Standardization of a method for measuring buccal and lingual bone plates using Cone Beam Computed Tomography

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Abstract

Introduction: The thickness of the buccal and lingual bone plates constitutes one of the limiting factors of the orthodontic movement. The imaging technology has permitted the evaluation of this anatomical region, by means of cone beam computed tomography. **Objectives:** To detailed describe and standardize a method for measuring the buccal and lingual bone plate thickness in CBCT images. **Methods:** Digital standardization of face image should constitute the first step before the selection of CBCT slices. Two axial sections of each jaw were used for measuring the thickness of buccal and lingual bone plates. The cemento-enamel junction of the first permanent molars was used as a reference, both in the upper and lower arches. **Results:** Axial sections parallel to the palatine plane were recommended for quantitative evaluation of the alveolar bone plate in the maxilla. In the mandibular arch, the axial sections should be parallel to the functional occlusal plane. **Conclusion:** The method described shows reproducibility for evaluating the periodontal effects of tooth movement for clinical or research purposes, permitting the comparison between pre and posttreatment images.

Keywords: Tomography. Spiral Cone Beam Computed Tomography. Diagnosis. Alveolar process.

Editor's abstract

Cone beam computed tomography (CBCT) permits the evaluation of tooth movement repercussion on the buccal and lingual alveolar bone plates.[1,2] For research purposes, it is necessary to detailed standardize a method for quantitative analyses of these alveolar regions in CBCT, which constitutes the main purpose of this study.

The steps of the methodology were adjusted

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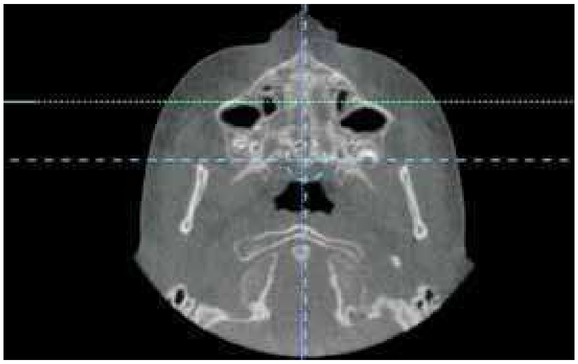

FIGURE 1 - Standardization of the axial section, making the bispinal line coincide with the vertical reference line.

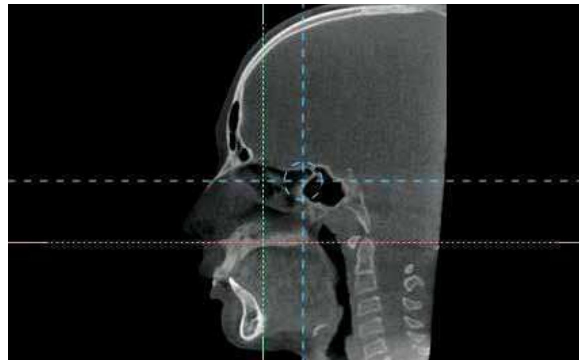

FIGURE 2 - Sagittal section, making the bispinal line coincide with the horizontal reference line.

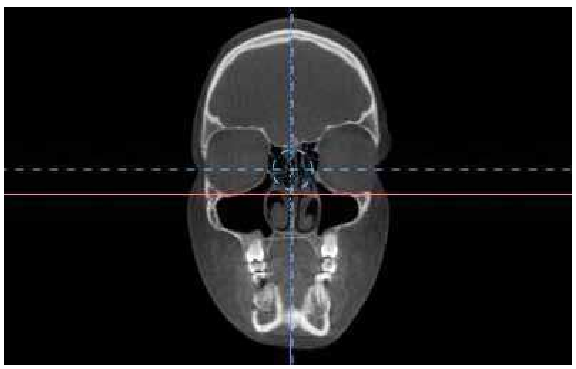

FIGURE 3 - Coronal section, making the infraorbital line coincide with the horizontal reference line (in pink).

for the i-CAT scanner (www.imagingsciences.com) and Nemoscan software (Madrid, Spain, www.nemotec.org) or Dolphin 3D software (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). During image acquisition, the "field of view" should include the entire face, with a voxel dimension of 0.3 or 0.4 mm. Before image selection for measurement, the image of the head should be standardized in all the three planes. Using Nemonscan software, the reference to standardize the axial and sagittal images was the palatal plane (ANS-PNS), making it to coincide with the vertical and horizontal planes, respectively (Figs 1 and 2). The reference used to standardize the frontal plane was the infra-orbital line coincident with the horizontal plane (Fig 3). Using Dolphin software, the standardization of head position is performed in 3D images and it is possible to use the Frankfurt plane as a horizontal reference in the right and left lateral view and to use the infra-orbital plane in the frontal view.

