DOI: 10.24938/kutfd.550667 **Kırıkkale Üniversitesi Tıp Fakültesi Dergisi 2019;21(3):313-324**
Original Article ***Özgün Araştırma***

ASSESSMENT OF BONE MORPHOLOGY AND STATUS OF MAXILLARY SINUS IN THE POSTERIOR MAXILLA: THREE-DIMENSIONAL ANALYSIS FOR IMPLANT THERAPY

Posteriyor Maksillanın Kemik Morfolojisi ve Maksiller Sinüsün Seyri: İmplant Tedavisi için Üç Boyutlu Analiz

Duygu GÖLLER BULUT[1], Yıldıray ŞİŞMAN[2]

[1]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Bolu Abant İzzet Baysal University, BOLU, TÜRKİYE

[2]Private Dentamer Oral and Dental Health Policlinic, Department of Oral and Maxillofacial Radiology, MERSIN, TÜRKİYE

ABSTRACT

Objective: The purpose of this study was to assess morphologic features of alveolar bone supporting maxillary premolars and molars and to determine the relationship between maxillary sinus and teeth using cone beam computed tomography (CBCT).

Material and Methods: In CBCT scans of 100 patients, the thickness of both trabecular bone and cortical plates surrounding 652 posterior teeth were measured and the relationship between teeth and maxillary sinus was classified. Also, the angle between the teeth and the alveolar crest was measured.

Results: Of the teeth examined, 25 % were in contact with the inferior wall of maxillary sinus, 12% had penetrated the sinus and 63 % were far away from maxillary sinus. The closest root to the maxillary sinus floor was mesiobuccally root of second molar teeth with 1.3 mm distance. The teeth which had thinnest bone configuration were maxillary first premolars. There were no significant differences for measurements between sides and gender (p>005). Buccal bone thickness and distance to the maxillary sinus floor showed a negative correlation in molars (p<0.001 and 0.003).

Conclusion: In order to prevent possible complications, a three-dimensional analysis of the posterior maxilla and maxillary sinus is required before implant procedures to be performed on the maxillary posterior region.

Keywords: *Bone thickness, CBCT, maxillary molars, maxillary premolars*

ÖZ

Amaç: Bu çalışmanın amacı, maksiller premolar ve molar dişleri destekleyen alveoler kemiğin morfolojik özelliklerini ve maksiller sinüs ile dişler arasındaki ilişkiyi koni ışınlı bilgisayarlı tomografi (KIBT) kullanarak değerlendirmektir.

Gereç ve Yöntemler: 100 hastanın KIBT taramalarında, 652 arka dişi çevreleyen hem trabeküler kemik hem de kortikal kemik kalınlığı ölçüldü ve dişler ile maksiller sinüs arasındaki ilişki sınıflandırıldı. Ayrıca, dişlerin alveol kreti ile arasındaki açı ölçüldü.

Bulgular: İncelenen dişlerin % 25'i maksiller sinüsün alt duvarı ile temas halinde, %12'si sinüsün içinde, % 63'ü ise maksiller sinüsten uzaktaydı. Maksiller sinüs tabanına en yakın kök 1.3 mm mesafe ile ikinci molar dişlerin meziyobukkal kökleriydi. En ince kemik konfigürasyonuna sahip dişler maksiller birinci premolardı. Taraflar ve cinsiyet arasında ölçümler açısından anlamlı fark yoktu (p>005). Bukkal kemik kalınlığı ve maksiller sinüs tabanına olan uzaklık, azı dişlerinde negatif korelasyon gösterdi (p<0.001 ve 0.003).

Sonuç: Olası komplikasyonları önlemek için, maksiller posterior bölgeye yapılacak implant işlemlerinden önce, posterior maksilla ve maksiller sinüsün üç boyutlu analizine ihtiyaç vardır.

Anahtar Kelimeler: *Kemik kalınlığı, KIBT, maksiller molarlar, maksiller premolar*

Correspondence / Yazışma Adresi: **Dr. Duygu GOLLER BULUT**
Bolu Abant İzzet Baysal University F. of Dentistry, Dept. Oral and Maxillofacial Radiology, BOLU, TÜRKİYE
Phone / Tel: +905446406640 **E-mail /** E-posta: duygugoller@hotmail.com
Received / Geliş Tarihi: 08.04.2019 **Accepted /** Kabul Tarihi: 15.12.2019
ORCID NO: [1]0000-0003-4260-2520 [2]0000-0002-8450-3260

