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Maxillary Cortical Bone Thickness in a South-Eastern Anatolian Population: A Cone-Beam Computed Tomography Study

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Background: The aim of this study was to measure the distance between the maxillary premolar and molar teeth apices to the buccal cortical bone and evaluate differences in gender and age group, using cone beam computed tomography (CBCT).

Material/Methods: This retrospective study comprised of 451 premolar and molar teeth of one hundred and thirteen patients who were admitted to Dicle University, Faculty of Dentistry, Department of Dentomaxillofacial Radiology for different reasons. Data were analyzed using Student's t-tests and Tukey HSD tests.

Results: There was significant difference in buccal bone thickness by gender ($p<0.05$). The thinnest point of the maxillary buccal bone was measured in women as 2.11 mm and in men as 2.02 mm in the first premolar teeth. The thickest point of maxillary buccal bone was measured in women as 9.87 mm and in men 10.71 mm palatinal root of the first molar. A comparison of buccal bone thickness between age showed a statistically significant difference at the distobuccal and palatinal roots of the first molar, at the mesiobuccal root of the second molar ($p<0.05$).

Conclusions: The measurements of maxillar buccal bone thickness using CBCT for various dental procedures especially in endodontic surgery, orthodontic mini implant treatment, dental implant procedures, and healing after tooth extraction that are important knowledge.

MeSH Keywords: Cone-Beam Computed Tomography • Maxilla • Retrospective Studies • Tooth

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Background

Recently, immediate implant placement after tooth extraction has become a more frequently used treatment option. A factor that should be considered when performing implantation with this method, which confers advantages such as reducing edentulous psychology, a shorter surgical procedure, and higher patient satisfaction, is buccal bone thickness following tooth extraction [1–3]. Buccal bone thickness is also an important factor in the stabilisation and long-term success of dental implant treatments [4,5].

Buccal bone thickness is closely related to the degree of bone resorption after tooth extraction [6]. In apical surgical interventions after endodontic treatment [7], the success of the treatment is associated with bone and soft tissue thickness in the operated region [8,9]. Cortical bone thickness is also an important factor in the primary stabilisation of mini-implants used in orthodontics [10].

Several methods have been used to measure cortical bone thickness. Although measurements made after incision of the mandible are accepted as the gold standard, there are disadvantages to this method, because it is costly, difficult to apply, and complex [11]. Conventional radiographs, such as panoramic and lateral cephalometry, have been used to measure both bone and skull thickness [12,13]. The disadvantages of these methods are that the films are two-dimensional and magnifications or distortions occur in the images [14].

In the literature, there are studies in which buccal bone thickness was measured by computed tomography (CT) and cone-beam computed tomography (CBCT) [6,10,15]. While CT allows for more detailed measurements by providing three-dimensional imaging, it has the disadvantage of a higher radiation dose than CBCT [16,17]. CBCT also has other advantages, such as a higher resolution than CT and shorter imaging time[18].

The aim of this study was to examine change of buccal bone thickness according to age and gender in the maxillary posterior region; this is an important issue for dentists especially in endodontic surgery, orthodontic mini implant and dental implant surgery and healing after tooth extraction.

Material and Methods

This retrospective study comprised of 451 maxillary premolar and molar teeth of 113 patients who were referred to Dicle University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology between January 2015 and December 2015. When the images of each patient were obtained, the ALARA ("as low as reasonably achievable") principle was followed, which advocates using the minimum dose of radiation required for diagnosis. In total, 200 CBCT images were examined. The patients selected for this study had no periodontal disease, no history of trauma that would affect their data, and no benign or malignant tumour or cyst that would impact on bone integrity. Patients who did not undergo any dental surgery operation from the maxillary posterior region were selected. Patients with facial or dental asymmetry were excluded. We measured 451 maxillary premolar and molar teeth of 113 patients who met the inclusion criteria. Patients were grouped by age (10–29, 30–49, and 50–69 years) and gender.

