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Original Research Article

# A Novel Method to Aproach a Hipoplasic Midface Diagnosis

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**Abstract:** Class III skeletal malocclusion is one of the less frequent but aesthetically impactful misalignments. It can be caused by maxillary hypoplasia or retrognathia, mandibular hyperplasia, or a combination of both. Its frequency varies between 2-11% of the global population, depending on the ethnic group. Diagnosis and treatment planning traditionally is determined by two-dimensional anteroposterior position using cephalometric analysis on lateral radiographs, with few studies analyzing bone volume rather than position, being of great importance for diagnosis and treatment planning. This study aims to measure maxillary volume and its anteroposterior position using CBCT (Cone Beam Computarized Tomography) in skeletal Class I, II, and III patients, establish the bone volume and determine if there is a correlation between volume, length and anteroposterior position using the Trujillo analysis as a reference. Tomographs of patients from the Orthodontic program of the Universidad Autonoma de Baja California with Class I, II, and III malocclusions were collected. The maxilla was segmented using the DIAGNOCAT software, and teeth removed to measure the volume. The skeletal groups were divided for measurements to determine the patient's sex and search for volume, length and anteroposterior position, using for the last two variables the Trujillo's analysis to compare them. *"T" students test* was used for statistical analysis. There was a statistically significant difference in maxillary length and volume when comparing Class III patients to Class I and Class II, with Class III patients exhibiting lower values. No significant difference was found in the anteroposterior position of the maxilla when comparing the Class III group to the Class II skeletal group.

**Keywords:** CBCT, Angle Class III malocclusion, maxillary volume.



## INTRODUCTION

In the case of Class III malocclusions, we can differentiate between dental problems, functional issues (pseudo-Class III), and skeletal problems [1, 2].

Ackerman and Proffit introduced new features, including the transverse, vertical, and anteroposterior planes. They also incorporated skeletal maxillary proportions within each plane of space [1, 3].

Although Class III is the musculoskeletal pattern with the lowest prevalence, it surprisingly exerts the most significant aesthetic impact [4]. Understanding the true underlying cause of the aesthetic impairment of the profile can greatly benefit from the volumetric analysis of the maxilla. The introduction of cone-beam computed tomography (CBCT) for imaging the maxillofacial region has shifted the approach from 2D to 3D for data acquisition and image reconstruction. CBCT allows for more comprehensive and detailed visualization of the maxillofacial structures, providing valuable information for diagnosis, treatment planning, and assessment of various conditions. The transition from traditional 2D imaging techniques to CBCT has significantly enhanced the accuracy and precision of imaging in the maxillofacial field [5, 6].

Image segmentation is the process of separating specific regions within an image to delineate structures or areas of interest. It enables measurements of volume, surface area, shape properties, 3D printing,

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and other analyses. By segmenting an image, it becomes possible to extract and analyze specific components, facilitating quantitative assessments and further applications in areas such as medical imaging, computer vision, and scientific research. Image segmentation plays a crucial role in obtaining precise and detailed information from images for various purposes and applications [7].

Regrettably, within the realm of assessment and diagnosis, the measurement of maxillary volume has not been regarded as a pivotal factor in determining treatment decisions [8, 9].

Nonetheless, it is essential to acknowledge that not everyone has equal access to these transformative technologies.

Furthermore, it is worth noting that not all dentists have the necessary resources for these technological advancements fully.

There is a need to explore potential differences in maxillary bone development among individuals with different skeletal classes and its volume.

Investigating the relationship between maxillary bone volume and the anteroposterior position of the maxilla can provide insights into the factors influencing the overall positioning of the maxilla within the craniofacial complex [10, 11].

Exploring the feasibility of utilizing a cephalometric landmark in tomography scans can offer valuable information regarding the anteroposterior position of the maxilla, facilitating the assessment of both its volume and spatial orientation.

## MATERIALS AND METHODS

CBCT records of patients of the Orthodontics Department of the Universidad Autónoma de Baja California were use under the following criteria: Patients with no previous orthodontic treatment, no history of maxillofacial surgery and no active upper airway diseases (sinusitis, allergies, adenoids, tonsillitis).

Exclusion Criteria was patients with previous or ongoing orthodontic treatment, patients with a history of maxillofacial surgery (orthognathic surgeries, facial reconstruction surgeries, accidents with impact on craniofacial structures, etc.) patients with active upper airway diseases (sinusitis, allergies, adenoids, tonsillitis).

