Objective: The aim of this study is to assess whether there is a correlation between buccal bone thickness and mean alveolar bone thickness around the central teeth using CBCT images.

Materials and Methods: Three points were selected at 3, 6 and 9 mm from the cemento-enamel junction, respectively, perpendicular to the long axis of the measuring points made to determine the width of the alveolar bone ridge. The arithmetic mean of the length measurements was taken as the average alveolar bone thickness. To determine the average buccal alveolar bone thickness, the buccal bone length was measured perpendicular to the long axis of the tooth from these 3 points, and the average of the measurements was taken from these 3 points.

Results: The mean coronal, mid-root, and apical third root widths of the maxillary, left central incisors were 7.72±0.60, 8.64 ± 0.93, and 9.23±1.45 mm, respectively, and the mean widths of the buccal alveolar bone at the coronal, mid-root, and apical third root positions of the left central incisor were 1.18±0.39, 1.15±0.44, and 1.06±0.50 mm, respectively. The Spearman correlation coefficients were 0.194 and 0.191 for the left and right central incisors, respectively.

Conclusions: There was no statistically significant difference between the alveolar bone thickness averages of the left and right central incisors, but the alveolar bone thickness was found to be thicker in males than females. Although the mean of alveolar and buccal bone thicknesses was positively correlated the statistical analysis demonstrated the correlation between the mean of alveolar and buccal bone thicknesses is not significant.

Keywords: Alveolar ridge, buccal bone, computed tomography, immediate implant, maxillary central incisor

Original Article

Correlation between Buccal and Alveolar Bone Widths at the Central Incisors According to Cone-beam-computed Tomography

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INTRODUCTION

Adequate alveolar bone volume and appropriate alveolar ridge architecture are essential for ideal functional and aesthetic prosthetic reconstruction after implant therapy.[1] According to the Branemark protocol, 3–4 months of healing is required to allow induration of the extraction socket. When prosthetic treatment is required, patients usually wait for up to 1 year before replacement of a lost tooth.[2] Immediate dental implantation, introduced in the 1970s, allows implantation immediately after extraction.[3] The treatment time is long, as it is well known that after tooth extraction, physiological processes cause dimensional changes in the alveolar ridge (e.g., resorption).[4] Proper planning is crucial if implantation is to be successful. The height, width, morphology, and density of alveolar bone surrounding the area to be implanted must be measured to determine the size of the implant and the placement angle.[5-7] Severe reductions in the buccolingual and apical coronal extents of the alveolar region are evident after tooth extraction.[8,9] The changes are usually clinically significant and may render it difficult to place a conventional bridge or implant-supported crown.

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How to cite this article: Üner DD, İzol BS, Görüş Z. Correlation between buccal and alveolar bone widths at the central incisors according to cone-beam-computed tomography. Niger J Clin Pract 2019;22:79-84.
Successful osseointegration of a dental implant requires a sufficient amount of healthy bone in the recipient region.\(^{[10]}\) It has been established that it can be difficult to create implant-supported prostheses after tooth extraction in the esthetic zone.\(^{[11,12]}\) Moreover, the buccal bony plate is usually thin, especially in that zone. Clinicians are always concerned about implant appearance.\(^{[13,14]}\) Adequate buccal bone in the anterior maxillary region is essential for correct implant positioning;\(^{[15,16]}\) the buccal plate of the upper jaw is resorbed to a greater extent than is the palatal plate, causing the center of the ridge to shift in the palatal direction.\(^{[17]}\)

Many two- and three-dimensional methods have been developed to determine alveolar bone height and width.\(^{[18]}\) Bone evaluation using only panoramic and intraoral periapical radiographs may be inadequate, as only two-dimensional data are available.\(^{[19]}\) Buccolingual ridge width can be measured by cone-beam-computed tomography (CBCT), ridge mapping, trans-tomography, and direct caliper measurements following surgical exposure of the bone.\(^{[20-24]}\) The alveolar ridge widths obtained by ridge mapping, CBCT, and direct surgical exposure do not differ significantly.\(^{[23,25-27]}\) However, ridge mapping is attractive because it is precise, inexpensive, yields immediate results and does not require the use of radiation.\(^{[26]}\)

The buccal bone thickness is essential to the immediate implant placement, and previous studies have shown precise information about the amount of alveolar bone thickness without using CBCT. Therefore, we evaluated the relationship between the alveolar ridge and buccal bone thickness using CBCT.

