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Evaluation of Maxillay Sinus Mucosal Thickness in Patients with Periodontal Bone Loss Using CBCT

Parisa Jafari[1], Sina Haghanifar[2], Amir kiakojori[3], Karimollah Hajian-Tilaki4
1.Student research committee , Babol University Of Medical sciences , Babol , Iran
2.Department of Oral and Maxillofacial Radiology,Dental materials research center , Health Research Institute , Babol University Of Medical Science, Babol , Iran
3.Department of Periodontology,Oral health research center , Health Research Institute , Babol University Of Medical Science, Babol , Iran
4.Deppartment of Biostatistics and Epidemiology , Babol University Of Medical Science, Babol , Iran
Corresponding Author:Amir Kiakojori

Abstract: *Background:Dental infections and periodontal diseases can induce inflammatory response in mxillary sinus not only due to the proximity of the maxillary posterior teeth but also due to the common vascular supply of the sinus membrane and the periodontal tissue. This study was aimed to evaluate maxillary sinus mucosal thickening(MT) in patients with periodontal bone loss (PBL) using cone beam computed tomography(CBCT)*

Materials and Methods: In this cross-sectional study, 200 CBCT scans were evaluated to examine the presence of PBL and its relationship with maxillary sinus MT. PBL was classified as mild(<25%) , moderate(25%-50%), severe(>50%)and based on availability of the scans categorized in to 2 groups of(Mild) and (Moderate/ Severe) and 100 scans in each group were examined. Sinus mucosal thickness was classified as < 1 mm,1 -<3 mm, 3-<6 mm, 6-<10 mm, >10 mm and thickness greater than 1 mm was considered pathological.The anatomic relationship between maxillary sinus and the teeth was evaluated as presence or absence of contact between the root apex of the teeth and floor of the maxillary sinus. Statistical analysis was performed using chi-square test for qualitative variables and t-test and Wilcoxon for quantitative variables. Pearson correlation coefficient between maxillary sinus parameters and PBL was calculated. P values less than 0.05 were considered significant.

Results: The percentage of PBL in cases with >1 mm mucosal thickness was 53.9%and in cases with ≤1 mm was 44.7% (p= 0.18 , χ^2 = 1.67) . The thickness of the sinus mucosa in presence of contact between the tooth and maxillary sinus floor showed mean value of 3.41 mm and in the absence of contact between the tooth and maxillary sinus the mean value was 3.25 mm (p=0.82)

Conclusion: The findings of this study indicate that PBL tends to be associated with maxillary sinus MTbut these findings were not statistically significant and therefore more studies are recommended in this regard.Alsothere was no statistically significant association between maxillary sinus mucosal thickening and anatomical relationship between teeth and the sinus floor.

Key word: *Alveolar bone loss, Maxillary sinus, Cone beam computed tomography,periodontitis.*

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I. Introduction

maxillary sinuses are air cavities that are connected to the nasal cavity through an ostium. The inner surface of the sinus is covered by a thin layer of respiratory mucosa called the Schneiderian membrane. The Schneiderian membrane is attached to the periosteum and is about 1 mm thick. However infections or allergic reactions can make the membrane 10-15 times thicker which make it visible in radiography1.Maxillary sinusitis that can be caused by viral ,fungal or bacterial infections is sometimes attributed to periodontal disease2. Periodontal disease is one of the most common infectious diseases known in humans with reported prevalence of 10-60% in adults based on diagnostic criteria3,4. The most destructive form of periodontal disease is periodontitis. Periodontitis is a chronic oral infection that is caused and sustained by a polymicrobial biofilm in the mouth. The resultantimmunoinflammatory response alters mucosa and supportive connective tissue elements and stimulates alveolar bone resorption2.Dental infections and periodontal diseases can induce inflammatory response in maxillary sinus not only due to the proximity of the maxillary posterior teeth but also due to the common vascular supply of the sinus membrane and the periodontal tissue.The sinus floor, on the other hand, is composed of dense cortical bone, so the spread of infection from a dental source were thought to be uncommon, but there are reports that pathogens, particularly when sinus was pneumatized, could cross the Schneiderian