The next step consisted of the selection of two axial sections of each jaw. For the maxilla, an axial section passing at the level of cemento-enamel junction of the distovestibular region of the right maxillary first molar was selected. From this reference axial section, two axial sections passing 3 and 6 mm apically to the cemento-enamel junction were selected, where the measurements of buccal and lingual bone plates can be performed. In this way, the axial sections of maxilla are parallel to the palatal plane (ANS-PNS) using Nemoscan software, or parallel to the Frankfurt plane using Dolphin software. For the mandible, axial sections parallel to the functional occlusion plane was selected. In this way, using Nemoscan software, the image of the head was repositioned, rotating it backward in the magnitude equivalent to the angle between the palatal plane (ANS-PNS) and the functional occlusal plane (measurement obtained in the CBCT reformatted image of the lateral cephalogram). Then, an axial section passing through the cemento-enamel junction of the distovestibular region of the right mandibular first molar was selected. From this reference axial section, two

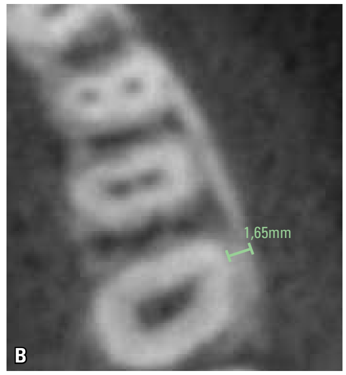

FIGURE 4 - Image zoomed in to facilitate measurement in **A** and with the measurement already executed in **B**.

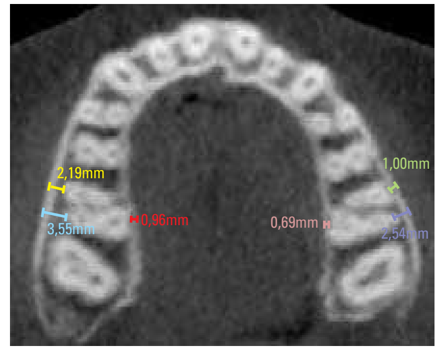

FIGURE 5 - Measurements taken using the software, indicating the thickness (in mm) of the buccal and palatal bone plates.

axial sections passing 4 and 8 mm apically to the cemento-enamel junction were selected for bone plate measurements. When the measurements are performed using Dolphin software, the selection of the axial sections of mandible should consider the angle between Frankfurt plane and occlusal plane, instead of PP.OP. The measurements are performed in amplified images in order to improve the visualization (Fig 4). The measurements of buccal bone plate are performed from the buccal limit of root contour to the buccal surface of the cortical plate, perpendicularly to the dental arch (Fig 5). The measurements of the lingual bone plate are performed from the lingual limit of the roots to the lingual surface of the cortical plate (Fig 5).

Using this method, a reproducible numerical evaluation can be performed by comparing pre and posttreatment exams. This methodology permits to evaluate the effects of buccal and lingual tooth moment, as well as to rationalize on the biological limits of tooth movement.

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Questions

1. What is the importance of evaluating the effects of tooth movement on the buccal and lingual bone plates?

The thickness of the alveolar bone defines the limits of orthodontic movement, and to challenge these boundaries can lead to iatrogenic collateral effects for the periodontal tissues. The most critical tooth movements include dental arch expansions and incisor retraction. Such movements can decentralize teeth from the envelop of the alveolar bone causing bone dehiscence, fenestration and gingival recession, depending on the initial morphology of the periodontal bone, as well as on the amount of tooth movement. Classic Orthodontics considered the amount of crowding, the mandibular incisor position and the growth pattern as the tripod which determined the diagnosis and treatment planning. The contemporary Orthodontics included the facial/smile esthetics in the list. The future Orthodontics may add the initial anatomy of the periodontal bone to these four factors.

2. What is the importance of the CBCT for this purpose?

Due to the high definition and sensitivity of spiral and cone-beam CT, the images can show bone dehiscences and fenestrations. Previously to CT advent, efforts to define the impact of tooth movement on the buccal and lingual bone plates were concentrated in experiments in animals or using conventional radiographs. Currently, many are the CT studies on the morphology of the buccal and lingual bone plates previously to orthodontic treatment and on the repercussions of tooth movement on the alveolar bone. These evidences can change usual treatment planning, pointing the limits of therapeutic options in Orthodontics. Additionally, the morphology of buccal bone plate can tell the orthodontist which patient can or cannot be treated with expansionist mechanics.

3. Comment some examples of the applicability of this methodology to research purposes.

The applications of this methodology should answer if it is reasonable to move teeth to a region of atrophic alveolar bone. CBCT will elucidate the acceptable amount of dental compensation or decompensation in skeletal Class II and Class III patterns. The periodontal effects of mandibular anterior repositioning appliances on the lower incisors can also be evaluated by means of this methodology.

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