KÜ Tıp Fak Derg 2019;21(3):313-324
Doi:10.24938/kutfd.550667

INTRODUCTION

The maxilla is the broadest bone among all face bones and it is formed by four parts; zygomatic, frontal, palatine and alveolar process. Alveolar process is the largest and spongiest part of the maxilla (1). It has socket spaces in which anterior and posterior teeth are located. Especially, posterior teeth have an important function in occlusion and chewing. When they are lost due to the proof caries, periodontal problems or other reasons, it is hard to rehabilitate because of its weak bone structure (1,2). Commonly partial prosthesis, crown and bridge restoration or dental implants are used for therapy (3). The use of dental implants is presently extensively accepted as a useful treatment for these patients (1-4). Success and survival rates of implants are 93% to 99% in long-term follow-up studies (1-4). But the cumulative success rate for maxillary implants has been presented to be less than that for mandibular implants (2). The edentulous posterior maxilla generally provides an inadequate amount of alveolar bone volume due to the atrophy of the alveolar bone and pneumatization of the maxillary sinus after tooth loss. As a result, maxillary dental implants inserted in reduced alveolar bone have commonly resulted in complications like the implant intruding into the maxillary sinus and mobility of implant (3,4).

For preserving the long-term integration of dental implant placement, many authors have highlighted that an adequate alveolar bone volume with good quality is necessary (2, 5-8). Cone beam computed tomography (CBCT) is a method that gives radiological imaging of bone structures in 3-dimensional (3D) projection. It has some advantages compared to medical computed tomography (CT) like shorter exposure time, lower radiation dose, and lower cost (9). Cortical and trabecular bone thickness can be accurately determined, and this is usually completed with a significantly lower effective dose compared with that of conventional CT (10-13). Therefore, topographic analysis evaluated by 3D CT imaging using CBCT is an effective method for planning a safe and reliable treatment (2).

In this study, we aimed to clarify morphological characteristics of the maxillary posterior teeth in healthy jaws, particularly the buccal and palatal bone thickness around roots by cross-sectional CBCT images and to identify the relationship between the maxillary sinus and the maxillary posterior teeth using 3D-CBCT images. This study may provide useful information for the treatment intended for maxillary posterior teeth, so as to help lead to successful treatment outcomes.

MATERIALS AND METHODS

In this retrospective study, 100 CBCT scans taken for clinical examination were used. CBCT images had been taken because of the patients' previous dentomaxillofacial problems. Patients with osteoporosis, bone lesions, trauma history, developmental problems, and immunocompromised health status were excluded from the study. Good quality CBCT images with healthy maxillary molar regions without periodontal problems (horizontal and vertical bone loss) were analyzed. Fully erupted teeth with fully formed apices were observed.

Image Evaluation

The patient underwent imaging using the New Tom VG (Quantitative Radiology, Verona, Italy) with flat-panel detector-based CBCT (FPD-CBCT). Automatically determined X-ray parameters (kV, mA) (from scout views by the New Tom VG) were used. All patients were scanned in the supine position and images were obtained. The slice thickness scanned on all patients was 0.25 mm. Cases were enrolled provided that the scans showed the bilateral maxillary premolars, molars and inferior wall of the maxillary sinus in both sides.

Measurements

To eliminate interoperator error, a sole dentomaxillofacial radiology specialist with 3 years of experience on CBCT imaging reconstructed the cross-sectional and sagittal CBCT images, plotted the landmarks, and measured linear items and interangles of all patients. The measurements were made on cross-sectional images of CBCT by using the method of Yoshimine et al. (2) First premolars with two root and second premolar with two fused roots were determined to have standardization. The cross-sectional images of CBCT were set up with the mesiodistally center line of each premolar teeth and each root of maxillary molar teeth (Figure 1a-c). The measurement items were as follows; 1: maximum width of the teeth in the cervical region, 2: maximum bone thickness between the buccal and palatal alveolar plates, 3a: maximum buccal alveolar bone width in the midpoint of the buccal root (mesiobuccally root for molar), 3b: horizontal bone width between the buccal root apex (mesiobuccally root apex for molar) and the buccal alveolar plate, 3c: minimum vertical distance between the buccal root apex (mesiobuccally root apex for molar) and the maxillary sinus floor, 4a: maximum palatal alveolar bone width in the midpoint of the palatal root, 4b: horizontal bone width between the palatal root apex and the palatal alveolar plate, 4c: minimum vertical distance between the palatal root apex and the maxillary sinus floor, 5: distance between the apices of the palatal and buccal roots (mesiobuccally roots for molar), 6: maximum cortical width of the maxillary sinus floor closest to the apex of the root, and for molar teeth ; 7a: horizontal bone width between the midline of distobuccally root apex and the buccal alveolar plate, 7b: horizontal bone width between the apex of distobuccally root apex and the buccal alveolar plate. 7c: minimum vertical distance between the distobuccally root apex and the maxillary sinus floor, 7d: distance between the apices of the distobuccally and palatal roots (Figure 2a).

