Research Article
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Dimensional changes of airways observed in lateral radiographs of patients undergoing orthognathic surgery at the carlos Ardila Lulle clinic from 2010 to 2016

Abstract

Introduction: Skeletal alterations are variations that occur in the jaws and occlusion. In addition, these can generate problems in the pharyngeal airways. For this reason, different procedures arise to correct bony problems, such as orthognathic surgery. However, these surgical techniques do not fully prove significant changes in the upper and lower pharyngeal airways.

Objectives: To determine the anteroposterior dimensional changes of the upper and lower pharyngeal airways in lateral skull radiographs of patients undergoing orthognathic surgery. Methodology: A descriptive observational study was carried out. Cross-sectional. The sample included 24 lateral cephalic radiographs of patients between 18 and 60 years of age who underwent orthognathic surgery. Proportions were calculated for qualitative variables and measures of central tendency and dispersion for quantitative variables. For cephalometric variables before versus after; the paired Student's t-test or the Wilcoxon sign test was applied according to the distribution of the data, additionally the Pearson correlation coefficient was applied to relate the dimensional changes of the pharyngeal airways with the SNA and SNB planes. A significance level of $\alpha \leq 0.05$ was considered for the analysis.

Results: It is important to highlight that for maxillary retrocession surgery there were statistically significant differences before and after the surgical process (p=0.0023) since thanks to this surgery the patients had 1.7 mm more in their upper pharyngeal space. While the forward and also the mandibular backward surgeries allowed them to gain 1.5 (p=0.0108) and 1.8 mm (p=0.0184) in this same pharyngeal space.

Conclusion: Twenty-four lateral skull radiographs were evaluated, in which it was possible to determine changes in the amplitude of the upper and lower pharyngeal airways, which could have been produced by the set of surgical procedures to which each of the patients underwent.

Keywords: orthognathic surgery, pharyngeal airway, skeletal diagnosis

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Introduction

Skeletal alterations are variations that occur in the jaws and occlusion. In addition, these can generate problems in the pharyngeal airways.[1]For this reason, different procedures arise to correct bony problems, such as orthognathic surgery. Orthognathic surgery is a surgical procedure that improves dento-skeletal malformations that compromise the craniofacial complex.[2,3] It is indicated in patients who present anteroposterior alterations such as: maxillary prognathism, maxillary retrognathism, mandibular prognathism, mandibular retrognathism.[4–11] Transversal alterations such as: mandibular asymmetry: laterognathism. Vertical alterations such as: increased vertical dimension: skeletal open bite. Decreased vertical dimension: skeletal deep bite. Also, alterations of the chin.[12]

These surgical procedures, in addition to helping to correct the aforementioned alterations, also improve problems associated with the airway such as: slurred speech, shortness of breath, wheezing, snoring and disorders such as Obstructive Sleep Apnea Syndrome (OSAS),[13–15] which is caused by intermittent and repetitive occlusion of the upper pharyngeal airway during sleep, resulting in a complete interruption (apnea) or partial (hypoapnea) of airflow,[1] Dentofacial alterations and respiratory problems have an impact on the quality of life of people, in terms of psychological, social, functional and esthetic aspects. Thus, it is necessary to identify the treatments implemented for these anomalies, in order to evaluate the alternatives offered to patients.

Despite the importance this represents for the management of respiratory problems such as OSAS, the question then arises: Are there any anteroposterior dimensional changes in the upper and lower pharyngeal airways after orthognathic surgery? Personally, we analyze the situation that society lives today, in terms of various predisposing factors that lead to develop or acquire dentofacial and airway disorders, then arises the interest to recognize respiratory disorders such as OSAHS and its effects as a problem that has been underdiagnosed.[16,17] Therefore, the diagnosis and appropriate treatments for this type of situations are an aspect that leads to deepen in the dimensional changes that occur in the airways after orthognathic surgery, to determine the expansion, reduction or absence of variations on them.[18]

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Objectives

1. Recognize the dimensional changes in millimeters in airway width after orthognathic surgery for maxillary or mandibular advancement, maxillary or mandibular retrogression and mentoplasty surgery.
2. To determine the skeletal diagnosis by means of cephalometric measurements in anteroposterior direction in the lateral cephalic radiographs of the patients involved in this work.
3. Describe the skeletal diagnoses according to the dimensional changes of the upper and lower pharyngeal airways.