All Cone-beam tomography scans of patients obtained randomly from the archives of the Postgraduate Orthodontics Program at UABC Mexicali Campus, and all files included a signed informed consent form from the patients, allowing their information to be used for academic and research purposes archives of the Postgraduate Orthodontics Program at UABC Mexicali Campus.

Intentional Sampling was performed, the variables were: age, sex, skeletal Class, maxillary volume, maxillary length, and anteroposterior position of the maxilla.

The measurement of maxillary bone volume was performed using Cone-Beam tomography scans of skeletal Class I, Class II, and Class III patients and the DIAGNOCAT (*Copyright © 2023 Diagnocat LLC. All rights reserved)* software was used to segment that maxillary bone and calculate the average volumetric values and those were established for both men and women (Fig. 1).

Using the CareStream (© *2023 Carestream Dental LLC. All Rights Reserved*) software linear measurements on the CBCT were made following the Trujillo´s analysis [12].

The Trujillo analysis for the maxilla stablishes measurements as follows:

1. **Anteroposterior position of the middle maxillary portion Mx-Vpt:** Average maxillary position (anteroposterior): Distance between the maxillary point (Mx - midpoint between ANS and PNS) and the pterygoid vertical (VPt). Standard: Women: 26 mm. Men: 30 mm. Standard Deviation: +/- 3 mm.
2. **Anteroposterior Maxillary Dimension (Ena-Enp):** Indicates the distance between the anterior nasal spine and the posterior nasal spine. Standard: Women: 52 mm. Men: 59 mm. Standard Deviation: +/- 3 mm. Determines the degree of horizontal or anteroposterior growth of the maxilla.

## RESULTS

A total of 43 patients were selected, 20 male and 23 female. 85% of the patient's age was between 21 to 30 years old. We found lower average values compared to the reference values established by Trujillo for both the mean and anteroposterior position of the maxilla, as well as for the length of the maxillary bone.

Comparison between maxillary bone volume, anteroposterior projection, and length in Class III patients vs. Class I and Class II was made as well as the comparation between the maxillary bone volume, anteroposterior projection, and length between Class III patients and Class I and Class II patients. Minitab 14 was used to analyze the data and convert it into statistics. A statistical hypothesis test for the difference in means was conducted on small samples using the Student's t-distribution. A significance level of 95% (alpha = 5%) was used.

