Bone density assessment for mini-implants position

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Abstract

Introduction: Cortical thickness, interradicular space width and bone density are key factors in the use of mini-implants as anchorage. This study assessed maxillary and mandibular alveolar and basal bone density in Hounsfield units (HU). **Methods:** Eleven files with CT images of adults were used to obtain 660 measurements of bone density: alveolar (buccal and lingual cortical) bone, cancellous bone and basal bone (maxilla and mandible). The Mimics software 10.0 (Materialise, Belgium) was used to estimate values. **Results:** In the maxilla, the density of buccal cortical bone in the alveolar region ranged from 438 to 948 HU, and the lingual, from 680 to 950 HU; cancellous bone ranged from 207 to 488 HU. The buccal basal bone ranged from 672 to 1380 HU, and cancellous bone, from 186 to 402 HU. In the mandible, the buccal cortical bone ranged from 782 to 1610 HU, the lingual cortical alveolar bone, from 610 to 1301 HU, and the cancellous bone, from 224 to 538 HU. In the basal area, density was 1145 to 1363 HU in the buccal cortical bone and 184 to 485 HU in the cancellous bone. **Conclusions:** In the maxilla, the greatest bone density was found between the premolars in the buccal cortical bone of the alveolar region. The maxillary tuberosity was the region with the lowest bone density. Bone density in the mandible was higher than in the maxilla, and there was a progressive increase from anterior to posterior and from alveolar to basal bone.

Keywords: Bone density. Orthodontic anchorage procedures. Orthodontics.

Editor's summary

Mini-implants have excelled in the preference of professionals due to their ease of insertion and removal, the possibility of immediate loading, their small size and low cost. The choice of a mini-implant insertion site should be made considering appropriate soft tissue regions, adequate amounts of cortical bone, mini-implant angulation and size and, foremost, the type of tooth movement. Cone-beam computed tomography assesses bone density of mineralized tissues. This study evaluated bone density in interdental regions.

The study sample comprised 11 files of CT scans in DICOM format used to evaluate, in both maxilla and mandible, the density of buccal and lingual cortical bone and cancellous bone in the region of the alveolar bone, and the densities of buccal cortical and cancellous bone

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in the basal bone region. Bone densities were calculated using the Mimics 10.01 software and measured in Hounsfield units (HU). CT slices of alveolar bone were obtained at a height of 3 to 5 mm from the bone crest and, of basal bone, at a height of 5 to 7 mm from the root apex (Fig 1). In the alveolar bone and basal bone areas of mandibles and maxillae, the sites between the following teeth were evaluated: central and lateral incisors; canines and first premolars; first and second premolars; second premolar and first molar; first and second molars; and second molar and distal region to second molar. Measurements in the areas between the teeth were density of buccal cortical, lingual cortical and cancellous bone in the region of alveolar bone, and density of buccal cortical and cancellous bone in the region of basal bone (Fig 2).

In the maxilla, the area with lower density was the maxillary tuberosity, and the area with the greatest bone density in cortical bone was in the area between the premolars. In the maxilla, cortical vestibular bone was denser in the region of basal bone than in the region of alveolar bone in all regions under analysis. The density of maxillary lingual alveolar cortical bone was slightly greater than that of cortical bone. In the mandible, in general, there was a progressive increase in bone density from the anterior mandible (lower density) to the posterior region (higher density). The density of buccal cortical basal bone was greater than that of the buccal alveolar cortical bone, except in the retromolar region. Bone density in the mandible was greater than in the maxilla in nearly all areas assessed, except between central and lateral incisors and between the second premolar and first molar. This study found that the bone density of cortical areas is greater than the density of the cancellous bone area. Therefore, mini-implants should be inserted at an angle of 10 to 20 degrees to the long axis of teeth to make the most of the low thickness but high density of lingual and buccal cortical bone.

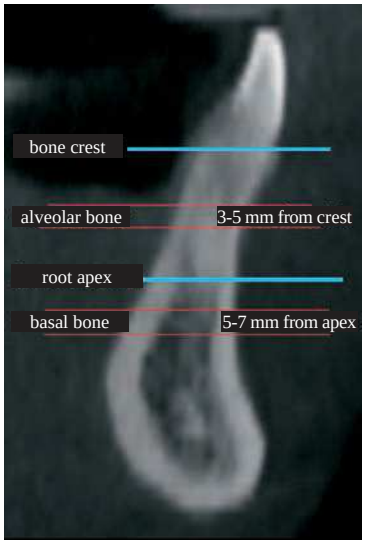

FIGURE 1 - Tranversal section computerized tomography, illustrating the location of the crest, and root apices, as well as determining the areas measured, corresponding to the alveolar bone (3 to 5 mm of bone crest) and the basal bone (5 to 7 mm of root apices).

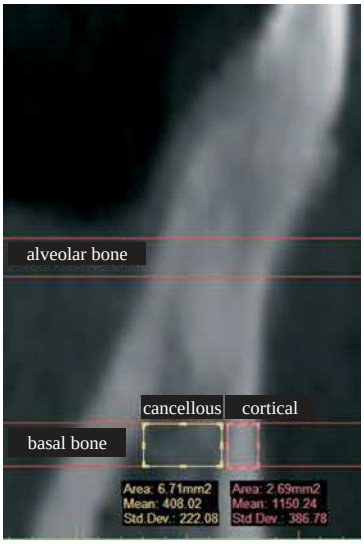

FIGURE 2 - Magnified view of CT scan of region between 1 and 2 in the mandible; basal bone density measurement in both buccal cortical and cancellous bone areas. The area of alveolar bone is defined by the upper red lines.

Questions to the authors

1) What are the clinical implications of this study?

With the advent of image interpretation using software for evaluation of cone beam CT (CBCT), there have been advances in studies in this field. Clinically, the results of bone density studies according to the mapping of regions in the maxilla and mandible give orthodontists a greater understanding of bone density differences and facilitate the selection, based on scientific evidence, of one or more maxillary and mandibular regions that are suitable for the installation of orthodontic mini-implants in adult patients.

2) Were there methodological difficulties in conducting this study?

The major difficulties resulted from the large number of regions on the CT images and, in a few cases, from image artifacts produced by metal restorations in some large teeth. However, as the areas measured were located near the bone crest (alveolar area) and the apical area (basal area), the artifacts did not prevent bone density readings in the study.

3) The thickness of cortical bone and bone density tend to coincide or differ for each particular region?

Yes. According to the tables and figures in the full manuscript, the cortical bone in the maxilla was denser in the area of basal bone than in the area of alveolar bone in all regions under analysis.

We also observed a progressive increase in bone density from the anterior mandible (lower density) to the posterior region (higher density). In the mandible, the buccal basal cortical bone had statistically higher density than the buccal alveolar cortical bone in all the regions under analysis, except in the retromolar region.

The alveolar bone density of mandibular cortical bone was statistically higher than in the maxilla, except as between central and lateral incisor and between the second premolar and first molar.

Comparing the cancellous bone of the alveolar region, the areas between canine and first premolar and between first and second premolars were statistically significant denser in the mandible compared to the maxilla.

In the alveolar bone, the values obtained for the lingual cortical were very similar with average values for vestibular cortical bone, for the maxilla as well as for the mandible.

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