Methodology

A cross-sectional descriptive observational study was carried out. A non-probabilistic convenience sampling was implemented. Twenty-four lateral cephalic radiographs of patients between 18 and 60 years of age before and after orthognathic surgery were included.[19,20] The inclusion criteria were: lateral cephalic radiographs of patients older than 18 years who had undergone orthognathic surgery at the Carlos Ardila Lulle clinic in Bucaramanga-Santander, lateral cephalic radiographs in optimal conditions to be interpreted and that had the measurement scale to correlate them with the megapixel scale of the software. The exclusion criteria were: radiographs of patients with cleft lip and palate, radiographs of people with craniofacial anomalies.[21] Sociodemographic variables were taken into account: sex, age, General Social Security Health System (Table 1). Orthognathic surgery variables were collected from medical records: maxillary advancement, mandibular advancement, maxillary recession, mandibular recession, and mentoplasty. Lateral skull radiographs were scanned for inclusion in the software. The software selected the option that allows marking two points, these two points show the distance in megapixels and then the number of millimetres is compared with the number of megapixels so that the software can determine how many millimetres are in total. McNamara that are automatically requested by the system. The software marked and plotted the different anatomical structures and the different planes used, as the software has the Trevisi Analysis, MBT Analysis, Trevisi/Arnett,[22] Analysis, Jarabak/Roth Analysis, Ricketts Analysis, McNamara Analysis, USP Analysis and Fonseca Analysis. It also allows selecting a series of measurements and forming a group of them, according to the operator's analysis needs. In this case, the Trevisi/Arnett,[23] and McNamara analysis was selected and the software returned all the results in one window.

Table 1 Characteristics demographics

Variable	Frequency	Percentage
Gender		
male	10	41,67
female	14	58,33
SGSS*		
contributory	24	100
Age		
Average	25±5,84	IC95%22.5-27.4

*General Social Security System

Each radiograph was analyzed for skeletal variables with the Steiner radiographic analysis:[24,25] SNA angle, SNB angle and ANB angle, the latter determining the skeletal classification. Patients with an ANB angle greater than 2° and class III patients with an ANB angle less than 2° were considered class II. The dependent variables were analyzed:[26–30] pharyngeal airways through the McNamara cephalometric analysis, which serves as a guide to observe the growth of the jaws, analyze the pharyngeal airways and examine the amplitude or reduction of these. The Frankfort plane was used as a reference plane, which is formed by joining the Porion-Orbital points with respect to the base of the skull.[31–33] For the measurement of the upper pharyngeal or adenoid space, the most posterior and superior point of the posterior contour of the soft palate and the closest point on the pharyngeal wall are located, thus distinguishing the amplitude of the upper pharyngeal space with an average value: 17.4mm. For the measurement of the lower pharyngeal space it is found at the intersection of the posterior contour of the tongue with the lower edge of the mandible to the closest point on the pharyngeal wall. This measurement indicates the width of the lower pharyngeal space with an average value: 13.5mm. Finally, the information was coded and systematized in Excel in duplicate.

Results

Demographic characteristics. A total of 24 lateral skull radiographs of the patients who underwent orthognathic surgery were evaluated; 58.3% of these were female. 100% of the patients underwent surgeries. Each one of the patients underwent several surgeries, 83%[34] underwent maxillary retrograde surgery and mandibular advancement surgery with equal frequency, 66% (16) underwent maxillary advancement surgery, and 41.7%[35] to mentoplasty surgery. Table2 quality of the systematization was validated using the Epidata 3.0 program. The necessary corrections were made and exported to the STATA 9.0 package for the respective processing.