As an angular measurement, the internal angle (α) designed by the long axis of the teeth and that of the alveolar bone on the maxillary posterior teeth were evaluated (Figure 2b). The long axis of the tooth was determined as the line that went through the crown and root around which the substance of a tooth was most symmetrically distributed. The correlation between the internal angle (α) and the linear items measured on the cross-sectional CBCT image was evaluated to gain valuable data for implant placement. The relationship between the roots of teeth and the maxillary sinus was classified in 5 groups and shown in Figure 3: group 1; the roots far away from sinus floor, group 2; the root apexes in contact with sinus floor, group 3; buccal roots penetrating the sinus cavity, group 4; palatal roots penetrating the sinus cavity, group 5; both buccal and palatal roots penetrating the sinus cavity.

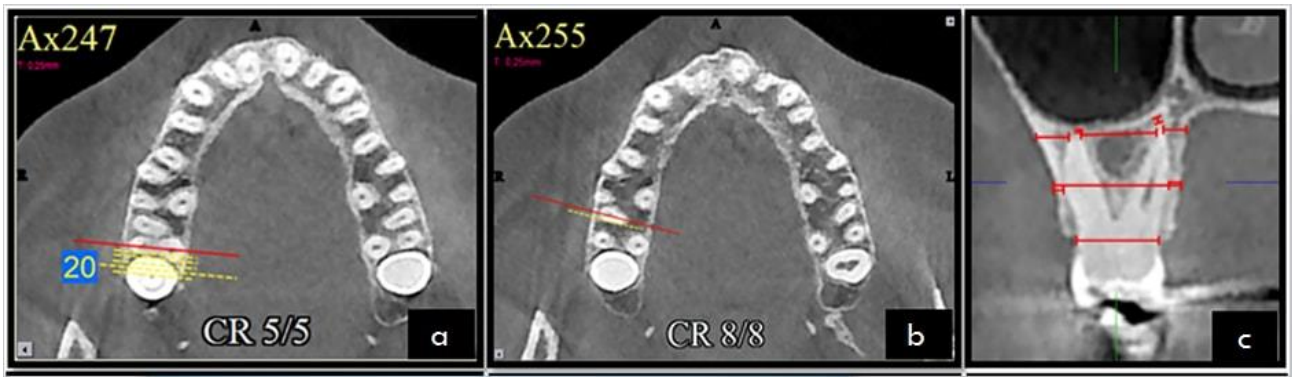

Figure 1a: Mesiodistally center line of distobuccally and palatal root of right maxillary second molar on axial CBCT section. **b)** Center line of mesiobuccally root of right maxillary second molar on axial CBCT section. **c)** Display of linear measurements made on molar tooth on cross-section CBCT image.

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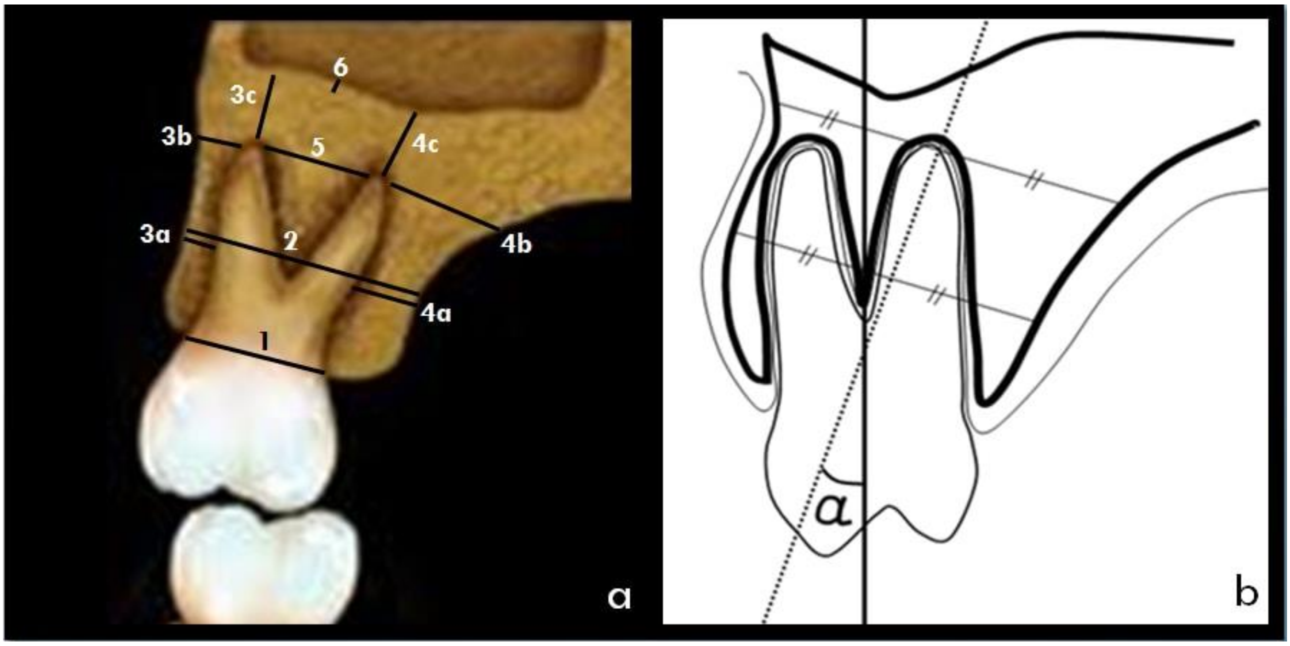

