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Original Article

The Effect of Periodontal bone loss on Maxillary Sinus Membrane in Egyptian population using CBCT: A Retrospective Study

Ola Mohammed Rehan[1], Nora Aly Al Abbady[1]

[1]Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University.

Email: nora.alabady@dentistry.cu.edu.eg

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Abstract

Background: Different local factors may affect the maxillary sinus membrane thickening (MSMT). The aim of this study is to assess the effect of periodontal bone loss (PBL) of maxillary molars on the MSMT, using a 3-dimension (3D) cone beam computed tomography (CBCT) imaging.
Methods: This is a retrospective observational CBCT study of 126 patients with PBL of maxillary molar that were selected and evaluated for presence of MSMT on a reconstructed sagittal cut. On a cut of the highest point of the MSMT the length of the thickening was recorded and correlated with severity of PBL and age using Spearman correlation coefficient.
Results: Statistically significant difference was found between the group with MSMT and the group without thickening with $p<0.001$. There was a positive poor relationship between the presence of mucosal thickening and PBL of 0.019. A negative poor relationship of -0.111 was found between MSMT and age, with no statistically significant difference between different age group of 20-40 y and 41-60 y, where $p=0.212$.
Conclusion: The presence of PBL may have an impact on the state of maxillary sinus membrane.
Keywords: CBCT; mucosal thickening; Schneiderian membrane; maxillary sinus.

Introduction

Maxillary sinuses are air-filled cavities within maxillary bone that communicate with the nasal cavity by ostium (**Sheikhi, et al. 2014**). The sinus is lined with a thin respiratory mucous membrane known as the Schneiderian membrane. It is attached to the periosteum and has a thickness of approximately 1 mm. On a radiograph, the normal sinus mucosa cannot be visualized, Nevertheless, when the mucosa is irritated or inflamed, it may become visible as thickened mucosa (**Lu, el al. 2012; Goller-Bulut, et al. 2015**). The cause of maxillary sinus membrane thickening (MSMT) could be odontogenic with the incidence of sinusitis secondary to odontogenic causes to be reported in approximately 10%–12% of cases (**Zadsirjan, et al. 2021**).

Periodontitis, is an inflammatory disease in which plaque microorganisms are the initiating factor that cause destruction of the supporting tissues of the periodontium. It is one of the

odontogenic causes that might also affects MSMT (**Zhang, et al. 2021**).

The sinus mucosa may be impacted by periodontal bone loss (PBL) in maxillary posterior teeth because of the close proximity between them and the sinus floor. This may occur in two different ways, either directly through direct infection dissemination through the supporting tissues and porous maxillary bone, or through the several anastomoses between the blood and lymph vessels in the apical portion of the tooth and the corresponding vessels in the sinus mucous mucosal lining allowing for the transmission of germs and their byproducts as well as cytokines (**Lathiya, et al. 2019**).

Mucosal thickening may be presented as a sinus polyp, that is mostly caused due to inflammatory response and it is characterized by areas of dense folded crypts in the sinus mucosa **(Sabeh, et al. 2016; Huang, et al. 2021)**.

Although conventional computed tomography (CT) is considered the gold standard for sinus imagining, cone-beam computed tomography (CBCT) has been used extensively for imaging of dental and maxillofacial regions. CBCT imaging offers lower radiation dose, shorter scanning time, higher image resolution, and lower cost compared to medical CT (**Phothikhun, et al. 2012**). Also, CBCT is reliable for the evaluation of structures in the maxillary sinus, besides periodontal alveolar bone changes (**Zhang, et al. 2020**). The condition of the maxillary sinus mucosa is crucial for elevating the maxillary sinus floor, as thickened mucosa may cause bleeding and mucosal perforation during operation (**Schwarz, et al. 2015; Zhang, et al. 2021**).

According to the systematic review by (**Eggmann, et al. 2016)** the relation between PBL and the MSMT in CBCT is controversial and inconclusive. Thus, this study aimed to assess the effect of PBL of maxillary molars on MSMT in Egyptian population using 3D CBCT.

Materials and methods

This retrospective observational study has been approved from ethics committee, faculty of Dentistry, Cairo university. Sample size was calculated depending on a previous retrospective study by **Sghaireen, 2020** with study power 0.8.

CBCT scans of 176 maxillary sinuses were obtained from CBCT archives at Oral Radiology department, faculty of Dentistry Cairo university. The patients were visiting Cairo university hospital mainly for dental implant purpose. Patients were divided into 2 age groups; from 20-40y and from 41-60y. 126 cases (maxillary sinus) (90 females and 36 males) were eligible for the study based on the following criteria:

Inclusion criteria: patients above 18 years, the presence of fully erupted maxillary molar/molars and the presence of periodontal bone loss greater than 2 mm from cemento-enamel junction (CEJ) to the alveolar crest.

