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ASSESSMENT OF ANATOMICAL RELATIONSHIP BETWEEN UPPER POSTERIOR MOLARS AND MAXILLARY SINUS FLOOR USING CONE-BEAM COMPUTED TOMOGRAPHY

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ABSTRACT

Abstract: A thorough knowledge of the anatomical relation between upper molars teeth and maxillary sinus is critical for dentists to prevent complications while performing dental procedures. Such prior knowledge should be acquired via a precise radiological examination of the relationship between the roots of upper molars and the floor of maxillary sinus. Three- dimensional imaging modalities as Cone-beam computed tomography may provide a solution to better visualize the complex representation of the anatomical relation between maxillary sinus floor and upper molars.

Materials and methods: 110 CBCT scans belonging to 105 patients (42 males and 63 females) involving 248, including 69 upper first molars, 101 upper second molars and 78 upper third molars were collected from patients' data base. The vertical relationship between the floor of maxillary sinus and roots of the examined teeth was evaluated on CBCT cross sectional images using "Jung classification" 2009.

Results: As for the horizontal relationship, Type 1; 1B and 1BP were observed with the highest percentage of 33.12% for each with first maxillary molars, while 1BP was observed with the highest percentage with second and third maxillary molars (54.45%) and (61.44%) respectively. Regarding type 3, 3P was observed on all maxillary molars with the highest percentage.

Conclusion: upper 2nd molars are the least close to the floor of maxillary sinus compared to the other molars, whereas 3rd molars (particularly palatal roots) are the most frequently communicated with the sinus floor. MSF is highly detectable interposed among the roots of upper 3rd molars followed by 2nd molars.

KEYWORDS: CBCT, Maxillary Sinus Floor, Upper Molars.

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INTRODUCTION

The maxillary sinus is the biggest pyramidal-shaped air sinus that located bilaterally and above the upper posterior teeth [1]. Maxillary sinuses develop during fetal life and continue after birth. [2]. Adult sinuses vary in size, shape, and extension not only among individuals, but also between sides of the same individual [3]. Root placement and anatomical relation between the molars' roots and floor of maxillary sinus determine the prognosis of orthodontic tooth movement [4]. A root protrusion in the maxillary sinus can result in root resorption or tipping during orthodontic treatment [5,6].

The relationship between the floor of maxillary sinus and roots of upper posterior teeth has clinical importance when diagnosing and treating posterior teeth [7]. It is possible to develop sinusitis following periapical or periodontal infections of the maxillary molars and premolars and perforations of the maxillary sinus floor as a result of iatrogenic trauma to the maxillary sinus[8]. According to the dental literature, dental diseases play a significant role in causing sinusitis in maxillary sinus[9,10]. A study by Maillet et al. (2011) who examined 82 CBCT scans demonstrating signs of maxillary sinusitis on behalf of evidence of dental pathology and found that nearly half of examined cases had a dental etiology [11]. Furthermore, tooth extraction or endodontic surgery can cause perforation, oroantral fistula formation, or root displacement into the MS in cases where the root is protruding into it. For accurate diagnosis of maxillofacial lesions and preoperative treatment planning, it is crucial to determine the anatomic relationship between the MS and posterior teeth in the clinical practice [12].

The radiographic examination play an important role for demonstrating the anatomical relation between the roots of upper molars and the floor of maxillary sinus. Conventional imaging modalities as periapical and panoramic radiography may result in inaccurate investigation of true relationship because these modalities are two-dimensional projections [13]. CBCT has consider a common maxillofacial radiographic modality. it provides a cross-sectional image that is beneficial for clinical diagnosis and developing successful treatment plans. Compared to multislice CT, CBCT involves less radiation, offers higher spatial resolution, and requires shorter scan time. CBCT can distinctly analyze the relation between the molars' roots and the floor of maxillary sinus by offering high-quality three-dimensional images of the maxillary posterior areas [14].

The aim of this study is evaluating the vertical and horizontal anatomical relation between the floor of maxillary sinus and the roots of maxillary molars by CBCT modality.