Figure 2a: Schematic illustrations of linear measurements on the maxillary first molar teeth, **b)** Schematic illustrations of angular measurement on the maxillary first premolar teeth (α).

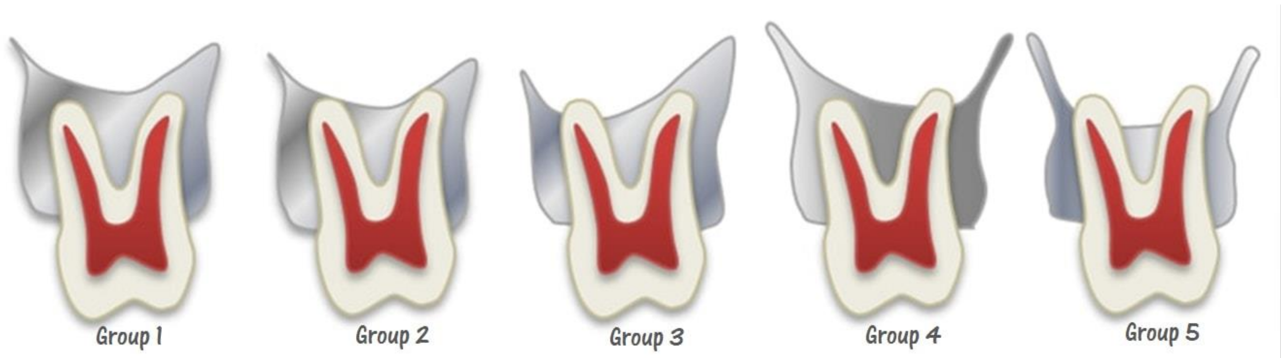

Figure 3: Schematic presentation of the groups defining the root relationship with the maxillary sinus: Group 1; the root is far away from sinus floor, Group 2; The root apex is contacted with sinus floor, Group 3; buccal root is penetrated in the sinus cavity, Group 4; palatal root is penetrated the sinus cavity, Group 5; both buccal and palatal roots are penetrated the sinus cavity.

Statistical Analysis

All data were evaluated using Package for the Statistical Package for the Social Sciences (SPSS), version 16.0 (SPSS Inc., Chicago, IL). Categorical variables were shown by n and % values. The correlations between the items were analyzed using Spearman's and Pearson's correlation coefficient. Statistical significance was determined at the level of $p<0.05$. The values were tabulated; the minimum and maximum average and standard deviations (SDs) were calculated for all parameters studied. T-tests were used to compare measurements between sides and genders. To assess the intra-examiner calibration, 20% CBCT images were measured again and the intra-observer correlation coefficient was 0.95 for all measurements.

