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Vertical asymmetry of the condyle and mandibular ramus measured by cone beam computed tomography (CBCT)

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Abstract

Mandibular asymmetries can be defined as morphological variations that indicate disproportion in its size, shape or position between the right and left side. In Ecuador there are no investigative contributions on the vertical symmetry of the condyle and mandibular ramus despite its importance and its affordable diagnosis through panoramic radiography. For this reason, the importance of this study is evident, for which Cone Beam Computed Tomography (CBCT) was used from adult patients from the Faculty of Dentistry of the University of Cuenca of the seventh cycle of the dental career, in which a higher prevalence of mandibular asymmetries is evidenced in the female gender and in Class II skeletal type patients. Through the Habets method, it was possible to determine the index of vertical asymmetries, concluding that there is a higher index of vertical asymmetries in the condyle, followed by asymmetry in the ramus, and finally, with a lower percentage, the total asymmetry of the condyle and ramus.

Keywords: Condylar morphology; Ramus height; CBCT; Panoramic radiography; Sidexis 4; Vertical skeletal pattern; Habets method; Mandibular asymmetry.

1. Introduction

In dentistry, the classification of asymmetries according to the structures that are involved include dental, skeletal, muscular, soft tissue, and functional parameters. These asymmetries can occur in vertical, transverse, and sagittal planes. It could be said that mandibular asymmetries are morphological variations that indicate disproportion in its size, shape or position between the right and left side. They can be imperceptible and do not affect function or aesthetics, as they can also be related to malocclusions, facial asymmetries and even affect the patient psychosocially. In this way, its early identification becomes essential, making it possible to use panoramic radiography, which is one of the most routinely used tools. In fact, according to Habets et al. the vertical mandibular asymmetry index should be evaluated in the diagnosis, since associated with other signs it increases the possibility of acquiring a TMD, a hypothesis that was verified in the Bezuur study where 74% of patients with TTM presented condylar asymmetry (1) (4) (5).

In Ecuador there are no investigative contributions regarding the subject despite its importance and its affordable diagnosis through panoramic radiography. Taking into account that the majority of cases that are presented for consultation are for aesthetic reasons, ignoring this aspect could lead to unsatisfactory and even risky results (1).

On the other hand, in the present study, computed tomography is used to evaluate said asymmetries. The disadvantage of this method is that it has a high dose of radiation and a high cost, so it is more suggested to use this alternative when it is required to clarify a diagnosis or there is any suspicion. In addition, it must be analyzed by someone properly trained since not all general dentists will be able to analyze it correctly (1).

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1.1. Work hypothesis

The presence of asymmetry in the length of the mandibular ramus is related to sex and skeletal class.

1.2. General objective

The general objective of this study is

Quantify the asymmetry of the mandibular ramus by Conical Beam Computed Tomography (CBCT) in adult patients with complete permanent dentition and its relationship with sex and skeletal class.

1.3. Specific objectives.

The specific objectives of this study are

- Determine the percentage of asymmetries in the total mandibular length between both sides of the mandible using the Habets method.
- Determine if the existence of asymmetries in the length of the mandibular ramus is related to sex and skeletal class.

2. Material and methods

2.1. Statistical Method

An Excel® sheet was created where all the variables and measurements were collected for further analysis.

2.2. Material used

- Laptop with Windows 10 operating system.
- The CBCT apparatus used was the Accuitomo 170 with FOV of 120mm x 170mm.
- SIDEXIS computer program (This program was used to visualize the slices and three-dimensional images obtained from the CBCTs).

2.3. Sample selection

The sample obtained consisted of Cone Beam Computed Tomography (CBCT) from adult patients from the Faculty of Dentistry of the University of Cuenca aged between 21 and 30 years.

2.4. The inclusion criteria for sample selection were:

- Patients of both genders.
- Adult patients who do not present active growth (determined by the maturation of cervical vertebrae).
- CBCT in which the mandibular ramus is clearly observed.

2.5. While the exclusion criteria for the selection of the sample were:

- Patients with the presence of supernumerary teeth or agenesis, without counting third molars and excluding the lower first molar because a relationship has been described between the absence of the lower first molar and mandibular vertical asymmetry (Halicioglu et al. 2014).
- Patients with craniofacial malformations or presence of syndromes.
- Patients with a history of craniofacial and/or dental trauma.
- Patients with fixed or removable dental prostheses.
- Patients whose scans were not clear.

2.6. Data collection

Data collection was carried out during the month of January 2023, under standardized conditions by 3 observers.

Table 1 Definition of variables

Variable	Variable type
Skeletal class	Categorical (class I, II, and III)
Condyle height (CH) Habets index	Continuous numerical (mm)
Ramus height (RH) Habets index	Continuous numerical (mm)
Total height (CH+RH) Habets index	Continuous numerical (mm)
Asymmetry index	Percentage
Sex	Dichotomous

2.7. Study protocol

The protocol of this study is divided into four clearly differentiated parts.

2.8. PART 1. Determination of the skeletal class. Habet's formula

Habets described a formula to determine mandibular asymmetry in patients and obtain a percentage (Habets et al. 1988).

