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Assessment of the anatomical relationship between maxillary sinus floor and root apices of maxillary posterior teeth using Cone Beam CT: A Systematic Review

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Abstract
Objectives: To determine the anatomical relationship between maxillary sinus floor and root apices of maxillary posterior teeth using CBCT.
Methods: An extensive systematic literature search was performed using online databases such as Pubmed, Google Scholar, etc. Studies that provided information on the anatomical relationship between maxillary sinus floor and root apices of maxillary posterior teeth using CBCT were selected.
Results: After searching the above mentioned data sources 194 articles were obtained. 194 articles were screened on the basis of title relevant to the topic of systematic review to get 41 articles. Further screening was done and 20 duplicates were obtained. After removing duplicates 21 articles were obtained. Abstracts of all 21 article were screened to get 20 articles. Out of 20 articles, 10 articles were paid articles. Thus 10 were obtained as free full text. And thus 10 studies were finally used for this systematic review.
Conclusion: The maxillary molar root apices compared to the premolars showed a closer relationship with the MSF, as seen on CBCT.

Keywords: anatomical relationship, maxillary sinus floor, maxillary teeth, cone beam computed

Introduction
Maxillary sinuses are pneumatic cavities within maxillary bone that communicate with the nasal cavity by ostium. The sinus is lined with a thin respiratory mucous membrane referred as the Schneiderian membrane [3].
Anatomically, the maxillary sinus is universally classified into a sclerotic, pneumatic and mixed types. Dental clinicians are particularly interested in patients with a highly pneumatized maxillary sinus. Most often the root apices of the molars of such patients are close to the maxillary sinus and a fairly large percentage of those teeth penetrate the sinus to varying degrees [4].
The biological constitution of different populations has a variety of genetic characters, which can determine distinct anatomical and topographical relationships. The anatomical knowledge of the structures that compose the middle and lower thirds of the face, especially the MS and its relation with posterior teeth, is of utmost importance not only for the accurate diagnosis of inflammatory alterations that may be established in both the MS and periapical region, but also for the correct establishment of therapeutic, surgical and rehabilitation plans [2].
It is essential for clinicians to be aware of the exact relationship between the apical roots of the maxillary teeth and the maxillary sinus floor. Cone beam computed tomography (CBCT) has raised the interest in revisiting the anatomical features of the jaws. It provides an accurate evaluation of maxillary bone quality and quantity around posterior root apices without the distortion and superimposition caused by teeth and the surrounding structures [3].
Compared to 2-dimensional techniques, CBCT has the advantage of eliminating the superimposition of adjacent structures and not involving image magnification. CBCT has the further advantages of a short scanning time, low radiation dose, and increasing availability in dental and radiological practices, and has been shown to be more effective than conventional radiography for assessment of the anatomical relationship between maxillary sinus floor and

root apices of maxillary posterior teeth [1].

Focussed Question
What is the proximity of maxillary posterior teeth root apices to the maxillary sinus floor, as seen on CBCT?

Objective
To search the literature for articles regarding assessment of the anatomical relationship between maxillary sinus floor and root apices of maxillary posterior teeth using CBCT.

Methods
Inclusion criteria
1. All articles in English or which can be translated to English.
2. Articles published between 2010 -2018.
3. Articles that include patients with normally erupted right and left maxillary premolars and/or maxillary molars.

Exclusion criteria
1. Articles that include tooth extraction or surgery involving sinus, orthodontic treatments including tooth movements, or any other treatment intervention that affects morphologic situation of maxillary posterior region.
2. Literature reviews.

PICO
P-Patients with normally erupted maxillary posterior teeth.
I- CBCT
O- Relationship between maxillary sinus floor and root apices of maxillary posterior teeth.

Information Sources
Internet source of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed), Google Scholar and manual search using DPU college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study. The databases were searched up to and including September 2018 using the search strategy.

