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Three-dimensional evaluation of craniofacial characteristics related to mandibular asymmetries in skeletal Class I patients

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Introduction: Our objective was to analyze the characteristics that affect skeletal Class I adults with mandibular asymmetries using cone-beam computerized tomography. **Methods:** The sample included cone-beam computerized tomography images of 120 subjects. Asymmetry was determined by the deviation of gnathion from the midsagittal plane and classified as relative symmetry, moderate asymmetry, or severe asymmetry. Maxillary and mandibular measurements were made, and the differences between the contralateral side and the deviated side were evaluated, as well as the differences between the categories of asymmetry. **Results:** For patients with moderate asymmetry, there were significant differences between the contralateral and deviated sides for some measuments in the transverse and vertical planes. For those with severe asymmetry, statistically significant differences were found between the sides for all measurements, except for the measuments that evaluated the position of the mandibular condyle in the transverse and sagittal directions. Furthermore, a strong correlation was found in patients with severe asymmetry, between the deviation of the mandibular dental midline and the lateral displacement of gnathion. Conclusions: Patients with relative symmetry had a bilateral balance, whereas those with moderate and severe asymmetries showed several skeletal imbalances. A great deviation of the mandibular dental midline may indicate severe skeletal asymmetry in Class I adults. (Am J Orthod Dentofacial Orthop 2018;154:91-8)

Originally, Class I was described by Angle as a dental malocclusion in which the mesiobuccal cusp of the maxillary first molar aligned with the buccal groove of the mandibular first molar.[1] Subsequently, with the advent of cephalometry, it was possible to verify that Class I patients tended to have an acceptable sagittal jaw relationship. Yet, it is also important to consider other dimensions, since skeletal disharmonies in the vertical and transverse planes may be present as well.[2,3]

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A wide range of studies dealing with such alterations can be found in the literature, mainly in regard to open bites, deepbites, and posterior crossbites.[4-6] However, recently, greater attention has been given to craniofacial asymmetries, mainly due to the dissemination of 3-dimensional (3D) tomographic images, which eliminate the previous limitations of traditional 2-dimensional techniques.[7]

It is well accepted that even faces considered pleasant may have some asymmetry, indicating that craniofacial development does not have absolute lateral uniformity. Once this inbalance between the sides of the face assumes a moderate to severe intensity, the craniofacial asymmetry is recognized.[8]

Deviations of the chin are the most striking feature of this asymmetry,[9-11] since the mandible has a longer growth period and is not rigidly connected to the skull base, as is the maxilla.[12] Recent studies have shown that the prevalence of moderate and severe mandibular asymmetry, when analyzed using 3D images, may be greater than 40%.[13]

Patients with mandibular asymmetry have an increased risk for developing psychosocial issues[14] and often need prolonged orthodontic and possibly surgical interventions.[8] A vast amount of literature exists on the craniofacial features related to asymmetrical patients with skeletal Class II malocclusion and, primarily, Class III malocclusions.[12,15-17] Little attention has been given to the characteristics of patients with Class I skeletal asymmetries.

Based on this assumption, we sought to analyze the characterisitcs of skeletal Class I adults with mandibular asymmetries, using cone-beam computed tomography (CBCT). This study is clinically relevant, since it allows professionals to evaluate the morphologic components related to these deformities and more carefully obtain correct diagnoses and treatment plans for these patients.

MATERIAL AND METHODS

Institutional review board approval from Universidade do Sul de Santa Catarina was obtained before the study (protocol number 1.591.220). This study was nested in a previous epidemiologic investigation that analyzed the prevalence and associations of mandibular asymmetries.[13] CBCT images of 120 subjects were eligible, and the power calculation for the statistical tests applied demonstrated that this sample size would be adequate using $\beta < 0.2$ and $\alpha = 0.05$ (StatsToDo, Queensland, Australia).

The analyzed CBCT images were part of a database of a service center for dental diagnosis and planning (Compass3D, Belo Horizonte, MG, Brazil). The images were obtained from orthodontic and orthognathic patients between 2011 and 2013.

The following inclusion criteria were adopted: CBCT images requested with clinical justification or when conventional radiographic techniques made it impossible to meet the clinical needs, thereby following the guidelines of the SEDENTEXCT[18] project and the American Academy of Oral and Maxillofacial Radiology[19]; patients aged 19 through 60 years with Class I sagittal skeletal pattern (ANB angle between 0° and 4.5°, as proposed by Tweed[3]); and no missing teeth other than third molars. The exclusion criteria were previous orthodontic treatment, facial fractures or facial surgery, degenerative disease in the temporomandibular joint, and craniofacial anomalies.

All scans were obtained from the same device (iCAT; Imaging Sciences International, Hatfield, Pa), adjusted to operate with the following specifications: extended field of view (16 × 22 or 17 × 23 cm), 120 kV(p), 3-8 mA, and 0.4 mm^3 voxel. All subjects were instructed to close their mouths in maximum interscupation and to relax their lips.

The CBCT images were exported in DICOM format, using the iCAT Vision software (Imaging Sciences International). The DICOM files were imported into the SimPlant Ortho Pro software (version 2.0; Materialise, Leuven, Belgium). The CBCT images were reoriented using the Frankfort horizontal plane as the horizontal and midsagittal plane passing through nasion and basion and perpendicular to the Frankfort horizontal plane. All landmarks and reference planes used in the study are described in Table I.

Landmarks were located using 3D reconstructions and multiplanar reconstruction view, with measurement scales of 0.01 mm and 0.01°. For landmarks such as gnathion and gonion, the center of the edge of the bone was chosen.

The outcome was categorized into 3 groups according to the degree of mandibular asymmetry, based on the lateral deviation of gnathion in relation to the midsagittal plane.[6,9,10] The methodology we used to determine the midsagittal plane was previously validated by Damstra et al.[20] Independently of the side of the deviation, patients with a gnathion displacement of up to 2 mm from the midsagittal plane were categorized as having relative symmetry.[12,16,21] Patients with a displacement greater than 2 mm and up to 4 mm were categorized with moderate asymmetry, and those with a displacement greater than 4 mm were categorized as having severe asymmetry.[12,22] Each category contained 40 subjects, totaling 120 evaluated persons.

Several measurements were evaluated (mandibular and maxillary components) and then grouped into the transverse, sagittal, and vertical planes. These measurements are described in Table II and illustrated in the Figure.

The deviation of gnathion from the midsagittal plane was considered in absolute values, independent of the side of the deviation. For the other measurements made in the tomographic midpoints, a positive value was given when the displacement of the point coincided with the side of the gnathion deviation (deviated side); a negative value was given when the displacement occurred on the opposite side (contralateral side). To determine the asymmetry between the measurements from bilateral landmarks, the difference of the contralateral side minus the side of mandibular deviation was analyzed.

To calculate the error of the method, 20% of the sample was evaluated at 2 different times by 1 examiner (B.F.G.) with a 2-week interval. The intraclass correlation coefficient was used, and a value greater then 0.80 was obtained for all measurements evaluated, demonstrating good reliability of the method.

Statistical analyses were conducted using SPSS software (version 20.0; IBM, Armonk, NY). The Shapiro-Wilk test was applied, demonstrating the normal distribution of the values obtained for bilateral measurements and the abnormal distribution of the values obtained for midpoint measurements. The values obtained on the contralateral and deviated sides were compared using the Student *t* test for paired samples. To verify possible