The formula is [(RL)(R+L)]x100, with asymmetry values between 1-100%. A value greater than 3% could be considered as a 'relevant asymmetry'.

The formula was applied as follows

- Asymmetry index for the vertical length of the mandibular condyle

$$CH: [(CHR-CHL/CHR+CHL)x100]$$

- Asymmetry Index for the vertical length of the mandibular ramus

$$RH: [(RHR-RHL/RHR+RHL)x100]$$

- Total asymmetry index

$$CH+RH: [(CHR+RHR)-(CHL+RHL)/ (CHR+RHR)+ (CHL+RHL)x100]$$

3. Results

3.1. Sample description

The final sample obtained after applying the inclusion and exclusion criteria was 31 CBCT from a group of students in the seventh cycle of the Faculty of Dentistry of the University of Cuenca. The patients had a mean age of 22.17 years and a range between 21-27 years, 10 CBCTs corresponded to men (32.25%) while 21 to women (67.74%), as observed in Figure 1.

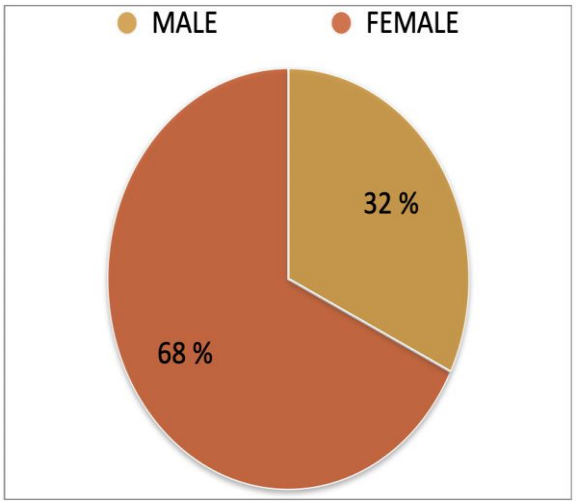

Figure 1 Distribution of CBCT by patient sex

3.2. Determination of skeletal class and facial pattern

Regarding the determination of skeletal class, 7 CBCTs correspond to individuals with skeletal class I (22.6%), 20 CBCTs to individuals with skeletal class II (64.5%), while 4 CBCTs correspond to individuals with skeletal class III (12.9%), as can be seen in Fig 2.

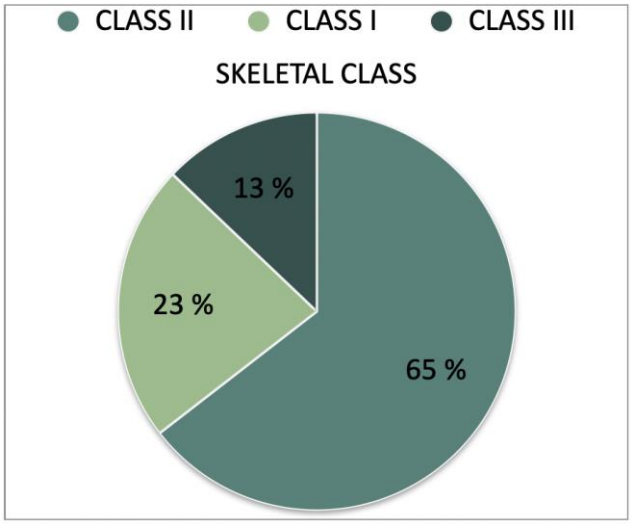

Figure 2 Distribution of individuals according to skeletal class

3.3. PART 2 Habets method: Results of the length and index of asymmetry of the condyle, ramus and total mandibular

3.3.1. Difference in lengths of the condyle, ramus and total mandibular between the right and left side

Table 2 Difference in the length of the condyle, ramus, and total mandibular length between both sides using the Habets method

	left -right difference Mean ± SD (mm)	**95% CI**
CONDYLE	0.17 ±1.31	0.042
BRANCH	0.25 ± 1.76	0.044
TOTAL	0.3 ± 1.77	0.04

As a first point, we wanted to detect the existence of differences between the lengths of the right and left side, for which a t-test was applied for dependent measures, which did not show statistically significant results between both sides (Table 2), for which later the total sample from both sides was joined.

The mean condylar asymmetry index is 6.87

The mean asymmetry index of the ramus of is 3.69

The average index of total asymmetry is 2.8

3.3.2. Determination of sex and skeletal class in relation to the proportion of total asymmetry.

From a sample of 31 students, 70.79% (22) presented asymmetry in the total mandibular length between both sides of the mandible. Of the 21 female patients that made up the sample, 80% (17) presented asymmetry, while 50% (5) of the 10 male patients presented said asymmetry.

Table 3 Proportion of asymmetric patients according to sex

	Sample	**# asymmetric patients**	**Percentage**
Female	21	17	80%
Male	10	5	50%
Total	31	22	70.97%

Regarding the skeletal class and the asymmetry in the total mandibular length between both sides of the jaw of the 7 Class I patients that made up the sample, 71.43% (5) presented asymmetry, of the 20 Class II patients, 75% (15) presented asymmetry and of the 4 Class III patients that made up the sample, 50% (2) presented said asymmetry.

