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Research

Evaluation of the position of maxillary incisors with and without apical root resorption

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ABSTRACT

Objective: Apical root resorption (ARR) is a condition commonly observed during orthodontic treatment, and several factors allow its occurrence to be foreseen. Some authors suggest that a possible movement of the tooth next to the cortical bone may be one of these factors. The purpose of this study was to determine, by means of cone-beam computed tomography images (CBCT), the distances between the root apex and the labial and lingual cortical bone and the axial inclination of maxillary incisors with and without resorption in patients under orthodontic treatment.
Methods: Twenty-one patients under orthodontic treatment who showed one maxillary incisor with ARR and its corresponding contralateral without ARR were selected and submitted to CBCT. From the images obtained, measurements of the distances between the root apex and the external surface of the labial and lingual cortical bone and of the upper incisor-palatal plane angle were performed.
Results: The maxillary incisors with ARR showed a significantly ($P = 0.020$) shorter distance from the root apex to the lingual cortical bone than did the maxillary incisors without ARR. As for the angulation between the long axis of the tooth and the palatal plane, the incisors with ARR showed a greater angulation ($P = 0.011$) when compared with the angulation of the corresponding contralateral without ARR. The difference between the groups was statistically significant.
Conclusion: The incisors with ARR showed a significantly greater angulation and shorter distance from the root apex to the lingual cortical bone when compared with the incisors without ARR.
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1. Introduction

Apical root resorption (ARR) associated with orthodontic treatment is characterized by the shortening of the roots of the teeth or by the rounding of the apices of the roots due to induced tooth movement [1]. It is a frequent undesirable side effect in orthodontic treatment [2] that affects particularly the maxillary incisors [3–5], probably because these teeth present conical and single roots that transmit more intense orthodontic forces to the apex [6] of the root and because they are submitted to a greater amplitude of orthodontic movement [7].

Inherent characteristics of the orthodontic treatment have been related to root resorption, such as length of treatment time [8], magnitude of force [9], and type of technique used [4,10]. Individual susceptibility was described [1,4] as a factor associated with ARR, highlighting the genetic and systemic factors [4], gender, age, root morphology [1], and history of trauma to the incisors [4].

Predisposition to root resorption may be associated with morphological characteristics of the root, such as shape, length, and angulation between crown and root. As for bone morphology, height, thickness, and shape of the alveolar crest are judged to be predisposing factors for root resorption. An association between the proximity of the cortical bone to the root apex has been suggested [11,12], being that the closer the root apex is to the cortical bone, the greater the chance of ARR. The proximity of the root apex to the lingual cortical bone has been associated with root resorption in maxillary incisors during orthodontic treatment [11,12], and this decreased distance could have been related to lingual torque of the incisors [11].

The relationship between the cortical bone and the presence of root resorption lesions may be due to the higher mineral density of the cortical bone [13], and by the compression of the periodontal ligament during the orthodontic movement [14,15].

All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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The aim of this study was to determine, by means of cone-beam computed tomography (CBCT) images, the distances between the root apex and the labial and lingual cortical bone and the axial inclination of the maxillary incisors with and without resorption in patients under orthodontic treatment.

2. Materials and methods

The sample of this study was obtained as follows. From a total of 1970 patients, 240 fulfilled the requirements for the first phase of the inclusion criteria: to be under orthodontic treatment with fixed edgewise appliances, have no systemic disorders involving calcium metabolism, have no history of trauma of the maxillary incisors, show symmetry of the malocclusion between the right and left sides of the arches, have maxillary incisors with similar root structures and root lengths, have no morphological abnormalities, have no detectable root resorption, and not have been endodontically treated. The 240 selected patients were submitted to periapical radiography of the maxillary incisors. Diagnosis of ARR in one of the maxillary incisors and the absence of ARR in the corresponding contralateral incisor characterized the second phase of the inclusion criteria, which resulted in 23 individuals eligible for CBCT. From this total, 21 were selected after the diagnosis of ARR in one maxillary incisor and the absence of ARR in its corresponding contralateral was confirmed with CBCT. In two individuals, some degree of root resorption in the contralateral tooth was detected only in the CBCT scans, and both patients were excluded from the sample. All linear and angular measurements were obtained from CBCT scans. This study was approved by the Ethics Committee in Research of Juiz de Fora Federal University under the protocol number 463/2008.

This CBCT study was performed with the i-CAT (Imaging Sciences International, Hatfield, PA), operated at 120 kV and 3 to 8 mA, voxel size of 0.25 mm, with 26.9-second rotation time, and a field of view of 160 mm (diameter) × 100 mm (height).