MATERIAL AND METHODS

A study protocol was approved by the College of Dentistry Research Centre, Princess Nourah Bint Abdulrahman University, Saudi Arabia (institutional review board number: 23-0334), which established ethical guidelines for the study.

Sample selection

This was a retrospective study including 110 CBCT scans belonging to 105 patients (42 males and 63 females) with a mean age of 38.96 (range: 16-70) including 248 molars (69 upper first molars, 101 upper second molars, and 78 upper third molars) were collected from Patients' data base of referred patients to oral and maxillofacial radiology clinics, at Princess Nourah Bint Abdulrahman University for assessing the upper posterior maxillary areas . Teeth that appeared with incomplete root formation and evidence of intra-osseous pathologies were excluded from the present study. Inclusion criteria were patients with no history of surgery involving the sinuses or orthodontic treatments, including tooth movements, that alter the morphological conditions of the maxillary posterior region

Image acquisition and assessment:

CBCT scans were acquired with a Planmeca 3D (Planmeca Co., Helsinki, Finland). The CBCT data will be reconstructed using Planmeca Romexis 6.0 software for assessing the images. The acquired data set was stored as digital imaging and communications in medicine (DICOM) files with codes corresponding to tooth, and the relevant roots.

For evaluating the relation between floor of maxillary sinus and the roots of upper posterior teeth; each root of the molars was individually assessed its anatomical relation with sinus floor following Jung classification in 2009 [15] **(fig 1).**

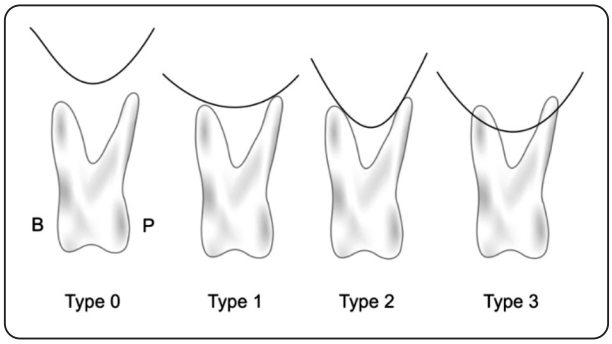

Fig. (1) The vertical relationship between the floor of maxillary sinus and the roots of upper molars on CBCT (B: buccal; P, palatal).

Type"0": The maxillary sinus floor is located above the root tip.

Type "1": The root apex touches the sinus floor.

Type "2": The maxillary sinus floor is interposed between the roots.

Type "3": Apical protrusion is observed over the maxillary sinus floor.

In type "1 and 3"; the horizontal relation between the roots of maxillary molars and floor of sinus was also assessed (Figs 2 and 3).

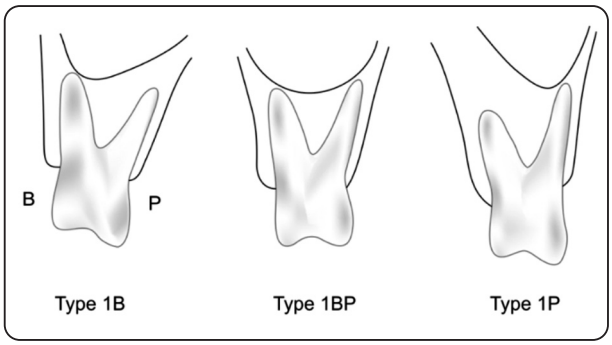

Fig. (2) Three classifications of root apex touching the floor of sinus (B: buccal; P: palatal). Type 1B: The buccal roots touch the sinus floor; Type IBP: the buccal and palatal roots touch the sinus floor; Type IP: The palatal root touches the sinus floor.