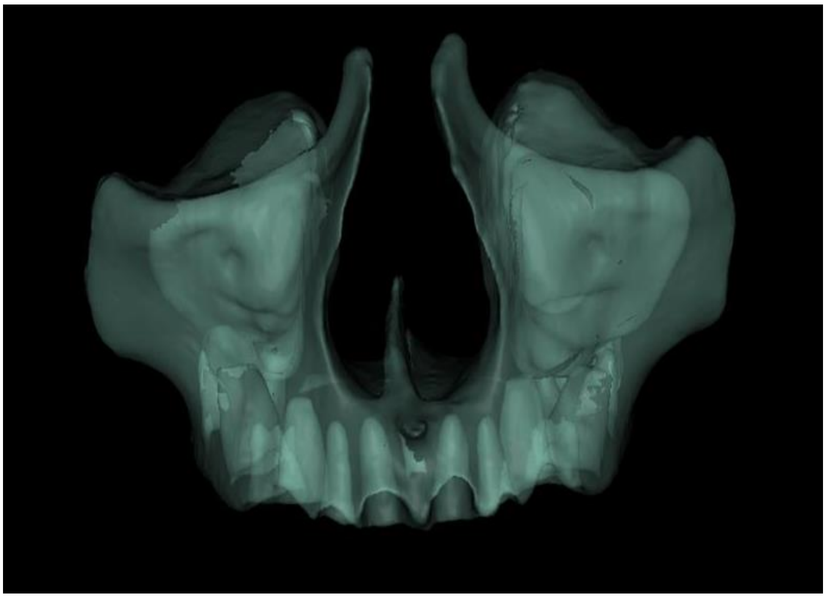
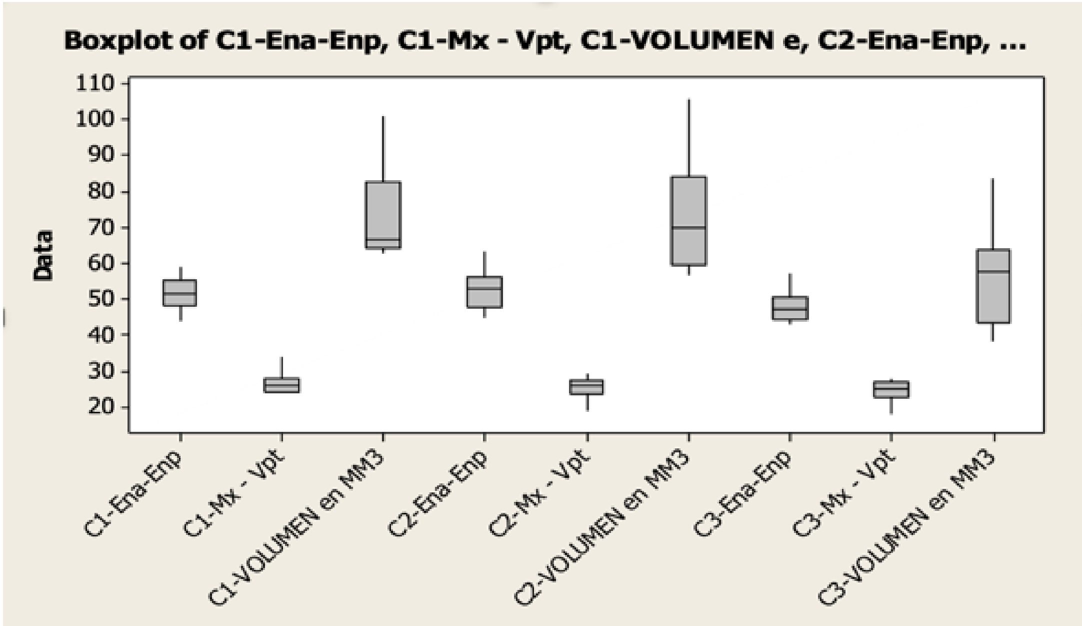


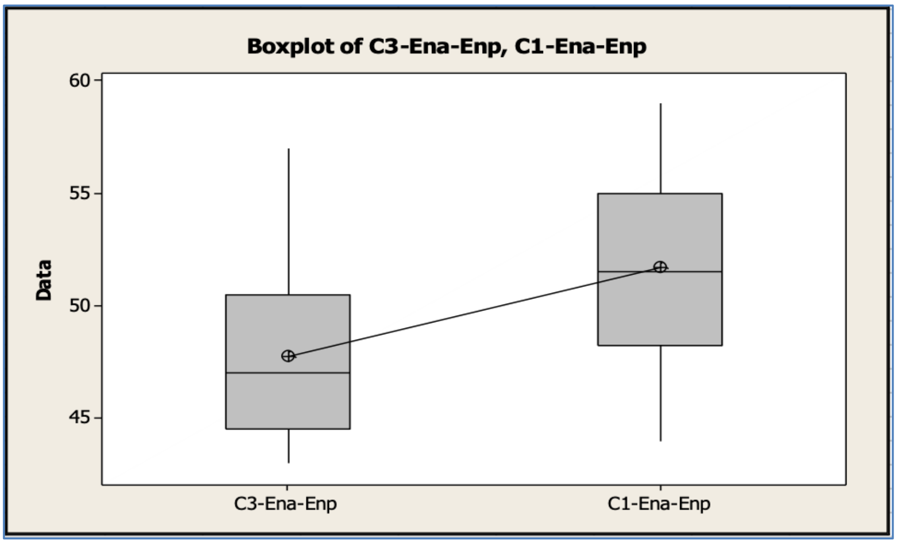
**Fig. 1: Maxillary segmentation for volume mesurements made with DIAGNOCAT**




