Assessment of Volume and Height of the Coronoid Process in Patients With Different Facial Types and Skeletal Classes: A Cone-Beam Computed Tomography Study

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Purpose: To determine the height and volume of the mandibular coronoid process (CP) by cone-beam computed tomography (CBCT) and to identify the presence of any correlations of these measurements with age, gender, facial type, and skeletal class.

Materials and Methods: The sample consisted of 132 patients from a departmental routine patient base. After CBCT, CP height was determined using OnDemand 3D software (CyberMed, Seoul, Republic of Korea), and CP volume was obtained using ITK-SNAP 3.0 software (Cognitica, Philadelphia, PA). Measurements were subjected to analysis of covariance against facial type, skeletal class, gender, and age, with a significance level of 5%.

Results: CP height and volume were similar regardless of age, facial type, and skeletal class. However, the 2 measurements were statistically different regarding gender, with larger values for men than for women.

Conclusions: These observations suggest that gender is the only factor influencing the height and volume of the CP.

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The relation between bone morphology and muscle function has been studied thoroughly since the 19th century. The interaction between these factors is governed by the Wolff[1] law, which states that morphology and internal bony architecture depend on the load applied by muscles onto bone.

Ideally, chewing should be bilateral, with frequent swinging of working and nonworking sides, which protects the integrity of the stomatognathic system. Seamless bilateral mastication exhibits the morphologic and functional harmony of the stomatognathic structures. It also guides proper craniofacial growth as masticatory muscles induce bone remodeling at their insertions.[2,3]

The main jaw-moving muscles are the masseter, temporalis, and medial and lateral pterygoid muscles. The temporal muscle is a large fan-shaped muscle that has its origin at the temporal fossa and its insertion at the mandibular coronoid process (CP). For anatomic purposes, it is divided into anterior, middle, and posterior thirds. Contraction of the entire temporalis elevates the mandible and allows for intercuspation, and selective activation of its middle and posterior fibers produces jaw retraction.[4]

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Some have suggested that during mandibular elevation the anterior portion of the temporalis exerts a superolateral pull on the CP. The resulting tension can influence the growth and morphology of the CP in different skeletal classes.[5,6] Other studies have reported CP atrophy in the absence of the temporalis muscle and inferred that the lack of muscle loading might be the sole cause of such degeneration.[7,8]

Another major determinant of bone morphology can be facial type, which is determined by the vector of condylar growth associated with lowering of the medial cranial cavity. These factors determine the extent that the mandible will move down, featuring the facial patterns and even the positioning relation between the skull base and mandible, which will appoint the skeletal classes and the development of malocclusion.[9,10] The facial patterns have different muscle strains owing to different craniofacial morphologies for each standard, which could be a factor that influences the morphology of the CP. Furthermore, some have claimed that, compared with women, men show greater bone remodeling and formation owing mainly to greater mastication forces.[11,12]

With the development of software that enables high-precision studies combined with the frequent use of cone-beam computed tomography (CBCT), a better understanding of bone morphology and its interactions with other structures of the human body is required. The lack of studies related to the CP and its importance in the stomatognathic system led to the need to determine the height and volume of the mandibular CP on CBCT images of 132 patients and to identify the presence of any correlations of these measurements with age, gender, facial type, and skeletal class.

Materials and Methods

The research ethics committee of Piracicaba Dental School, State University of Campinas (São Paulo, Brazil) approved this work without restrictions (protocol 065/2014).

SAMPLE SELECTION

This prospective study examined CBCT images of 132 male and female patients 21 to 80 years old who were seen at the university dental radiology clinic with different indications for CBCT. Patients younger than 21 years, non-Brazilians, and those with chronic inflammation, previous surgeries, or hyperplasia of the CP were excluded. CBCT was performed with the Picasso TRIO imaging device (E-Woo Technology Co, Ltd, Yongin, Republic of Korea) with the following exposure protocol: 65 kVp, 4 mA, 17-second acquisition time, 62-second reconstruction time, and 0.2-mm voxel.

DETERMINATION OF ANTEROPOSTERIOR PATTERN AND FACIAL TYPE

Skeletal class (Class I, II, or III) and facial type (brachycephalic, mesocephalic or dolichocephalic) were determined for each patient from multiplanar reconstructions (lateral cephalometric) derived from CBCT images with NemoCeph software (Nemotec, Madrid, Spain). Angles formed by the sella, nasion, and A point; sella, nasion, and B point; and A point, nasion, and B point were calculated according to Steiner's[13] cephalometric analysis and were used with Jacobson's[14] AO-BO measurement to determine skeletal class. Facial type was determined by the VERT index as calculated by Ricketts'[15] cephalometric analysis.

DETERMINATION OF CP VOLUME AND HEIGHT

CP volumetric analysis was performed from reconstructions obtained by semiautomatic segmentation using ITK-SNAP 3.0 software (Cognitica, Philadelphia, PA),[16] which was developed and adapted at the University of Northern California's Laboratory of Neuroimaging Analysis. Volume was calculated in cubic millimeters. Limits for 3-dimensional delineation were set as follows (Figs 1, 2):

- Anteriorly, at the anterior edge of the CP
- Posteriorly, with a vertical line crossing the mandibular ramus at the most inferior point of the mandibular notch

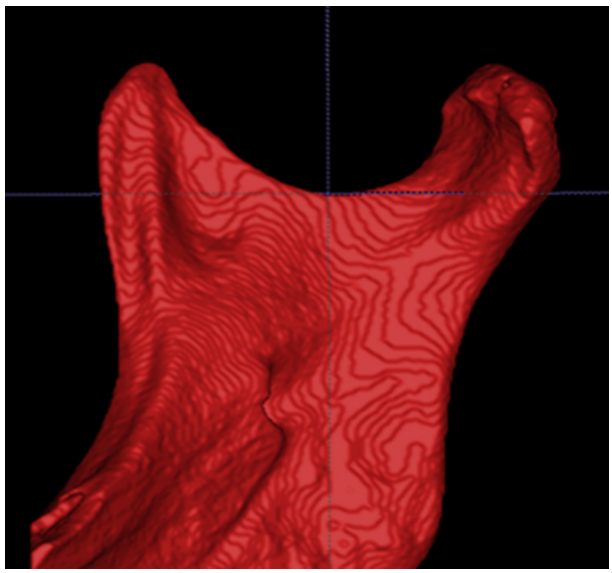

FIGURE 1. The *horizontal line* crossing the mandibular ramus at the most inferior point of the mandibular notch standardizes the local measurement of the volume of the coronoid process.

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