Anthropometric considerations between lower first molar, condyle ramus height and coronoid process

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Abstract

This study examines the relationships between the lower first molar, the condyle-ramus height, and the coronoid process of the mandible. It is based on the idea that craniofacial structures maintain consistent anatomical proportions, which could assist in orthodontic and prosthetic rehabilitation. The first molar is considered crucial to occlusion development, with its position possibly reflecting underlying skeletal patterns.
Materials and Methods. A pilot clinical trial was carried out at the University of L'Aquila using CBCT scans from 27 adult patients. Measurements were taken at four points: - A: Top of the mandibular condyle - B: Mandibular angle - C: Buccal surface of the first lower molar - D: Coronoid process on the opposite side. Distances AB (condyle to angle), BC (angle to first molar), and CD (coronoid to molar) were calculated. Scans with asymmetries or artifacts were excluded to ensure consistency.
Results. Patients were categorized by Angle's classification: - **Class I (n=14): AB/BC average around 55.9 mm; CD approximately 84.7 mm - **Class II (n=7)**: AB/BC average about 55.2 mm; CD around 86.5 mm - **Class III (n=6)**: AB/BC average roughly 61.6 mm; CD approximately 90.6 mm In 85% of cases, point C (molar location) was found in the mesial half of the first molar. While AB and BC measurements correlated strongly (indicating a predictable molar location), no significant correlation was found between CD and the other distances. Discussion. The study confirms a consistent anthropometric relationship between the condyle, mandibular angle, and the lower first molar. This suggests that the position of the lower first molar is structurally determined and should guide orthodontic and prosthetic treatments. Therefore, clinicians should focus on maintaining or restoring this natural alignment in treatments, including implants or dentures.**

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Conclusion. The position of the mandibular first molar demonstrates a consistent geometric relationship with skeletal landmarks. This anatomical constant should be utilized in clinical practice to improve long-term treatment outcomes in orthodontics and prosthodontics.

Keywords: first molar, vertical dimension, prosthetic rehabilitation

Introduction

Interest in craniofacial anthropometry stems from the desire to identify reference points and their relationships, recognizing consistent characteristics that define "normal" patterns and their physiological and pathological variability within populations.

The aim of this work was to determine the role of the lower first molar in relation to the condyle-ramus height and the position of the coronoid process. The lower first molar is considered key to occlusion in terms of orthodontic and prosthetic rehabilitation; therefore, understanding whether there are relationships with the bone structure could help improve prosthetic, orthodontic, and occlusal rehabilitation. The first molars play an essential role in the development of occlusion and masticatory function, supporting and maintaining overall oral health. These teeth are fundamental in establishing proper dental alignment and ensuring optimal distribution of masticatory forces (1-3).

Angle was the first to recognize the importance of the first molars during the occlusion formation phase, describing the molar relationship as the key to occlusion. Later, Andrews incorporated the "Six Keys to a Normal Occlusion" into Angle's classification. Three of these keys determine the correct spatial position of the permanent first molars in a normal occlusion. Over the years, criteria, norms, and guidelines for proper dental positioning have been proposed, mainly based on anthropometric studies (2).

Through these studies, it has been recognized that different parts of the human body are proportionally related to each other. For example, some researchers have identified a consistent relationship between the lateral arm of the Gothic arch tracing and the position of the posterior teeth. Keshvad et al. suggested that the intercondylar distance could serve as a reliable guideline for the complete placement of teeth in full dentures (3). Other researchers examined the anthropometric relationship between the intercondylar distance, intercanine and intermolar distances of the maxillary arch, and vertical occlusal dimension in dentate individuals from the South Indian population, asserting that these measurements can be used to determine the inclination of posterior teeth regardless of facial shape (4-5).

Other researchers have also examined the relationship between the interocclusal distance and the gonial angle, with findings indicating an inverse correlation: as the gonial angle increases, the interocclusal distance decreases (6).

This study aims to show that the distance from the highest point of the condyle to the mandibular angle is the same as the distance from the condyle to the lower first molar. A second correlation was also examined: the distance from the coronoid process to the point established by the previous measurement on the lower arch (7).

Materials and Methods

The authors designed an open-label, single-arm pilot study. The current investigation was carried out between 2018 and 2023 at the Prosthodontic Unit Service of the Integrated Head and Neck Care Department of the University of L'Aquila. All participants signed informed consent. The Principles of the Declaration of Helsinki require clinical trials for human research. Informed consent was obtained from all participants involved in the study (6-8).

Participants and Sampling

The inclusion and exclusion criteria listed below were used in this study:

Inclusion criteria: (a) subjects >18 years old

Exclusion criteria: (a) connective tissue disorders and scleroderma, fracture and trauma, deformities, cancers, TMJ ankylosis.

