Alveol Kret Yüksekliği ve Maksiller Sinüs Mukozası: Konik Işınlı Bilgisayarlı Tomografi Değerlendirmesi

Alveolar Crest Height and Maxillary Sinus Mucosa: Cone Beam Computed Tomography Evaluation

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ÖZ

Giriş ve Amaç: Dental implantların uygulanabilmesi için birincil gereklilik yeterli kemik miktarıdır. Maksiller posterior bölgede alveolar kretin atrofisi maksiller sinüs augmentasyonunu gerekli kılabilir. Sinüs augmentasyonu sırasında maksiller sinüs anatomisine ve patolojilerine bağlı olarak komplikasyonlar gözlenebilir. Bu çalışmanın amacı alveolar kret yüksekliği (AKY) ve maksiller sinüs mukozal değişiklikleri (SMD) arasındaki ilişkiyi değerlendirmektir.

Yöntem ve Gereçler: Çalışmaya, implant planlaması amacıyla konik ışınlı bilgisayarlı tomografi (KIBT) görüntüsü alınmış 60 hasta dahil edildi. KIBT görüntüleri üzerinde ölçüm yapılacak kesitleri belirlemek amacıyla panoramik rekonstrüksiyonlar yapıldı ve cross-sectional kesitler üzerinde AKY ölçüldü. Maksiller sinüs mukozasındaki herhangi bir değişiklik kaydedildi.

Bulgular: Değerlendirilen 60 hastanın % 63.3' ünde SMD gözlendi. AKY değerleri, SMD olmayan ve olan hastalarda sırasıyla; birinci premolar için 16.78 ve 17.39 mm., ikinci premolar için 8.92 ve 7.83 mm., birinci molar için 7.07 ve 5.37 mm., ikinci molar için 10.05 ve 8.5 mm. olarak ölçüldü. Birinci molar bölgesinde ortalama AKY değerleri SMD olan hastalarda daha düşük bulundu ($p<0.05$).

Tartışma ve Sonuç: Molar bölgede ortalama alveolar kret yüksekliği ile sinüs mukozal değişiklikleri arasında ilişki vardır. Maksiller sinüs mukozasında değişimler izlenen hastaların molar bölgede ortalama kret yükseklikleri, mukozal değişiklik olmayan hastalardan daha düşüktür. Molar bölgede sinüs augmentasyonu işleminde maksiller sinüs mukozası dikkat gerektirmektedir.

Anahtar Kelimeler: *Konik ışınlı bilgisayarlı tomografi, maksiller sinüs mukozası, alveol kret yüksekliği, Sinüs lift*

ABSTRACT

Introductıon: For dental implant placement, primary requirement is adequate bone. Alveolar crest atrophy in maxillar posterior area may necessitate sinus augmentation. During sinus augmentation, complications may be seen due to anatomy and pathologies of the maxillary sinus. The purpose of this study is to evaluate the relationship between alveolar crest height (ACH) and maxillary sinus mucosal changes (SMC).

Methods: Study included sixty maxillary posterior edentulous patients who had undergone cone beam computed tomography (CBCT) evaluation for implant planning. On CBCT images panoramic reconstructions were made to define the measurement sections and on cross-sectional images ACHs were measured. Any visible change in maxillary sinus mucosa were recorded.

Results: Of the evaluated 60 patients, 63.3% showed SMCs. ACHs were, 16.78 and 17.39 mm for first premolar, 8.92 and 7.83 mm for second premolar, 7.07 mm and 5.37 mm for first molar and 10.05 mm and 8.5 mm for second molar areas in patients without and with SMCs, respectively. Average ACHs were lower in patients with SMCs in molar area ($p<0.05$).

Dıscussıon and Conclusıon: There is a correlation between alveolar crest height of the molar area and sinus mucosal change existence. Average alveolar crest height in the molar area is lower in patients with mucosal changes, compared to patients without mucosal changes. Sinus augmentation in the molar area requires attention for maxillary sinus mucosa.