Exclusion criteria:

Scans that showed partial or complete sinus opacification, tumors, any alteration in the maxillary sinus due to systemic abnormalities such as hematologic or endocrine diseases, and sinuses that showed any signs of trauma or surgery radiographically. Additionally, scans with edentulous maxillary molar area, maxillary implant, periapical lesions, drafted, as well as badly decayed molars were excluded from the research.

CBCT image analysis:

Planmeca Promax imaging system (Planmeca Oy, Helsinki, Finland) was used in the study with exposure parameters of 90 kVp, 8 mA for 12-13.5 sec and 0.2-0.4 mm isotropic voxels, the FOV varied between 8 x 5 cm, 20 x 6.2 cm

and 20 x 10.2 cm for quadrant, single arch, and both arches respectively.

The DICOM images were then exported to computer running windows 10, and then viewed using Plameca romaxies viewer software version 6.1.0.997. Reconstructed axial, sagittal and coronal images were observed and reoriented such that the mid sagittal plane is perpendicular to the floor. The maxillary sinus membrane in all cases with PBL was examined for the presence or the absence membrane thickening. The software processing tools were used to adjust the contrast and brightness for better visualization of sinus membrane and periodontal status during the measurements. For standardization all the periodontal assessment as well as the measurements of membrane thickening were conducted on a sagittal reconstructed image.

Periodontal assessment:

For bone loss assessment the distance from CEJ to the alveolar crest was first measured in mm, cases with bone loss greater than 2 mm was considered as PBL **(Zhang, et al. 2021)**. Then, PBL of the most affected/diseased molar on each side of the patient was assessed and categorized into three categories:

Mild bone loss: periodontal bone loss approximately less than 20 % of the distance between alveolar crest to the tip of the root.

Moderate bone loss: periodontal bone loss approximately more than 20% but less than 50% of the distance between alveolar crest to the tip of the root.

Sever bone loss: periodontal bone loss approximately more than 50% of the distance between alveolar crest to the tip of the root.

Maxillary sinus membrane assessment:

MSMT was measured and recorded from the floor of the sinus to the highest point of thickened mucosa (fig.1) and categorized to groups; the first group with no thickening or thickening less than 1 mm and the second group with thickening more than 1mm, or presence of polyp.

All the cases were examined and evaluated by 2 expert radiologists 10 years' experience. For inter-observer reliability, 40 randomly selected cases were reevaluated.

Statistical analysis

Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, age data showed parametric (normal) distribution while frequencies data showed non-parametric (not normal) distribution. Chi square test was used to analyze frequencies for qualitative data. The mean and standard deviation values were calculated for each group in each test. For inter-observers' agreement group ICC coefficients test was used.

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

Results

CBCT of 126 maxillary sinuses were included in this study. Out of which 70 (55.6%) were from 20-40 years age range and 56 (44.4%) were from 41-60 years with no statistically significant difference between different age group where (p=0.212). From age range (20-40y); 22 maxillary sinuses (31%) showed no thickening while 48 (69 %) showed thickening. While, in older age group from (41-60y); 20 maxillary sinuses (36%) showed no thickening while 36 (64 %) showed thickening.

Significant difference was found on comparing all cases regarding the severity of periodontal problem with p-value of (p<0.001), 30 molars (23.68%) showed mild periodontal disease, 72 (57.1%) showed moderate periodontal disease and 24 (19%) showed severe

periodontal disease.

Regarding the MSMT, 42 (33.3%) showed no thickening of maxillary sinus membrane and 84 (66.7 %) showed thickening of maxillary sinus, which revealed a statistically significant difference with ($p<0.001$). 14 (11.1%) of thickened cases showed thickening in the form of polyps (table 1) (fig. 2).

On correlating the membrane thickness with the PBL and age, there was a positive poor relationship of 0.019 between MSMT and PBL (fig. 3). And a negative poor relationship of -0.111 between MSMT and age (fig. 3) (table 2).

Reliability:

No statistically significance difference was found between the two examiners regarding periodontal status and membrane thickening where ($p=0.49$) and ($p=0.35$) respectively, with inter class correlation coefficient (ICC) of (0.963) and (0.971) respectively, which reveals a strong inter-observer reliability and agreement between the two examiners.