For image acquisition, each individual was positioned in a seated posture, with the chin on the chin rest, with the Frankfort plane parallel to the floor, the midsagittal plane perpendicular to the floor, and the occlusal contacts in maximum intercuspal position. The field of view was positioned in a way that the occlusal plane could occupy its vertical center and the anterior nasal spine would be 35 mm from its anterior border. Images were analyzed by the i-CAT Vision software (Imaging Sciences International), using slice thickness of 0.50 mm on multiplanar reconstruction visualization mode.

The selected sagittal image was the one corresponding to the plane of the mesiodistal geometric center of the incisor under analysis. Thus, the tooth was positioned vertically in the image so that the intersection between the sagittal and coronal slices would coincide with the long axis of the tooth and the coronal slice would be parallel to the line that determines the incisal border of the tooth (Fig. 1).

To evaluate the root length of the incisor, a horizontal line, perpendicular to the long axis of the tooth, passing in the midpoint between the labial and lingual cementum-enamel junctions, was traced. The most apical point of the root (point A) was projected orthogonally onto this line (point A′), being the root length determined by the distance A-A′. Because the incisor with resorption and its corresponding contralateral without resorption exhibited the same root length at the beginning of the orthodontic treatment, the extension of the ARR was determined by the difference between the root length of the incisors with and without resorption.

From these images, the following variables were determined: labial distance, characterized by the distance from the center of the root apex of the incisor to the external surface of the cortical bone in the labial direction, perpendicularly to the long axis of the tooth; lingual distance, measured from the center of the root apex of the incisor to the external surface of the cortical bone in the lingual direction, perpendicularly to the long axis of the tooth (Fig. 2); and incisor-palatal plane angle, measured from the posteroinferior angle between the long axis of the maxillary incisor and the palatal plane, formed by a line that connects the posterior nasal spine to the anterior nasal spine (Fig. 3).

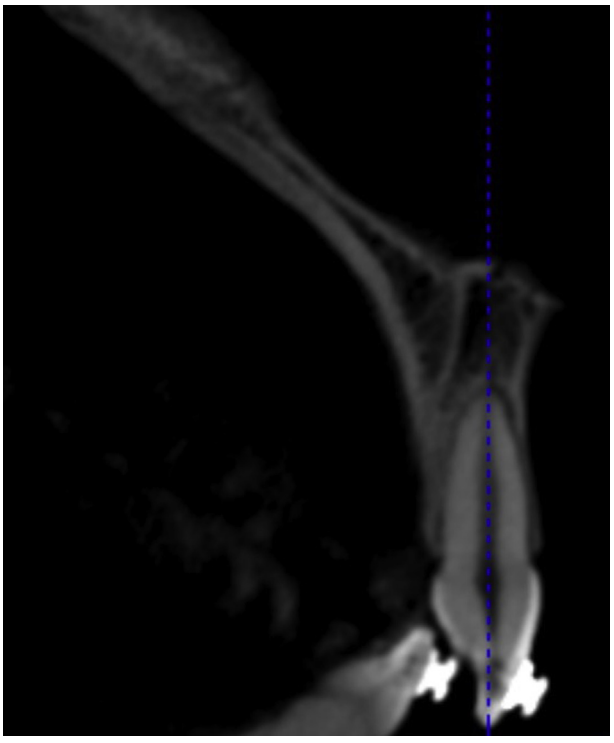

Fig. 1. Sagittal slice corresponding to the plane that determines the mesiodistal geometric center of each incisor.

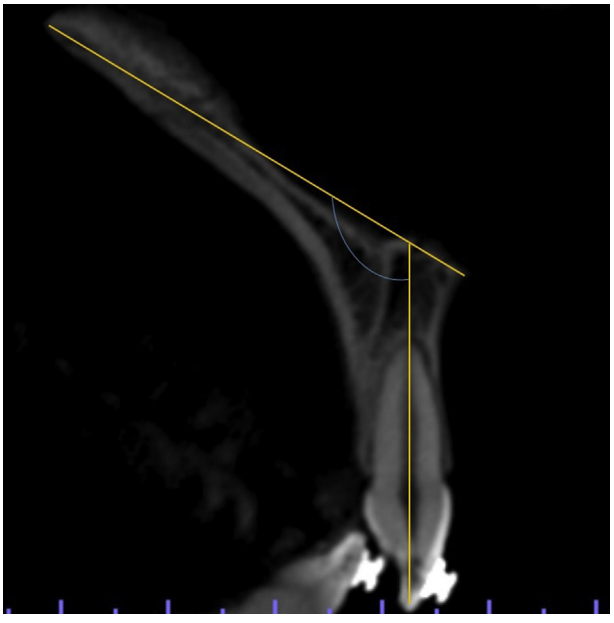

Fig. 2. Representative figure of the measurements: labial distance (1), lingual distance (2).

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