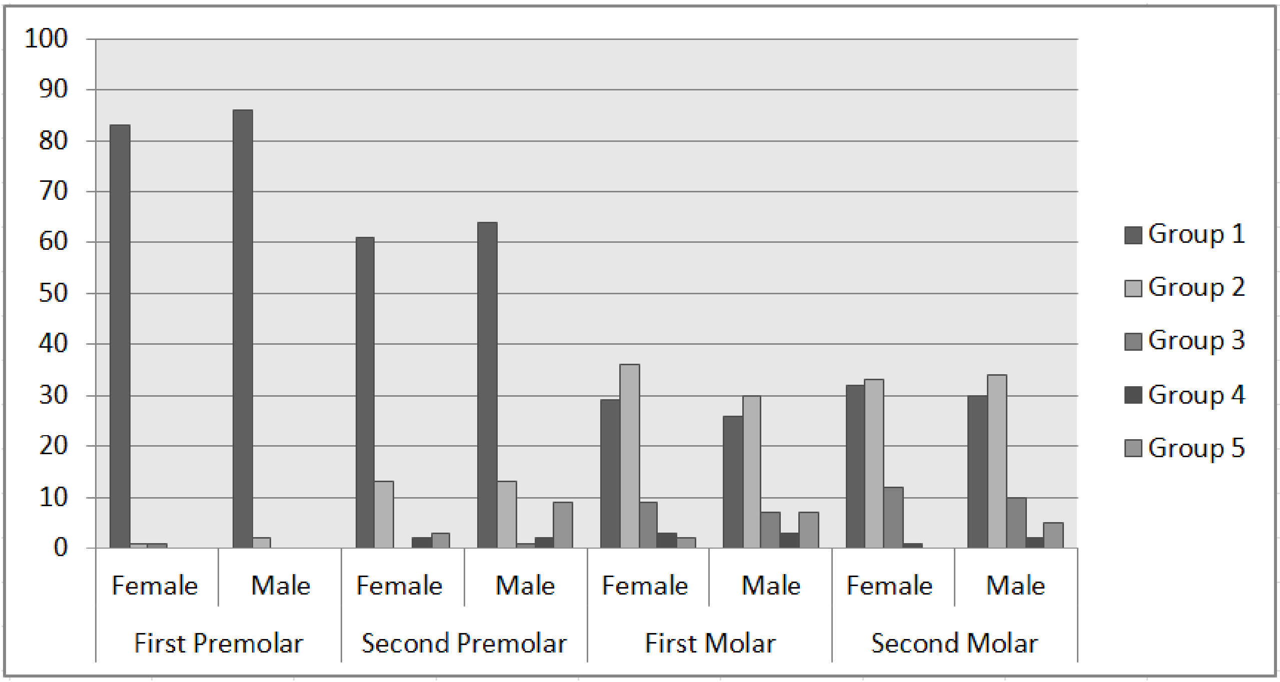

Figure 4: A graph showing the distribution of groups according to sexes and posterior teeth. Group 1-5 shows the relation between the maxillary sinus floor and tooth roots.

RESULTS

CBCT images of 100 patients consisted of 51 men and 49 women with an average age of 35.21 years (range, 22–65 years) who met our inclusion criteria. A total of 652 posterior teeth; 341 maxillary premolar teeth (168 first premolar and 173-second premolar) and 311 maxillary molar teeth (152 first molar and 159-second molar) were detected. The relationship between teeth and maxillary sinus were shown in Figure 4. When we considered the premolar teeth, 86.2% had a distance between maxillary sinus, 8.8% were in contact with sinus floor and 5% were in the maxillary sinus. Among the molar teeth, 38% had a distance between maxillary sinus, 42% were in contact with sinus floor and 20% were in the maxillary sinus.

The minimum and maximum values and standard deviation of each item measured on the cross-sectional images of CBCT are shown in Table 1 for premolar teeth and in Table 2 for molar teeth. The closest root to the maxillary sinus floor was mesiobuccally root of second molar teeth with 1.3 mm distance and the farthest root was the buccal root of first premolar teeth with 6.6 mm. The distance between the buccal root apexes of molars and the buccal alveolar bone plate (items no. 3b) and the shortest distance from the buccal root apexes of molars to the maxillary sinus floor (item no.3c) showed a negative correlation ($p<0.001$ and 0.003) (Table 3). Conversely, the distance between the apex of the buccal and palatal the roots (item no. 5) and the maximum width between the buccal and the palatal alveolar bone plates (item no. 2) exhibited a positive correlation ($p=0.045$). The means and standard deviations of the angular measurements are shown in Table 4. The internal angle (a) formed by the long axis of the teeth and alveolar bone was higher at premolar region compared to molars. It was 9.88 degrees (range, 0.4–30.0 degrees) at the maxillary first premolars and 7.83 degrees (range, 1.0– 22.0 degrees) at the maxillary second premolars, respectively.

Table 1: Descriptive values of the measurement results made on the maxillary first and second premolar teeth and adjacent anatomical structures (mm)