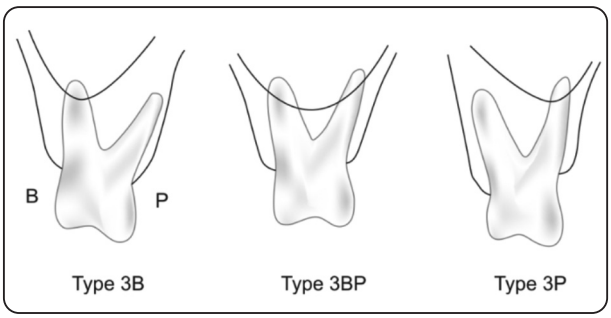

Fig. (3) Three classifications of roots protrusion (B: buccal; P: palatal). Type 3B: The buccal roots project into the sinus cavity; Type 3BP: The buccal and palatal roots project into the sinus cavity; Type 3P: The palatal root projects into the sinus cavity.

All CBCT images were interpreted in a room with dim light by two trained independent oral radiologists with more than 10 years of experience. Then, the images were analyzed to reach a consensus to ensure inter-observer reliability. All images were analyzed using Romexis 6.0 software. All images were interpreted on a 24-inch screen LCD Dell monitor and 1920 × 1080 high-definition screen resolution.

Statistical analysis

Categorical data were presented as frequencies and percentages. A chi-square test and Fisher's exact test were used to evaluate associations between

categorical variables. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, version 23.0 (Armonk, NY, IBM Corp.).

RESULTS

In total, 248 teeth, including 69 upper first molars, 101 upper second molars and 78 upper third molars that were collected from 110 scans belonging to 105 patients: 42 males (40%) and 63 females (60%). The mean (SD) values for age were 38.96 (12.53) years range from 16 to 70 years. Out of the contained number, 28 teeth were excluded due to apical periodontitis, and poor image quality.

The vertical relation of the examined molars teeth and the scores of mentioned classifications was statistically significant ($P < 0.001$). Accordingly, As regards to **1st molar**; MB and DB roots showed the highest occurrence of scores (1, and 2) with (46.08%), (38.88%), (30.24%), and (27.36%) respectively. while, MB, DB roots showed the lowest occurrence of score (3) with (1.44%), and (0%) respectively. Whereas palatal root had the highest prevalence of score (0, and 3) with (47.52%), and (7.20%) respectively. (Figure 4).

Regarding **2nd molar**; MB and DB roots showed the highest occurrence of scores (1, and 2) with (29.70%), (23.76%), (46.53%), and (39.60%) respectively. While palatal root had the highest occurrence of score (3) with (7.92%) (Figure 5).

as regards to **3rd molar**; MB, DB roots showed the highest occurrence of score (1, and 2) with (39. 68%) , (34.56%), (48.64%), (44.80%) respectively. Whereas palatal root had the highest occurrence of score (0, and 3) with (21.76%), and (14.08%) respectively (Figure 6).

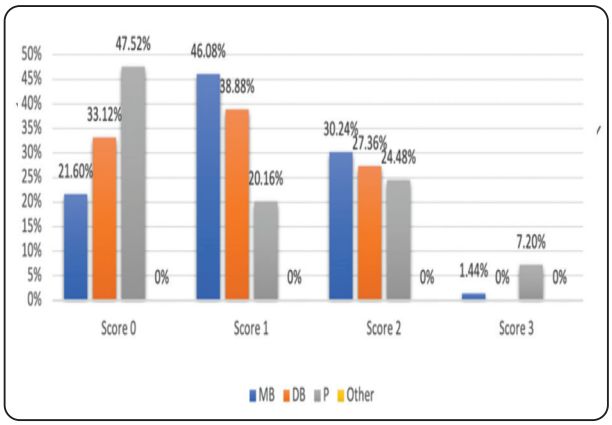

Fig. (4) The vertical relation of floor of maxillary sinus and upper first molar roots

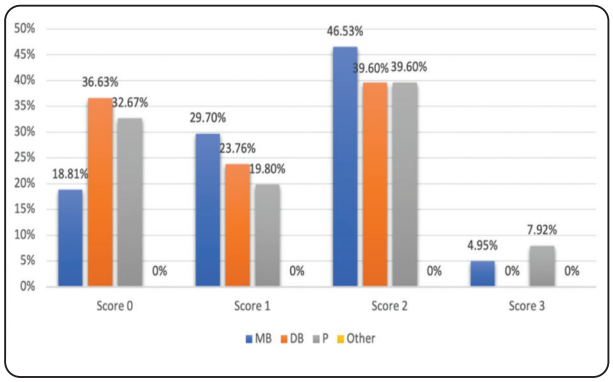

Fig. (5) The vertical relation of floor of maxillary sinus and upper second molar roots