membrane and enter the sinus space5. In addition, the porosity of the maxillary bone can contribute to the direct diffusion of bacteria and their products into the maxillary sinus6 .local odontogenic problems and periodontal diseases are said to be the cause of 58 – 78% of maxillary sinus mucosal thickening7.Radiographic evaluation of the maxillary sinus near the root of the molar teeth is sometimes difficult due to superimposition of adjacent structures8. But CBCT has the unique ability to create clear images of soft and hard tissues, making it the method of choice for examination of the maxillary sinus. CBCT has no limitations of conventional CT and is faster and safer. it has lower radiation dose, shorter scanning time and higher resolution than CT and by creating a three-dimensional image, make diagnosis easier9,10. Few studies have investigated the relation between periodontal disease and maxillary sinus mucosal thickening and the results of such studies are inconclusive11 .so this study was aimed to evaluate maxillary sinus mucosal thickness in patients with periodontal bone loss using CBCT.

II. Materials And Methods

In this retrospective cross-sectional study, 200 CBCT images of patients referred to oral and maxillofacial Radiology department of Babol Dental School and a specialized oral and maxillofacial radiology clinic in Sari city (Iran) were studied.

Study designe: Retrospective cross-sectional studyStudy location: Babol University of Medical Science–IranStudy duration: October 2018 to October 2019Sample size :200 CBCT scans
CBCT unit specifications: CBCT Images were taken using :
1.Cranex 3D (Soredex , Helsinki , Finland) ,Field of view :6×8 cm , Kvp: 89 , mA: 6 , voxel size: 200 µm
2.X MIND (ACTEON , Olgiate olona , Italy) , Field of view : 11 × 8 cm , Kvp :90 , mA : 8 , voxel size : 150 µm On Demand 3D dental software was used in both Units.
Inclusion criteria:1.All CBCT scans of maxillary sinus with at least one or more teeth beneath the sinus. 2.Permanent teeth with compeletly formed apex.4.No presence of supernumerary teeth.
Exclusion criteria :1. Low quality or incomplete images.
2. Prescription of CBCT due to trauma.3.Presence of tumor or cyst in the maxilla.4.Previous dental implant or bone graft in posterior part of the maxilla.
5.Scan with presence of pulp or periapical diseases, Root canal treated teeth,supraerupted teeth.6. Symptoms of acute sinusitis such as air- fluid level and thickening of all sinus wallsand closed osteum.
Evaluation of PBL:
PBL was evaluated in panoramic view of CBCT. The normal position of alveolar crest was considered to be 2 mm apical to the Cemento- enamel junction (CEJ). To measure the amount of PBL, the distance between the point 2 mm apical to CEJ and the highest point of the alveolar bone was measured. this number was then divided by the distance from a point 2 mm apical to the CEJ and the apex of the longest root (Figs. 1 A and B) and according to the percentage obtained, the PBL was classified as follows12 :
1: Mild : when ≥ 1 side of a tooth below the sinus had bone loss < 25%
2: Moderate : when ≥ 1 side of a tooth below the sinus had bone loss= 25%- 50%
3: Severe : when ≥ 1 side of a tooth below the sinus had bone loss > 50%
The arches were classified based onthe highest degree ofPBL. If the arch had 2 or more degrees of PBL, the highest degree of PBL was used for statistical analysis.
Based on availability of the samples,the scans categorized in to 2 groups of(Mild) and (Moderate/ Severe) and 100 scans in each group were examined.