	Gender		Number of items 1*	2*	3a*	3b*	3c*	4a*	4b*	4c*	5*	6*
First Premolar Teeth	Male	Min.	6,6	8,1	0	0	0	0	0	0,5	0	0,1
		Max.	15,2	18	3,3	8,7	22,9	4,5	9,7	23,5	6	1,8
		Mean	8,5	10,4	1,1	1,1	6,2	2,2	4,7	5,4	2,7	0,9
		SD	1	1,5	0,8	1,4	3,9	1	2,1	3,9	1,4	0,3
	Female	Min.	6,1	6,8	0	0	0	0	1,3	0,6	0	0
		Max.	11	13,3	2,4	7,6	7,3	5,1	10,8	17,1	11	1,3
		Mean	8,3	9,9	1	0,8	7,9	2,1	4,9	6,9	3,1	0,9
		SD	0,9	1,3	0,6	1	8,5	1	1,9	3,6	2,1	0,3
	Total	Min.	6,1	6,8	0	0	0	0	0	0,5	0	0
		Max.	15,2	18	3,3	8,7	22,9	5,1	10,8	23,5	11	1,8
		Mean	8,4	10,2	1	1	6,6	2,2	4,8	6	2,8	0,9
		SD	1	1,4	0,7	1,2	6,6	1	2	3,8	1,8	0,3
Second Premolar Teeth	Male	Min.	6,6	7,8	0	0	0	1	2,3	0	0	0
		Max.	11,6	14	3,8	10	17,3	9,1	9,5	11,2	5,8	1,8
		Mean	8,6	10,6	1,8	2,4	2,9	2,6	5,8	1,9	3	0,7
		SD	0,8	1,3	0,9	1,7	3,5	1,1	1,6	2,5	1,4	0,4
	Female	Min.	6,2	7,6	0	0	0	0,5	3,5	0	0	0
		Max.	11,2	13,8	5	9,5	12,7	6,7	10,8	9,1	6,4	1,5
		Mean	8,5	10,5	1,9	2,1	3,5	2,3	6,2	3	3,1	0,8
		SD	0,9	1,3	1	1,6	3,1	1	1,7	2,7	1,7	0,3
	Total	Min.	6,2	7,6	0	0	0	0,5	2,3	0	0	0
		Max.	11,6	14	5	10	17,3	9,1	10,8	11,2	6,4	1,8
		Mean	8,5	10,6	1,8	2,3	3,2	2,5	6	2,3	3	0,8
		SD	0,9	1,3	0,9	1,6	3,3	1,1	1,6	2,6	1,5	0,4

Min: Minimum value, Max: Maximum value, SD: Standard Deviation. *Number abbreviations: 1; the thickness of the cervical region of the tooth, 2, the maximum thickness of the alveolar bone, 3a-c, bone thickness supporting the buccal root (a, middle triple, b, apex, c, distance to sinus floor), 4a-c; bone thickness supporting palatal root (a, middle triple, b, apex, c, distance to sinus floor) 5; maximum distance between buccal and palatal tooth roots, 6; cortical bone thickness of the sinus floor.

Table 2: Descriptive values of the measurement results made on the maxillary first and second molar teeth and adjacent anatomical structures (mm)

	Gender	Values	1*	2*	3a*	3b*	3c*	4a*	4b*	4c*	5*	6*	7a*	7b*	7c*	7d*
First Molars	Male	Min.	7,8	11,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	12,6	17,3	3,0	5,7	14,1	3,1	6,5	13,8	11,9	1,8	32,0	12,5	14,6	10,8
		Mean	10,2	14,4	1,0	2,1	2,0	1,3	2,4	1,8	7,4	0,5	2,1	2,6	1,8	6,1
		SD	1,0	1,5	0,9	1,7	3,0	0,7	1,3	3,0	2,4	0,4	3,7	2,5	2,9	2,1
	Female	Min.	8,2	11,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	13,1	17,0	3,8	6,3	12,0	2,8	6,6	10,3	13,2	12,3	5,8	6,5	12,3	11,5
		Mean	10,3	14,4	1,1	1,8	2,0	1,0	2,1	2,2	8,0	0,8	1,8	2,0	1,8	7,3
		SD	0,9	1,3	0,8	1,7	2,9	0,7	1,2	2,7	2,4	1,4	1,2	1,7	2,6	2,4
	Total	Min.	7,8	11,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	13,1	17,3	3,8	6,3	14,1	3,1	6,6	13,8	13,2	12,3	32,0	12,5	14,6	12,5
		Mean	10,3	14,4	1,1	1,9	2,0	1,1	2,2	2,0	7,7	0,7	1,9	2,3	1,8	7,2
		SD	0,9	1,4	0,9	1,7	3,0	0,7	1,3	2,8	2,4	1,0	2,7	2,1	2,7	2,2
Second Molars	Male	Min.	8,3	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	13,5	18,7	6,1	10,5	11,6	4,3	8,0	10,8	11,9	1,5	6,3	9,3	11,8	10,5
		Mean	10,5	14,5	2,2	3,9	1,6	1,5	2,2	2,5	6,0	0,5	2,4	3,1	2,1	5,7
		SD	1,1	1,6	1,2	2,1	2,9	0,8	1,5	3,0	2,5	0,4	1,3	2,0	3,1	2,3
	Female	Min.	8,0	10,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	12,3	18,1	5,5	9,3	8,8	3,5	5,3	9,3	12,1	1,3	4,6	23,0	10,1	10,9
		Mean	10,3	14,5	2,3	4,2	1,0	1,6	2,1	1,9	6,2	0,6	2,2	3,4	1,5	5,8
		SD	1,1	1,4	1,0	1,8	1,7	0,9	1,2	2,3	2,6	0,3	1,2	3,0	2,2	2,6
	Total	Min.	8,0	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Max.	13,5	18,7	6,1	10,5	11,6	4,3	8,0	10,8	12,1	1,5	6,3	23,0	11,8	11,5
		Mean	10,4	14,5	2,3	4,1	1,3	1,6	2,2	2,2	6,1	0,6	2,3	3,3	1,8	5,6
		SD	1,1	1,5	1,1	2,0	2,4	0,8	1,4	2,7	2,6	0,4	1,3	2,5	2,7	2,3

