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Major considerations of orthognathic surgery in treating obstructive sleep apnea syndrome: a systematic review

Marcely Fonn Martineli[1,2*], Ana Caroliny Barros Torres[1,2], Vinícius Sônego Siqueira Marim[1,2], Andreia Borges Scriboni[1,2]

[1] UNORTE - University Center of Northern São Paulo, Dentistry Department, São José do Rio Preto, São Paulo, Brazil.
[2] UNIPOS - Post Graduate and Continuing Education, Dentistry Department, São José do Rio Preto, São Paulo, Brazil.

*Corresponding author: Marcely Fonn Martineli.
Unorte/Unipos - University Center of Northern São Paulo,
Dentistry Department, and Postgraduate and continuing
education, Sao Jose do Rio Preto, Sao Paulo, Brazil.
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Abstract

Introduction: In the setting of airway obstruction, obstructive sleep apnea syndrome (OSAS) is associated with several comorbidities. Patient evaluation includes a detailed history, clinical and radiographic examination, endoscopy, and polysomnography. Treatment may be nonsurgical or surgical, and Phase II of the Stanford Protocol for surgical treatment involves maxillomandibular advancement. **Objective:** It was conducted a systematic review to present the main considerations of orthognathic surgery in treating obstructive sleep apnea syndrome. **Methods:** The systematic review rules of the PRISMA Platform were followed. The search was carried out from June to August 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:** A total of 92 articles were found. A total of 22 articles were fully evaluated and 17 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 48 studies with a high risk of bias and 22 studies that did not meet GRADE and AMSTAR-2. Most studies showed homogeneity in their results, with X^2=82.4%>50%. It has been concluded that orthodontists should perform appropriate screening for obstructive sleep apnea. This can be done as part of our health history, our clinical examination, and review of radiographs taken for purposes other than diagnosis and screening for OSA. Orthodontic treatment for obstructive sleep apnea syndrome can be helpful and effective. However, this can only be done after referral to the appropriate medical specialist, as part of a multidisciplinary team, with consideration of the likely efficacy of the treatment, and after all likely and potential negative consequences have been considered and discussed thoroughly with the patient. Orthognathic surgery combined with soft tissue surgery is most effective as a curative treatment for obstructive sleep apnea syndrome.

Keywords: Orthognathic Surgery. Obstructive Sleep Apnea Syndrome. Comorbidities. Maxillomandibular advancement.

Introduction

In the setting of airway obstruction, obstructive sleep apnea syndrome (OSAS) is associated with several comorbidities. Patient evaluation includes a detailed history, clinical and radiographic examination, endoscopy, and polysomnography. Treatment may be nonsurgical or surgical, and

Phase II of the Stanford Protocol for surgical treatment involves maxillomandibular advancement. Orthognathic Surgery (OS) corrected the deformities of maxillary and mandibular bones [1,2]. 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 [2,3].

In this context, 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]. Thus, OS treats patients with moderate and severe facial deformities, allowing the achievement of functional balance and harmony in facial aesthetics [7].

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 [8].

Also, 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). 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 [8].

Given this, this study conducted a systematic review to present the major considerations of orthognathic surgery in treating 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: 12/08/2024. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 12/08/2024.

Research Strategy and Search Sources

The literary search process was carried out from June to August 2024 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, covering scientific articles from various eras to the present. The Health Science Descriptors (DeCS /MeSH Terms) were used: "Orthognathic Surgery. Obstructive Sleep Apnea Syndrome. Comorbidities. Maxillomandibular advancement", and using the Boolean "and" between the terms MeSH and "or" between historical discoveries.

Study Quality and Risk of Bias

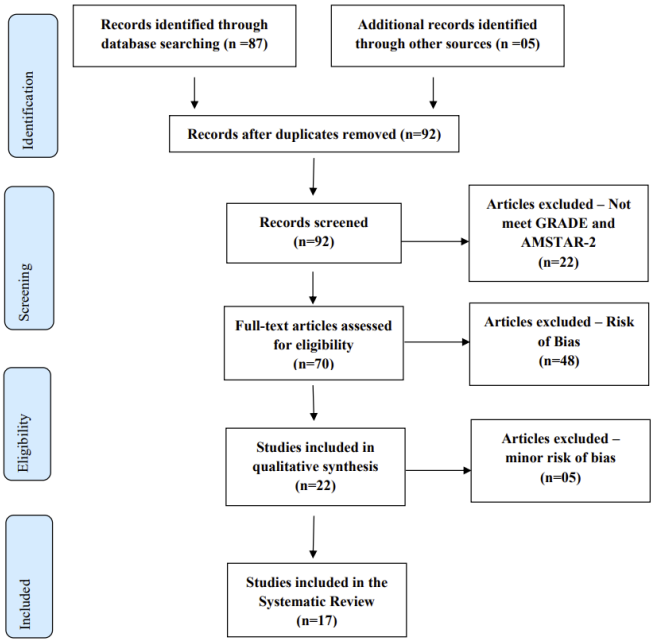
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The 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 92 articles were found that were subjected to eligibility analysis and, subsequently, 17 of the 22 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 metaanalysis, 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=82.4%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 48 studies with a high risk of bias and 22 studies that did not meet GRADE and AMSTAR-2.

