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Original Research

Impact of Volumetric Changes in the Upper Airways after Orthognathic Surgery: Study Pilot

Impacto das Alterações Volumétricas nas Vias Aéreas Superiores após Cirurgia Ortognática: Estudo Piloto

Impacto de los Cambios Volumétricos en las Vías Respiratorias Superiores después de la Cirugía Ortognática: Estudio Piloto

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Abstract

OBJECTIVE: The aim of the present study was to assess volumetric changes in the upper airways of patients submitted to orthognathic surgery and the impact on quality of life. METHODS: The study evaluated clinical and psychosocial aspects of patients undergoing orthognathic surgery at Hospital Getúlio Vargas in the city of Recife, Brazil, in 2019 and 2020. A prospective longitudinal study pilot was carried out. Quality of life, self-esteem, obstructive sleep apnea syndrome symptoms and upper airway volume changes were assessed preoperatively and over one year postoperatively. RESULTS: Eight patients (three men and five women) agreed to participate in the study and answered the questionnaires in the preoperative and postoperative periods. Three were between 18 and 24 years of age and five were between 25 and 44 years of age. Half of the patients had the long face pattern (50%) and most had occlusal pattern III (87.5%). Although the average volume and minimum cross-sectional area had diminished in the overall sample, a reduction occurred in signs and symptoms of obstructive sleep apnea syndrome. Surgery also had a strong impact on quality of life assessed using the OHIP-14 and orthognathic quality of life questionnaire. CONCLUSION: Orthognathic surgery exerts a positive impact on quality of life and self-esteem. However, airway size is not a determinant of this improvement.

Descriptors: Orthognathic Surgery; Quality of Life; Obstructive Sleep Apnea; Oral Surgery.

Resumo

OBJETIVO: O objetivo do presente estudo foi avaliar as alterações volumétricas das vias aéreas superiores de pacientes submetidos à cirurgia ortognática e o impacto na qualidade de vida. MÉTODOS: O estudo avaliou aspectos clínicos e psicossociais de pacientes submetidos à cirurgia ortognática no Hospital Getúlio Vargas, na cidade de Recife, Brasil, em 2019 e 2020. Foi realizado um estudo piloto longitudinal prospectivo. Qualidade de vida, autoestima, sintomas da síndrome da apnéia obstrutiva do sono e alterações no volume das vias aéreas superiores foram avaliados no pré-operatório e ao longo de um ano de pós-operatório. RESULTADOS: Oito pacientes (três homens e cinco mulheres) concordaram em participar do estudo e responderam aos questionários no pré e pós-operatório. Três tinham entre 18 e 24 anos e cinco tinham entre 25 e 44 anos. Metade dos pacientes apresentava padrão face longa (50%) e a maioria apresentava padrão oclusal III (87,5%). Embora o volume médio e a área transversal mínima tenham diminuído na amostra geral, ocorreu redução nos sinais e sintomas da síndrome da apneia obstrutiva do sono. A cirurgia também teve forte impacto na qualidade de vida avaliada pelo OHIP-14 e pelo questionário ortognático de qualidade de vida. CONCLUSÃO: A cirurgia ortognática exerce impacto positivo na qualidade de vida e na autoestima. No entanto, o tamanho das vias aéreas não é um determinante desta melhoria.

Descritores: Cirurgia Ortognática, Qualidade de Vida, Apneia Obstrutiva do Sono, Cirurgia Oral.

