

INVESTIGATING THE CORRELATION BETWEEN ROOT PROJECTION OF A MAXILLARY MOLAR WITH PERIODONTITIS AND ANTRAL CYSTS: A RETROSPECTIVE CROSS-SECTIONAL CBCT STUDY

Lobna M. ElSaadawy^{1*} BDS, Maha R. Taalab² PhD, Shaimaa M. Abu El Sadat³ PhD, Yousria S. Gaweesh⁴ PhD

ABSTRACT

BACKGROUND: Periodontal disease is an inflammatory disease that induces regional inflammation, alveolar bone loss, tooth movability, and exfoliation. Considering that the maxillary molars are in close relation to the maxillary sinus floor, infection in the maxillary molars can diffuse into the maxillary sinuses.

STUDY OBJECTIVE: This research aimed to study the correlation between root projection of upper molars in periodontitis patients and the presence of mucosal cysts within the antrum as a possible parameter influencing their appearance within the sinus using CBCT imaging.

MATERIALS AND METHODS: CBCT scans were checked for the presence of root projection into the antrum and the presence of antral cysts.

RESULTS: A non-significant statistical relation between root projection into the antrum and the appearance of antral cysts (F_{Ep}=0.667) was detected.

CONCLUSION: These results indicate that the appearance of mucosal cysts within the maxillary sinus is not affected by the presence of the root projection of molar teeth suffering from periodontitis into the sinus.

KEYWORDS: Mucosal cysts of the maxillary sinus, CBCT, Periodontitis, Root projection.

1 Assistant lecturer of Oral Medicine, Oral Periodontology, Oral Diagnosis, and Oral Radiology, Faculty of Dentistry, Alexandria University.

2 Associate Professor of Oral Medicine, Oral Periodontology, Oral Diagnosis, and Oral Radiology, Faculty of Dentistry, Alexandria University.

3 Lecturer of Oral and Maxillofacial Radiology, Faculty of Dentistry- Ain Shams University

4 Professor of Oral Medicine, Oral Periodontology, Oral Diagnosis, and Oral Radiology, Faculty of Dentistry, Alexandria University.

**Corresponding author:*

Lobna.ragab.dent@alexu.edu.eg

INTRODUCTION

Periodontitis is a chronic multifactorial inflammatory disease associated with plaque biofilms, in which the tooth-supporting apparatus is progressively being destroyed (1). Periodontal infection may easily affect the maxillary molars due to their sophisticated root shapes characterized by trifurcation and curved roots (2). The maxillary molars are in close relation to the floor of the maxillary sinus (3), with the 2nd molar roots being in the nearest position to the antrum, then the 1st molar roots, and 3rd molar in order (4). Considering this close relation with the antrum, infection in the maxillary molars can diffuse into the antrum; especially in case of root projection into the sinus with no bony barrier in-between the root tip and the Schneiderian membrane (5).

Under normal conditions, a thin layer of compact bone that represents the floor of the antrum acts as a barrier in-between the tooth and the antral mucosa. In some conditions, the sinus bony floor is absent; therefore, the antral mucosa becomes frankly in contact with the periodontium, allowing easy transfer of pathogens into the sinus mucosa inducing sinus disease (6).

Among the variable maxillary sinus, diseases are antral intrinsic cysts. One of the antral intrinsic cysts is the mucous retention cyst, it is a true cyst lined fully by epithelium; that is formed due to blockage of a duct of a sero-mucinous gland of the sinus. Mostly these cysts are not obvious in a clinical or radiographical examination, because of their small size. Though, these cysts when large enough appear as radiopaque dome-shaped masses and are similar to pseudocysts (7).

Another entity of antral intrinsic cysts is pseudocysts, they are false cysts; which are formed as a result of the piling of inflammatory exudates that up-lift the sinus mucosa away from the bone, resulting in a homogenous dome-shaped radiopacity seen radiographically (7). Although pathologically different, mucous retention cysts and pseudocysts are indistinguishable clinically or radiographically. Therefore, many researchers use these terms synonymously. Combined, they are usually quoted as antral cysts or maxillary mucosal cysts (MMC) (8).