Min: Minimum value, Max: Maximum value, SD: Standard Deviation. *Number abbreviations: 1; the thickness of the cervical region of the tooth, 2; the maximum thickness of the alveolar bone, 3a-c; bone thickness supporting the mesiobuccally root (a, middle triple, b, apex, c, distance to sinus floor), 4a-c; bone thickness supporting palatal root (a, middle triple, b, apex, c, distance to sinus floor) 5; maximum distance between buccal and palatal roots, 6; cortical bone thickness of the sinus floor, 7 a-c; bone thickness supporting the distobuccally root (a, middle triple, b, apex, c, distance to sinus floor).

The internal angle (a) at the maxillary premolars and the vertical distance between the apices of both the buccal and palatal roots on the premolars and the maxillary sinus floor (items no. 3c and 4c) showed a positive correlation (p=0.018, 0.008, and 0.033, 0.034 respectively) (Table 5). The horizontal bone thickness was thinnest on the buccal plate of first premolar teeth and midline of mesiobuccally and distobuccally root of the maxillary first molar. Buccal roots of teeth had thinner bone configurations surrounding it than palatal roots. There was no significant difference for linear measurements between sides and gender (p>0.05).

Table 3: Correlation between buccal bone thickness (No.3b) and distance of root to the sinus wall (No. 3c)

Analysed Teeth	rho	P
First Molar		
No. 3b and No 3c	-0,508	<0,001
Second Molar		
No. 3b and No 3c	-0,233	0,003

rho: correlation coefficient, p<0.05

Table 4: Descriptive values of the Angular measurements between the long axis of maxillary posterior teeth and the long axis of alveolar bone.

Tooth Number	Min.	Max.	Mean	SD.
14	0,4°	20,4°	**8,88°**	3,86°
15	1,0°	22,0°	7,35°	3,84°
24	2,1°	30,0°	**12,04°**	4,61°
25	2,9°	18,8°	**9,93°**	4,01°
16	0,3°	34,0°	5,43°	4,06°
17	1°	21,2°	7,70°	3,98°
26	1,9°	13,4°	5,23°	2,44°
27	1,5°	16,7°	6,56°	3,16°

Min: Minimum value, Max: Maximum value, SD: Standard Deviation.

Table 5: Correlation between the Angular and Linear items measured

Analysed Teeth	Correlation coefficient	
First premolar	**Rho**	**p**
item no. 3c and α	0,181	0,018
item no. 4c and α	0,252	0,008
Second premolar	**Rho**	**p**
item no. 3c and α	0,165	0,033
item no. 4c and α	0,332	0,034

Correlation analysis p< 0.05

DISCUSSION

In this study, we to analyze the topographic anatomy of the maxillary posterior teeth and maxillary sinus using 3D images on CBCT and to provide clinicians with beneficial information for sinus augmentation, periapical surgery and immediate dental implant treatment (2). Only a panoramic radiograph is accessible to the dental clinicians in most cases, and limited clinicians demand a CBCT (14). In the study of Freisfeld et al. that intended to compare the relationship between maxillary teeth and the inferior wall of maxillary sinus, CTs and panoramic radiographs of 30 patients were inspected (15). The anatomic relationships between the sinus and roots of maxillary teeth as measured by panoramic radiographs were considerably dissimilar from those measured by CT. Because of the disadvantages such as vertical and horizontal magnification, superposition of anatomic structures, and absence of cross-sectional images that

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are related to panoramic radiographs, this study was conducted using CBCT images (16).

Due to the close anatomical association between the roots of maxillary posterior teeth and the floor of maxillary sinus, periapical surgery and tooth extraction can cause oroantral communication and this complication allows bacteria from resected root tips and infected periapical tissue to be displaced into the maxillary sinus and cause chronic or acute sinusitis. (16-18) Complications are seen much more in the maxillary first molar side (19-22).