Resumen

OBJETIVO: El objetivo del presente estudio fue evaluar los cambios volumétricos en las vías respiratorias superiores de pacientes sometidos a cirugía ortognática y el impacto en la calidad de vida. MÉTODOS: El estudio evaluó aspectos clínicos y psicosociales de pacientes sometidos a cirugía ortognática en el Hospital Getúlio Vargas de la ciudad de Recife, Brasil, en 2019 y 2020. Se realizó un estudio piloto longitudinal prospectivo. La calidad de vida, la autoestima, los síntomas del síndrome de apnea obstructiva del sueño y los cambios en el volumen de las vías respiratorias superiores se evaluaron antes de la operación y más de un año después de la operación. RESULTADOS: Ocho pacientes (tres hombres y cinco mujeres) aceptaron participar en el estudio y respondieron los cuestionarios en el preoperatorio y postoperatorio. Tres tenían entre 18 y 24 años y cinco entre 25 y 44 años. La mitad de los pacientes tenía el patrón de cara larga (50%) y la mayoría tenía el patrón oclusal III (87,5%). Aunque el volumen promedio y el área transversal mínima habían disminuido en la muestra general, se produjo una reducción en los signos y síntomas del síndrome de apnea obstructiva del sueño. La cirugía también tuvo un fuerte impacto en la calidad de vida evaluada mediante el OHIP-14 y el cuestionario de calidad de vida ortognática. CONCLUSIÓN: La cirugía ortognática ejerce un impacto positivo en la calidad de vida y la autoestima. Sin embargo, el tamaño de las vías respiratorias no es un determinante de esta mejora.

Descriptores: Cirugía ortognática, Calidad de vida, Apnea obstructiva del sueño, Cirugía Oral.

INTRODUCTION

Functional dentofacial deformities are defined as severe malocclusion problems that require orthodontic treatment and orthognathic surgery. Such deformities are deviations from normal facial and dental relationships that are severe enough to become disabling[1,2]. Orthognathic surgery is a branch of oral-maxillofacial surgery for the treatment of dentofacial deformities, enabling the correction of the occlusion as well as improvements in breathing, quality of life, self-esteem, facial esthetics and, possibly, muscle and joint pain[3]. Some of the conditions for the indication of orthognathic surgery include chewing difficulty, phonetic problems, orthodontic problems, chronic pain in the maxillomandibular region,

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difficulty opening the mouth, facial asymmetry, lip incompetence, chronic mouth breathing and sleep apnea[3-6].

As orthognathic surgery results not only in the correction of the occlusion, but also a change in facial esthetics, psychosocial aspects are directly related to ortho-surgical treatment[3]. Facial changes exert an impact on one's personal and social life due to the psychological state of the patient being prepared for treatment[7]. Quality of life is related to the perceptions of individuals regarding their position in life, cultural context and value system as well as goals, expectations, standards and proportions[8]. Half of patients with dentofacial deformities have low self-esteem and unhappiness and expect surgery to improve their social life.[9] Therefore, the perceptions of patients with regards to their physical and emotional state and quality of life are crucial to treatment[7].

Obstructive sleep apnea syndrome (OSAS) is a condition related to dentofacial deformities and is characterized by snoring, excessive daytime sleepiness and episodes of apnea[10]. Excessive daytime sleepiness is associated with automobile accidents, diminished cognition, which can affect work productivity, and behavioral changes[7]. An increased risk of complications resulting from nocturnal hypoxia and hypercapnia, such as cardiovascular and neurological problems, may be associated with OSAS. Thus, patients with deformities that contribute to the narrowing of the pharyngeal space during sleep may benefit from orthognathic surgery[11-13].

Surgical procedures during orthognathic surgery affect the position of the muscles and soft tissues linked to the maxilla and mandible, exerting an impact on the nasal cavity, oral cavity as well as the shape and volume of the upper airways[14,15]. Maxillomandibular advancement surgery is recommended for the correction of the skeletal deformities that are most associated with OSAS by increasing the dimensions of the oropharynx[16]. Therefore, the aim of the present study was to assess volumetric changes in the upper airways of patients submitted to orthognathic surgery and the impact on quality of life.

MATERIAL AND METHOD

A prospective, descriptive, longitudinal, case-series study pilot was conducted with a convenience sample of eight patients undergoing orthognathic surgery. Assessments were performed in the preoperative period as well as throughout one year postoperatively on how the deformity and surgery exerted impacts on quality of life. This study was developed at Getúlio Vargas Hospital in the city of Recife, Brazil, in the period between January 2019 and December 2020.