As a result of the limited reliability of 2 Dimensional (2D) radiography, maxillofacial imaging studies are usually accomplished by cone-beam computed tomography (CBCT) (9). When compared with 2D radiography, 3 Dimensional (3D) radiography affords exceptional diagnostic efficiency in defining antral cysts, periodontal bone defects, as well as root projection into the sinus without a bony barrier (8, 10).

This research aimed to use 3D imaging using CBCT to study the presence of a correlation between root projection of upper molars in periodontitis patients and antral cysts as a possible parameter influencing antral cysts formation. The null hypothesis of this research was the absence of correlation between root projection of an upper molar with periodontitis and the appearance of antral cysts.

MATERIALS AND METHODS

This research was conducted at the Faculty of Dentistry, Alexandria University after acquiring the permission of the Alexandria University, Faculty of Dentistry, the Research Ethics Board, (IRB NO: 00010556-IORG0008839) with date 8/11/2020.

The estimation of sample size was based on Zhang et al. (11) having: an alpha error= 5% and a study power= of 80%. Based on the comparison of proportions, the minimum sample size was calculated to be 82 (12, 13).

This research was performed on a sample of 83 CBCT scans collected from patients' scans imaged for other radiographic purposes as such (pre-operative implant assessment, impacted teeth, etc-----) which meet the inclusion and exclusion criteria. The patient age range was from 21 to 65 years with a mean of (41 ± 5.5). The retrospective CBCT scans were collected from the Oral Radiology Unit, Faculty of Dentistry, Alexandria University.

CBCT scans were collected from the imaging system i-CAT Next Generation (Imaging Sciences International, Hatfield, Pa) CBCT unit present in the Faculty of Dentistry, Alexandria University. All scans were acquired with a standardized protocol of the i-CAT with the fixed exposure parameters of 120 Kvp and 5 mA settings as well as a voxel size of 0.25 mm. Files from CBCT scans were transferred in Digital Imaging and

Communications in Medicine (DICOM) format into the OnDemand3D™ operating system (Cybermed Inc) for image analysis and case evaluation.

The following inclusion criteria were applied for image selection: (1) Presence of evidence of alveolar bone loss related to one or more of the maxillary molars under investigation. The presence of alveolar bone loss related to the maxillary posterior molars was detected when the distance between cemento-enamel junction and crest of alveolar bone for any surface (buccal, lingual, mesial, and distal) was more than 2 mm (biological width). (2) scans with no patient movement or artifacts that obscure the area of interest. (3) There is ≥ 1 maxillary posterior molar in the quadrant being under investigation. (4) Only CBCT scans displaying the whole maxillary sinus in their field of view (FOV) were evaluated.

The following exclusion criteria were adopted: (1) Sinuses having the appearance of acute sinusitis, such as opacification of the sinus entirely or having an air-fluid level. (2) Sinuses with evidence of odontogenic cysts, benign or malignant tumor masses. (3) Sinuses with evidence of surgeries or trauma fractures.

The used sample included scans that did not show any evidence of dental diseases other than alveolar bone loss. Only one maxillary molar per sinus in a CBCT image was assessed; the one with the most severe periodontal condition concerning alveolar bone loss.

The following parameters were assessed for every scan:

Presence of root projection for the upper molar with maximum periodontal bone loss around any of the 1st or the 2nd maxillary molars,

Mucosal cysts present within the maxillary sinus related to its floor.

On the coronal view, the axial plane was adjusted to be passing through the cemento-enamel junction (CEJ) of the 1st upper molar. Though, on axial view, the other two reference planes were adjusted to be crossing the pulp chamber at the midpoint of the same tooth (Figure 1).

The lost periodontal alveolar bone was measured for both 1st as well as 2nd maxillary molars; to determine the molar with the maximum periodontal alveolar bone loss.