| Variable | N | N* | Mean | SE Mean | StDev | Minimum | Q1 | Median | Q3 | Maximum | Range |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C1-Ena-Enp | 16 | 0 | 51.69 | 1.09 | 4.36 | 44 | 48.25 | 51.5 | 55 | 59 | 15 |
| C1-Mx-Vpt | 16 | 0 | 26.438 | 0.677 | 2.707 | 24 | 24 | 26 | 28 | 34 | 10 |
| C1-VOLUMENenMM | 10 | 0 | 72341 | 3950 | 12491 | 62826 | 64269 | 66494 | 82358 | 101088 | 38262 |
| C2-Ena-Enp | 14 | 0 | 52.5 | 1.35 | 5.03 | 45 | 47.75 | 53 | 56 | 63 | 18 |
| C2-Mx-Vpt | 14 | 0 | 25.479 | 0.7 | 2.617 | 19 | 23.65 | 26 | 27.25 | 29.2 | 10.2 |
| C2-VOLUMENenMM | 9 | 0 | 72833 | 5413 | 16239 | 56604 | 59294 | 69843 | 83721 | 105478 | 48874 |
| C3-Ena-Enp | 13 | 0 | 47.77 | 1.16 | 4.19 | 43 | 44.5 | 47 | 50.5 | 57 | 14 |
| C3-Mx-Vpt | 13 | 0 | 24.308 | 0.82 | 2.955 | 18 | 22.5 | 25 | 27 | 28 | 10 |
| C3-VOLUMENenMM | 12 | 0 | 56039 | 3984 | 13800 | 38170 | 43277 | 57316 | 63717 | 83385 | 45215 |

**Fig. 2: Descriptive statistics of variables**

The length of the maxillary bone was found to be shorter in Class III patients compared to Class I and Class II patients (Fig. 3 and 4).



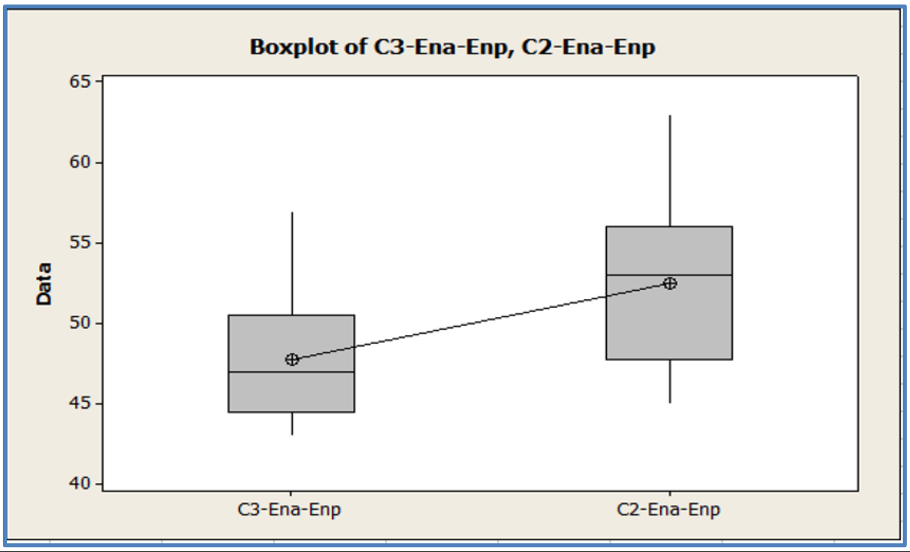

**Two-Sample T-Test and CI: C3-Ena-Enp, C2-Ena-Enp**

```
Two-sample T for C3-Ena-Enp vs C2-Ena-Enp

             N   Mean  StDev  SE Mean
C3-Ena-Enp  13  47.77   4.19      1.2
C2-Ena-Enp  14  52.50   5.03      1.3


Difference = mu (C3-Ena-Enp) - mu (C2-Ena-Enp)
Estimate for difference:  -4.73077
95% CI for difference:  (-8.39880, -1.06274)
T-Test of difference = 0 (vs not =): T-Value = -2.66  P-Value = 0.014  DF = 24
```