Patients between 18 and 59 years of age with skeletal dentofacial deformities were included. All volunteers needed to be treated based on the standard operating procedure for orthognathic surgery of the hospital.[17] and agree to participate by signing a statement of informed consent. Individuals not submitted to the surgical procedure at Getúlio Vargas Hospital, those younger than 18 or older than 59 years of age, those who declined to participate in the study, those having previously undergone orthognathic surgery, those with degenerative diseases of the temporal mandibular joint, those with a history of jaw fractures, those with syndromes of the maxillofacial region and those with cleft lip/palatal were excluded from the study.

The clinical history of the patients was taken with the aid of the questionnaire used by Arnett and McLaughlin.[18] to collect data on general health and dental health in the preoperative period. Sex, age group, facial pattern and occlusal pattern[17] were recorded during the first appointment of each patient. Facial and occlusal patterns were classified by two assessors. In cases of doubt regarding the classification of the patterns, a third assessor was consulted.

The volume and minimum cross-sectional area of the pharynx were quantified using helicoidal tomography with the aid of the SIEMENS SOMATOM Scope® tomograph in the preoperative period and one year postoperatively. Using the NemoFAB - NEMOTEC® software program, the selected region of the pharynx was demarcated superiorly by a line from the posterior nasal spine to the basion and inferiorly by a horizontal line passing through the inferoanterior portion of cervical vertebra C4 (Figure 1).

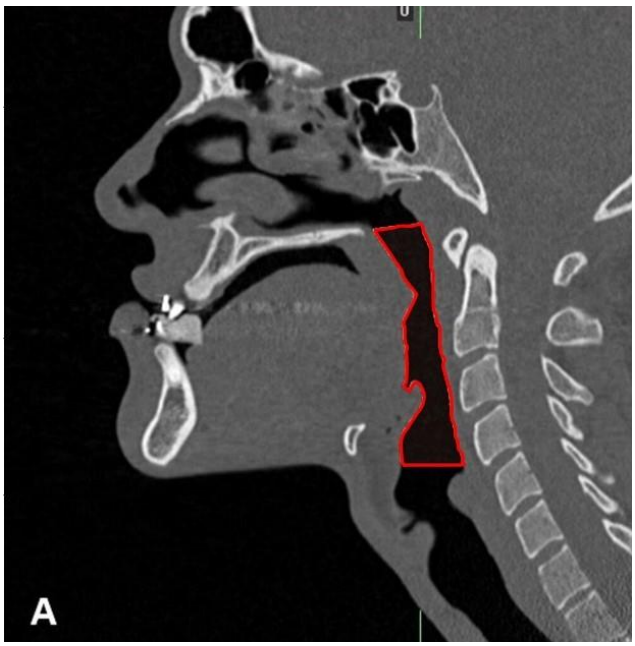

Figure 1: Demarcation of pharynx by line from posterior nasal spine (PNS) to basion superiorly and horizontal line passing through the inferoanterior portion of cervical vertebra C4 inferiorly.

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These limits were chosen for corresponding to the areas of the oropharynx and hypopharynx where points of narrowing and obstruction commonly occur[12,15].

Signs and symptoms of OSAS were investigated using the Epworth Sleepiness Scale, which quantifies the likeliness of dozing during eight routine situations. A score of 0 to 9 is considered normal, whereas a score of 10 to 24 is considered indicative of excessive sleepiness that should be investigated.[19] The impact of the functional dentofacial deformity on quality of life and self-esteem was investigated using the Orthognathic Quality of Life Questionnaire (OQLQ) and Oral Health Impact Profile (OHIP-14). The OQLQ [20] was administered in the preoperative period as well as 30 days, 90 days and one year postoperatively. This questionnaire has 22 items addressing social aspects, facial esthetics, oral function and concern with the deformity. Each item is scored on a five-point scale ranging from zero (does not apply/'does not bother me') to 4 ('bothers me a lot'). The total ranges from 0 to 88 points, with higher scores denoting a greater negative impact of the deformity.