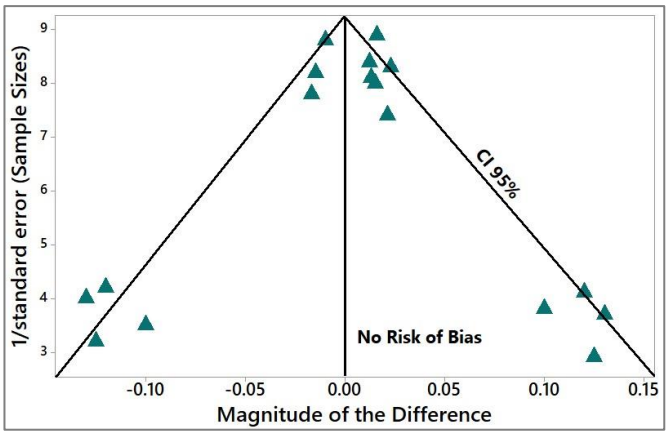
Figure 1. Flow Chart of Study Eligibility.



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=17 studies).



Major Findings

Authors Bègue et al. (2024) [9] compared the efficacy of orthognathic surgery combined with soft tissue surgery with that of soft tissue surgery alone as curative treatments for moderate to severe OSAS through a retrospective cohort study of 50 patients (age ≥18 years) considering apnea-hypopnea index (AHI) >15). A total of 28 (56%) patients underwent orthognathic surgery combined with soft tissue surgery, while 22 (44%) underwent soft tissue surgery alone. There were no significant differences between the groups in sex ($p = 0.53$), age ($p = 0.08$), body mass index ($p = 0.42$), and preoperative AHI ($p = 0.17$). The mean improvement in AHI at 6 months after surgery was significantly greater in the orthognathic surgery group than in the soft tissue surgery group (32.18 vs. 10.41; $p < 0.0001$). Similarly, the mean postoperative AHI was significantly lower in the orthognathic surgery group than in the soft tissue surgery group (8.46 vs. 29.62; $p < 0.0001$).

Also, a recent systematic review study analyzed the factors that may contribute to the development of OSAS after orthognathic surgery in patients with skeletal class III. The occurrence of OSAS after orthognathic surgery in patients with skeletal class III relationships depends on surgical factors and patient self-factors. Surgical factors include the type of surgery, the amount of maxillary and mandibular movement, and the patient's postoperative swelling. Patient etiologies include weight, age, sex, and hypertrophy of the soft palate, tonsils, and tongue. The wider upper airway in patients with skeletal class III may be the reason for the rare occurrence of OSAS after surgery. In addition, the predictors of obesity and advanced age may lead to sleep apnea after orthognathic surgery [10].

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 [1,2,11]. 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 [2,12]. Long-term presence may cause or aggravate respiratory failure, or cerebrovascular risk factors for accidents, myocardial infarction, and hypertension [3,13-15]. Early appropriate diagnosis and treatment can significantly improve patients' quality of life, reduce sudden death, and prevent various complications [16-22].

Thus, the basic principle of surgical treatment is to alleviate the structural factors of upper airway stenosis [1,7]. It is suitable for patients who can alleviate upper airway obstruction through surgery. The surgical methods commonly used include uvulus palate pharyngoplasty 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, ectomy, nasal septoplasty, nasal turbinate radiofrequency ablation or nasal surgery, etc [3].

In particular, OS is an effective treatment for OSAS due to mandibular factors. 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. 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 [1-3].

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 [1]. 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 [2,3].

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. This preliminary report suggests that mandibular distraction can provide consistent reductions in the rate of apnea and hypopnea [5].

In addition, although maxillomandibular advancement (MMA) is an orthognathic surgical procedure used to control OSAS, it encounters problems in terms of aesthetic results with pre-existing dentoalveolar protrusion. Thus, a prospective study investigated changes in posterior pharyngeal space and aesthetic outcomes of patients suffering from OSAS after OS rotational counter-clockwise [6]. Patients were skeletal class II patients undergoing 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 [2,6].

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. The advancement of the maxilla can reduce the degree of mandibular retro positioning and expand the skeletal structure in the pharyngeal region, leading to an increase in the airway. However, the 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 (ACVY). After treatment, better occlusal relationships and improvement in OSAS were observed [3,7].