Protocol

The procedure was carried out using Cone Beam CT scans (CBCT) with an extended Field of View (FOV) that covered the entire mandibular structure, including the condyle. Using dedicated PC software, volumetric measurements were conducted on a 3D reconstruction of the radiographic scans.

The anthropometric points used for measurements are (Figure 1):

- Point A: the highest radiographic point of the mandibular condyle on the outer side of the mandibular ramus
- Point B: the outermost point of the mandibular angle
- Point C: a point located in the equatorial zone of the vestibular crown surface of the lower first molar
- Point D: the highest point of the coronoid process on the opposite side of the analyzed mandibular condyle, on the inner side of the mandibular ramus

In this CBCT image, point A is marked in red, point B in blue, point C in yellow, and point D in green.

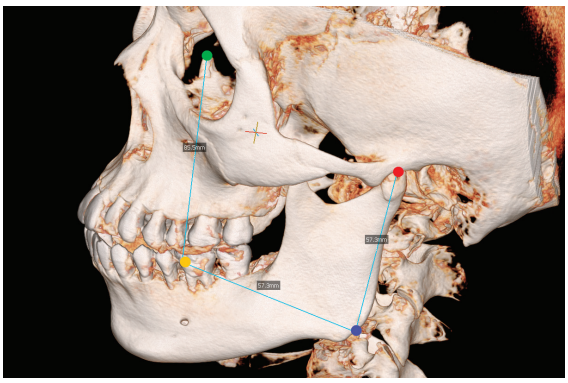

Figure 1. In this CBCT image, point A is marked in red, point B in blue, point C in yellow, and point D in green.

10.59987/ads/2025.3. 315-319

The distances calculated based on these points are (Figure 2-3):

- Distance AB: between the highest point of the mandibular condyle on the outer side of the ramus and the outermost point of the mandibular angle
- Distance BC: between the outermost point of the mandibular angle and the equatorial zone of the vestibular crown surface of the lower first molar and it should be the same as distance AB.
- Distance CD: between the highest point of the contralateral coronoid process on the inner side of the ramus and the same point C on the first molar

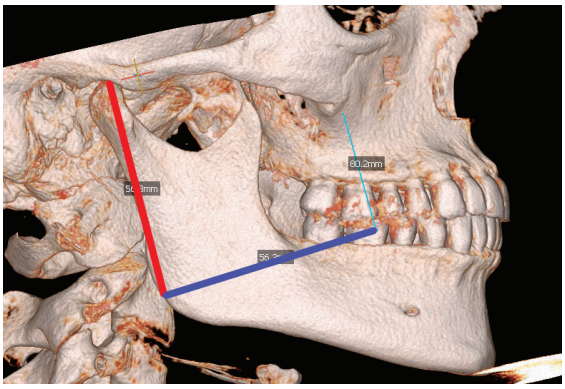

Figure 2. The red line indicates the AB distance, and the blue one indicates the BC distance.

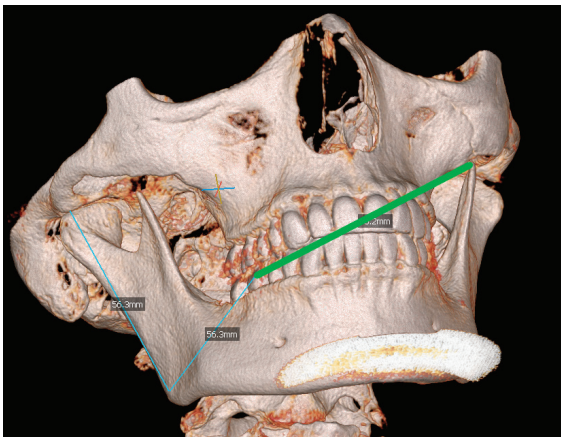

Figure 3. The green line indicates the CD distance.

In cases where artifacts interfere with measurements in one hemimandible, the study was performed on the opposite side, and CBCT scans with significant structural asymmetries were excluded. It is important to note that when radiographic artifacts in one hemimandible hindered or distorted the measurements, the study was conducted on the opposite hemimandible. This is because CBCT scans from patients with notable structural asymmetries were excluded from the study (9-13).

Data collection involved 27 patients of different sexes, races, and ages ranging from 25 to 55 years.

Furthermore, specific assessments were made for each patient, noting their respective Angle dental class, to evaluate possible anthropological differences related to occlusion type.

First, after dividing the CBCT scans based on the Angle classification, points A and B were identified on each radiograph. Then the distance AB between the condyle and the mandibular angle was measured.