Search Strategy: A detailed description of the electronic search strategy in the selected databases is presented in Table 1. The search terms that were selected are as follows:
1. Maxillary molars AND maxillary sinus AND CBCT
2. Maxillary sinus floor AND maxillary first molar AND cone beam computed tomography
3. Posterior teeth AND maxillary sinus AND cone beam computed tomography
4. Relation AND sinus AND roots AND cone beam computed tomography
5. Distance And roots AND sinus AND cone beam computed tomography

Data collection process: A standard pilot form in excel sheet was initially used and then all those headings not applicable for review were removed. Data extraction was done for one article and this form was reviewed by an expert and finalized. This was followed by data extraction for all the articles.

Data items
The data items included were
1. Author – The name of the author
2. Year of publication – The year in which the study was published
3. Sample size – No. of participants included in the study
4. Setting – Place where the study was conducted
5. Age Group- Age range of the participants
6. Intervention- Cone Beam Computed Tomography
7. Outcome variable –Analysis of which parameter is made
8. Outcome value – Result of the study
9. Conclusion- Inference obtained.
10. Remark

Results
Study Selection: After searching the above mentioned data sources, 194 articles were obtained. 194 articles were screened on the basis of title relevant to the topic of systematic review to get 41 articles. Further screening was done and 20 duplicates were obtained. After removing duplicates 21 articles were obtained. Abstracts of all 21 article were screened to get 20 articles. Out of 20 articles, 10 articles were paid articles. Thus 10 were obtained as free full text. And thus 10 studies were finally used for this systematic review.
A flow chart of the process of identification, screening, eligibility and inclusion of studies is shown in Figure 1.

Study Characteristics: A summary of the key methodological data and study results is found in Table 2.
The more posterior the maxillary teeth, the more probability for root protruding into the maxillary sinus. In most of the studies the maxillary sinus distances were shortest in the area of the buccal roots of the maxillary second molars and longest in the area of maxillary first premolars. Palatal roots of first premolars were always located closer to the maxillary sinus than buccal roots (irrespective of the CBCT plane). Roots of second premolars were, on average, positioned much closer to the maxillary sinus than roots of first premolars. In both the first and second maxillary molars, the buccal root apices were found to be closer to the maxillary sinus floor than the palatal root apices.
Kilic C *et al.* [6] assessed the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using dental cone-beam CT. A total of 87 right and 89 left maxillary sinus regions from 92 patients were examined using dental cone-beam CT. Perpendicular lines were drawn on the cross-sectional images between the deepest point of the maxillary sinus floor and the root tips of the maxillary first and second premolars and first, second and third molars, and the distances were measured using built-in measurement tools. Results showed that the distance between sinus floor and root tip was longest for the first premolar root tip and shortest for the second molar buccodistal root tip for both right and left sides. No statistically significant differences were found between the right and left side measurements or between female and male patients.
Jung YH *et al.* [7] investigated the relationship between the roots of the maxillary molars and the maxillary sinus using cone beam computed tomography (CBCT), and measured the distances between the roots of the maxillary molars and the sinus floor as well as the thickness of the bone between the root and the alveolar cortical plate. The study sample consisted of 83 patients with normally erupted bilateral maxillary first and second molars. A total of 332 maxillary molars were examined using CBCT images. The vertical relationship of each root with the maxillary sinus was classified into four types on CBCT cross-sectional images. The distance between the sinus floor and root and the bone

thickness between the root and alveolar cortical plate were measured. Results showed that in the buccal roots of the maxillary molars, a root protruding into the sinus occurred most frequently. A root projecting laterally along the sinus cavity was most common in the palatal roots of the maxillary first molars. The mesiobuccal roots of the maxillary second molar were closest to the sinus. The mesiobuccal roots of the first molars were closest to the cortical plate.