The OHIP-14[21] was also administered in the preoperative period as well as 30 days, 90 days and one year postoperatively. This questionnaire is composed of 14 items addressing physical limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. Each item is scored on a five-point scale ranging from 0 (never) to 4 (very often). The total ranges from 0 to 56 points, with higher scores denoting a greater impact on quality of life.

This study was conducted in accordance with the norms governing research involving human subjects stipulated in Resolution nº 466 of the National Board of Health.[22] The project for the study was submitted for approval through Platform Brazil and received approval from the Human Research Ethics Committee (protocol number: 23038319.0.0000.5613; approval number: 3.851.080).

The study did not involve physical or surgical risks, as the patients had dentofacial deformities and were submitted to surgery independently of participation in the study. Therefore, a possible risk of the study was embarrassment upon answering the questionnaires. In such cases, the participant would be promptly sent to the psychology service of the hospital with no negative impact on the continuity of treatment. The expected benefits of this study are a contribution to better postoperative results in patients undergoing orthognathic surgery and the assessment of the impact on sleep quality resulting from volumetric changes in the upper airways.

The data were analyzed descriptively with the calculation of absolute and relative (%) frequencies for categorical variables. Numerical variables were expressed as mean, standard deviation (SD), coefficient of variation (CV), minimum, median, interquartile range (25th to 27th percentile) and maximum values.

RESULTS

Eight volunteers (three men and five women) participated in the study. Three participants were between 18 and 24 years of age and five were between 25 and 44 years of age. Half of the participants (50%) had the long face pattern and most (87.5%) had occlusal pattern type III (Table 1). No participants had a medical history that could exert an influence on the surgical procedure. The reasons for undergoing orthognathic surgery were investigated with the aid of the questionnaire proposed by Arnett and McLaughlin[18] and are displayed in Figures 2, 3 and 4.

Tabela 1: Demographic characteristics, facial pattern and occlusal pattern of the participants.

Variable	Sample Total n (%)
Group Total	8 (100,0)
Age group (years)	
18 a 24	3 (37,5%)
25 a 44	5 (62,5%)
Gender	
Male	3 (37,5%)
Female	5 (62,5%)
Facial pattern	
II	2 (25%)
III	1 (12,5%)
Long Face	4 (50%)
Short Face	1 (12,5%)
Occlusal pattern	
II	1 (12,5%)
III	7 (87,5%)

Source: Research Data

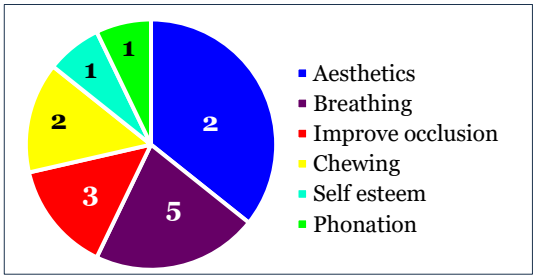

Figure 2: Graphic representation of participants' answers to **"**Why do you want treatment with orthognathic surgery?"

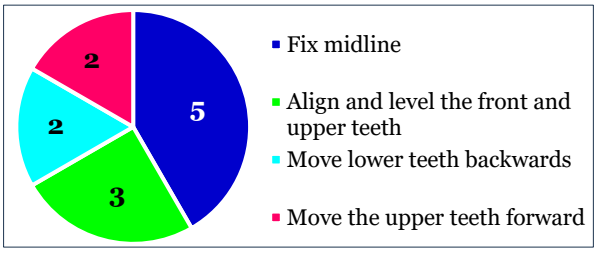

Figure 3: Graphic representation of participants' answers to "What would you like to change in your teeth?"

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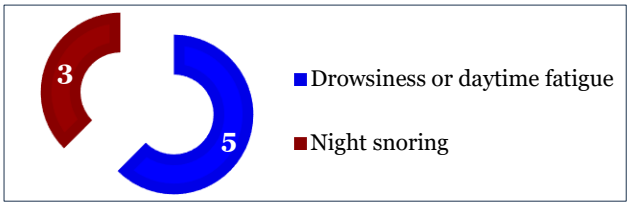

Figure 4: Graphic representation of participants' answers to "What symptoms of obstructive sleep apnea do you want to treat?"

