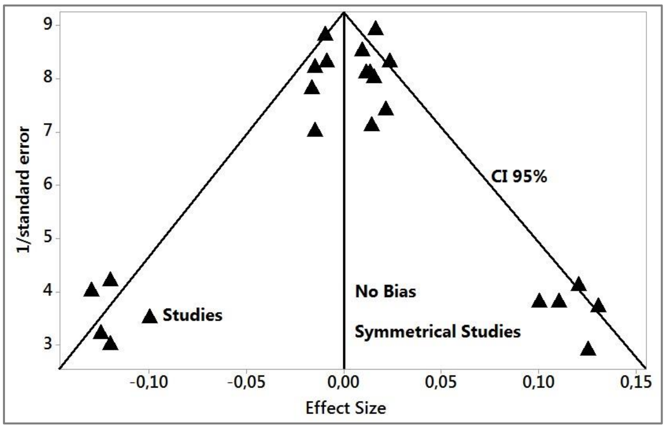
Figure 1. Flowchart showing the article selection process.



Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the plot. High confidence and high recommendation studies are shown above the graph (n=23 studies).



Source: Own Authorship.

Major Clinical Results

Maxillomandibular advancement surgery is a successful treatment for obstructive sleep apnea syndrome (OSAS), but there are still concerns about aesthetic results due to the major advances involved. In general, maxillomandibular advancement surgery for the treatment of OSAS does not harm the aesthetics of the facial profile, and external evaluators judged the changes as favorable in the majority of patients evaluated [11].

In this sense, a study carried out by Hassing et al.2022 [12] investigated volumetric and circumferential changes in the pharyngeal air space (PAS) and stability over time, assessed by cone beam computed tomography (CBCT) before and after orthognathic surgery, 2 years after surgery. A total of 128 patients underwent bimaxillary orthognathic surgery. Patients were divided into 4 groups based on the amount of mandibular advancement in 5 mm increments (< 0 mm, 0-5 mm, 5-10 mm, or > 10 mm). CBCT data were acquired preoperatively and 1-6 weeks, 6 months, 1 year, and 2 years after surgery. Patients with a history of trauma or maxillofacial surgery, obstructive sleep apnea syndrome, or craniofacial anomalies were excluded. Nasopharyngeal, oropharyngeal, and hypopharyngeal SBP volumes and contracted surface areas were measured and compared between each time point with a paired t-test. The greatest significant increase in oropharyngeal volume and superficial constriction areas was observed at 5-10 mm (+13.3-21.7%, +51.3-83.0%)) and >10 mm (+23. 3-44.6%, +92.3-130.0 %) mandibular advancement groups. This increase remained stable only 2 years after surgery in the >10 mm group. In other mandibular advancement groups, increases in oropharyngeal volume and constriction surface areas were observed in the short term, which returned to baseline levels 6 months to 1 year after surgery.

Furthermore, OSAS refers to when an adult experiences at least 30 apneas during 7 hours of nightly sleep, at least 10 seconds or more for each episode; or more than 4% apnea during breath-holding or an apnea-hypopnea index (apnea-hypopnea index, AHI, the average number of apneas and hypopneas per hour) is greater than 5 times per hour, so the apnea is mainly obstructive [5,10].

Thus, it can be highlighted that the main pathophysiological characteristic of OSAS is high stenosis caused by apnea or restricted ventilation during sleep, causing nocturnal hypoxemia, resulting in chronic damage to multiple organs of the body [6,13]. Long-term presence may cause or worsen respiratory failure or cerebrovascular risk factors for accidents, myocardial infarction, and hypertension [14-16]. Early and appropriate diagnosis and treatment can significantly improve the patient's quality of life, reduce sudden death, and prevent various complications [17,18].

Thus, the basic principle of surgical treatment is to alleviate the structural factors of upper airway stenosis [19,20]. It is suitable for patients who can relieve upper airway obstruction through surgery. Commonly used surgical methods include uvula-palate pharyngoplasty and its enhancement, mandibular advancement, anterior and mandibular migration, anterior maxillofacial migration and suspension of the lingual muscular suspension, laser-assisted pharyngoplasty, pharyngeal angioplasty, tracheostomy, bariatric surgery, implant, such as soft abutment implant, hypoglossal nerve stimulation, upper airway surgery reconstruction, soft airway reconstruction, tonsillectomy, adenoidectomy, nasal septoplasty, turbinate radiofrequency ablation or nasal surgery, etc [1-3].

In particular, OS is an effective treatment for OSAS due to mandibular factors [2,21]. OS is a type of surgery that corrects maxillofacial deformities through incisions in the upper and lower jaw. It has a significant relieving effect on OSAS symptoms in patients with upper airway stenosis, especially in small jaw patients. Surgical methods include maxillary and maxillary incision, mandibular incision, mandibular incision, and osteogenic distraction of a small and severe mandibular deformity [21]. Due to the advancement of the maxilla and mandible, the parameters of upper airway volume and upper cross-sectional area of the upper airway were significantly increased compared with those before surgery, which can significantly improve the symptoms of OSAS until it reaches disappearance completeness of symptoms [3,4].