Keywords: *Cone beam computed tomography, maxillary sinus mucosa, alveolar crest height, sinus lift procedure*

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INTRODUCTION

Edentulousness is a common problem caused by many reasons. Removable dentures are used for recovery of function and esthetics but atrophy of alveolar crests results with insufficient denture suitability and inadequate function. Dental implants which are developed to eliminate disadvantages of removable dentures are now widely used for rehabilitation of loss of function and esthetics.[1]

Sufficiency and quality of bone is the initial necessity for implant placement. Maxillary sinus augmentation is a surgical procedure applied to acquire adequate bone for implant placement in cases alveolar atrophy cause bone insufficiency in maxillary posterior area where has a close relationship with maxillary sinus.[2] External and internal approaches are two basic methods used for sinus augmentation.[3]

Although rare, complications like bleeding and sinus membrane perforation during sinus augmentation surgery or post-operative problems in wound healing, sinusitis, exposure or infection of graft material may be seen. Most of these problems are related with anatomy and existing pathologies of maxillary sinus.[4] Presence of anatomic variations and pathologies of maxillary sinus - which are not rare problems- may cause difficulties in surgery and increase in post-operative complications. Definition and if possible elimination of these problems is substantial before surgery.[5]

In a study residual alveolar crest heights were measured in edentulous maxillary first molar area; it is found that, patients who have residual alveolar crest lower than 5 mm significantly have higher prevalence of sinus mucosal anomalies.[6] Another study revealed that there is a decrease in sinus membrane thickness in patients with crest heights lower than 3.5 mm, also it is reported that all the sinus membrane perforations occured in patients with residual ridge heights lower than 5 mm.[7] There is an increasing interest on cone-beam computed tomography (CBCT) with its primary advantages like, lower radiation dose compared to conventional computed tomography, lower cost and availability and providing high contrast in hard tissue imaging, for imaging of paranasal sinuses and related pathologies.[8,9]

The purpose of this study is to define the relationship between alveolar crest height (ACH) and existence of maxillary sinus mucosal changes in maxillary posterior edentulous patients using cone beam computed tomography.

MATERIALS AND METHODS

Patient Selection: For this research ethical approval was obtained from İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee No: 10840098604.01.01-E.65172. Study was conducted in a group of patients who had undergone CBCT examination in a dental school between 2013 and 2014. Inclusion criteria was maxillary posterior edentulousness unilaterally or bilaterally. Exclusion criteria were; any artifact resulting decrease in image quality (metal artifacts, patient motion artifacts etc.), any radiographic sign of recent tooth extraction from the region of interest, any pathological change or destruction affecting normal maxillary sinus course and borders (radiographic signs of agressive lesions of maxillary sinus and/or surrounding structures, and lesions such as residuals cysts which may cause displacement of the inferior border of maxillary sinus superiorly) and any radiographic sign of history of maxillary or paranasal sinus surgery.

Image acquisition: CBCT examinations were made using i-CAT 3D Imaging System (Imaging Sciences International, Hatfield, PA, USA) with exposure parameters 80kVp, 5-7 mA and 20 seconds with a voxel size 0.25 mm. Image analyses and measurements were performed using i-CAT *Vision* software (Imaging Sciences International).

Measurements: On saggital images Frankfurt horizontal plane was adjusted parallel to the floor and panoramic reconstructions were prepared using guide line passing from the middle of the alveolar crest on axial images where incisive canal was first seen.

On panoramic reconstructions, 4 measurements for right and 4 measurements were left areas were made for females and males depending on the values obtained by Pramstraller et al. in their study made to define the distance of maxillary premolars and molars from midline.[10] For first premolars 21.15±0.58 mm and 22±0.45 mm, for second premolars 28.15±0.58 mm and 29±0.45 mm, for first molars 36.05±0.51 mm and 37.05±0.51 mm and for second molars 43.95±0.82 mm and 44.95±0.51 mm distances were measured from the midline for females and males respectively. (Figure 1)

Alveolar crest heights were measured on cross-sectional images which were acquired on above mentioned distances from the midline for first premolar (ACH 1), second premolar (ACH 2), first molar (ACH 3) and second molar areas (ACH 4). (Figure 2)

Maxillary sinuses were evaluated for existence of any visible mucosal changes on maxillary sinus floor. When mucosal changes are detected, dimensions of the sinus mucosa were measured.