Another study explored how mandibular advancement without maxillary involvement would affect posterior air space in patients with mandibular retrognathism. Cone-beam computed tomography (CT) was performed for 20 patients before and six months after the mandibular advancement. Cephalometric analysis at both moments 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 airway area of 7.11 (1.88) cm^2 and volume of 14.92 (4.46) cm^3. Six months postoperatively presented a Wits value of 2.7 (0.41) mm, an airway area of 11.33 (3.49) cm^2, and a volume of 25.7 (6.10) cm3. There was an average increase (range) of 59 (22-82)% 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 [14].

Thus, as literary results, Foltán R. et al. [15], 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 were 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. [16] showed that the Brazilian profile presented a substantial difference when compared to the North American profile.

Also, Faria et al. [17], demonstrated, through comparisons of cephalometric radiographs, that in each millimeter of maxillo-mandibular advancement, there is an increase of 0.76 mm in the retropalatal region and 1.2 mm in a retrolingual region. However, there was a decrease in the upper airway space in patients submitted to maxillary advancement associated with mandibular retreat, confirming with Mattos et al. [18] that in orthognathic surgery mandibular retreatment leads to a decrease in parapharyngeal space and maxillary advances, combined with indentations can lead to a moderate decrease in the upper airways.

Conclusion

It has been concluded that orthodontists should perform appropriate screening for obstructive sleep apnea. This can be done as part of our health history, our clinical examination, and review of radiographs taken for purposes other than diagnosis and screening for OSA. Orthodontic treatment for obstructive sleep apnea syndrome can be helpful and effective. However, this can only be done after referral to the appropriate medical specialist, as part of a multidisciplinary team, with consideration of the likely efficacy of the treatment, and after all likely and potential negative consequences have been considered and discussed thoroughly with the patient. Orthognathic surgery combined with soft tissue surgery is most effective as a curative treatment for obstructive sleep apnea syndrome.

CRediT

Author contributions: **Conceptualization -** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim, Andreia Borges Scriboni; **Data curation -** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim; **Formal Analysis -** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim, Andreia Borges Scriboni; **Investigation-** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim; **Methodology-** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim; **Project administration-** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim; **Supervision-**Andreia Borges Scriboni; **Writing - original draft -** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim, Andreia Borges Scriboni; **Writing-review & editing-** Marcely Fonn Martineli, Ana Caroliny Barros Torres, Vinícius Sônego Siqueira Marim, Andreia Borges Scriboni.

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Conflict of Interest

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It was performed.

References

1. Kazmierski RH. Obstructive sleep apnea: What is an orthodontist's role? Prog Orthod. 2024 Jul 1;25(1):21. doi: 10.1186/s40510-024-00524-4.
2. Francisco I, Nunes C, Baptista Paula A, Marques F, Prata Ribeiro M, McEvoy M, Santos M, Oliveira C, Marto CM, Spagnuolo G, Carrilho E, Travassos R, Vale F. Patient-Reported Outcomes of Maxillomandibular Surgery for Obstructive Sleep Apnea Treatment: A Scoping Review. J Clin Med. 2024 Feb 21;13(5):1232. doi: 10.3390/jcm13051232.
3. Quah B, Sng TJH, Yong CW, Wen Wong RC. Orthognathic Surgery for Obstructive Sleep Apnea. Oral Maxillofac Surg Clin North Am. 2023 Feb;35(1):49-59. doi: 10.1016/j.coms.2022.06.001.
4. Shaeran TAT, Samsudin AR.Temporomandibular Joint Ankylosis Leading to Obstructive Sleep

Apnea. J Craniofac Surg. 2019 Jun 28. doi: 10.1097/SCS.0000000000005689. [Epub ahead of print]