**Fig. 3: Length of maxillary bone between CIII and CI**




**Two-Sample T-Test and CI: C3-Mx - Vpt, C2-Mx - Vpt**

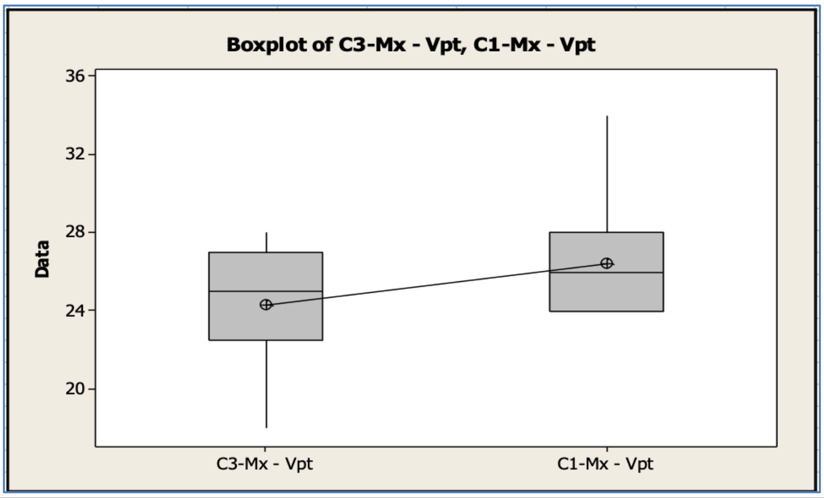
```
Two-sample T for C3-Mx - Vpt vs C2-Mx - Vpt

             N   Mean  StDev  SE Mean
C3-Mx - Vpt  13  24.31   2.95     0.82
C2-Mx - Vpt  14  25.48   2.62     0.70


Difference = mu (C3-Mx - Vpt) - mu (C2-Mx - Vpt)
Estimate for difference:  -1.17088
95% CI for difference:  (-3.39468, 1.05293)
T-Test of difference = 0 (vs not =): T-Value = -1.09  P-Value = 0.288  DF = 24
```

**Fig. 4: Length of maxillary bone between CIII and CII**

The anteroposterior projection of the maxilla was less pronounced in Class III patients, indicating a more posterior position of the maxilla with a very low statistically difference (Fig. 5 and 6).

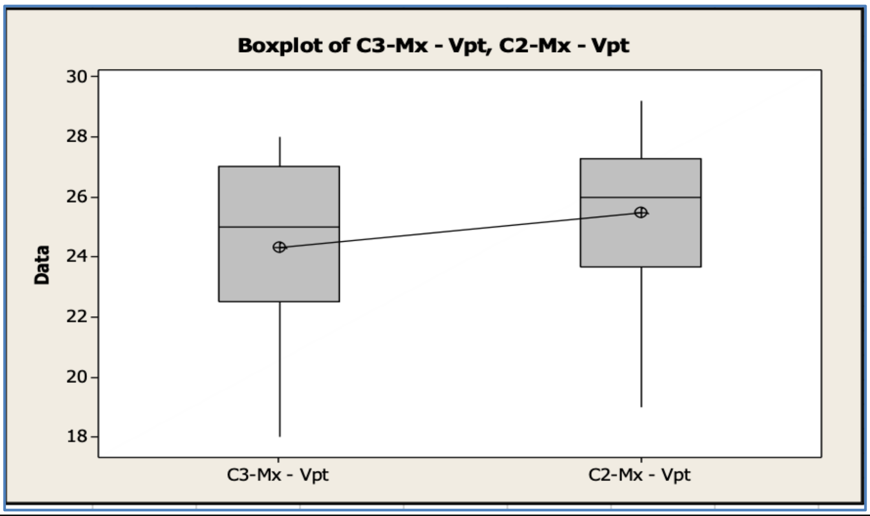



**Two-Sample T-Test and CI: C3-Mx - Vpt, C1-Mx - Vpt**

```
Two-sample T for C3-Mx - Vpt vs C1-Mx - Vpt

              N   Mean  StDev  SE Mean
C3-Mx - Vpt  13  24.31   2.95     0.82
C1-Mx - Vpt  16  26.44   2.71     0.68


Difference = mu (C3-Mx - Vpt) - mu (C1-Mx - Vpt)
Estimate for difference:  -2.12981
95% CI for difference:  (-4.32344, 0.06383)
T-Test of difference = 0 (vs not =): T-Value = -2.00  P-Value = 0.056  DF = 24
```




**Two-Sample T-Test and CI: C3-Mx - Vpt, C2-Mx - Vpt**

```
Two-sample T for C3-Mx - Vpt vs C2-Mx - Vpt

              N   Mean  StDev  SE Mean
C3-Mx - Vpt  13  24.31   2.95     0.82
C2-Mx - Vpt  14  25.48   2.62     0.70


Difference = mu (C3-Mx - Vpt) - mu (C2-Mx - Vpt)
Estimate for difference:  -1.17088
95% CI for difference:  (-3.39468, 1.05293)
T-Test of difference = 0 (vs not =): T-Value = -1.09  P-Value = 0.288  DF = 24
```

