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Short report

Mandibular sexual dimorphism analysis in CBCT scans

Thiago de Oliveira Gamba [a, *], Marcelo Corrêa Alves [b, 1], Francisco Haiter-Neto [a, 2]

[a] Division of Oral Radiology, Department of Oral Diagnosis, Piracicaba Dental School, State University of Campinas, Limeira Avenue, 901, PO Box 52, Piracicaba, SP, Brazil
[b] Superior School of Agriculture "Luiz de Queiroz" Technical Section of Information Technology, University of São Paulo, Pádua Dias Avenue, 11, PO Box 19, Piracicaba, SP, Brazil

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ABSTRACT

The aim of this study was to evaluate sexual dimorphism using anthropometric measurements on mandibular images obtained by cone beam computed tomography (CBCT). The sample consisted of 160 CT scans collected from a Brazilian population (74 males, 86 females) aged 18–60 years. The CBCT images were analyzed by five reviewers. Six measurements (ramus length, gonion–gnathion length, minimum ramus breadth, gonial angle, bicondylar breadth, and bigonial breadth) were collected for the sexual prediction analysis. For the statistical analysis, intraclass correlation was used to evaluate intra- and inter-reviewers, analysis of variance was used to compare the mean values of these measurements, binary logistic regression equations were created to predict sex. Using these four variables, the rate of correct sex classification was 95.1%. After, the discriminant function was used to validate the formula built. Accuracy of 93.33% and 94.74% was found for estimating male and females, respectively. Thus, the formula developed in this study can be used for sex estimation in forensic settings.

1. Introduction

Identity can be described as a set of characteristics that individualize a person and differentiate one person from another; the term is widely used in forensic studies. The process of comparing details in missing individuals and searching for coincidences between previously recorded data is called identification.[1]

Sexual prediction is one of the parameters used for preliminary identification of missing people. Craniofacial structures have advantages because they consist of dense long bones that are comparatively indestructible. A high diagnostic value can be assigned to well-preserved skeletal parts, such as the mandible.[2–5]

Distinct morphologic and morphometric manifestations of sexual dimorphism have been observed in different populations in most countries throughout the world, including the United States, China, Japan, and Europe. Such differences have been reported in many studies, therefore it is essential to target a specific population with current skeletal features.[6–11]

Kharoshah et al.[12] used mandibular osteometric measurements on computed tomography (CT) images to estimate the sex of a specific population. The measurements involved the longest ramus,[3] gonial angle, mandibular base length, and shorter length of the mandibular branch. Measurements were made in sagittal view reconstructed in three dimensions, and the distance between the gonia and between the condyles was measured in three-dimensional (3D) axial view.[12–14]

CT, a method of diagnostic imaging using X-radiation, reproduces sections of the human body in all planes of space.[15–17] Two CT systems are available according to their operating principles: fan beam CT (FBCT) and cone beam CT (CBCT). CBCT was the first technique used to examine the maxillofacial complex.[18,19]

Biwasaka et al.[20] and Angel et al.[21] studied sexual prediction and age using CBCT images in different views of reconstruction. Angel et al.[21] performed measurements on anatomic structures that frequently present anatomical variations, such as the mandibular canal and the mandibular and mental foramina, and found some sex-specific characteristics.[22]

The aim of this study was to create a formula with potential predictive variables using anthropometric mandibular measurements on CBCT images in Brazilians and compare the values

* Corresponding author. Rua Limeira, 901, PO Box 52, Piracicaba, SP, Brazil. Tel.: +55 19 32106 5321.
E-mail addresses: thiagodeo.gamba@hotmail.com (T.O. Gamba), macalves@usp.br (M.C. Alves), haiter@fop.unicamp.br (F. Haiter-Neto).
[1] Tel.: +55 19 34294540.
[2] Tel.: +55 19 32106 5321.

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between the sexes. Variables were evaluated to check for their suitability for sex estimate.

2. Material and methods

This retrospective study included 160 CBCT images of the mandible of adult patients (74 males and 86 females), aged between 18 and 60 years, selected from a database of clinical examinations made at the Dental Radiology Clinic, Piracicaba Dental School, State University of Campinas. This study was approved by The Ethics Committee in Research of the Piracicaba Dental School – State University of Campinas (no. 109/2011).

The images were selected visually by a dentomaxillofacial radiologist. CBCT images of individuals who had any type of pathologic condition or mandibular fractures in the jaw region were excluded. CBCT images were obtained using an i-CAT scanner (Imaging Sciences, Hatfield, PA, USA), and the following parameters: 80 kVp, 4.8 mA, acquisition time 40 s, reconstruction time 62 s, voxel size 0.3 mm, and an extended field of view (FOV) of 23 cm × 17 cm. The images were of patients with orthodontic indications. This FOV was selected to provide images with all the fundamental elements of the mandibular anthropometric points for the present study.

CBCT scans were obtained with the patients seated. The head position was kept in the midsagittal plane perpendicular to the horizontal plane and the Camper plane (an imaginary line that runs from the nose to the wing tragus), thus remaining parallel to the horizontal plane. During the examination, the patients remained immobile for maximum intercuspation.