Statistical Analysis: Data obtained from the study were evaluated using IBM SPSS Statistics (Version 23; IBM Corp., Armonk, NY, USA) software package. Shapiro Wilks test was used for assessment of normal distribution of data. For the comparison of normal distributed data with gender and mucosal change existence, independent variables t test was used. One way analysis of variance was used for comparison of

left and right areas with mucosal change existence. Multiple comparisons were made by Tukey HSD. Chi-Square test was used for categoric data analysis. Relationship between age and alveolar crest heights and relationship between alveolar crest height and sinus mucosa dimensions were investigated with Pearson correlation. A significance level of $p<0.05$ was deteremined for all analyses.

Figure 1: Determination of Measurement Areas on Panoramic Reconstruction

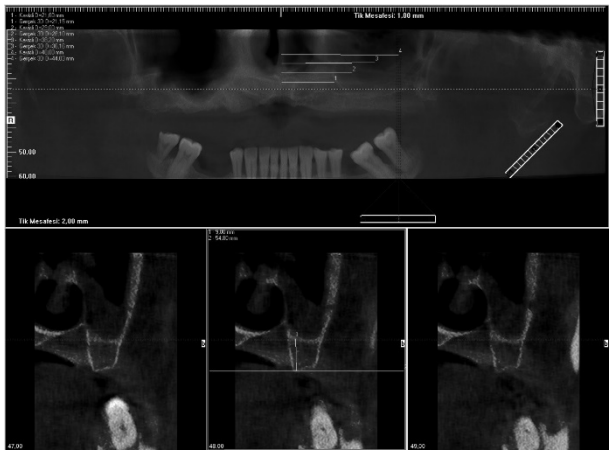

Figure 2: Alveolar Crest Height Measurement on Cross-Sectional Images

RESULTS

45 right and 53 left edentulous alveolar crests in 60 CBCT scans, consisting of 28 female (46.7%) and 32 male (53.3 %) patients were evaluated. Patients' ages ranged from 33 to 70 with an average of 55.05 (females: 58.11±7.62; males: 55.53±8.03). Age and gender distribution of patients are summarized in Table 1.

Table 1: Age and Gender Distribution of Patients

	Age Av. ± SD	n
Female	58.11±7.62	28
Male	55.53±8.03	32
Total	55.05±7.8	60

Of the evaluated 60 patients right, left and bilateral SMCs were seen in 38 (63.3 %) patients; no SMCs were observed in 22 (36.7 %) patients. Of the female patients; 7 (25%) had bilateral SMCs, 6 (21.4%) had SMCs on the right side, 5 (17.9%) on the left side and 10 (35.7%) showed no SMCs. Bilateral SMCs were observed in 12 (37.5%) of the male patients; 1 (3.1%) had on the right side, 7 (21.9%) on the left side and 12 (37.5%) showed no SMCs.

No statistical relationship was found between genders, ages and existence of SMCs ($p>0.05$). Table 2 and Table 3 demonstrates distribution of genders, ages and SMCs, and their relationships.

Table 2: Gender and mucosal change distribution

	Male	Female	p
Right maxillary sinus mucosal change			
(-)	8 (38,1)	11 (45,8)	0,824
(+)	13 (61,9)	13 (54,2)	
Left maxillary sinus mucosal change			
(-)	12 (42,9)	13 (52,0)	0,697
(+)	16 (57,1)	12 (48,0)	
Mucosal change existence			
Bilateral	12 (37,5)	7 (25,0)	0,161
Right	1 (3,1)	6 (21,4)	
Left	7 (21,9)	5 (17,9)	
None	12 (37,5)	10 (35,7)	

Average alvolar crest heights were 16.81 mm and 17.39 mm for first premolar (ACH 1), 8.32 mm and 8.33 mm for second premolar (ACH 2), 5.98 mm and 6.28 mm for first molar (ACH 3) and 9.63 mm and 8.89 mm for second molar areas (ACH 4); in the right and left edentulous crests, respectively.