The root apices of the maxillary premolars are commonly located farther from the floor of the maxillary sinus than molars (2). In the study of Eberhardt et al. it is reported that the distance between the root apices of the maxillary posterior teeth and the inferior wall of maxillary sinus changes; it is 7.05 mm on the palatal root of the first premolar and 0.83 mm on the mesiobuccally root of the second molar (23). In another study by Kwak et al. they used CT images and defined five vertical relationships (7). They found that the most frequent relationship was type one in which roots had no contact with the inferior wall of the sinus. However, in this study the closest root to the inferior wall of the sinus was the apex of the distobuccally root of the second molar with average 2.74 mm and farthest root from the inferior wall of the maxillary sinus was the palatal root of the first premolar with average 6.27 mm. Kılıç et al. found that the first premolar root apex was farthest and the second molar distobuccally root apex was closest to the sinus floor on both sides (right and left) (16). In our study, in 20% of examined molars, the roots had penetrated maxillary sinus, in 42% the root apexes contacted to the inferior wall of maxillary sinus. The closest root to the maxillary sinus floor was mesiobuccally root of second molar teeth with 1.3 mm distance, same with previous studies (24, 25). Evaluation of the relationship between molar teeth and maxillary sinus is essential to reduce complications that occur in the molar side of maxillary sinus (21,22,26,27). Also it is suggested that the distance between the maxillary posterior teeth root apex and maxillary sinus floor has a tendency to reduce toward the posterior region (2,7,15,23).

Over the years, dental implant therapy has evolved towards a usual and likely treatment option and success rates exceeding 95% have been reported. Systematic and local disease condition, smoking habits, metabolic bone disease, radiotherapy and many other clinical circumstances and variables have been reported to have a potential effect on implant success. In view of that, as all these circumstances and variables can directly or indirectly change bone conditions, it is clear that we must pay attention to the local bone quality and quantity during the pre-surgical dental implant planning period (28).

The morphologic characteristic of maxillary posterior teeth is important for the selection of a suitable method in patients undergoing post-extraction immediate dental implant placement. Nevertheless, only limited information is presented about the important morphologic characteristic of alveolar bone on the maxillary posterior region in immediate implant patients before tooth extraction (2). The dental implant failure rate tends to be higher in a reduced bone quality region because implants rely on the adjacent bone for their support and stabilization (28).

Bone thickness around roots of posterior teeth is important for long survival time of teeth and after extraction remaining bone surround socket is also essential for immediate implant loading (6). In the study of Kwak et al. among maxillary posterior teeth, the distance from the buccal root apex to the buccal alveolar bone plate was the shortest at the first premolar area with a mean of 1.99 mm and the maximum bucco-palatal alveolar bone width was shortest at the first premolar area with a mean of 11.52 mm (7). As a result of this study, buccal bone thickness is solid than palatal one. The buccal alveolar bone was thinnest on the maxillary first premolars same as the previous studies (2,7). The buccal alveolar bone thickness has an effect on the facial convexity of the alveolar process at the emerging implant crown. Thus at the time of extraction, we must make every effort to avoid unnecessary damage to the buccal alveolar bone of the maxillary posterior teeth. Clinicians should determine the remaining bone configuration of posterior teeth before any treatment.

The cortical thickness of the inferior wall of the maxillary sinus is necessary for successful augmentation of the maxillary sinus floor. Likewise, the thickness of the maxillary sinus floor and its association with the adjacent teeth are essential for estimating the prognosis of sinus augmentation (2). The result of previous studies and this study indicates that the cortical thickness of the inferior wall of the maxillary sinus reduces in the molar side (2,7,29).

The association between the angle of dental implants and the position of the inferior wall of the maxillary sinus is crucial to insert the dental implant appropriately. The results of this study show that the mean angle between maxillary first premolar and alveolar bone was greater than other maxillary posterior teeth. Furthermore, similar to the previous study the internal angle and the vertical distance between the root apex and the inferior wall of the maxillary sinus showed a positive correlation on the maxillary premolars (2). These findings indicate that the angle shown at a high position on the inferior wall of the maxillary sinus was larger than that at a low position on the maxillary premolars. The many conventional dental implant treatments at high positions on the floor of maxillary sinus have tended to involve insertion of long dental implants on the alveolar bone along the long axis of the tooth. Thus, we advise that the estimation of the angle between long axis of teeth and the alveolar bone and determination of the position of the inferior wall of the maxillary sinus is important to suitably insert dental implants into the alveolar bone on the maxillary premolars.

For successful maxillary dental implant treatment, especially immediate implant therapy or sinus augmentation with minimal complications, it is essential to determine the morphological characteristics of the alveolar bone and the relationship between maxillary posterior teeth and maxillary sinus. Dentists should be ready to solve problems during operation by knowledge of the morphology of teeth and surrounding bone in the posterior maxilla. This study provides useful information for the next studies which intend to search maxillary posterior bone structure.

Ethics Committee Approval: Ethics Committee approval for this study was obtained from the Ethics Committee of Erciyes University, Turkey (Date: 03.04.2015; Decision No: 2015-166).

Conflict of Interest: The authors have no conflicts of interest to declare.

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