In this surgical context, a case study in a 12-year-old boy with unilateral ankylosis of the temporomandibular joint and OSAS underwent successful surgical release of the ankylosis by opening the mouth [5]. However, he continued to suffer from OSAS, as confirmed by postoperative polysomnography. Thus, OS for mandibular advancement was not favorable due to his young age and mandibular distraction. Osteogenesis was not a choice. A mandibular advancement device similar to the orthodontic myofunctional appliance was the preferred choice postoperatively pending surgical treatment of definitive retrognathism after skeletal maturity. Surgical release of temporomandibular joint ankylosis corrects the oral problem but does not adequately address the narrow pharyngeal air space [5,22].

Moreover, OSAS is a common problem in patients with achondroplasia. One study aimed to evaluate changes in airway volumes after varying degrees of facial skeleton advancement. Six patients with Achondroplasia underwent midface advancement to treat OSAS. Therefore, in patients with OSAS associated with achondroplasia, there are variable improvements in airway volume [23]. This preliminary report suggests that mandibular distraction may provide consistent reductions in the rate of apnea and hypopnea [6,23].

Although maxillomandibular advancement is an orthognathic surgical procedure used to control OSAS, it encounters problems in terms of aesthetic results with pre-existing dentoalveolar protrusion [1,2,23]. Therefore, a prospective study investigated changes in the posterior pharyngeal space and aesthetic outcomes of patients suffering from OSAS after counterclockwise rotational OS [3]. The patients were skeletal class II OS patients. A total of 14 patients were included. Satisfactory results were achieved without complications in all OSAS patients. Airway parameters for anteroposterior length increased significantly. Thirteen patients responded to a questionnaire about facial appearance, and the visual analog scale had an average of 7.31 points, indicating a favorable facial appearance. A counterclockwise rotational OS without advancing the maxilla for OSAS correction can effectively increase the posterior pharyngeal space with favorable aesthetic results [7].

In some patients with severe skeletal Class III, mandibular retraction surgery using sagittal branch osteotomy (SSBO) is performed to correct mandibular protrusion. However, in patients diagnosed with OSAS, the risk of worsening as a result of SSBO is very high [8]. Maxillary advancement can reduce the degree of mandibular retroposition and expand the skeletal structure in the pharyngeal region, leading to an increase in the airway. However, nasal deformity is an undesirable outcome of the procedure. Thus, a case report described a 23-yearold man with maxillary and retrograde OSAS. Maxillary retrusion was treated with Le Fort I osteotomy with alar suture and V-Y mucoperiosteal closure. After treatment, better occlusal relationships and improvement in OSAS were observed [22,23].

Another study explored how mandibular advancement without maxillary involvement would affect the posterior air space in patients with mandibular retrognathism [15]. Cone beam computed tomography (CT) was performed on 20 patients before and six months after mandibular advancement. Cephalometric analysis at both moments included two-dimensional and three-dimensional assessment of the upper airways. Eight men and 12 women had mean preoperative W values (7.4) (1.54) mm, with an airway area of 7.11 (1.88) cm^2 and volume of 14.92 (4.46) cm^3. Six months postoperatively, the Wits value was 2.7 (0.41) mm, the airway area was 11.33 (3.49) cm^2 and the volume was 25.7 (6.10) cm^3. There was an average increase (range) of 59 (22-82)% in area and 73 (29-108)% in volume. A preoperative value equal to or greater than 8.0 mm was significantly correlated with a greater increase in the posterior air space ($p=0.002$). At the same time, an improvement in reasoning value of 4.5 mm or more significantly correlated with an increase in volume ($p=0.016$). The effect of mandibular advancement on the posterior air space was significant, and the volumetric effect appears to be even more relevant than the two-dimensional changes.

Thus, as literary results, Foltán R. et al. [16], in a study on the influence of orthognathic surgery on ventilation during sleep, found a mean age of 22 ± 0.8 years, ranging from 16 to 28 years, which contrasts with our study in which the average patient was older old, 36.50 years old. ± 12.10 years, with ages ranging from 23 to 52 years and a higher prevalence in females. There is little data available on the predominance of facial features. However, Sant'ana E. et al. [17] showed that the Brazilian profile showed a substantial difference when compared to the North American profile.

Conclusion

It was concluded that maxillomandibular advancement surgery is a successful treatment for obstructive sleep apnea, but there are still concerns regarding the aesthetic results due to the major advances involved. Bimaxillary advancement osteotomy significantly increases oropharyngeal volume and contracted superficial areas, which remain stable between 6 months and 1 year postoperatively.

CRediT

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Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

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It was performed.

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