**Fig. 5 and 6: Anteroposterior position of the maxillary bone between CIII and CI and CII groups**

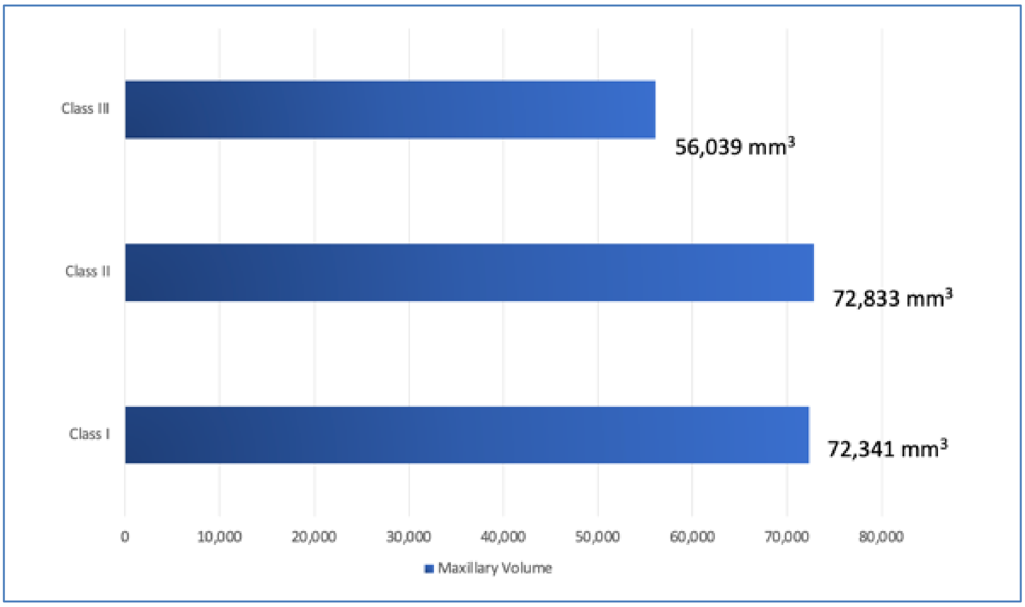



**Fig. 7: Maxillary Volume on Class I, Class II and Class III patients**

Results showed that Class III patients exhibited significantly lower maxillary bone volume (56,039 $mm^3$) compared to Class I (72,341 $mm^3$) and Class II (72,833 $mm^3$) patients (Fig. 7). The mean for maxillary bone volume measurements were 75, 979.75 $mm^3$ for men and 59, 979.73 $mm^3$ for women.

These findings suggest that Class III patients have distinct characteristics in terms of maxillary bone volume, anteroposterior projection, and length compared to Class I and Class II patients, highlighting the significance of these variables in understanding the skeletal differences observed among different malocclusion classes.

## Discussion

An average maxillary volume was established for Class I, Class II, and Class III skeletal patients, with limited reference studies available such as Nair [13] and Deguchi *et al.*, [14]. Our findings showed significantly lower measurements compared to these previous studies.

There was a statistically significant difference in maxillary length and volume when comparing Class III patients to Class I and Class II skeletal patients, with Class III patients exhibiting lower values.

No significant difference was found in the anteroposterior position of the maxilla when comparing the Class III group to the Class II skeletal group.

It is suggested to conduct a study with a larger sample size, including patients without growth and considering a wider range of age groups. Additionally, utilizing more accessible software for image segmentation of tomographic images is recommended.

Furthermore, it is important to consider not only the measurement of maxillary bone volume but also the volume of the maxillary sinuses to investigate any potential relationship between the volumes of both structures and their influence on the growth and development of the midfacial region [15].

## Conclusions

1. The musculoskeletal pattern with the lowest prevalence has the greatest aesthetic impact.
2. Analyzing the maxilla volumetrically can be helpful in identifying the true cause of aesthetic profile impairments, so we can consider patient’s volume evaluation as a routine, specially at a growing phase, to find the main etiology to develop this lack of maxillary growth and treat it at an earlier age as possible.
3. The measurement of maxillary volume has not been considered as an important factor in treatment decision-making in current assessment and diagnosis studies.
4. Despite the availability of advanced technology and tools for accurate diagnoses and treatment planning, not all individuals have access to these resources, and not all dentists possess the necessary technological capabilities.