Roots of the molar tooth suffering maximum alveolar bone loss were examined on both sagittal and coronal views to determine the presence of a root projection within the antrum. On the condition of using the coronal view, the reference line was assigned, on the sagittal view to cut across the selected root long axis, and vice versa (Figure 2).

Root projection within the antrum was verified by the presence of some root portion projecting above the antral floor, in the absence of intermediate cortical bone (14).

The reference lines were reassigned vertically again on both sagittal and coronal cuts, and the presence of maxillary mucosal cysts was investigated by surveying the whole sinus floor (Figure 3). The criterion

for radiographic detection was a radiopaque dome-shaped or hemispherical mostly sessile radiopaque masses on the floor of the antrum with the sharp demarcation of lateral borders and a well-defined, smooth, and non-corticated spherical outline (4-6).

Statistical analysis

IBM SPSS operating system version 20.0 was used to analyze the obtained information. Numbers were used to describe qualitative data. The Distribution normality was verified using the Kolmogorov-Smirnov test. The gained outcomes were considered significant at the 5% level. Fisher Exact test was used to analyze contingency tables that display the frequency distribution of the variables.

Figure 1: It shows the standardization of image cuts. on the axial view, the reference planes were adjusted to be crossing the pulp chamber of the upper 1st molar.

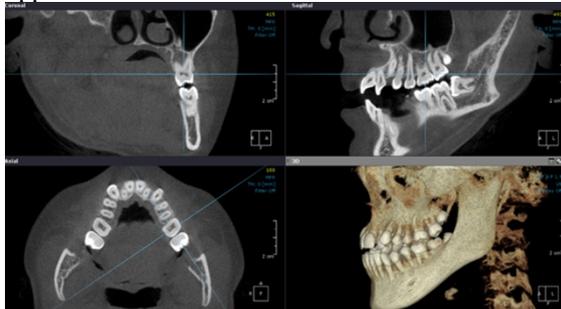


Figure 2: Coronal view showing palatal root projection of the upper right 1st molar into the antrum (blue arrow), green arrow points at the antral floor.

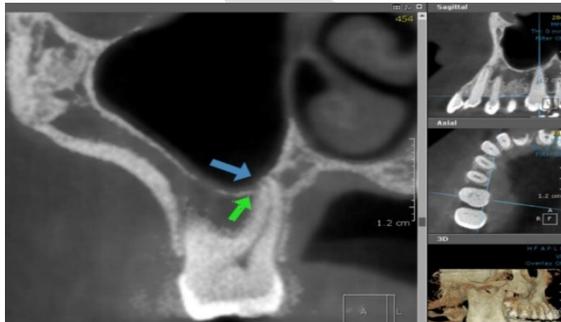
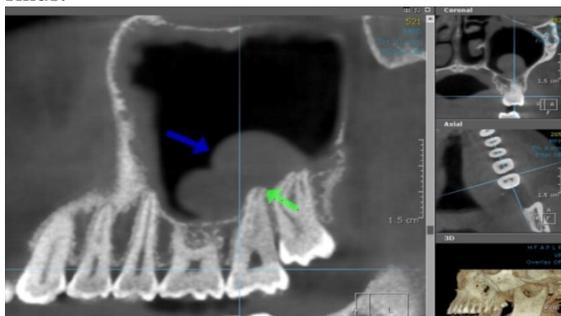


Figure 3: Sagittal view showing the presence of root projection (green arrow) with the presence of antral cyst (blue arrow) within the left maxillary sinus.



RESULTS

This research included eighty-three retrospective CBCT scans. All CBCT scans in 2019 – 2020 were reviewed and only scans that passed the inclusion and exclusion criteria were used.

Radiographic Results

Only 28.9% of the studied molar teeth showed root projection within the antrum (Table 1). Mucosal cysts appeared within the maxillary sinus of only 7.2% of the studied scans (Table 2).