The facial patterns, occlusal patterns and anteroposterior movements of the anterior nasal spine, Point A, Point B and pogonion are described in Table 2.

Table 2: Medical history of participants

	YES	NO
Currently under medical care?	1	7
Undergoing transplant surgery?	0	8
Hospitalized in the last 2 years?	1*	7
Medication in the last 6 months?	3**	5
Allergy?	1	7
Do you smoke?	0	8
Bad experience with anesthesia?	0	8
Pregnant?	0	8
Do you use drugs?	0	8
Tuberculosis?	0	8
Persistent cough?	0	8
Vaccinated against tuberculosis?	1	7
HIV?	0	8
Shortness of breath/fatigue?	2	6
Do you rest after climbing stairs?	2	6
Swollen feet during the day?	0	8
Waking up short of breath?	1	7
Have you ever slept sitting up?	1	7
Do you use more than one pillow?	1	7
Chest pain during exercise?	2	6
Whispering sound when breathing?	1	7
Did you feel signs of arrhythmia?	3	5
Osteoporosis?	0	8

Source: Research Data
*Participant reported recent hospitalization for kidney stone treatment.
** Reported medications: oral contraceptive (Adoless), Metformin Hydrochloride 500mg andLosartan Potassium 50mg.
***Diseases reported by individuals: diabetes, anemia and drop in blood pressure.

Differences in the score of the Epworth Scale of the different patients between the preoperative period and one year postoperatively are shown in Figure 5.

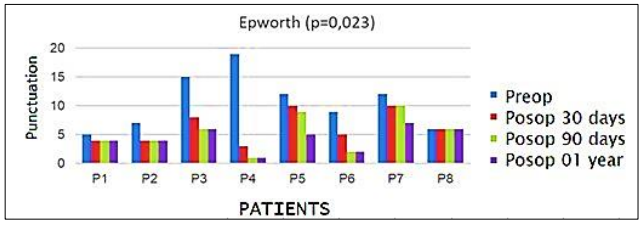

Figure 5: Assessment of sleepiness using Epworth Scale throughout one-year follow-up after orthognathic surgery.

Table 3 displays the mean Epworth, OQLO and OHIP-14 scores in the preoperative period as well as 30 days, 90 days and one year postoperatively.

In the assessment of quality of life using the OHIP-14, OQLQ and Epworth Sleepiness Scale, mean scores presented a decreasing trend throughout the one-year postoperative period for all questionnaires.

Table 3: Participants' orthodontic history

	n
Do you observe or have you observed the following habits?	
Mouth breathing	3
Interposition of the tongue	1
Finger suction	2
Pacifier sucking	1
Procedures performed or planned	
Exodontia	8
Orthodontic and/or orthopedic appliances	2
Elastics	2
What treatment do you think you need?	
Surgery on the maxilla and mandible	7
Plastic surgery	1
Surgery for OSAS	1
Are you currently wearing braces?	
Yes	8
No	0
How long in total? (years)	
Mean ± Standard Deviation	6 ± 3,08
Minimum	3
Maximum	12

Source: Research Data

Figures 6 and 7 show the volume and minimum cross-sectional area of the upper airways of the patients in the preoperative period and at the one-year postoperative assessment, respectively. An increase in these measures after orthognathic surgery occurred in only two patients.

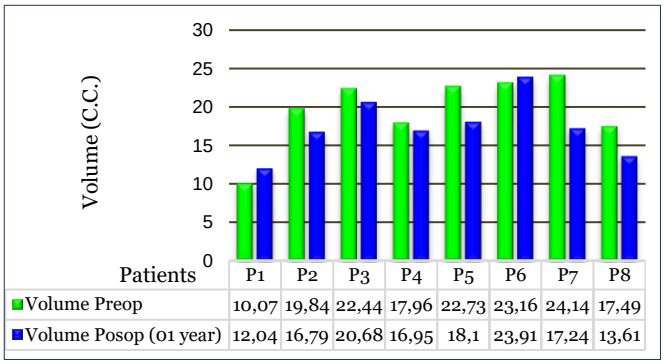

Figure 6: Airway volume of patients in preoperative period and one year after orthognathic surgery.