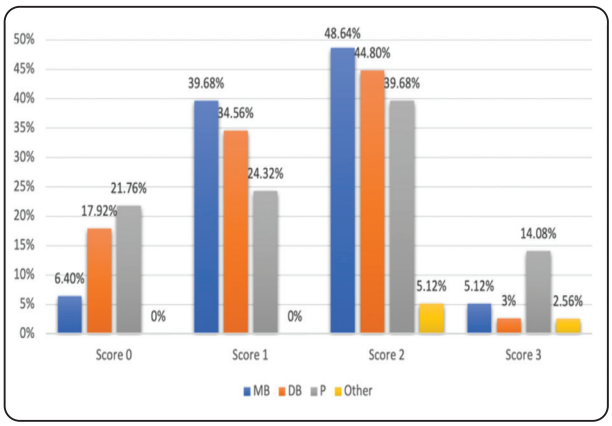

Fig. (6) The vertical relation of floor of maxillary sinus and upper third molar root.

TABLE (1) The horizontal relation between the roots of the upper molars and the sinus floor.

	1 Type						Total		3 Type						Total	
	Buccal		Buccal- palatal		Palatal				Buccal		Buccal-palatal		Palatal			
	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
First Molar	33.12	23	33.12	23	1.44	1	68	47	1.44	1	0	0	7.20	5	8.7	6
Second Molar	16.83	17	54.45	54	1.98	2	72	73	2.97	3	2	2	5.94	6	11	11
Third Molar	12.80	10	61.44	48	2.56	2	77	60	3.84	3	4	3	11.52	9	19	15
Total	50		125		5		180		7		5		20		32	

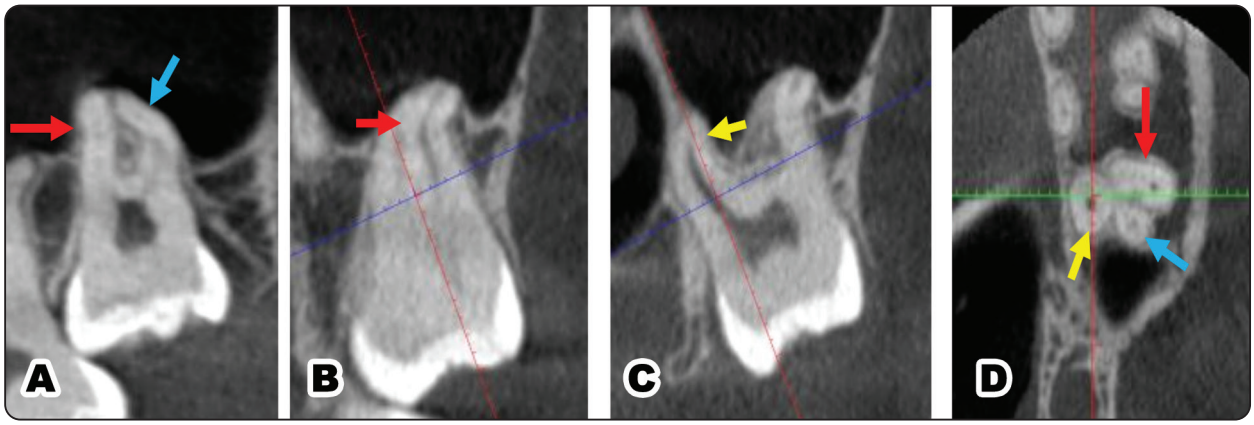

Fig (7) Axial, Sagittal and Cross-sectional CBCT views show tooth **# 28**, Roots number inclinations as follows: **Image (A, B)** reveal MB roots (Red arrows) as its apical third is dilacerated buccally, and image A also shows the **DB root** (Blue arrow) as its apical third is dilacerated in mesial direction. **Image (C)** shows the floor of maxillary sinus interposed between bucco-palatal roots [Type 2], and **axial view (D)** reveals the roots' numbers and alignments at the level just apical to furcation area.