Correlation results

This research demonstrated a non-significant statistical relation between the presence of mucosal cysts and root projection into the antrum using Fisher Exact test (^{FE}p=0.667) (Table 3).

Intra-examiner reliability results

All scans were evaluated by an oral radiologist (MSD) (7 years of CBCT experience). The 2nd radiologist (Ph.D.) reviewed all scans for the presence of antral cysts. Intra-examiner reliability was checked by re-evaluating 14.45% of the scans after 40 days, and the kappa test was computed to be 0.824 for root projection presence

Table 1: Assortment of the included scans in accordance with root projection presence (n = 83).

Root protrusion	No.	%
No	59	71.1
Yes	24	28.9

Table (2): Assortment of the included scans in accordance with mucosal Cyst presence (n = 83).

Mucosal Cyst	No.	%
No	77	92.8
Yes	6	7.2

Table (3): Relation between mucosal Cysts and root protrusion presence.

	Mucosal Cyst		Test of sig.	p
	No	Yes		
Root protrusion (%)				
No	(n = 77)	(n = 6)		
Yes			$\chi^2=0.472$	^{FE} p=0.667

χ^2 : Chi Square test , FE: Fisher Exact test
p: p value for comparing between no and yes

DISCUSSION

In this study, 83 CBCT scans were used in this research with evidence of alveolar bone loss in the 1st and/or 2nd maxillary molars, to assess the relationship between the appearance of antral cysts and root projection into the sinus. CBCT images were used in this research. Some researchers concluded that CBCT scans were more reliable in comparison to panoramic radiographs for assessing the root-maxillary sinus relationship (15, 16). Additionally, Kalkur et al. (17) concluded that it is difficult to use a 2D panoramic radiograph to analyze precisely a 3-D maxillary sinus; therefore, it is difficult to assess root projection into the sinus using 2-D radiography.

Pagin et al., (18) stated that 14.3% of the studied upper posterior teeth showed root projection within the antrum. A second study reported a higher rate (38%) of root projection within the antrum (16). Consequently, the incidence of root projection within the antrum in this study is in accordance with the literature. Necessary precautions should be taken by oral surgeons during dental treatments to escape breaching the Schneiderian membrane and the influx of extrinsic objects (6). Additionally, antral cysts prevalence according to a review article (7), which included 33 articles, varied between 3.6% to 35.6%. Their results were in accordance with our results.

Results of this research showed a non-significant statistical relation between root projection of maxillary molars with periodontitis and the appearance of antral cysts. Similarly, one study used CBCT and stated that the presence or absence of a root projection into the antrum did not affect the appearance of MMCs (19). Additionally, Phothikhun et al. (8) didn't find any significant statistical correlation between mucosal cysts and any dental observations including periodontal bone loss. Kanagalingam et al. (20) also stated that antral cysts presence doesn't imply a dental disease presence and is not necessarily an indication for sinus surgery.

On the contrary, the results of Roque-Torres et al. (6) presented that the probability was about double for roots projecting within the antrum to be related to a pathological antrum than a normal antrum. But their paper didn't differentiate between different pathologies of the sinus, considering all pathologies as one group including maxillary mucosal thickening and antral cysts.

Limitations to our study were that: the absence of a questionnaire regarding the patients' sinus condition, and a larger sample size would be more conclusive.

CONCLUSIONS

These results indicate that the appearance of mucosal cysts within the maxillary sinus is not affected by the presence of a root projection of the molar teeth suffering from periodontitis into the sinus.

CONFLICT OF INTEREST

We affirm having no economic or personal benefit conflicts.

FUNDING STATEMENT

No definite funding was gained by any of the authors for this research.