Skeletal diagnosis of patients

Before the surgical procedure 54.2% [36] of the patients were classified as class III and 45.8% as class II (Table 3). After the procedure 91.7% [37] of the patients were diagnosed as class II and 8.3% [38] as class III.

Dimensional Changes in the Pharyngeal Spaces

When analyzing the dimensions of the pharyngeal spaces in the 24 radiographs of the evaluated subjects, it was observed that before surgery the mean of the upper pharyngeal space was 13.3±2.9 mm and after surgery it was 14.6±3.5 mm, showing a statistically significant difference (p=0.0142) between them. This difference was not observed for the lower pharyngeal space (Table 2 & 3). It is important to highlight that for maxillary retrocession surgery there is a statistically significant difference before and after the surgical procedure (p=0.0023) because thanks to this surgery patients have 1.7 mm more in their upper pharyngeal space. While advancement and also mandibular recession surgeries allow them to gain 1.5 (p=0.0108) and 1.8 mm (p=0.0184) in this same pharyngeal space (Table 2).

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Table 2 Measurements of the upper and lower pharyngeal spaces before and after surgical procedures

Surgery		n(%)	Airway	Before	IC95%	After	IC95%	Difference	IC95%	P*
	Total	24(100)		13,3±2,9	13,1;13,5	14,6±3,5	14,3;14,9	1,3±2,4	l,l,;l,5	0,0142
Maxillary	Advance	16(66,7)	Superior	13,1±3,1	12,7;13,5	14,1±3,3	13,7;14,5	1±2,5	0,7,1,3	0,1137
			lower	10,7+3	10,3;11,1	12,2±3,9	11,7;12,7	1,5±2,9	1,1;1,9	0,0556**
	Recoil	20(86,3)	Superior	13,1±2,9	12,8;13,4	14,8±3,6	14,4;15,2	1,7±2,1	1,5,1,9	0,0023
			lower	11,4±3	11,1;11,7	13,1±5	12,6;13,6	1,7±4,3	1,3;2,1	0,1169**
Mandibular	Advance	20(86,3)	Superior	13,3±2,9	13,0;13,6	14,8±3,5	14,5;15,1	1,5±2,4	1,3;1,7	0,0108
			lower	12,3±3	12,0;12,6	13,7±5,4	13,2;14,2	1,4±4,5	1,0;1,8	0,2471**
	Recoil	12(50)	Superior	12,8±3,5	12,2;13,4	14,6±3,9	14,0;15,2	1,8±2,2	1,4;2,2	0,0184
			lower	10,2±2,9	9,7;10,7	12,6±5,8	11,7;13,5	2,5±4	1,8;3,2	0.0596**
Mentoniana		10(41,7)	Superior	13±2,5	12,5;13,5	14,1±3	13,5;14,7	1,1±2,2	0,7;1,5	0,1665
			lower	11,6±3	11,0;12,2	12,4±3,1	11,8;13,0	0.8±3	0,2;l,4	0,3863**

*T de Student parade

**Wilcoxon signed-rank test

Table 3 Description of the dimensional changes of the upper and lower pharyngeal spaces according to initial skeletal diagnosis

Pharyngeal airway	Moment	Total	Skeletal diagnosis				
			IC95%	Class II	IC95%	Class III	IC95%
		24(100)		11(45,8)		13,(54,2)	
Superior	Before	13,3±2,9	13,3;13,4	13,9±2,8	13,8;14,1	12,8±2,9	12,7;12,9
	After	14,6±3,5	14,5;14,7	14,5±3,5	14,3;14,7	14,7±3,7	14,6;14,9
	Difference	1,3±2,4	1,2;1,3	0,6±2,8	0,5;0,8	1,9±1,9	1,8;2,0
	P	0,0142*		0,4884*		0,0043*	
lower	Before	11,7±3,2	11,7;11,8	10,7±3,4	10,5;10,9	12,5±2,9	12,4;12,6
	After	13,3±5,1	13,2;13,4	12,5±4,3	12,3;12,7	14±5,8	13,8;14,2
	Difference	1,6±4,2	0,08;3,3	1,8±3,5	1,6;2,0	1,4±4,8	1,2;1,6
	P	0,075**		0,1147**		0,3018**	