5. Susarla SM, Mundinger GS, Kapadia H, Fisher M, Smartt J, Derderian C, Dorafshar A, Hopper RA. Subcranial and orthognathic surgery for obstructive sleep apnea in achondroplasia. J Craniomaxillofac Surg. 2017 Dec;45(12):2028-2034. doi: 10.1016/j.jcms.2017.09.028. Epub 2017 Oct 5.
6. Jeong WS, Kim YC, Chung YS, Lee CY, Choi JW. Change in Posterior Pharyngeal Space After Counterclockwise Rotational Orthognathic Surgeryfor Class II Dentofacial Deformity Diagnosed With Obstructive Sleep Apnea Based on Cephalometric Analysis. J Craniofac Surg. 2017 Jul;28(5):e488-e491. doi: 10.1097/SCS.0000000000003761.
7. Ishida T, Manabe A, Yang SS, Watakabe K, Abe Y, Ono T. An orthodonticorthognathic patient with obstructive sleep apnea treated with Le Fort I osteotomy advancement and alar cinch suture combined with a muco-musculo-periosteal V-Y closure to minimize nose deformity. Angle Orthod. 2019 Jan 30. doi: 10.2319/052818-406.1.
8. Wan HC, Zhou XD, Zou SJ, Zhu SS, Liu YF, Zhou GY, Zheng GN, Yang JN, He YH. Oral treatment for obstructive sleep apnea syndrome. Hua Xi Kou Qiang Yi Xue Za Zhi. 2018 Dec 1;36(6):581-589. doi: 10.7518/hxkq.2018.06.001.
9. Bègue L, Raoul G, Barry F, Nicot R. Effectiveness of orthognathic surgery by maxillomandibular advancement combined with soft tissue surgery as curative treatment for obstructive sleep apnea syndrome. J Stomatol Oral Maxillofac Surg. 2024 Sep 12:102075. doi: 10.1016/j.jormas.2024.102075.
10. Wei Z, Jiang H, Wang S, Wang Z, Qu B, Hu M. Influencing factors for the development of obstructive sleep apnea after orthognathic surgery in skeletal class III patients: A systematic review. J Craniomaxillofac Surg. 2024 Apr;52(4):503-513. doi: 10.1016/j.jcms.2024.02.014.
11. Jang SI, Ahn J, Paeng JY, Hong J. Three-dimensional analysis of changes in airway space after bimaxillary orthognathic surgerywith maxillomandibular setback and their association with obstructive sleep apnea. Maxillofac Plast Reconstr Surg. 2018 Nov 9;40(1):33. doi: 10.1186/s40902-018-0171-3.
12. Gong X, Li W, Gao X. Effects of Craniofacial Morphology on Nasal Respiratory Function and Upper Airway Morphology. J Craniofac Surg. 2018 Oct;29(7):1717-1722. doi: 10.1097/SCS.0000000000004638.
13. Louro RS, Calasans-Maia JA, Mattos CT, Masterson D, Calasans-Maia MD, Maia LC. Three-dimensional changes to the upper airway after maxillomandibular advancement with counterclockwise rotation: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2018 May;47(5):622-629. doi: 10.1016/j.ijom.2017.11.003. Epub 2017 Nov 26.
14. Dalla Torre D, Burtscher D, Widmann G, Rasse M, Puelacher T, Puelacher W. Long-term influence of mandibular advancement on the volume of the posterior airway in skeletal Class II-patients: a retrospective analysis. Br J Oral Maxillofac Surg. 2017 Oct;55(8):780-786. doi: 10.1016/j.bjoms.2017.06.005. Epub 2017 Jun 29.
15. Foltán R., Hoffmannová J., Pavlíková G., Hanzelka T., Klíma K., Horká E., Adámek S., Sedý, J. The influence of orthognathic surgery on ventilation during sleep. Int. J. Oral Maxillofac. Surg. 2011;40: 146-149.
16. Sant´Ana E., Furquim LZ, Rodrigues MTV, Kuriki EU, Pavan AJ, Camarini ET, Iwaki Filho L. Planejamento digital em cirurgia ortognática: precisão, previsibilidade e praticidade. Rev ClinOrtodon Dental Press. Maringá.2006:5:2:92-102.
17. Faria AC, Xavier SP, Silva Jr. SN, VoiTrawitzki LV, de Melo-Filho FV. Cephalometric analysis of modifications of pharynx due to maxilla-mandibular advancement surgery in patients with obstructive sleep apnea. Int J Oral MaxillofacSurg.2013;42:579-584.
18. Mattos C.T., Vilani G.N.L., Sant´Anna E.F., Ruellas A.C.O., Maia L.C.: Effects of orthognathic surgery on oropharyngeal airway: a meta-analysis. Int. J. Oral Maxillofac.Surg.2011; 40: 1347-1356.
19. O'brien K, Wright J, Conboy F. et al. Prospective, multi-center study of the effectiveness of orthodontic/orthognathic surgery care in the United Kingdom. American Journal of Orthodontics and Dentofacial Orthopedics, 2009, v. 135, n. 6, p. 709-714.
20. Proffit WR, Jackson TH, Turvey TA. Changes in the pattern of patients receiving surgicalorthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics, 2013, v. 143, n. 6, p. 793-798.
21. Farhad B. Naini, Daljit S. Gill. Orthognathic Surgery: Principles, Planning and Practice is a

definitive clinical guide to orthognathic surgery, from initial diagnosis and treatment planning to surgical management and postoperative care. WileyOnline Library. 23 DEC 2016. DOI: 10.1002/9781119004370.

22. Jaspers GW, Booij A, De Graaf J, De Lange, J. Long-Term Results of Maxillomandibular Advancement Surgery In Patients With Obstructive Sleep Apnoea Syndrome. J Oral Maxillofac Surg, 2013, v. 51, n. 3, p. 37-39.