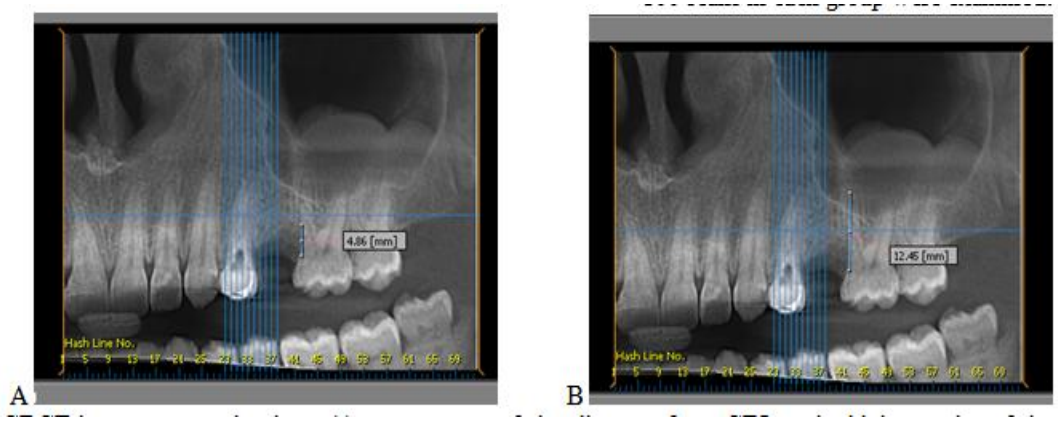

Fig 1: CBCT image,panoramic view, A)measurement of the distance from CEJ to the highest point of the alveolar bone.B)measurement of the distance from CEJ to the apex of the longest root

Evaluation of MT

Absence or presence of MT in the floor of the maxillary sinus was identified from cross-sectional view of CBCT. Thickness greater than 1 mm was considered as MT and measured from floor of the sinus to the highest border of the mucosa13 and were classified as follow6:Class 1:memberane thickness <1mmClass 2:memberane thickness =1- <3mmClass 3:memberane thickness =3- <6mm Class 4:memberane thickness =6- <10mm
Class 5:memberane thickness ≥ 10mm

Anatomic relationship between maxillary sinus floor and teeth was analyzed by using sagittal and coronal reconstruction and classified as follows8:
1) No contact betweenthe root apex and the maxillary sinus
2) At least one of the teeth root was in contact with the sinus floor or protruded in to the maxillary sinus (Fig. 2A and B)

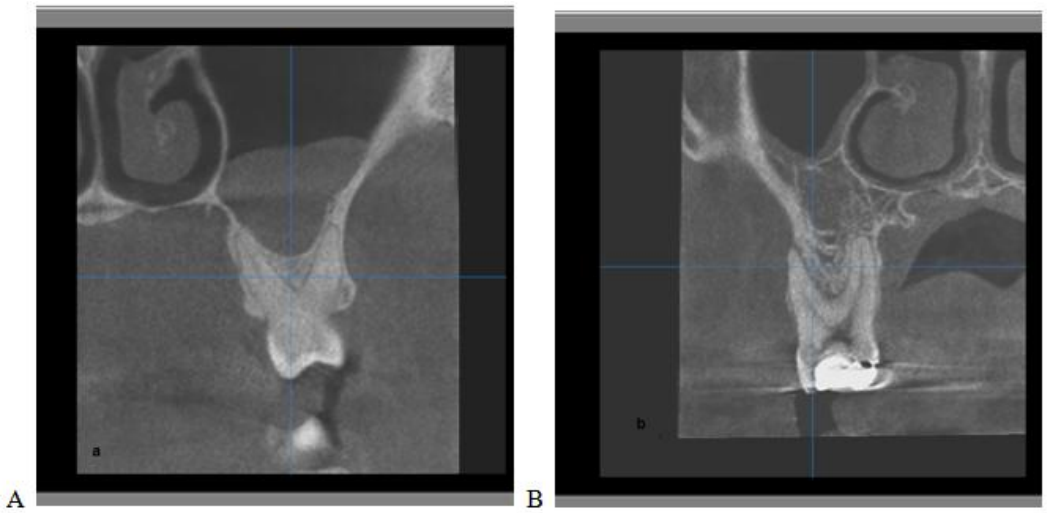

Fig 2:CBCT image, cross sectional view, A)the root is in contact with the sinus floor B) No contact between the roots and sinus floor

Statistical analysis

Data analysis were performed using SPSS software (version 21).Comparison of mean quantitative parameter in (Mild) and (Moderate-Severe) groups of periodontal disease was done by t-test and Wilcoxon test and chi-square test was performed for association of qualitative data. Pearson correlation coefficient between maxillary sinus parameters and PBL was calculated. P values less than 0.05 was considered statistically significant.

III. Results

CBCT scans of 200 maxillary sinus including 100 scan with mild PBL and 100 scan with moderate – severe PBL were examined to evaluate degree of PBL as well as MT. Based on the evaluation performed The minimum, maximum, mean and standard deviation (SD) measuerments were obtained as shown in Table 1. According to the results of this study, the minimum percentage of PBL was 1.21% and the maximum percentage was 91.34% with mean of 24.6%. Also, the thickness of the sinus membrane showed mean of 3.33 mm and the sinus had a minimum thickness of 0.1 mm and a maximum thickness of 30 mm.