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**Wilcoxon signed-rank test

Dimensional changes in the pharyngeal spaces according to skeletal diagnosis. The dimensional changes in the upper and lower pharyngeal spaces,[39] according to skeletal diagnosis before the surgical procedure are shown in Table 2. From this Table it should be noted that only in class III patients were statistically significant differences (p=0.0043) between before and after the surgical treatment to which the patients were submitted, since this group of patients gained 1.9 mm in the upper pharyngeal space after the treatment (Table 3).[40]

Correlation of pharyngeal airway and SNA-SNB angles

Correlation of the upper airway with the SNA angle.[41,42] Low levels of correlation between the upper pharyngeal airway (measured in millimeters (Y-axis)) and SNA angle (measured in degrees (X-axis)) both before (Coefficient: 0.1724) and after treatment (0.00064) were evident (Figure 1). Correlation of the lower pharyngeal airway with the SNB angle. While the correlation between the lower pharyngeal airway with the SNB angle recorded a coefficient of 0.5053 before surgical procedures, which is reduced to 0.3491 after them (Figure 2).[43–45]

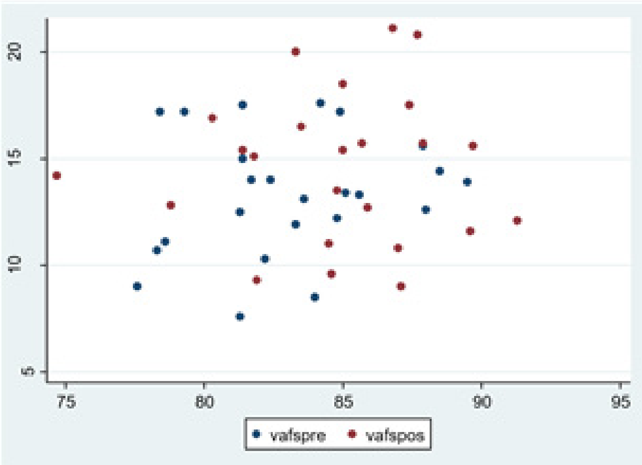

Figure 1 Correlation coefficients of upper pharyngeal airway with ANS angle before and after surgeries.

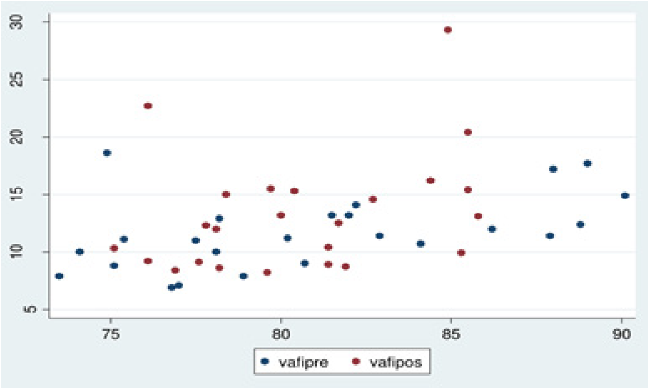

Figure 2 Correlation coefficients of lower pharyngeal airway with SNB angle before and after surgeries.