Table 3: Age and mucosal change distribution

Left	Av. ± SD	p
(-)	54,32 ± 6,93	0,479
(+)	56,08 ± 8,95	
Right		
(-)	54,00 ± 6,54	0,219
(+)	56,43 ± 7,55	

Mild positive correlation between alveolar crest height and age was found in right first premolar area ($r:0.309$; $p:0.039$, $p<0.05$). No statistical significance was observed between age and alveolar crest heights of other evaluated areas ($p>0.05$). Average ACH 1 (first premolar alveolar crest height) values were 16.1±7.9 mm and 16,7±7,8 mm in females for right and left areas, respectively, and were 17.6±9.3 mm and 18±9.7 mm in males. Average ACH 2 (second premolar alveolar crest height) values of females were 7.9±5.6 mm on the right side and 8±5.5 mm on the left side. For the male

patients average ACH 2 values were 8.8±6.6 mm and 8.6±4.7 mm on the right and left sides, respectively. ACH 3 (first molar alveolar crest height) values were 6±3.4 mm and 6.2±3.3 mm for the right and left sides of female patients and were 6±3.8 and 6.4±3.5 mm of male patients. ACH 4 (second molar alveolar crest height) values of females were 9.4±4.4 mm and 8.8±3.9 mm for right and left areas and, for males ACH 4 values were 9.9±5.9 mm and 9±5.3 mm. Gender and alveolar crest heights showed no significant relationship (p>0.05). Table 4, 5 and 6 demonstrates alveolar crest heights and relationships between age and gender.

Table 4: Alveolar crest height measurements

	N	Average	SD	Median	Minimum	Maximum
Right ACH 1	45	16,81	8,54	15,50	4,00	40,50
Right ACH 2	45	8,32	6,03	6,75	0,75	28,00
Right ACH 3	45	5,98	3,55	5,00	1,25	15,00
Right ACH 4	45	9,63	5,11	8,00	1,75	24,25
Left ACH 1	53	17,39	8,77	15,75	1,25	40,50
Left ACH 2	53	8,33	5,02	7,25	1,00	24,25
Left ACH 3	53	6,28	3,38	6,00	0,75	15,50
Left ACH 4	53	8,89	4,64	8,50	1,00	26,50

Table 5: Alveolar crest height and age

			Age
Right	**ACH 1**	r	**0,309**
		p	**0,039**
	ACH 2	r	0,207
		p	0,173
	ACH 3	r	-0,049
		p	0,751
	ACH 4	r	-0,004
		p	0,979
Left	**ACH 1**	r	0,195
		p	0,161
	ACH 2	r	-0,170
		p	0,225
	ACH 3	r	-0,222
		p	0,111
	ACH 4	r	-0,056
		p	0,693

r: Pearson Correlation Coefficient

Table 6: Alveolar crest height and gender

		Male	Female	p
Right	**ACH 1**	17,6 ± 9,3	16,1 ± 7,9	0,543
	ACH 2	8,8 ± 6,6	7,9 ± 5,6	0,614
	ACH 3	6 ± 3,8	6 ± 3,4	0,960
	ACH 4	9,9 ± 5,9	9,4 ± 4,4	0,782
Left	**ACH 1**	18 ± 9,7	16,7 ± 7,8	0,574
	ACH 2	8,6 ± 4,7	8 ± 5,5	0,675
	ACH 3	6,4 ± 3,5	6,2 ± 3,3	0,797
	ACH 4	9 ± 5,3	8,8 ± 3,9	0,848

Except for the left first molar area, alveolar crest heights showed no statistically significant relationship with existence of mucosal changes (p>0.05). While average left ACH 3 value was 5.2±3.2 mm of the patients with mucosal changes on the left side; patients without mucosal changes showed 7.5±3.3 mm average values. Significantly lower alveolar crest heights were observed in left first molar area (ACH 3) of the patients with mucosal changes (p:0.014, p<0.05). Table 7 gives detailed information about the relationship between alveolar crest heights and mucosal change existence.