Of the 200 CBCT scans evaluated 83 sinuses (41.5%) had normal mucosal thickness, 62 sinuses (31%) had mucosal thickness between 1 -<3 mm, 24 sinuses (12%) had mucosal thickness between 3 - <6 mm, 11 sinuses (5.5%) had mucosal thickness between 6 - <10 mm and 20 sinuses (10%) had mucosal thickness > 10 mm.The degree of mucosal thickness and it's correlation with the percentage of PBL is shown in table 2.

	Minimum	Maximum	Mean ± SD
the distance between the point 2 mm apical to CEJ and the highest point of the alveolar bone	0.21	9.60	2.55 ± 1.64
the distance from a point 2 mm apical to the CEJ and the apex of the longest root	6.14	18.46	10.89 ± 2.29
PBL Percentage	1.21	91.34	24.60 ± 16.11
Mucosal thickness	0.1	30	3.33 ± 4.90

Table No 1: Descriptive statistics indices of PBL and maxillary sinus mucosal thickness

PBL percentage	Mucosal thickness (in millimeter) No (%)				
	<1	1-<3	3-<6	6-<10	>10
	n(%)	n(%)	n(%)	n(%)	n(%)
< 25	47(47)	30(30)	14(14)	0(0)	9(9)
≥ 25%	36(36)	32(32)	10(14)	11(11)	11(11)

Table No 2: Correlation between the degree of mucosal thickness and PBL percentage

Pearson's correlation indicates the relationship between mucosal thickness and percentage of PBL.The pearson correlation coefficient between PBL and sinus mucosal thickness wsa 0.107 which is not statistically significant(P = 0.133)

Figure 3 also shows the correlation results using regression. As seen in the graph , R^2 = 0.011 which indicates that approximately 1% of the mucosal thickness changes are justified by PBL.

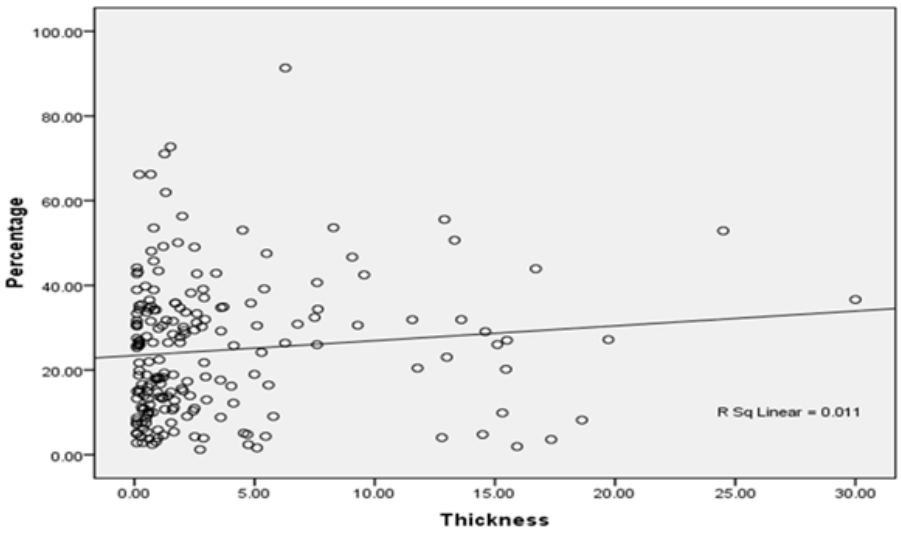

Fig 3: Scatter plot and linear correlation between mucosal thickness and PBL

Table 3 shows that The percentage of PBL in cases with more than 1 mm mucosal thickness was 53.9% and in cases with less than 1 mm was 44.7%, in other words, about 10% of cases with more than 1 mm Mucosal thickness had higher percentage of PBL but chi-square test did not show any significant differences (p= 0.18 , x^2 = 1.67) .