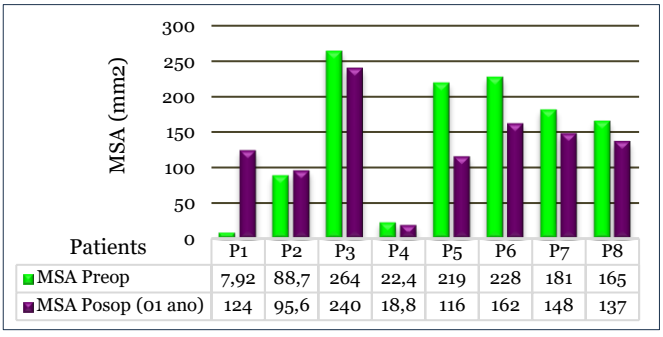

Figure 7: Minimum cross-sectional area (MCA) of airways in patients in preoperative period and one year after orthognathic surgery.

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Table 4 displays the mean volume and minimum cross-sectional area of the patients in the preoperative period and one year postoperatively, showing a reduction in both measures. The type of dento-facial deformity of each of the study group members, the type of orthognathic surgery performed and the magnitude of the movement is described in Table 5.

Table 4: Joint disc symptoms reported by participants

Disk symptoms	*Law*	*Left*
Has your mouth opening narrowed?	0	0
Do you hear popping near your ear(s)?	3	1
Do you feel pain in your ear?	0	1

Source: Research Data

Table 5: Type of dento-facial deformity, the type of orthognathic surgery performed and the magnitude of the movement

Patients	Facial pattern	Occlusal pattern	Type Surgery	ENA	Point A	Point B	Pogonium
P1	II	III	Maxilla, mandible and chin	2.55mm	3.13mm	3.47mm	9.19mm
P2	Long Face	III	Maxilla, mandible and chin	3.82mm	3.99mm	1.82mm	8.98mm
P3	III	III	Maxilla, mandible and chin	2.81mm	2.30mm	- 4.65mm	- 2.00mm
P4	II	II	Maxilla, mandible and chin	1.94mm	2.18mm	11.18mm	13.08mm
P5	Long Face	III	Maxilla, mandible and chin	4.52mm	4.22mm	- 4.72mm	- 6.09mm
P6	Long Face	III	Maxilla, mandible and chin	4.94mm	5.07mm	- 1.81mm	1.48mm
P7	Long Face	III	Maxilla, mandible and chin	5.08mm	4.84mm	- 2.74mm	- 5.44mm
P8	Short Face	III	Maxilla, mandible and chin	5.45mm	4.93mm	0.92mm	- 2.81mm

Source: Research Data

DISCUSSION

Orthognathic surgery is a procedure that enables the movement of the jaws and adjacent soft tissues to ensure occlusal and facial harmony.[14] This procedure leads to morphological and positional changes in different structures of the stomatognathic system, corrects functional disorders and improves esthetics[3,4,17]. Although dentofacial deformities are defined as severe malocclusion problems associated with abnormal facial proportions, the present findings revealed that esthetics was the main reason for seeking orthognathic surgery. This is in agreement with data described in previous studies, which reported that dissatisfaction with one's facial appearance was of the major factors related to seeking ortho-surgical treatment[1,2]. Individuals with functional dentofacial deformities are accompanied by signs and symptoms of the deformity over the years and tend to become accustomed to the functional abnormalities. However, esthetic factors, although present the entire time, can cause psychosocial disorders resulting from daily discrimination from people in one's social circles[1,2].