2.1. Tomographic measurements

Tomographic measurements were made on multiplanar reconstruction images generated by the software tools (OnDemand3D, Cybermed, Seoul, Korea) on a liquid crystal display computer monitor.

Initially, the evaluators marked out the 3D locations of the three anthropometric landmarks: gonion, condylion, and gnathion. The gonion is the most inferior, posterior, and lateral point on the external angle of the mandible. The condylion is the most superior and posterior point of the mandibular condyle. The gnathion is the most inferior and anterior point on the profile curvature of the chin. Then, six measurements were taken in the jaws on CBCT images according to Kharoshah[12]: gonial angle (GA), ramus length (RL), minimum ramus breadth (MRBr), gonion–gnathion length (GGL), bicondylar breadth (BicBr) and bigonial breadth. The first four measurements were obtained from 3D sagittal views (Fig. 1) and the latter two, from 3D axial views (Fig. 2). The junction of the posterior and lower borders of the mandible forms the gonial angle. The distance between the anatomic landmarks condylion and gonion is the ramus length, the distance between the gonion and gnathion is the gonion–gnathion length and the shortest width of the mandibular branch is the minimum ramus breadth. The distance between the most lateral points on the two condyles is the bicondylar breadth. The distance between the right and left gonion is the bigonial breadth.

Five PhD students in Oral Radiology with experience in CBCT image diagnosis performed all measurements. After 15 days, the measurements were repeated for 25% of the sample.

2.2. Statistical analysis

Statistical analysis of the data was done using the SAS system (SAS Institute Inc., SAS system, Release 9.2. SAS Institute Inc., Cary, NC, USA). The reliability of the measurements was assessed by the intraclass correlation coefficient (ICC) using the Shrout–Fleiss test ($ICC_{3,1}$) for the intra-reviewer analysis and $ICC_{2,k}$ for the inter-reviewer analysis.[23]

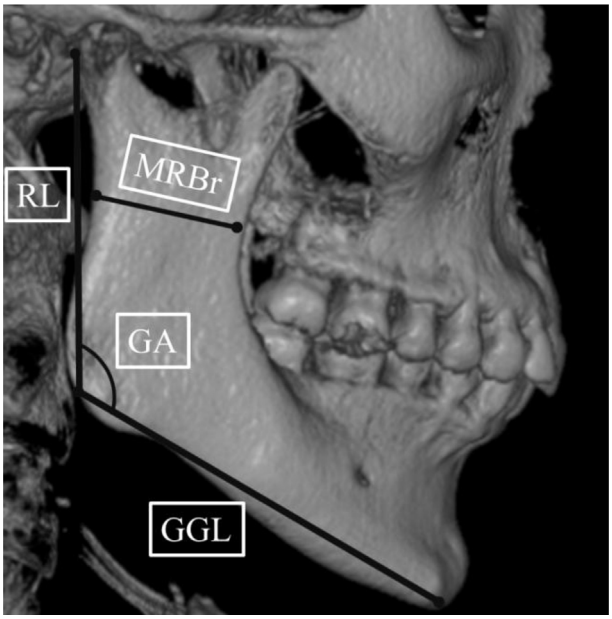

Fig. 1. (RL) Ramus length; (MRBr) minimum ramus breadth; (GA) gonial angle; (GGL) gonion–gnathion length.

A one-way analysis of variance (ANOVA) model appropriate for experiments with a factor with repeated measures was used. The model was adjusted using logistic regression with stepwise selection of variables. A significance level of 5% was used for all statistical tests. Discriminant function analysis was done to confirm the results obtained with the logistic regression, as well as to validate the formula.

3. Results

3.1. ICC

The Shrout–Fleiss intraclass correlation coefficient ($ICC_{1,3}$) showed substantial intra-reviewer agreement (>0.70). Exceptions

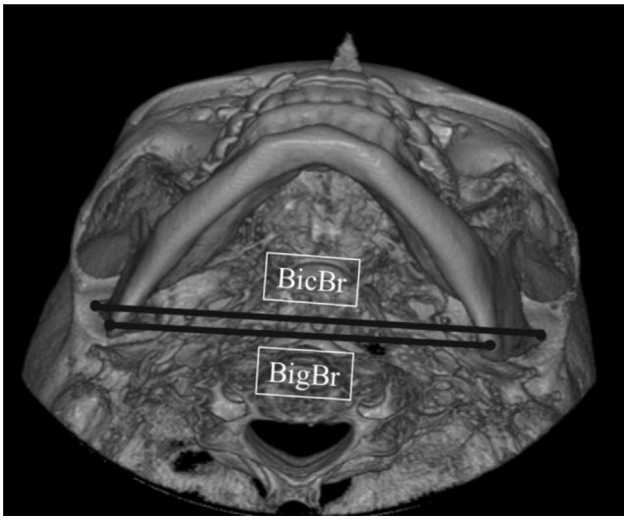

Fig. 2. (BigBr) Bigonial breadth (distance between the two gonia); (BicBr) Bicondylar breadth (distance between the two condyles).