Discussion:

Maxillary sinus anatomy and development may have a significant preoperative evaluation and therapeutic implications in dental fields. It starts growth from birth till it reaches its maximum size by the age of 18 years. For so, patients below 18 years were not included in this research (**Muszyńska, et al. 2019**).

There is a contradiction in the literature about the healthy MSMT as different authors have considered different measurements for the diagnosis of mucosal thickening. In the current study, normal MSMT was set at 1mm, while thickening more than 1mm was considered as abnormal mucosal thickening. This is compatible with (**Phothikhun, et al. 2012; Sheikhi, et al. 2014; Nascimento, et al. 2016; Shahidi, et al. 2016 and Lathiya, et al. 2018)**. On the contrary, other studies considered abnormal mucosal thickening when it exceeded 2mm (**Oksoy, et al 2019; Zhang, et al. 2020 and Yusufoglu, et al. 2021).**

Significance difference were found on comparing all cases regarding the severity of periodontal problem with $p<0.001$. From total 23.68% showed mild PBL, 57.1% showed moderate PBL and 19% showed severe PBL, with moderate PBL being the most common. This is consistent with what has been found in previous study by **(Phothikhun, et al. 2012)** who concluded that the prevalence of PBL is 28.6%, 51.2% and 20.2% in patients with mild, moderate and severe PBL respectively.

Other study by **(Zhang, et al. 2020)** had shown different percentage of 2.6%, 14.9%, and 75.5% for patients with mild, moderate, and severe PBL, respectively. Whereas, **(Ren, et al. 2015)** found that the prevalence was 14.5%, 29.5% and 87.9% in patients with mild, moderate and severe alveolar PBL, respectively.

Furthermore, 33.3% of the cases showed no thickening of maxillary sinus membrane, while 66.7 % showed thickening, with statistically significant difference and p value of $p<0.001$. This is consistent with (**Aksoy, et al. 2018**) who examined the effect of PBL on the maxillary sinus membrane using CBCT and found that mucosal thickening in 58.5%. Meanwhile, (**Phothikhun, et al. 2012; Sheikhi, et al. 2014 and Huang, et al. 2021**) results showed a lower percentage of membrane thickening (39.4%), (36.6%) and (42%) respectively.

On correlating PBL and MSMT, our results showed a positive poor relationship which agreed with **(Sheikhi, et al. 2014; Ren, et al. 2015; Lathiya, et al. 2019; Huang, et al. 2021; and Aksoy, et al. 2018)** results**,** where they concluded that; there is a direct correlation between PBL and MSMT, where severe PBL is the most commonly associated type with increased MSMT.

Figure (1): Maxillary sinus membrane thickening measurement on a reconstructed sagittal CBCT image.

Table (1): Distribution of PBL and MSMT according to number and frequency of cases.

Variables		Demographic data		
		n	**%**	**p-value**
Periodontal disease	**Mild**	30	23.8%	**<0.001***
	Moderate	72	57.1%	
	Severe	24	19%	
Sinus membrane thickness	**Absent**	42	33.3%	**<0.001***
	Present	84	66.7%	

*; significant (p<0.05) ns; non-significant (p>0.05)

Table (2): Correlation between MSMT with PBL and age.

Variables	**Spearman correlation**	
Sinus membrane thickness and Periodontal disease	Correlation coefficient	0.019
	Sig. (2-tailed)	0.832
Variables	**Spearman correlation**	
Sinus membrane thickness and Age	Correlation coefficient	-0.111
	Sig. (2-tailed)	0.217