DISCUSSION

The relation between upper molars and maxillary sinus floor needs to be carefully evaluated to prevent dental problems during and after dental treatments. A possible risk accompanying with penetration of root tips of upper teeth into the maxillary sinus underlines the importance of this issue. For an instance, files in type 3 relationships pose a high risk of apical tissues rupture. a case reported of orbit abscess following endodontic treatment of upper first molar, because of a rapid aggravation of periapical inflammation[16]. Additionally, this relationship has an impact on surgical treatment and periodontal surgery among a case reported in 2006 by **Huang and Brunsvold;** in which bone defects and periodontal pockets resulted in maxillary sinusitis [17].

The use of CBCT as an imaging modality was due to its tomographic description and natural high contrast when assessing the relation between upper teeth and maxillary sinuses. **Freisfeld et al** compared panoramic radiography with CT images in a study of 30 patients, showing that there was a significant difference between the measurements; among 129 roots seen in panoramic radiography, 64 penetrated the maxillary sinus, while only 37 did in transverse CT images [18]. Accordingly, CBCT was used in the current study because panoramic images are limited by limitations like anatomical structures,

superimposition, magnification horizontally and vertically, and inability to provide cross-sectional images.

The present study used a classification proposed by "Jung et al" in 2009. Jung classification is composed of 4 scores represented by numbers 0, 1, 2& 3. As the greater the score number meaning the nearer the roots to floor of sinus. Concerning the vertical relation of roots of upper molars and MSF in the present study, the maxillary second molar was the least near to sinus floor compared to other upper molars with the highest prevalence of buccal roots of all molars being touching with floor of maxillary sinus. The present findings were in disagree with the results conducted by **Asthana et al 2015 & Ok et al. 2014** whom found that MB and DB roots of upper first molars had the highest incidence of being distant from the MSF in both studies that were conducted on over than 2500 molars [19, 20].

In the current study, the examined teeth having type 1 and 3 were separately assessed regarding the horizontal relationship of their involved roots with MSF. In type 1, buccal and bucco-palatal roots were frequently touching the sinus floor than palatal root with statistically significant difference. While, type 3, the most occurrence was associated to the protrusion of palatal root into the floor of maxillary sinus, with not a significant difference with the buccal-palatal and buccal roots. The present findings were in disharmony with the results reported by "Jung et al" in 2012 who used CBCT to assess the relationship between the roots of 332 molar teeth and sinus floor, they concluded that buccal roots were the most penetrated into sinus floor [8]. Moreover, **Anter et al in 2019** concluded that the buccal roots of upper second molar were the highest frequency of penetrating MSF (score3) [21]. While our findings were in agree with the result conducted by **Punwutikorn et al., 1994** whom found that the palatal root of the upper first molar is most frequently involved in cases of Oro-antral communication [22].

The present findings demonstrated that CBCT can distinctly identify the condition of posterior maxillary teeth in relation to MSF. Therefore, it is advised that a CBCT be ordered before any treatment relating to upper posterior teeth or pre-implant planning of posterior maxillary edentulous ridge. Our study was limited to the evaluation of upper posterior molars with usual root configuration. Future studies should be carried out utilizing the present methodology to evaluate the relation of all upper posterior teeth with the floor of maxillary sinus.

CONCLUSIONS

The maxillary 2nd molars are the least near to the floor of maxillary sinus compared to the other molars' roots, while 3rd molars (particularly palatal roots) are the most frequently communicated with the sinus floor. Moreover, the MSF cross-sectionally interposed is highly detectable with maxillary 3rd molars followed by 2nd molars. Thus, it is advised that a CBCT be ordered before surgical procedures that may involve the posterior teeth particularly, the third molar.

Conflicts of Interest

The authors announce that there is no conflict of interest regarding the publication of this paper.

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