MedNEXT
Journal of Medical an Health Sciences

REVIEW ARTICLE

DOI: 10.54448/mdnt23S103

Major clinical results of orthognathic surgery and maxillomandibular advancement in obstructive sleep apnea syndrome: a concise systematic review

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DOI: https://doi.org/10.54448/mdnt23S103
Received: 08-11-2022; Revised: 11-20-2022; Accepted: 12-28-2022; Published: 01-12-2023; MedNEXT-id: e23S103

Abstract

Introduction: Obstructive sleep apnea involves obstruction or narrowing of an individual's airway during sleep and is associated with several comorbidities. Management can be surgical or nonsurgical, and Phase II of the Stanford Protocol for surgical management involves maxillomandibular advancement. **Objective:** It was to carry out a concise systematic review to present the main considerations and clinical results of orthognathic surgery in obstructive sleep apnea syndrome. **Methods:** The systematic review rules of the PRISMA Platform were followed. The research was carried out from September to November 2022 in 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:** A total of 270 articles were found, 47 articles were evaluated and 23 were included in this systematic review. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 35 studies at high risk of bias and 125 studies that did not meet the GRADE. Most studies showed homogeneity in their results, with I2 =95.9% >50%. Maxillomandibular advancement surgery is a successful treatment for obstructive sleep apnea, but there are still concerns about the aesthetic results due to the great advances involved. The bimaxillary advancement osteotomy significantly increases the oropharyngeal volume and constricted surface areas, which remains stable between 6 months to 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 airway 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 (eg, degree of movement, timing of surgery) and possible complications specific to maxillomandibular advancement need to be discussed as maxillomandibular advancement is effective in the treatment of OSA [1].

In this sense, orthognathic Surgery (OS) corrected the deformities of maxillary and mandibular bones of the OSAS [2,3]. OS 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 area cause respiratory problems and may lead to reduced levels of growth hormone in children [3].

Also, facial deformity with destructive psychological and social potential has a negative impact, which may influence not only the patient's self-confidence but also external relations, resulting in social and psychological disadvantages [4-6]. The objectives of the patient with dentofacial deformity, related to the

repair, are also psychosocial and this can express the expectation of solving their personal and social difficulties with the 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 can occur, which is the airway arrest by the upper airway, in the presence of respiratory effort, lasting more than 10 seconds. Hypopnea, constitutes a reduction in the passage of air, in said area, in this same period. These respiratory events occur innumerable times and exclusively during sleep, determining symptoms and signs that characterize OSAS [9].

Besides, OSAS is related to comorbidities such as systemic arterial hypertension or diabetes mellitus. The prevalence reaches 32% in the general population, ranging from 1% to 20% when it is associated with COPD (overlap syndrome), and is described as over 60% in populations with COPD and obesity (COPD triad, OSAS, and obesity) [9]. The methods of treatment 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 become increasingly recognized [9,10]. Therefore, the present study carried out a concise 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 a systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic review and meta-analysis, access available in: http://www.prisma-statement.org/).

Search Strategy and Search Sources

The literary search process was carried out from September to November 2022 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, addressing scientific articles from various eras to the present day. The descriptors (MeSH Terms) were used "*Obstructive sleep apnea syndrome. Orthognathic Surgery. maxillomandibular advancement*", and using Boolean "and" between MeSH terms and "or" between historical discoveries.

Study Quality and Risk of Bias

Quality was rated as high, moderate, low, or very low for risk of bias, clarity of comparisons, accuracy, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis 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 through the analysis of the Funnel Plot graph (Sample size versus Effect size), using Cohen's test (d).

Results and Discussion

Summary of Findings

As a corollary of the literary search system, a total of 270 articles were found that were submitted to the eligibility analysis, and, then, 23 of the 47 final studies were selected to compose the results of this systematic review. The listed studies showed medium to high quality (**Figure 1**), considering in the first instance the level of scientific evidence of studies in types of study such as meta-analysis, consensus, randomized clinical trial, 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 I2=95.9%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 35 studies with a high risk of bias and 125 studies that did not meet GRADE.