Table 4 Proportion of asymmetric patients according to bone skeletal class

	Sample	**# asymmetric patients**	**Percentage**
Class I	7	5	71.43%
Class II	20	15	75%
Class III	4	2	50%
total	31	22	70.97%

3.3.3. Mandibular ramus asymmetry index.

Table 5 Left and right length and asymmetry index of the mandibular ramus using the Habets method

Asymmetry index and length of the mandibular ramus		
Left (cm)	N.º	22
	Half	0.47
	Minimum	0.2
	Maximum	0.9
Right (cm)	N.º	22
	Half	0.44
	Minimum	0.2
	Maximum	0.9

Asymmetry index (%)	N.º	22
	Half	3%
	Minimum	0%
	Maximum	7%

The mean asymmetry index of the mandibular ramus is 3% in a number of 22 individuals whose asymmetry did not exceed 7% and had a minimum of 1.5%, as observed in Table 3.

4. Discussion

The objective of the study was to quantify the length of the condyle together with the ramus and of the total mandibular in order to determine asymmetries and thus relate the measurements with the different skeletal classes.

The morphology, dimensions and symmetry of the craniofacial structures as it is in this study, the condyle and the mandibular ramus can be affected by environmental factors during the formation process, systemic diseases, craniofacial anomalies, the sagittal and transverse relationship of the maxilla and the mandible, and vertical skeletal patterns. The diagnosis of mandibular asymmetry is a complex process since it has a multifactorial etiology. The traditional way of diagnosing jaw asymmetry is analyzed by a combination of diagnostic tools, such as clinical examination, photo analysis, and routine x-rays; these x-rays involve increased radiation exposure and are expensive. However, panoramic radiography is used in our daily clinical practice, with acceptable cost and minimal radiation exposure, and provides acceptable results (2)(4).

Mandibular asymmetries, which can cause functional and aesthetic problems, are characterized by morphological and dimensional differences between the left and right sides of the mandible. Even a slight asymmetry is rather considered a risk factor for the presence of temporomandibular disorders (TMD), which over time can cause malocclusions, psychosocial and functional problems and even facial alterations (23).

Habets et al found that when evaluating a panoramic radiograph, the head should be positioned in the center of the head support and the head support should be connected to the device. An image with uneven magnification in the horizontal dimension may be seen if there is a failure to position the midsagittal plane in the midline of rotation of the machine. All radiographs used in this study were taken by a qualified and experienced technician in ideal conditions (5).

Most studies on mandibular asymmetry did not assess data between gender. Saglam investigated jaw asymmetry in different skeletal patterns and indicated that condylar asymmetry and ramus asymmetry measurements were significantly affected by gender. Bal et al investigated the asymmetry of the mandibular ramus and indicated that the asymmetry of the ramus was observed more frequently in women, but the difference was not statistically significant, in the same way in the present study this prevalence of the female gender was confirmed. regarding the percentage of patients with vertical asymmetry in the condyle and mandibular ramus. Fuentes et al. obtained a higher prevalence of asymmetry in women than in men using the Habets method (4)(5).

4.1. Description of the sample and study design

The patients selected for the present study were random patients from the 7th semester of the Faculty of Dentistry of the University of Cuenca.

The final sample consisted of 31 CBCTs; CBCTs were performed with the same equipment (3D ACCUITOMO 170), under the same operator and conditions.

For the processing of the CBCT images and their measurements, the SIDEXIS 4 ® program was used.

5. Conclusion

General conclusion

The length of the condyle and mandibular ramus have been quantified in CBCT (Cone Beam Computed Tomography) in young patients.

Specific conclusions

- It has been determined that there are asymmetries both in the length of the condyle, mandibular ramus and the total between the sides of the mandible.
- Regarding the skeletal class, it has been determined that in this sample there is a higher proportion of asymmetries in class II patients with 75%, followed by Class I with 43%, with asymmetry in Class III being the least frequent with 50%. .
- It has been determined that the vertical asymmetry index is 6.87% for the condyle, 3.69% for the ramus and 2.8% for total mandibular asymmetry with the Habets method.
- Based on the results of the asymmetries presented in the sample and its relationship with the sex of the participants, we could conclude that the asymmetry in the total mandibular length between both sides of the jaw is more frequent in female patients.

Compliance with ethical standards

Acknowledgments

Thanks to my classmates who collaborated with the necessary information to carry out this study. And to our teacher Dr. Estuardo Bravo who gave us the opportunity to make our first publication and was always willing to guide us.

Disclosure of conflict of interest

I, Karen Andrea Ayora with CC 0924312432 as principal investigator of the research project entitled: "Vertical asymmetry of the condyle and mandibular ramus measured by cone beam computed tomography (CBCT)", which was carried out in the city of Cuenca - Ecuador, in the period: December 2022 - January 2023, I declare that I have no conflict of interest to carry out this study.

Statement of ethical approval

This research paper does not contain any studies conducted on animals/human subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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