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Correlation between midline deviation and condylar position in patients with Class II malocclusion: A cone-beam computed tomography evaluation

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Introduction: Midline deviation of the mandible and maxilla can affect craniofacial growth and occlusion and cause consequences to the temporomandibular joint. The aim of this study was to evaluate the lateral displacement of the skeletal and dental midlines in relation to the condyle head position in Class II patients with cone-beam computed tomography. **Methods:** We used 82 cone-beam computed tomography images. The lateral displacement of the skeletal and dental midlines considering the 3-dimensional reference plane was analyzed with points in the maxillary and mandibular central incisors, anterior nasal spine, and menton. The condyle-fossa relationship, concentric position of the condyles, and dimensional and positional symmetries between the right and left condyles were evaluated. **Results:** There was a statistically significant difference regarding anterior nasal spine with maxillary central incisor, menton, and mandibular central incisor points for both sides, and also for maxillary central incisor-menton for the displacement of the left side. We found differences in the temporomandibular joint for inclination and diameter measurements of the condylar process. Strong correlations were observed between the maxilla and the condylar process diameter (right side) and the distance between the geometric centers (left side), in addition to a strong correlation between the sagittal midline displacement and the geometric center differences on the right and left sides. **Conclusions:** In patients with Class II malocclusion, lateral displacement of skeletal and dental midlines in relation to the condyle head position has a significant correlation with the anteroposterior difference between the geometric center of the right and left condylar processes. (Am J Orthod Dentofacial Orthop 2018;154:99-107)

Mandibular deviation is one of the most common craniofacial deformities. Midline lateral displacement of the mandible or maxilla may have dental or skeletal causes, resulting in asymmetric growth or other changes that affect craniofacial growth.[1-3] On the other hand, facial growth pattern, occlusal forces, dental occlusion changes, increases or decreases of muscle activity, functional pathologic changes, sex, and age are factors that affect morphology and position of the temporomandibular joint (TMJ).[4]

Previous studies have evaluated TMJ morphology and position, especially the condyle-fossa relationship and condylar morphology related to different malocclusions.[3-9]

However, the influence of the type of malocclusion is still controversial, and little has been studied regarding midline lateral displacement of the mandible and maxilla, either dental or skeletal.

The condyle-fossa relationship can be understood in different ways, depending on the type of image used for diagnosis, as well as the reference planes used in positioning the patient's head at the examination.[10,11]

With the introduction of cone-beam computed tomography (CBCT) in dentistry, tomographic examinations

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are increasingly requested; they have benefits for diagnosis of the craniofacial bony structures, especially the position and morphology of the TMJ.

Unlike 2-dimensional (2D) images, 3-dimensional (3D) CBCT images do not have overlapped anatomic structures or magnification and image distortion problems. CBCT images are reliable and accurate representations of the patient's anatomy, spatial location, size, and shape, in addition to providing accurate information about the relationship with adjacent anatomic structures.[12] In addition, several studies have confirmed the accuracy of measurements of the images generated by the CBCT compared with 2D images.[13-16]

Thus, considering the aforementioned information, the objective of this study was to evaluate lateral displacements of skeletal and dental midlines to the sagittal plane in relation to the position of the condyles in Class II patients using the 3D reference plane on CBCT images.

MATERIAL AND METHODS

This study was approved by the research ethics committee of State University of Campinas (protocol number 070/2014). We used 82 CBCT images of patients from 18 to 35 years of age. The images were obtained from the Department of Dental Radiology; they had been previously obtained for the initial diagnosis of orthodontic patients.

CBCT images of patients of both sexes were included; the patients had a Class II skeletal pattern, diagnosed through the cephalometric tracings. In addition, we selected only images of patients with the Frankfort horizontal plane parallel to the ground, with no missing teeth, supernumerary teeth, or pathological conditions in the craniomaxillofacial region. Moreover, these images had no asymmetry considering the sagittal plane, starting from the 0-mm difference with the 3D reference plane. All images had appropriate sharpness, density, and contrast for evaluation of the structures of interest.

The tomographic images were acquired with the i-CAT CBCT (Imaging Sciences International, Hatfield, Pa), with protocol of 8 mA, 120 kV(p), 23 × 17 cm field of view, 0.3-mm voxel, and 40-second acquisition time.

Once the images were imported to the software (On Demand Software, Vancouver, Wash), the volume was reformatted in the 3D module to check the patient's head correct position. This reformatting was done by covering the entire volume and using the 3D reference plane proposed by Katsumata et al[17] joining sella, nasion, and axis odontoid process points in the midsagittal plane. The coronal and axial planes were defined from a perpendicular line through the midsagittal plane. After reformatting, the volumetric data set was displayed in transaxial or multiplanar reconstructions and volume windows.

Two radiologists (G.D.R.T., P.D.P.) experienced in CBCT images evaluated all images. Analyses were performed with the only lighting from the FlexScan S2000 LCD monitor (EIZO, Ishikawa, Japan), with a 21-in dimension. Before evaluation of the images, the evaluators were trained by evaluating 10 CBCT images that were not part of the sample. They could use the tools of the CBCT software, including zoom, brightness, and contrast, with no time limitation.

First, lateral displacements of the skeletal and dental midlines were evaluated considering the 3D reference plane on the On Demand software. Then the dental and skeletal points were found according to the study of Sanders et al[10]: contact point of the maxillary central incisors, contact point of the mandibular central incisors, most anterior midpoint of the maxillary anterior nasal spine, and the most inferior point on the mandibular symphysis (menton) (Fig 1). Finally, we carried out the perpendicular measure from the points to the localized points up to the 3D reference plane. If there was a deviation to right side, the measurements were positive; if centered, the value was zero; and if there was a deviation to the left side, the measurements were negative (Fig 1).

For evaluation and to obtain the position measurements of the condyles in the CBCT images, the volumetric data set was displayed in multiplanar windows. The tomographic images were analyzed on the sagittal and axial planes of the TMJ region. First, the orientation lines were positioned on the condyle head; this generated a straight line for orientation in the sagittal, axial, and coronal planes.

After that, we evaluated the condyle-fossa relationship, concentric position of the condyles, and dimensional and position symmetries between the right and left condyles according to the study of Rodrigues et al.[5] (Fig 2).

Table 1 gives the landmarks for the analyses of the tomographic images of the TMJ region.

A week later, the evaluations were repeated on 25% of the sample to statistically examine intraobserver concordance. Interobserver concordance was also performed. Both were evaluated with intraclass correlation coefficients. Statistical correlation between lateral displacement of the midline and position of the condyles was carried out with descriptive analyses. Comparative analyses between 2 groups were performed with the Student *t* test for paired samples, and correlations between variables were verified with the Pearson test with 5% and 1% significance levels. All statistical analyses were performed using Statistics for Windows (version 17.0; SPSS, Chicago, Ill) at a significance level of 5%.