Figure 1. Flowchart showing the article selection process.

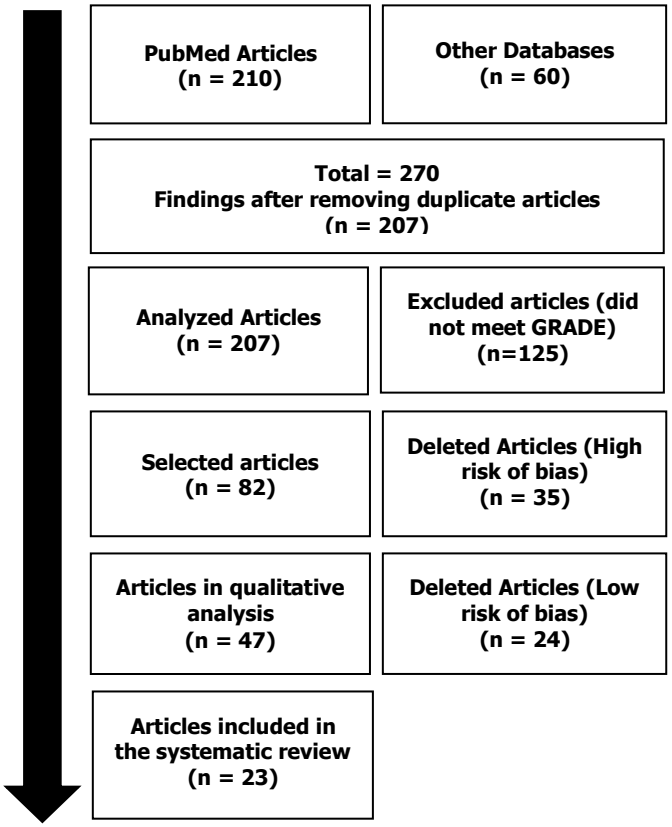
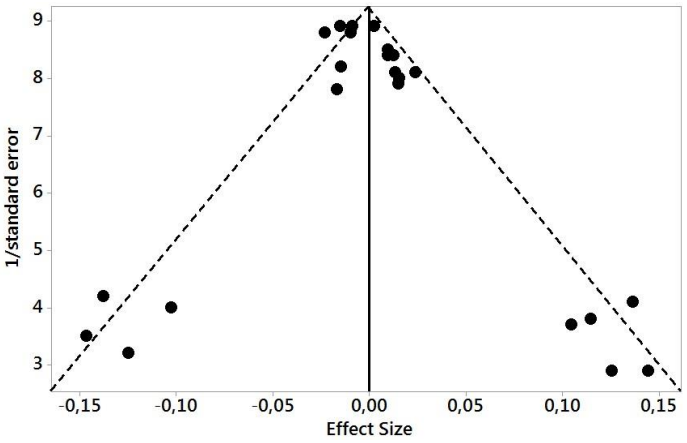


Figure 2 presents the results of the risk of bias of the studies through the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was indirectly determined by the inverse of the standard error (1/Standard Error). This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

Figure 2. The symmetrical funnel plot does not suggest a 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 Findings

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

In this sense, a study carried out by Hassing et al.2022 investigated volumetric and circumferential alterations of the pharyngeal airway space (PAS) and stability over time, assessed with 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 maxillofacial trauma or surgery, obstructive sleep apnea syndrome, or craniofacial anomalies were excluded. Nasopharyngeal, oropharyngeal, and hypopharyngeal SBP volumes and constricted surface areas were measured and compared between each time point with a paired t-test. The greatest significant increase in oropharyngeal volume and surface areas of constriction was seen 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 [12].