REFERENCES

- Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol.* 2018;89:S173-82.
- Al-Shammari KF, Kazor CE, Wang HL. Molar root anatomy and management of furcation defects. *J Clin Periodontol.* 2001;28:730-40.
- Ameri A, Eslambolchi A, Bakhshandeh H. Anatomic variants of paranasal sinuses and chronic sinusitis. *Iran J Radiol.* 2005;2:121-4.
- Mehra P, Murad H. Maxillary sinus disease of odontogenic origin. *Otolaryngol Clin North Am.* 2004;37:347-64.
- Jang J, Kwak S, Ha J, Kim H. Anatomical relationship of maxillary posterior teeth with the sinus floor and buccal cortex. *J Oral Rehabil.* 2017;44:617-25.
- Roque-Torres GD, Ramirez-Sotelo LR, Vaz SL, Bóscolo SM, Bóscolo FN. Association between maxillary sinus pathologies and healthy teeth. *Braz J Otorhinolaryngol.* 2016;82:33-8.
- Giotakis EI, Weber RK. Cysts of the maxillary sinus: a literature review. *Int Forum Allergy Rhinol.* 2013;3:766-71.
- Phothikhun S, Suphanantachat S, Chuenchompoonut V, Nisapakulorn K. Cone-beam computed tomographic evidence of the association between periodontal bone loss and mucosal thickening of the maxillary sinus. *J Periodontol.* 2012;83:557-64.
- Choi JY, Oh SH, Kim SH, Ahn HW, Kang YG, Choi YS, et al. Effectiveness of 2D radiographs in detecting CBCT-based incidental findings in orthodontic patients. *Sci Rep.* 2021;11:1-10.
- Woelber JP, Fleiner J, Rau J, Ratka-Krüger P, Hannig C. Accuracy and Usefulness of CBCT in Periodontology: A Systematic Review of the Literature. *Int J Periodontics Restorative Dent.* 2018;38:289-97.
- Zhang B, Wei Y, Cao J, Xu T, Zhen M, Yang G, et al. Association between the dimensions of the maxillary sinus membrane and molar periodontal status: A retrospective CBCT study. *J Periodontol.* 2020;91:1429-35.
- Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods.* 2007;39:175-91.

13. Petrie A, Sabin C. Medical statistics at a glance. 3rd ed. Oxford: Wiley-Blackwell; 2009.
14. Themkumkwun S, Kitisubkanchana J, Waikakul A, Boonsiriseth K. Maxillary molar root protrusion into the maxillary sinus: a comparison of cone-beam computed tomography and panoramic findings. *Int J Oral Maxillofac Surg.* 2019;48:1570-6.
15. Sharan A, Madjar D. Correlation between maxillary sinus floor topography and related root position of posterior teeth using panoramic and cross-sectional computed tomography imaging. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006;102:375-81.
16. Lopes LJ, Gamba TO, Bertinato JV, Freitas DQ. Comparison of panoramic radiography and CBCT to identify maxillary posterior roots invading the maxillary sinus. *Dentomaxillofac Radiol.* 2016;45:20160043.
17. Kalkur C, Sattur AP, Guttal KS, Naikmasur VG, Burde K. Correlation between maxillary sinus floor topography and relative root position of posterior teeth using Orthopantomograph and Digital Volumetric Tomography. *Asian J Med Sci.* 2017;8:26-31.
18. Pagin O, Centurion BS, Rubira-Bullen IR, Alvares Capelozza AL. Maxillary sinus and posterior teeth: accessing close relationship by cone-beam computed tomographic scanning in a Brazilian population. *J Endod.* 2013;39:748-51.
19. Nascimento EH, Pontual ML, Pontual AA, Freitas DQ, Perez DE, Ramos-Perez FM. Association between Odontogenic Conditions and Maxillary Sinus Disease: A Study Using Cone-beam Computed Tomography. *J Endod.* 2016;42:1509-15.
20. Kanagalingam J, Bhatia K, Georgalas C, Fokkens W, Miszkil K, Lund VJ. A maxillary mucosal cyst is not a manifestation of rhinosinusitis: results of a prospective three-dimensional CT study of ophthalmic patients. *Laryngoscope.* 2009;119:8-12.