In total, 98 edentulous alveolar crests and maxillary sinuses (45 right and 53 left) were evaluated. Average ACH 3 value was 7.07 mm in patients without mucosal changes and, this value was 5.37 mm in patients who showed mucosal changes. Statistically significant relationship was observed between patients with mucosal changes and patients without mucosal changes. Average ACH 3 was lower in patients with mucosal changes (p:0.01, p<0.05). No statistically significant relationship was found for average ACH 1, ACH 2 and ACH 4 values between patients with and without mucosal changes (p>0.05). Further evaluation was made for defining any possible relationship between alveolar crest heights of premolar and molar areas and existence of mucosal changes. Averages of ACH 1 and ACH 2 values were calculated for the premolar area and averages of ACH3 and ACH 4 values were calculated for the molar area. Average ACH of the molar area was 8.56 mm in patients without sinus mucosal changes and was 6.96 mm in patients with sinus mucosal changes. Significantly lower alveolar crest height measurements in molar area was observed in patients with sinus mucosal changes (p:0.01, p<0.05); however for the premolar area such a relationship was not detected (p>0.05). (Table 8)

Table 7: Alveolar crest height and mucosal change existence

		Mucosal Change		
		(-)	(+)	p
Right	**ACH 1**	16,8 ± 8,6	16,8 ± 8,6	0,979
	ACH 2	8,7 ± 5,6	8,1 ± 6,4	0,750
	ACH 3	6,6 ± 4	5,6 ± 3,2	0,352
	ACH 4	10 ± 5	9,4 ± 5,3	0,713
Left	**ACH 1**	16,8 ± 7,7	17,9 ± 9,7	0,644
	ACH 2	9,1 ± 5,5	7,6 ± 4,5	0,284
	ACH 3	7,5 ± 3,3	5,2 ± 3,2	**0,014***
	ACH 4	10,1 ± 3,5	7,8 ± 5,3	0,066

*p<0.05

Of the 54 sinuses where SMCs were detected (right 26 sinuses, left=28 sinuses), average sinus mucosa

dimensions were 11.86±8.42 mm. and 10.33±5.69 mm. for right and left maxillary sinuses, respectively. No statistically significant relationship between sinus mucosa dimensions and alveolar crest heights were observed on the right and left sides (Table 9).

Table 8: Alveolar Crest Heights and Mucosal Change Existence (Left and right areas together for ACH 1, 2, 3 and 4 and premolar-molar areas seperately)

	n	Mucosal Change (-) n=44	Mucosal Change (+) n=54	p
ACH 1	98	16.78	17.39	0.12
ACH 2	98	8.92	7.83	0.33
ACH 3	98	7.07	5.37	0.01*
ACH 4	98	10.05	8.5	0.33
Premolar (ACH 1-2)	196	12.85	12.61	0.84
Molar (ACH 3-4)	196	8.56	6.96	0.01*

*p<0.05

Table 9: Sinus mucosa dimensions and alveolar crest height

ACH RIGHT		**Sinus Mucosa Dimension Right (Av. ±SD)**		
		11.86±8.42	**R**	**p**
ACH 1	16,8 ± 8,6		0.027	0.895
ACH 2	8,1 ± 6,4		0.312	0.119
ACH 3	5,6 ± 3,2		-0.076	0.712
ACH 4	9,4 ± 5,3		-0.203	0.319
ACH LEFT		**Sinus Mucosa Dimension Left (Av. ±SD)**		
		10.33±5.69		
ACH 1	17,9 ± 9,7		-0.312	0.106
ACH 2	7,6 ± 4,5		0.011	0.955
ACH 3	5,2 ± 3,2		-0.190	0.332
ACH 4	7,8 ± 5,3		-0.172	0.387

DISCUSSION

Atrophy of alveolar crest as a consequence of tooth loss may necessitate sinus augmentation procedures for placement of dental implants and sinus augmentation procedures have risks like perforation of sinus membrane, bleeding, infection, exposure and loss of graft material due to anomalies and pathologies of the maxillary sinus.[4,5,10]

In Kasabah et al's study including 146 sinus lift procedures, 82 sinus membrane perforations were observed. Patients were classified into six groups according to their medical conditions and clinical findings as patients having sinus septa, cyst-like lesions, mucosa thickness, smoking history, allergy history and smoking and sinus septa presence. Although they found no statistical relationship, patients with mucosal thickness had lowest sinus membrane perforation rates. Sinus membrane perforation was observed in all patients with cyst-like lesions.[11]