## References

1. Arnett, W., & Bergman, R. (1993). Facial keys to orthodontic diagnosis and treatment planning. Part I. *Am J Orthod Dentofacial Orthop*, 299-12.
2. Angle, E. (1907). Treatment of malocclusion of the teeth. 7th ed. Philadelphia:SS White Dental Manufacturating Co.

3. Proffit, W., Fields, H., & Sarver, D. (2007). Contemporary Othodontics. 4th ed. St Louis: MO Mosby.
4. Moyers, R. E. (1992). Manual de Ortodoncia. 4ta. Ed. Buenos Aires: Edit. Medica-Panamericana SA.
5. Ryan, D. P. O., Bianchi, J., Ignacio, J., Wolford, L. M., & Goncalves, J. R. (2019). Cone-beam computed tomography airway measurements: Can we trust them? *Am J Orthod Dentofacial Orthop, 156*, 53-60.
6. Ihlis, R. L., Giovanos, C., Liao, H., Ring, I., Malmgren, O., Tsilingaridis, G., ... & Shi, X. Q. (2023). Cone beam computed tomography indications for interdisciplinary therapy planning of impacted canines. *Oral surgery, oral medicine, oral pathology and oral radiology*, *135*(1), e1-e9. Available at: http://dx.doi.org/10.1016/j.000.2022.06.013
7. Whaites, E., & Drage, N. (2021). Essentials of Dental Radiography and Radiology. Edinburg: Elsevier.
8. Pirelli, P., Fiaschetti, V., Fanucci, E., Giancotti, A., Saccomanno, S., & Mampieri, G. (2021). Cone beam CT evaluation of skeletal and nasomaxillary complex volume changes after rapid maxillary expansion in OSA children. *Sleep Medicine*, *86*, 81-89. Available at: http://dx.doi.org/10.1186/j.sleep.2021.08.01
9. Abesi, F., Yousefi, M. J., & Zamani, M. (2023). Prevalence and anatomical characteristics of maxillary sinus septa: a systematic review and meta-analysis of cone-beam computed tomography studies. *Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology*. Available at: http://dx.doi.org/10.1016/j.ajoms.2023.03.015
10. Florez, B. M., Tagawa, D. T., Inoue, D. P., Yamashita, H. K., de Arruda Aidar, L. A., & Dominguez, G. C. (2023). Associations between skeletal discrepancies, breathing pattern, and upper airway obstruction in Class III malocclusions. *International Journal of Pediatric Otorhinolaryngology*, *166*, 111471. Available at: http://dx.doi.org/j.ijporl.2023.111471
11. Dehesa-Santos, A., Iber-Diaz, P., & Iglesias-Linares, A. (2021). Genetic factors contributing to skeletal class III malocclusion: A systematic review and meta-analysis. *Clinical Oral Investigations*, *25*, 1587-1612.
12. Zamora EM de O, C., Ricketts, R. M., Teramoto, A., Katagiri, K. M., & Día, R. R. (2010). Compendio de cefalometría. Caracas: Amolca.
13. Nair, R. A. H. U. L., Deguchi, T. S., Li, X., Katashiba, S., & Chan, Y. H. (2009). Quantitative analysis of the maxilla and the mandible in hyper- and hypodivergent skeletal class II pattern. *Orthodontics & craniofacial research*, *12*(1), 9-13. doi: 10.1111/j.1601-6343.2008.01431.x. PMID: 19154269.
14. Deguchi Sr, T., Katashiba, S., Inami, T., Foong, K. W., & Huak, C. Y. (2010). Morphologic quantification of the maxilla and the mandible with cone-beam computed tomography. *American journal of orthodontics and dentofacial orthopedics*, *137*(2), 218-222. doi: 10.1016/j.ajodo.2008.02.029. PMID: 20152678.
15. Fieramosca, F., Lezama, E., Manrique, R., Quiros, O., Farias, M., Rondon, S. La función respiratoria y su repercusión a nivel del sistema estomatognático. Revista Latinoamericana de Ortodoncia y Odontopediatria [serial online] Available at: http://www.ortodoncia.ws/publicaciones/2007/art5.asp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