**Materials and Methods**

**Study population**

This study conformed to all relevant tenets of the 1964 Helsinki Declaration and was approved by the Ethics Committee of the Dicle University Faculty of Dentistry. The research was conducted between December 2014 and February 2016 at the Dicle University Faculty of Dentistry. Eighty patients admitted to the departments of Oral Diagnosis and Radiology; Oral, Dental and Orthopaedic Surgery; Periodontology, Orthodontics; Prosthetic Dentistry, Pedodontics; Dental Diseases; and Endodontics for any reason underwent three-dimensional CBCT (I-CAT®, Model 17-19; Irma Medicine Sciences International, Hatfield, PA, USA). CBCT images were obtained at 120 kV for 8–9 s at 5 mA (voxel size 0.3 mm). The ages of the 80 males and 80 females ranged from 21 to 53 years (mean age 36.86 ± 7.78 years). The anterior maxilla and the central incisors were clear on the CBCT images. Patients with crowns, fillings, or bruises; who had undergone root canal treatment; who exhibited periodontal bone loss or dental pathology; and those with irregular, anterior maxillary teeth were excluded.

**Study design**

All measurements were made by a periodontologist using Vision software. To determine the width of the alveolar ridge, measurements were taken at 3, 6, and 9 mm distance from the cemento-enamel junction, perpendicular to the long axis of the tooth; the three regions were termed the crestal, mid-root, and apical regions, respectively, of both the right and left central teeth [Figure 1]. The average alveolar ridge thickness for each tooth was the mean of the three values. Next, buccal alveolar bone thickness (measured perpendicular to the long axis of the tooth) was measured at the three regions [Figure 2]. The average buccal bone thickness was the mean of the three values.

**Statistical analysis**

Descriptive statistics are presented as means with standard errors or standard deviations, and averages. The normality of the data was explored using the Shapiro–Wilk test, and data homogeneity was evaluated employing Levene’s test. Thickness data were compared between the genders using the independent t-test. Spearman correlation coefficients (\(\rho\) values) were calculated to assess the relationship between mean alveolar ridge and buccal bone thicknesses. In all analyses, \(P\) values of 0.05 and 0.01 were considered to reflect statistical significance.

**Results**

In total, 160 CBCT scans were analyzed (320 teeth). The mean coronal, mid-root, and apical third root widths of the maxillary left central incisors were 7.72 ± 0.60, 8.64 ± 0.93, and 9.23 ± 1.45 mm, respectively; the figures for the maxillary right central incisors were 7.76 ± 0.60, 8.67 ± 0.83, and 8.98 ± 1.89 mm, respectively [Graph 1]. In females, the mean coronal, mid-root, and apical root, left incisor, alveolar bone widths were 7.55 ± 0.52, 8.27 ± 0.89, and 8.73 ± 1.5 mm; the figures for males

<p>| Table 1: Mean buccal bone widths of the left and right anterior maxillary incisors |
|-----------------------------------|----------------|----------------|-------|----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>(n)</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBC</td>
<td>160</td>
<td>0.30</td>
<td>2.23</td>
<td>1.1864</td>
<td>0.39866</td>
</tr>
<tr>
<td>LBM</td>
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<td>0.10</td>
<td>2.21</td>
<td>1.1510</td>
<td>0.44357</td>
</tr>
<tr>
<td>LBA</td>
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<td>0.20</td>
<td>2.34</td>
<td>1.0656</td>
<td>0.50199</td>
</tr>
<tr>
<td>RBC</td>
<td>160</td>
<td>0.56</td>
<td>2.00</td>
<td>1.1338</td>
<td>0.30395</td>
</tr>
<tr>
<td>RBM</td>
<td>160</td>
<td>0.21</td>
<td>2.40</td>
<td>1.0859</td>
<td>0.43327</td>
</tr>
<tr>
<td>RBA</td>
<td>160</td>
<td>0.10</td>
<td>2.93</td>
<td>1.0660</td>
<td>0.53709</td>
</tr>
</tbody>
</table>

LBC=Left Bucco-Coronal; LBM=Left Bucco-Medial; LBA=Left Bucco-Apical; RBC=Right Bucco-Coronal; RBM=Right Bucco-Medial; RBA=Right Bucco-Apical
were 7.88 ± 0.63, 9.02 ± 0.83, and 9.73 ± 1.23 mm, respectively. In females, in the right maxillary incisor region, the mean alveolar bone widths at the coronal, mid-root, and apical third root were 7.63 ± 0.60, 8.31 ± 0.69, and 8.81 ± 1.29 mm, respectively; the figures for males were 7.89 ± 0.59, 9.03 ± 0.81, and 9.61 ± 1.39 mm, respectively. The between-gender differences were statistically significant for all regions except the coronal region of the right central incisor. The alveolar ridge width was greater in males than in females in all regions measured.