PBL percentage	Maxillary sinus mucosal thickness			
	<1 mm		>1mm	
	No	%	No	%
<25%	47	55.3	53	46.1
≥25%	38	44.7	62	53.9

Table No 3: Frequency distribution ofPBL percentage based on mucosal thickness

Table 4 shows the results of T-test. using the T-test, the mucosal thickness was evaluated based on anatomical relationship between maxillary sinus floor and the teeth. In 103 cases, the contact between the teeth and maxillary sinus floor was present whereas in 97 cases, there was no contact between the teeth and maxillary sinus floor. mucosal thickness in case of presence and absence of contact showed mean value of 3.41 and 3.21 respectively which wasn't statistically significant (p=0.82).

variables	Anatomic relationship of teeth and maxillary sinus floor	No	Mean ± SD	P value
Mucosal thickness	No contact	97	3.25 ± 4.35	0.82
PBL Percentage	Presence of contact	103	3.41 ± 5.39	

Table No 4: association between mucosal thickness and anatomic relationship of teeth and sinus floor

IV. Discussion

The aim of this study was to clarify the possible association betweenmaxillary sinus MT and PBL using CBCT. Since the normal thickness of the maxillary sinus mucosa is 1 mm14, the mucosal thickness greater than 1 mm was considered as MT, which is consistent with the study of Phothikhun et al. and Goller-Bulut et al13,15.In the present study, MT was observed in 58.5% of evaluated sinuses. The prevalence of MT can be varied based on the definition of normal mucosal thickness. Vallo et al considered presence of 3-6 mm thick radiopaque bandalong the sinus wall as MT and reported that MT was found in 12% of the cases16.Janner et al and Aksoy et al defined presence of >2 mm mucosal thickness as MT17,18.Janner reported prevalence of 37%.phothikhun et al defined MT when it was >1 mm and found MT in 42% of the cases13. The results of this study showed that there was a positive relationship between PBL and maxillary sinus MT, although it was not statistically significant (P> 0.05)This result was consistent with the result of Ardakani et al and Dagassan et al and in contrast with the results of Aksoy et al , Phothikhun et al and Vallo et al13,16,18-20.Aksoy et al. Considered thicknesses greater than 2 mm as MT and reported that there was a significant relationship between PBL and MT18. the differencbetween results of the present study and Aksoy results can be due todifferences in definition of MT. On the other hand, despite the use of similar methods of evaluation , the results of this study was in contrast with the results of Phothikhun et al13. It is not possible to make a definitive comment on this issue, However considering similarity of the results of present study and study of Ardakani et al in Yazd city (Iran)20, this difference can be attributed to continental and genetic factors.Different radiographic techniques used in different investigations can also be considered as one of the reasons for the differences in the results of these studies. Many previous studies have used conventional radiographic techniques in which differentiation of MT due to infectious diseases, maxillary sinus neoplasms and cysts can be difficult6. Vallo et al. Used panoramic radiography in their investigations and found that MT was associated with vertical and horizontal bone loss16. Therefore, it may be possible to attribute the differences of these results to the use of different radiographic techniques. A notable advantage of present study was the use of CBCT in assessing maxillary sinus and PBL. Using CBCT without superimposition seen in conventional radiographs, as well as the ability to produce high resolution images, allow more accurate examination of MT as well as PBL6 . The anatomic proximity of maxillary teeth and floor of the maxillary sinus can result in spread of odontogenic infections in to the sinus. In this study, The mean of MT in presence of contact between the tooth and maxillary sinus floor was 3.41± 5.3 mm and in the absence of contact between the tooth and maxillary sinus was 3.25± 4.3 mm which suggest thatthere is no significant relationship between anatomic proximity of the teeth and MT (p=0.82). This finding is inconsistent with the findings of khorramdel et al. and Janner et al17,21. who reported significant relationship between maxillary sinus mucosal thickening and location of maxillary posterior teeth.Since this study was a retrospective study and archived CBCT images

were used,there was lack of clinical examination of patients for active or inactive periodontal disease and alsoevaluation of factors affecting sinus mucosal thickening such as cold, smoking, history of sinusitis, antibiotic therapy etc. were not possible, therefor further prospective studies are suggested in this regard.

V. Conclusion:

Findings of this study indicate that PBL tends to be associated with maxillary sinus MT but these findings were not statistically significant and therefore more studies are recommended in this regard. Also there was no statistically significant association between maxillary sinus MT and anatomical relationship between teeth and sinus floor.

Acknowledgments

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