Another study investigated the role of sinus membrane thickness upon membrane perforation during sinus lift procedure. In the study 122 sinus lift procedures were included and membrane perforations were observed in 17.30% of the procedures. Patients were grouped into 3 categories according to their membrane thickness and shape of the sinus membrane. Sinus membrane perforations were signficantly higher in patients with membrane thickness below 1 mm and above 2 mm. They found no correlation between flat shaped, polypoid shaped and irregular sinus membranes in terms of membrane perforations.[12]

Maiorana et al. performed 14 sinus lift procedures to 10 patients with mucosal cysts by aspiring the liquid content of the cyst. Membrane perforation was observed during three procedures. After six month follow-up, mucosal cysts were not evident in 11 cases and in all cases grafting material was successfully integrated.[13]

In a study conducted with 79 sinus lift and implant candidates, 15 patients' computed tomography scans showed mucosal abnormalities. After transnasal endoscopy four patients showed normal sinus mucosa discordant with computed tomography findings. Cysts, fungal material and hyperplastic mucosa were observed in eleven patients and the lesions were removed with inferior meatotomy and antrostomy. Researchers recommended that, candidates for sinus augmentation procedures should be evaluated with the collaboration of oro-maxillofacial surgeons and ENT specialists for the diagnosis and treatment of sinus diseases to avoid the loss of graft and implant.[14]

Pre-surgical assessment with endoscopic applications and with computed tomography is recommended in patients who will undergo sinus augmentation procedures. In case of sinus diseases and/or anatomical impairments involving the sinonasal area, management of these problems is highly suggested to avoid complications during or after sinus augmentation procedures.[15]

Treatment protocols may alter depending on the presence of mucosal changes of maxillary sinus. Chen et al., according to the results of their research, suggested an algorithm for candidates who will undergo implant and sinus augmentation. They classified patients into six groups depending on their history, clinical findings, and CT findings. According to their suggestions; first group of patients with no specific findings can be treated normally. In patients with solitary cysts or polyps (2nd group) and mucosal thickening (3rd group), the treatment protocol can be normal only if they have no sinusitis related symptoms

or signs and if the dimensions of the lesions are less than half of the maxillary sinus. If they have symptoms or the dimensions of the lesions are greater, patients should be treated for their sinusitis and if the treatment using medications is insufficient, preventive endoscopic sinus surgery should be performed. Sinus augmentation and implant procedures can be performed after 3-6 months follow-up. Fourth group, patients with air-fluid levels, should be treated with medication and if the disease is persistent endoscopic sinus surgery should be performed and after 3-6 months follow-up, augmentation procedures can be applied. Patients with totally opacified sinus (5th group) or with calcification spots in maxillary sinus (6th group) should be treated and if medication is insufficient, endoscopic sinus surgery should be performed. Augmentation can be applied in these groups of patients after 3-6 months follow-up period.[16]

Paolo and Tymour stated that, abnormalities of the maxillary sinus membrane should be detected and treated before any procedures. In cases where the pharmacological treatment using with decongestants, antihistamines, steroids, and antibiotics is insufficient, functional endoscopic sinus surgery must be applied and sinus augmentation procedures must be performed after 6 months follow-up period. Also, they noted that, osteomeatal unit must be evaluated to make sure the drainage pathways of maxillary sinuses are normal. [17]

Definition of these anomalies and pathologies are of importance before sinus augmentation procedures. Although definition and classification of paranasal sinus diseases differ from study to study; mucosal thickening, polyps, retention pseudocysts and air-fluid level are the most widespread radiographic findings and common radiographic view is an increased radioopacity in normal and totally radiolucent sinus.[18-20] In this study, any increased radioopacity in totally radiolucent maxillary sinus is defined as mucosal change existence. Of the evaluated 60 patients 63.3% showed mucosal changes and in terms of 98 maxillary sinuses compared for alveolar crest height mucosal changes were evident in 55.1%. Prevalence of maxillary sinus pathologies were reported between 50% and 72.4 % in previous studies.[18, 20-22] Males and elderly showed higher sinus pathology prevalence in Ritter et al' s CBCT study including 1029 patients. [18] Female and elderly predominancy in terms of maxillary sinus disease was found in another study.[22] Despite a relatively higher age group is introduced in this study, no correlation between maxillary sinus pathologies and age was found; also no statistically significant relationship was found between genders.