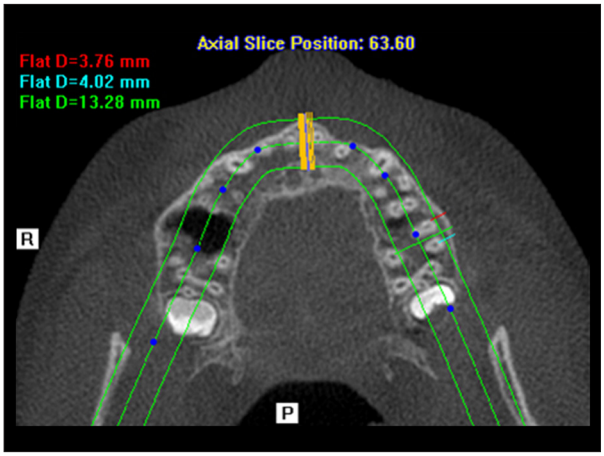

Figure 1. Maxillary axial CBCT images for measurements. Distance between the first molar mesiobuccal, distobuccal and palatinal apex and the buccal bone plate.

All images were taken with an I-CAT Vision (Imaging Sciences International, Hatfield, PA, USA). The scanning parameters were 120 kVp, 5 mA, 8–9 s acquisition time, 0.3 mm voxel size, and 13×10 cm image area.

The method used for obtaining measurements in this study followed that of Jin et al., who examined buccal bone plate thickness in an Asian population. For measurements obtained on the tomographs, the apical root to the maxillary root of the root apex was taken as the shortest horizontal distance between the outer surfaces of the buccal bone in 1 mm axial sections. If two roots were detected in the mesiobuccal root of the maxillary first molar tooth, the measurement was made based on the midpoint of these two roots (Figure 1).

Statistical analyses

Concerning the comparison of the groups by gender, the Kolmogorov-Smirnov test showed a normal data distribution, so an independent-samples Student's *t*-test was used. The level of significance was set at $p<0.05$.

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Table 1. Descriptive statistics for maxillary buccal bone thickness by sex (mm).

	4		5		6			7	
	Buccal	Palatinal	Buccal	Mesiobuccal	Distobuccal	Palatinal	Mesiobuccal	Distobuccal	Palatinal
Female	2.117± 0.778	4.857± 0.887	3.405± 0.900	3.157± 0.843	2.469± 0.924	9.878± 1.471	4.208± 1.174	3.465± 1.056	9.363± 1.525
n	58	58	56	54	54	54	59	59	59
Male	2.022± 0.690	5.637± 1.180	4.085± .077	3.003± 0.916	2.626± 0.990	10.710± 1.186	4.059± 1.108	3.290± 1.154	10.636± 1.147
n	55	55	55	55	55	55	59	59	59
p	0.491	**0.000***	**0.000***	0.362	0.394	**0.002***	0.480	0.390	**0.000***

All data are expressed as means (mm) ±SD. '*n*' indicates the number of obtainable measurements from the samples in each age group. P<0.05. * The mean difference is significant at the 0.05 level.

Regarding the comparison by age group, the Kolmogorov-Smirnov test showed a normal data distribution, so one-way ANOVA was used. P values <0.05 were considered to indicate statistical significance. Within-group comparisons were done using Tukey's HSD test.

All statistical analyses were performed using SSPS software (ver. 20.0; SPSS Inc., Chicago, IL, USA).

Results

Measurements were obtained from 451 premolar and molar teeth of 113 patients. The patients were grouped into three different age groups (10–29, 30–49, and 50–69 years), and by gender.

The thinnest point of the maxillary buccal bone was 2.11 mm for women, and 2.02 mm for men, at the buccal roots of the maxillary first premolar teeth. The greatest thickness of the maxillary bone was 9.87 mm in women, and 10.71 mm in men, at the palatinal roots of the maxillary first molar teeth. There was a significant difference in buccal bone thickness by gender (p<0.05).