Another reason cited was breathing, which can be worrisome if related to OSAS. The combination of snoring, excessive daytime sleepiness and episodes of apnea can potentially cause morbidity and mortality due to the increased risk of automobile accidents as well as cardiovascular, neurological and psychological problems[11]. Polysomnography for measuring the quantity of episodes of apnea was not possible in the present study, but five of the eight patients reported excessive daytime sleepiness or fatigue and three reported snoring. Indeed, the mean score on the Epworth scale in the preoperative period was indicative of excessive sleepiness (scores higher than 9 points).

Most studies indicate that the prevalence of OSAS is higher among patients with facial pattern II due to mandibular retrognathism.[23,24] Maxillomandibular advancement is believed to be ideal in such cases for moving bone structures and suprahyoid tissues anteriorly, which improves symptoms of OSAS, whereas retraction could lead to the worsening of symptoms[16,25-27]. This makes surgical planning difficulty in patients with a facial pattern that requires mandibular retraction or clockwise occlusal plane rotation, as such movements lead to the narrowing of the airway[25-28].

In this study, only two patients had facial pattern II, whereas four had the long face pattern, one had the short face pattern and one had facial pattern III. Besides the difference in facial patterns, there was also a variety of anteroposterior movements, even for patients with the same facial pattern. However, the Epworth Scale revealed a reduction in symptoms in all cases, except one patient who maintained the same score throughout the one-year follow-up period. Thus, the retropositioning of the mandible and chin may not necessarily be a counterproductive movement for these patients.

In the analysis of the volume and minimum cross-sectional area of the pharynx, an increase in these measures was found in only two of the patients, whereas a reduction in airway volume was found in the overall sample. From the anatomical standpoint, one may infer that a smaller airway is related to greater obstruction of the passage of air and, consequently, more symptoms of OSAS. However, a significant improvement in symptoms was found among the patients of this study independently of the facial pattern and movement performed during surgery.

A previous study assessed sleep quality following mandibular retraction and found no increase in symptoms of OSAS[29]. In the analysis of 50 patients with skeletal class III malocclusion, pharynx volume diminished significantly and the apnea/hypopnea index increased in some patients.

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Nonetheless, the patients' answers to the questionnaires revealed no difference in symptoms. Thus, the dimensions of the upper airways did not exert an impact on the daily routine of these individuals. One may therefore suggest that airway size *per se* is not a determinant for the occurrence of OSAS and other aspects should be assessed to define surgical planning in patients with respiratory complaints, such as body weight, tissue flaccidity, muscle tone and position of the hyoid bone[26,30,31].

Orthognathic surgery is a procedure that generates considerable expectations in terms of the impact on quality of life. Therefore, the psychosocial aspects of patients should be considered to ensure a satisfactory result[20,30,31]. The OQLQ and OHIP-14 were used in the present investigation to measure quality of life and self-esteem among the patients, the results of which revealed improvements in these aspects. This agrees with data described in the literature. Indeed, a systematic review involving the analysis of 30 articles found improvements in the quality of life of the participants in terms of both physical and psychological aspects as well as high rates of patient satisfaction after orthognathic surgery[32].

Despite the small sample size, all patients in this study presented improvements in aspects such as functional limitation, physical pain, psychological discomfort, physical disability, social aspects, facial esthetics, oral function, concern with the deformity and breathing. Thus, although airway size diminished in the overall sample, improvements occurred with regards to the symptoms of OSAS, even in patients submitted to mandibular retraction, contributing to improvements in quality of life and self-esteem. This shows that factors that yet need to be discovered may clarify the association between airway size and the occurrence of OSAS. Thus, further studies are needed with a greater number of patients separated into different groups based on facial and occlusal patterns.

CONCLUSION

In the present study, most patients were women, between 25 and 44 years of age, with the long face pattern and occlusal pattern III. Esthetics was the main reason for seeking orthognathic surgery. Mean minimum cross-sectional area and volume of the pharynx were diminished at the one-year postoperative assessment, but improvements were found in signs and symptoms of obstructive sleep apnea syndrome and quality of life in the same period. Therefore, airway size *per se* was not a determinant factor in these patients for improvements in respiratory symptoms related to functional dentofacial deformities, as orthognathic surgery exerted a substantial positive impact on self-esteem and quality of life.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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