Once this value was obtained, a line was drawn starting from point B, with a length equal to the previously measured distance AB, positioned at the level of the mandibular first molar's equator, at point C. This line represents the distance BC.

Next, point D was identified on the contralateral coronoid process of the hemimandible, where points A, B, and C had already been marked, and a line was drawn from D to C. This resulted in the last anthropometric measurement: the distance CD.

All data were then collected and statistically analyzed using ANOVA and Kruskal-Wallis tests with a confidence level set at 95% to compare results across multiple groups.

Results

In the 14 first-class cases, measurements ranged from 49.5 mm to 67.2 mm, with an average of 55.90 ± 4.40 mm. For the 7 cases of Angle's second class, measurements ranged from 49.9 mm to 60.8 mm, with a mean of 55.2 ± 3.25 mm. Lastly, the 6 cases of Angle's third class showed values between 58.6 mm and 65 mm, averaging 61.6 ± 2.24 mm. Significant differences exist between groups (<0.01), especially after post hoc comparison; first and second-class cases differ significantly from third-class cases.

Subsequently, using the AB values, a line representing the BC distance was traced in each CBCT, extending to the dental equator of the lower arch at the first molar zone. The aim was to demonstrate a potential anthropometric correlation between these elements, maintaining the same AB value across all cases.

The BC line ending at the lower first molar exhibited various localization patterns. To simplify findings and enhance accuracy, the lower first molar was divided into two sections: mesial and distal. In most cases (85%), point C was located in the mesial part of the first molar, while in others, it was near the distal segment.

From these data, it appears that classification based on Angle has limited anthropometric relevance, as point C is not consistently located across different occlusal situations. The dominance of cases where point C falls in the mesial half of the mandibular first molar is quite clear.

Regarding DC distance, first-class cases have measurements ranging from a minimum of 78 mm to a maximum of 98.8 mm, with an average of 84.73 5.09. Second-class cases show a minimum value of 77.8 mm and a maximum of 92.80 mm, with an average of 86.52 5.12 mm. The last group, Class III patients, have a minimum measurement of 86.6 mm and a maximum of 96.4 mm, resulting in an average of 90.61 3.47 mm. There are significant differences between groups (<0.01), especially after post hoc comparison, where

first-class cases differ significantly from third-class cases.

There is no correlation between the CD and AB and BC measurements in each class group, as indicated by p>0.05 (first-class cases p=0.08; second-class cases p=0.35; third-class cases p=0.27).

Discussion

The objective of this study was to verify the presence of consistent anthropometric measurements between specific anatomical elements of the craniofacial complex, particularly the mandibular condyle, mandibular angle, mandibular first molar, and coronoid process of the mandible (14).

Regarding the first point of the study, the authors used the measurement of AB and BC to determine where the first molar should be positioned. In most cases examined, a consistent feature was observed: the endpoint of the traced line consistently fell on the mesial surface of the first molar. This indicates that the position of the first molar is anthropologically conserved, regardless of skeletal class, and correlates mainly with the length of the mandibular branch. This supports the idea that the mandible is the guiding arch, as always indicated by Angle, though there are exceptions. Therefore, the placement of the upper first molar in orthodontic treatment should be adjusted based on the principles of Angle and Andrews. It is not just the first-class relation that ensures a stable occlusion, but that a first-class relation is achieved through correct positioning of the first molar. Variations in the stability of Class I cases can sometimes be attributed not to the molar relationship itself but mainly to incorrect positioning of the first molar. This suggests that any treatment that moves it to an improper position is likely to fail or relapse (15-17).

Conversely, there is no correlation between the AB distance and the CD distance. Therefore, we should only consider the correlation between AB and BC as a guide for rehabilitation. The hypothesis is that the position of the first molar in the mandible may be more effective from a masticatory standpoint. Indeed, it would be necessary to evaluate this information functionally using tests such as T-scan and electromyography. At this point, if it exists, the problem is that it is not modified when placing an implant or when performing proper uprighting or repositioning in cases of early element loss. The molar relationship is also crucial when planning extensive implant rehabilitations, supported both from a dynamic and anatomical-functional perspective, as previously discussed by the authors. The placement of the first lower molar marks the start of occlusal load distribution (18-19).

The molar ratio also plays an active role in the patient's vertical dimension and provides a stable starting and ending point for the masticatory and swallowing cycle (20-21).

The data indicate that the proper positioning of the mandibular first molar is crucial for a balanced and functional occlusion. It should be respected in both orthodontic treatments and clinical cases where it needs to be restored after loss. This suggests a possible universal constant in the geometry of the mandibular bone structure, which could help guide the functional positioning of the mandibular first molar in occlusal rehabilitation.

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