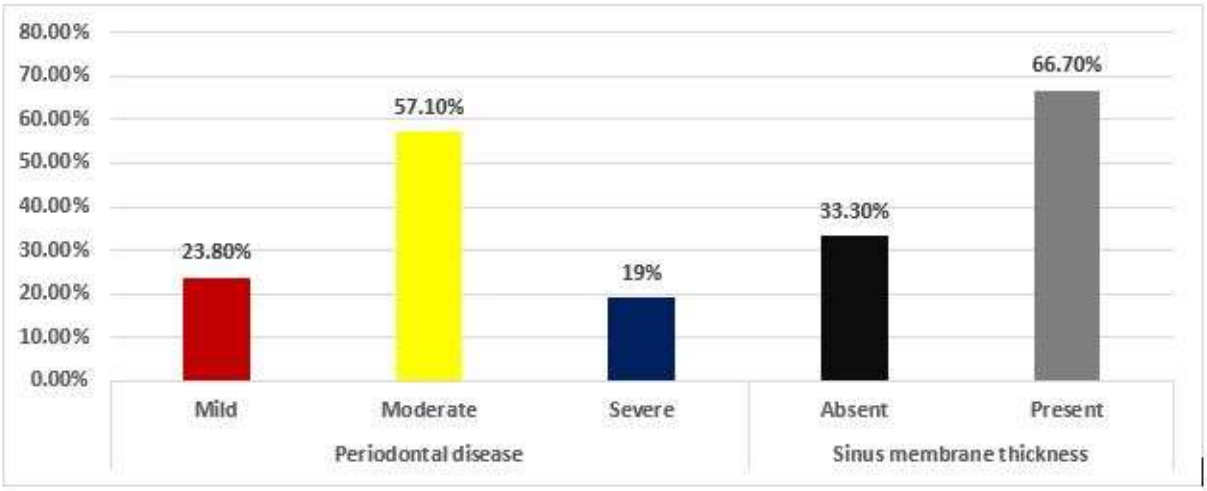

Figure (2): Bar chart representing the severity of PBL and MSMT.

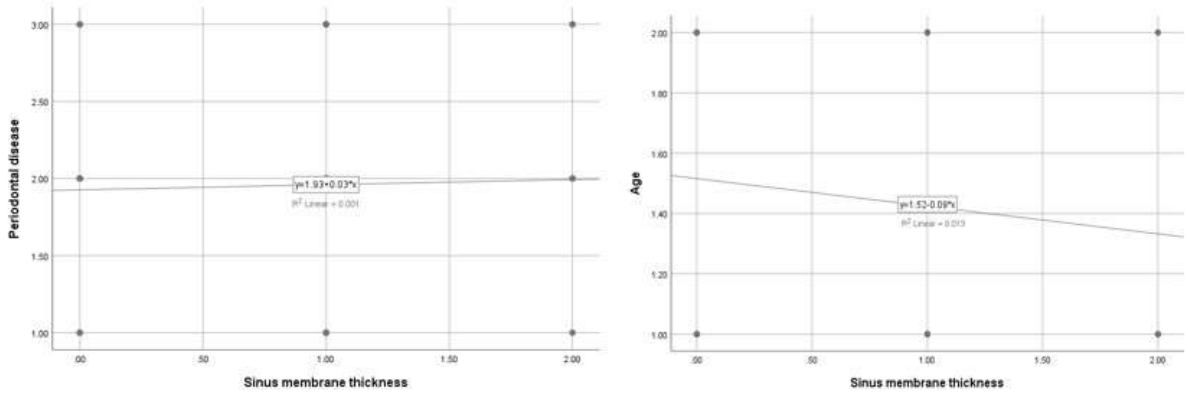

Figure (3): Scatter plot representing correlation between MSMT with PBL and age.

Meanwhile, (**Yusufoglu, et al. 2021)** reported no correlation between severe periodontal disease and MSMT although a substantial positive correlation between mild periodontal disease and MSMT was observed in his study. Conversely, (**Phothikhun, et al. 2012**) results showed that severe PBL was significantly associated with MSMT although moderate PBL was not.

Furthermore, on relating periodontal problems of premolars and molars to membrane thickening (**Ramanauskaite, et al. 2019**) study revealed that although flat thickening was the most prevalent membrane thickening with positive correlation to periodontal problems, but it was not correlated to the amount of periodontal bone loss.

The results also demonstrated that on correlating age and MSMT, there was a negative poor relationship between them of -0.111 correlation coefficient. Given that (69%) of age range 20-40 and (64 %) of age range 41-60 showed thickening. (**Rege, et al. 2012)** study agreed with these results. Meanwhile, (**Phothikhun et al. 2012; Ren, et al. 2015; Lathiya, et al. 2019; Huang, et al. 2021; Zhang, et al. 2020**) resulted revealed positive correlation with different age group.

This variations between the various studies could be as a result of different diagnostic criteria for assessing the pathological radiographic mucosal thickening in the literature, different patient selection criteria, or ethnic differences between studied populations.

Conclusion

PBL may have an effect on the maxillary sinus membrane, as PBL revealed a positive poor relationship on correlating it with MSMT, while age revealed a negative poor relationship with MSMT.

Limitations

Limitations of the current study should be taken into consideration; the lack of the clinical data concerning periodontal conditions of patients, as well as patient history were not evaluated, this might lead to the underestimation of the possible association between periodontal disease and sinus membrane thickening. Also, classifying patients into two age groups may be not adequate to find a reliable relationship between age and mucosal thickening.

Conflict of interest

The authors declared no conflict of interest.

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