The mean widths of the buccal alveolar bone at the coronal, mid-root, and apical third root positions of the left central incisor were 1.18 ± 0.39, 1.15 ± 0.44, and 1.06 ± 0.50 mm, respectively; the figures for the right central incisor were 1.13 ± 0.30, 1.08 ± 0.43, and 1.06 ± 0.53 mm, respectively [Table 1]. The average thicknesses were the arithmetic means of these values: 1.13 ± 0.33 and 1.09 ± 0.33 mm for the left and right central incisors, respectively.

We sought to predict buccal bone width before immediate implantation. Thus, we calculated the arithmetic means of data from the coronal, mid-root, and apical third root alveolar bone measurements and used these to determine the correlation between alveolar ridge and buccal bone widths [Figure 1]. The mean widths of the alveolar ridges were 8.53 ± 0.87 and 8.56 ± 0.82 mm for the left and right maxillary incisors, respectively; these figures did not differ significantly.

In females, the left central incisor mean facio-palatal dimension was 8.18 ± 0.84 mm, and the mean alveolar bone ridge width of the right central incisor was 8.27 ± 0.73 mm; for males, the figures were 8.88 ± 0.76 and 8.85 ± 0.82 mm, respectively [Graph 2]. The mean (left and right) incisor, alveolar ridge widths of males and females differed significantly (t-test \( P < 0.05; P = 0.0001 \) on the right, and \( P = 0.0002 \) on the left); the alveolar bone ridge was thicker in males than in females. However, age did not affect either buccal bone width or alveolar ridge width. The relationship between alveolar ridge width and buccal bone width was not significant for the left and right central incisor (left central incisor’s \( \rho = 0.194, P = 0.085 \); right central incisor’s \( \rho = 0.191, P = 0.090 \)).
**Discussion**

Our aim was to predict alveolar, bone, buccal plate thickness before immediate implantation and to compare that value with the alveolar, bone, ridge thickness revealed by CBCT. Immediate implant placement is associated with high cumulative implant survival (96.16–100%).

It is essential to know the alveolar bone dimensions prior to surgery. The proportion of alveolar bone resorption after tooth extraction is approximately 45%. Furthermore, a meta-analysis showed that the alveolar bone dimensions near implant sites fell by about 0.5–1.0 mm both vertically and horizontally 4–12 months after surgery. The extent of vertical resorption of buccal bone was related to the initial buccal, crest bone thickness. A major concern when planning implantation is correct estimation of bone thickness, as the mucosal contours can mask the alveolar ridge. Therefore, CBCT, ridge mapping, and direct measurement of bone thickness during surgery have been developed. When ridge mapping using calipers under local anesthesia, the pointed caliper tips penetrate the buccal and lingual soft tissues to measure the buccolingual width of the underlying bone. This is simple, and the patient is not exposed to radiation. We sought to determine the correlations between alveolar and buccal bone thicknesses using CBCT. As it is clear that both CBCT and ridge mapping can be used to determine alveolar bone thickness, the existence of a correlation between alveolar and buccal bone thickness would mean that CBCT would not be required for assessment of buccal bone thickness. Several studies measured buccal and alveolar ridge thicknesses around natural teeth. The coronal, mid-root, and apical, central, incisor, alveolar bone, mean bone widths were 0.73–0.83, 0.69–0.80, and 0.6–0.90 mm, respectively.

Here, the coronal, buccal, alveolar bone thicknesses were 1.18 and 1.13 mm for the left and right central incisors, respectively. The apical third of the alveolar bone width of the maxillary, right central incisors, were 9.55, 8.07 ± 0.93, 8.67 ± 1.62, and 11.91 ± 2.38 mm, respectively. The alveolar ridge thickness was greater in males, who impart more biting force using stronger masticatory muscles than females. Here, the mean alveolar bone thickness was 9.05 mm, and males had thicker bone than females. The mean alveolar bone thickness in males (left incisor 8.88 mm, right incisor 8.85 mm) was significantly greater than in females (left incisor 8.18 mm, right incisor 8.27 mm) (t-test, P < 0.001).

We found no prior study evaluating the relationship between alveolar and buccal bone thicknesses. Here, the correlation between the mean buccal bone and alveolar ridge thicknesses was not significant for the left and the right, central incisor. The Spearman correlation coefficients were 0.194 and 0.191 for the left and right central incisors, respectively.

To identify the correlation between buccal bone and alveolar bone thickness, a power analysis test was performed. The result of power analysis was detected for the left and right sides as 0.4104399 and 0.3997926, respectively. According to this result, we can report that there is a weak correlation between buccal and alveolar bone thickness.

**Conclusion**

The mean thicknesses of the alveolar ridge near the left and right central incisors did not differ significantly, but the bone was thicker in males than females. The mean alveolar and buccal bone thicknesses were positively correlated, and the statistical analysis demonstrated that the correlation of between the mean alveolar and buccal bone thicknesses is not significant. As our sample size was relatively small, further studies are recommended.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**