Discussion

The dimensional changes of the pharyngeal airways is a controversial subject, since few studies analyze the variations during maxillary, mandibular and chin advancement and retreat, and do not specify the cephalometric changes in patients treated with these procedures surgical.[46–48] In this research project, evidence was obtained on the anatomical variation of the upper and lower pharyngeal airway, finding an increase in the amplitude of the pharyngeal airway in both upper and lower with all surgical procedures (maxillary and mandibular advancement-retraction). Villalba-Rodriguez et al,[49] in 2012, performed preoperative measurements in the nasopalatine, oropharyngeal and hypopharyngeal anatomical structures in 57 patients with a diagnosis of class II and III dentofacial anomaly,[50] who underwent different types of orthognathic surgery procedures. The surgical procedure in all cases consisted of bilateral sagittal mandibular branch osteotomies,[51–53] Le Fort I osteotomies, chin osteotomies or a combination of the above. The anatomical variation in the pharyngeal airway produced by different orthognathic surgery procedures, including advancement mentoplasty, was evidenced, which showed important differences in combination with the retrograde osteotomy in the nasopharyngeal area, and in the oro and hypopharyngeal areas when combined with the advancement osteotomy.[54] In accordance with these results, in the present investigation, an increase in the upper and lower pharyngeal air spaces was evidenced in patients who underwent surgical procedures of maxillary and mandibular advancement-retraction, and mentoplasty surgery, among others. It should be noted, however, that only the upper pharyngeal airspace showed a statistically significant increase for the surgical procedures related to maxillary-mandibular recession and mandibular advancement. This increase in this pharyngeal space can be understood only if the set of surgical procedures that each patient underwent is analyzed.

In the study by Evangelista Rodriguez,[54] 20 pre-surgical Cone Beam CT scans and 20 post-surgical CT scans (1 month after surgery) of 14 males and 6 females skeletal class III undergoing bimaxillary orthognathic surgery were analyzed, finally the measurements of the pre and post orthognathic surgery CT scans were compared to determine the anatomical and dimensional variations of the pharyngeal airway. The results of that study do not establish that the changes in pharyngeal airway space are permanent. That research evaluated the changes after bimaxillary surgery one month after the surgical intervention, since the time interval would be too short to indicate that these changes are not modified over time.[55,56] In this research this aspect was not taken into account, considering this, it would be recommended to retake from the clinical history this information with the purpose of establishing the consistency of the changes; in addition to this, it would be considered necessary to take new radiographs to the patients in the medium and long term after the surgery, to corroborate if the changes are permanent or vary through time. In the present investigation it is evident that before orthognathic surgery the class II diagnosis corresponded to 45.8% of the patients and class III in 54.2%.[57–60] However, after the surgical procedures, 91.7% of the patients were classified as class II and 8.3% as class III; in this sense, it is important to point out the functional and esthetic benefits that the patients received. With the results of this work it can be inferred that the surgical procedures related to orthognathic surgery had a positive impact by improving their maxillomandibular relationship and facial appearance, in addition to the change in the anteroposterior dimension of the upper pharyngeal airways.[61–65]

In summary, orthognathic surgery including its different procedures, causes important changes in the different areas of the pharyngeal airway, which accompany the maxillomandibular skeletal changes generated by it.[66] It is essential to take into account the anteroposterior dimension of the pharyngeal space when analyzing a case,[67,68] in order to avoid inducing obstructive events, especially in patients who present obstructive factors. Predisposing to these.[54] One of the limitations of the present work was the type of orthognathic surgeries of maxillary, mandibular or bi-maxillary repositioning, which were registered in the treatment plan recorded in the clinical history,[69–71] which could be modified during the procedure, this could be due to the fact that in the surgical process unforeseen events can occur that prevent to stick to the initially programmed.[72–74]

Conclusion

When evaluating the dimensions of the upper and lower pharyngeal air spaces before and after orthognathic surgery, it is possible to determine changes in their amplitude, which were statistically significant, that is, they presented values different from zero. For the increase of the upper pharyngeal airway with maxillary (increased by 1.7 mm), mandibular (1.8 mm) and mandibular advancement (1.5 mm) surgery. The present investigation shows that before orthognathic surgery, 45.8% of the patients were diagnosed as class II and 54.2% as class III. After the surgical procedures, it was found that 91.7% of the patients were classified as class II and 8.3% as class III.[75–77] Regarding the dimensional changes in the upper and lower pharyngeal spaces according to skeletal diagnosis, it was found that only in class III patients was there a statistically significant difference (p=0.0043) between before and after the surgical procedure to which the patients were subjected, since the patients in this group gained 1.9 mm in the upper pharyngeal airspace.[78,79]

Acknowledgments

None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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