In males, the buccal bone thickness at the palatal root of the first premolar was 5.63 mm, compared with 10.71 mm at the palatinal root of the first molar and 10.63 mm at the palatinal root of the second molar. The buccal bone thickness at the second premolar was 4.08 mm. These values were significantly higher than the respective values in women. Among the buccal roots of the three rooted molar teeth, the buccal bone thickness was greatest at the mesiobuccal root of the second molar in both genders (Table 1).

There was a significant difference in buccal bone thickness by age group (p<0.05). A comparison of buccal bone thickness at the first and second premolars, and at the mesial root of the first molar among, showed no statistically significant difference by age group (Tables 2, 3).

At the distobuccal root of the first molar, a significant difference was found between the 10–29 and 30–49 years age groups, and also between the 10–29 and 50–69 years age groups. The buccal bone thickness was 2.87 mm in the 10–29 years age group, 2.15 mm in the 30–49 years age group, and 1.94 mm in the 50–69 years age group.

At the palatinal root of the first molar, the buccal bone thickness was measured as 10.58 mm in the 10–29 years age group and 9.81 mm in the 30–49 years age group. A statistically significant difference was found between these two age groups (p<0.05).

The buccal bone thickness at the mesiobuccal root of the second molar tooth was 4.39 mm in the 10–29 years age group and 3.87 mm in the 30–49 years age group. Although there was statistically significant difference between these two age groups, there was no significant difference in buccal bone thickness at the distobuccal and palatinal roots of the second molar among the age groups (p>0.05).

Discussion

Buccal bone thickness has been studied using many methods, including cadavers [19,20], panoramic radiographs [21,22], CT [23,24], and CBCT [7]. However, there have been few studies comparing changes in maxillary buccal thickness on CBCT images by age group [10,25].

Sathapana et al. divided a total of 82 post-mortem CT's (41 females, 41 males into five age groups (11–20 [pre-puberty],

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Table 2. Descriptive statistics for maxillary buccal bone thickness in different sites and age groups (mm).

Age groups	4		5		6			7	
	Buccal	Palatinal	Buccal	Mesiobuccal	Distobuccal	Palatinal	Mesiobuccal	Distobuccal	Palatinal
10–29 age	1.963± 0.751	5.3752± 1.190	3.775± 0.916	3.205± 0.887	2.872± 0.969	10.583± 1.360	4.397± 1.132	3.575± 1.108	10.276± 1.317
30–49 age	2.160± 0.720	5.104± 1.043	3.681± 1.229	2.919± 0.924	2.157± 0.787	9.817± 1.430	3.871± 1.127	3.232± 1.038	9.636± 1.551
50–69 age	2.381± 0.575	4.950± 0.673	3.821± 1.000	2.888± 0.344	1.943± 0.610	10.425± 0.839	3.668± 0.817	2.720± 1.215	10.038± 2.037

All data are expressed as means (mm) ±SD.

Table 3. Descriptive statistics for maxillary buccal bone thickness in different age groups (p value).

Age groups	4		5		6			7	
	Buccal	Palatinal	Buccal	Mesiobuccal	Distobuccal	Palatinal	Mesiobuccal	Distobuccal	Palatinal
10–29/30–49	0.186	0.350	0.886	0.231	**0.000***	**0.019***	**0.041***	0.058	0.081
10–29/50–69	0.186	0.350	0.886	0.231	**0.017***	0.948	0.194	0.058	0.081
30–49/10–29	0.186	0.350	0.886	0.231	**0.000***	**0.019***	**0.041***	0.058	0.081
30–49/50–69	0.186	0.350	0.886	0.231	0.809	0.484	0.882	0.058	0.081
50–69/10–29	0.186	0.350	0.886	0.231	**0.017***	0.948	0.194	0.058	0.081
50–69/30–49	**0.186**	**0.350**	**0.886**	**0.231**	**0.809**	**0.484**	**0.882**	**0.058**	**0.081**

P<0.05. * The mean difference is significant at the 0.05 level.