Pramstaller et al' s computed tomography study made to define alveolar crest height and width, showed 13.1 mm in first premolar, 9 mm in second premolar, 5.4 mm in first molar and 6.6 mm in second molar area average alveolar crest heights.[10] Another study conducted to define alveolar ridge heights in 21 patients who will undergo sinus augmentation procedure, average edentulous alveolar crest heights were reported 4.25 mm.[24] Yılmaz and Tözüm' s study, made to evaluate the correlation between residual ridge height, sinus membrane thickness, gingival phenotype and sinus membrane perforation, an average of 4.24 mm residual ridge height was described. Also, it is reported that, as the residual ridge height decreases, sinus membrane thickness decreases and 91% of sinus membrane perforations were seen in patients with crest heights lower than 3.5 mm.[7] Acharya et al studied residual ridge height, sinus anomalies and periodontal status in edentulous maxillary first molar area of 628 patients from two different ethnicities using cone beam computed tomography. Average alveolar crest heights were found 7.05 mm and 6.28 mm in two groups, furthermore sinus membrane anomalies were more prevalent in patients with alveolar crest heights below 5 mm.[6]

In this study, alveolar crest heights were 16.78 and 17.39 mm for first premolar, 8.92 and 7.83 mm for second premolar, 7.07 mm and 5.37 mm for first molar and 10.05 mm and 8.5 mm for second molar areas in patients without and with mucosal changes in maxillary sinus, respectively. First molar area showed significanly lower alveolar crest heights in patients with mucosal changes; additionally although insignificant, lower alveolar crest heights were evident in patients with mucosal changes. Statistically significant lower values were observed in molar area (ACH3, ACH4) in patients with mucosal changes. Results of this study is compatible with Acharya et al' s study[6] in which lower crest heights defined in patients with mucosal abnormalities, but inconsistency with Yılmaz and Tözüm's[7] results draws attention. Difference may be originating from the methods used and definition of sinus mucosa. Yılmaz and Tözüm's study used computed tomography for evaluation of sinus mucosa membrane and there is no doubt that computed tomography is superior to cone beam computed tomography in assessment of soft tissues. Also, they have excluded patients with excessive sinus membrane thickness which may be a sign of sinus disease. In this study any radiographically visible change in sinus membrane is counted as mucosal change.

Probably, most important finding in this study is that, mucosal changes are more evident in patients with lower alveolar crest heights in the molar area. Trauma to alveolar crest and response of sinus mucosa may be considered as a reason for this conclusion. However, one of the disadvantages of this study is that, this is a retrospective cone beam computed tomography research in which factors such as medical history, habits etc. that may contribute with changes in maxillary sinus mucosa are unknown and the diagnosis of a sinus disease can not only be given with radiographic findings. Although during patient selection maxillary posterior edentulousness and no radiographic sign of recent tooth

extraction is taken in to account to eliminate the known contribution of dental problems to sinus mucosal changes; it is impossible to ignore multifactorial nature of maxillary sinus diseases.

In conclusion, CBCT and its capability of three-dimensional assessment prior to surgical procedures, allow detection of the changes of maxillary sinus mucosa and besides, anatomical alterations of bony components of maxillary sinus such as septae can be detected. We found a statistically significant relationship between average alveolar crest height of the molar area and sinus mucosal changes. Patients who had mucosal changes in the maxillary sinus showed lower alveolar crest heights in the molar area, compared to patients who showed no mucosal changes. No such relationship was observed in the premolar region. Maxillary sinus mucosal changes were evident in 63.3% of the evaluated 60 patients and average mucosal thickness was 11.86 and 10.33 mm for the right and left maxillary sinuses, respectively. Also, no correlation between alveolar crest height and thickness of the sinus mucosa was seen. Further studies including patient history, clinical evaluation in terms of sinus diseases may be useful to discover the correlation between maxillary sinus mucosa and alveolar crest height.

Conflict of Interest: Authors state that they have no conflict of interest.

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