In this sense, OSAS refers to when an adult presents at least 30 apneas during 7 hours of nocturnal sleep, at least 10 s or more for each episode; or more than 4% of apnea during apnea or an apnea-hypopnea index (apnea and hypopnea index, AHI, the average number of apnea hypopneas per hour) is greater than 5 times per hour, so 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 aggravate respiratory failure, or cerebrovascular risk factors for accidents, myocardial infarction, and hypertension [14-16]. Early appropriate diagnosis and treatment can significantly improve a 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 alleviate upper airway obstruction through surgery. The surgical methods commonly used include uvulas palate pharyngoplasty (UPPP) and its enhancement, mandibular advancement, anterior and mandibular migration, anterior maxillofacial migration and suspension of lingual muscle suspension, laser-assisted pharyngoplasty, pharyngeal angioplasty, tracheostomy, bariatric surgery, implant surgery such as soft abutment implantation, hypoglossal nerve stimulation, reconstruction of upper airway surgery, soft airway reconstruction, tonsillectomy, adenoidectomy, nasal septoplasty, nasal concha 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 by incising the upper and lower jaws. It has a significant relief effect on

the symptoms of OSAS in patients with upper airway stenosis, especially in small mandibular patients. Surgical methods include maxillary and maxillary incision, mandibular incision, mandibular incision, and osteogenic distraction of a small, severe mandibular deformity [21]. Due to the advancement of the maxilla and mandible, the parameters of the upper airway volume and the upper transverse area of the upper airways were significantly increased compared to those before surgery, which can significantly improve the symptoms of OSAS until reaching the complete disappearance of symptoms [3,4].

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

Furthermore, OSAS is a common problem in patients with achondroplasia. One study aimed to evaluate changes in airway volumes after various degrees of advancement of the facial skeleton. Six patients with achondroplasia were submitted to the advancement of the middle of the face for the treatment of OSAS. Therefore, in patients with OSAS associated with achondroplasia, there are variable improvements in airway volume [23]. This preliminary report suggests that mandibular distraction can provide consistent reductions in the rate of apnea and hypopnea [6,23].

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

Also, in some patients with severe skeletal Class III, mandibular recoil surgery using sagittal branch osteotomy (SSRO) is performed to correct mandibular protrusion. However, in patients diagnosed with OSAS, the risk of worsening as a result of SSRO is very high [8]. The advancement of the maxilla 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-year-old man with maxilla and retrograde OSAS. Maxillary retrusion was treated with Le Fort I osteotomy with alar suture and mucoperiosteal V-Y 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 posterior air space in patients with mandibular retrognathism [15]. Cone-beam computed tomography (CT) was performed on 20 patients before and six months after the mandibular advancement. Cephalometric analysis at both times included two-dimensional and three-dimensional upper airway evaluation. Eight men and 12 women presented preoperative mean W values (7.4) (1.54) mm, with an airway area of 7.11 (1.88) cm2 and volume of 14.92 (4.46) cm3. Six months postoperatively presented a Wits value of 2.7 (0.41) mm, an airway area of 11.33 (3.49) cm2, and a volume of 25.7 (6.10) cm3. There was an average increase (range) of 59 (2282)% of the area and 73 (29-108)% of the volume. A preoperative figure of 8.0 mm or greater was significantly correlated with a greater increase in posterior air space ($p = 0.002$). At the same time, an improvement in the Reasoning value of 4.5mm or more correlated significantly with an increase in volume ($p = 0.016$). The effect of mandibular advancement on posterior air space was significant, and the volumetric effect appears to be even more relevant than 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 an average age of 22 ± 0.8 years, ranging from 16 to 28 years, which contrasts with our study in which the mean of patients was older, 36.50 ± 12.10 years, with ages ranging from 23 to 52 years and with a higher prevalence in the female gender. There is little data available on the predominance of facial features. However, Sant'ana E.

et al. [17] showed that the Brazilian profile presented 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 about the aesthetic results due to the great advances involved. The bimaxillary advancement osteotomy significantly increases the oropharyngeal volume and constricted surface areas, which remains stable between 6 months to 1 year postoperatively.

Acknowledgement

Not applicable.

Funding

Not applicable.

Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

Similarity check

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