11–20 [post-puberty], 21–30, 31–40, and 41–50 years). The largest thickness at the maxillary molar region, of 1.38 mm, was recorded in the 31–40 years age group. The smallest thickness, 1.3 mm, was measured in the 11–20 years (pre-puberty) group. In the premolar region, the largest distance, 1.35 mm was in the 1120 years group (post-puberty), while the smallest distance which was 1.22 mm was measured in the group of 11–20 years group (pre-puberty) [10].

Jin et al. measured the buccal bone thickness in their study and the axial cross-section measurements were taken as the shortest horizontal distance between the root apex of the apical root and the outermost point of the maxillary buccal bone. If two channels were detected in the mesiobuccal root of the maxillary first molar tooth, the measurement was made based on the midpoint of the two channels [26]. In that study, it was stated that the buccal bone thicknesses at the second molar mesiobuccal and distobuccal roots were 4.63 mm and 3.61 mm, respectively, and these values were largest at the maxilla. Although the buccal bone thickness of men was higher, there was no statistically significant difference in thickness by gender [26]. The distance measurements in our study were obtained by reference to the points used in the study of Jin et al.

Consistent with literature reports, we found that the area of thinnest buccal bone measurement in the maxillary posterior region in both genders, was located at the buccal root of the first premolars [7,24,26].

Kang et al. measured maxillary buccal bone thickness on 132 CBCT images: comparison of the buccal roots of the molar teeth between men and women showed that the buccal bone was thickest at the mesiobuccal root of the second molar tooth [7]. Another finding was that buccal thickness at the palatal root of the first premolar and second premolar in males was significantly higher than that in females, and the buccal bone thickness measured from the palatal root of first molar was significantly greater than that at the level of the palatal root of the second molar [7]. The findings of our study are similar to those of Kang et al.

Fayed et al. studied the CBCT images of 100 patients, and measured buccal bone thickness after dividing the maxillary crest into 2-, 4-, and 6-mm sagittal sections. They stated that the buccal bone thickness was greatest at the first and second premolars and buccal bone thickness was higher in males than in females [27].

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Deguchi et al. studied the radiographic images of 10 patients and reported that the buccal bone thickness at the apex of the distal root of the maxillary second molar was thinner than that at the apex of the mesial and distal roots of the first molar [28]. The reason that their findings differed from ours was likely due to differences in the number of images used in the two studies and in the measurement parameters.

Ono et al. reported that buccal bone thickness of the first molar at the mesial root was greater in males than in females. However, they concluded that buccal bone thickness at the distal root of the first molar was not associated with gender, consistent with our study [29].

In our study, measurement were done to identify the apex on the 0.3-mm cross-sectional axial CBCT images, the last root apex visible in the image was considered an apex, but in real-life dental surgery is not performed in only the axial or parallel plane; this represents a limitation of our work.

For treatment planning, CBCT images are both clinically effective and non-invasive [30–32]. They have also been shown to be reliable, in terms of showing the relationship between the examined region and the surrounding tissue and anatomical features [20,33]. With isotropic voxels, it is possible to perform a CBCT examination on curved structures, such as the dental arches. Another advantage of CBCT is that a lower radiation dose than required by CT can be used to obtain images [34,35]. During dental implant surgery, buccal bone thickness can be measured, for example for orthodontic mini-implant placement [18,29]. Although CBCT is an effective tool for diagnosis and treatment, it should be based on the ALARA principle and images should be obtained from patients with the minimum dose required for diagnosis.

Conclusions

Buccal bone thickness of the maxillary posterior region varies according to the tooth, as well as by gender and age. Measurement of buccal bone thickness with CBCT before treatment, assessment of the anatomy of the region, and evaluation of variation, can increase the quality of treatment.

Conflict of interest

None.

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