Arx TV *et al.* [9] evaluated the proximity of the roots of the maxillary premolars to the maxillary sinus. Cone-beam computed tomographic images of 192 patients were reconstructed in sagittal, coronal, and axial planes to quantify the distances between the root apices of the maxillary premolars and the adjacent maxillary sinus. Measurements were taken for each root, and data were correlated with age, sex, side, and presence ofboth or absence of 1 of the 2 premolars. Results showed that the frequency of a premolar root protrusion into the maxillary sinus was very low in first premolars (0%–7.2%) but higher in second premolars (2.5%–13.6%). Sex, age, side, and presence/absence of premolars failed to significantly influence the mean distances between premolar roots and the maxillary sinus.

Shokri A *et al*· [5] assessed the vertical and horizontal relationship between the maxillary sinus floor and maxillary posterior teeth roots using cone beam computed tomography. 110 CBCT scans were selected. For evaluating the relationship between maxillary sinus floor and maxillary posterior teeth, the classification implemented in the study of Jung in 2009 was used. Results showed that Type 0 was more frequently observed with maxillary first and second premolars. Type 3 was most commonly observed with maxillary first and second molars. The most frequent horizontal relationships observed in Type 1 were: Type BP for maxillary first premolar, first molar and second molar, and Type B for second premolar. The most frequent horizontal relationships observed in Type 3 were: Type B for maxillary first premolars and Type P for maxillary first and second molars.

Georgiev T *et al.* [4] assessed the relationship between root apices of maxillary posterior teeth and the maxillary sinus floor in patients from the Varna region**.** The study involved a retrospective randomized analysis of 245 scans of the maxilla, 465 scans of sinuses and 960 scans of teeth and their relationship to the maxillary sinus. The distance between root apices and the maxillary sinus floor was measured and the measurements featured canines, premolars and molars. Results showed that 746 teeth, out of the 960 teeth examined, were in dangerous proximity to the maxillary sinus, 156 of which penetrated the sinus cavity at different depths. The maxillary second molars appeared to be the most common teeth to project into the sinus.

Lanzer M *et al.* [10] evaluated anatomic (positional) variation of maxillary wisdom teeth with special regard to the maxillary sinus. In total, CBCT recordings of 713 maxillary wisdom teeth from 430 patients were evaluated. The bivariate statistical analysis revealed that the inclination of the third molars was significantly associated with their relationship to the maxillary sinus. Thus, with increasing inclination in the sagittal plane both to the mesial and distal, the positional relationship to the sinus became closer, insofar as larger portions of the tooth exhibited a direct contact with the antrum. In nearly 50% of the patients with mesially inclined third molars, the crown had a direct connection to the maxillary sinus ($p < 0.001$). In cases of inclinations in the transversal plane, a particularly large percentage (45.5%) of palatally inclined teeth revealed a direct contact of crown portions with the antrum, whereas vestibularly inclined third molars revealed a less close relationship to the sinus.

Goller-Bulut D *et al.* [3] assessed the relationship between mucosal thickness (MT) of the maxillary sinus and periodontal bone loss (PBL) and periapical condition of related teeth. The study also aimed to identify the association between root apices and the inferior wall of the maxillary sinus using Cone beam computed tomography (CBCT). CBCT images of 205 patients with 410 maxillary sinuses were examined, retrospectively. A total of 582 maxillary molars and 587 premolars were observed. The relationship of each root with maxillary sinus and apical lesions of these roots were classified, PBL was examined and the situations of adjacent teeth were estimated. The study revealed that there was a positive correlation between mucosal thickness (MT) of maxillary sinus and age of the patient and periodontal bone loss. The anatomic relationship between root apices or periapical lesions and the maxillary sinus floor influenced the likelihood of maxillary sinus MT development.

Estrela C *et al.* [2] evaluated the anatomical relationship between posterior teeth root apices and maxillary sinus floor (MSF) on 202 cone beam computed tomography (CBCT) exams. The distance between the root apices and the MSF, as well as the MSF thickness of the cortical bone closest to root apices and furcation regions were measured. The vertical and horizontal relationships of the MSF with the molar roots were classified into categories adapted from the criteria proposed by Kwak et al. The shortest distances between MSF and the root apices were observed in the mesiobuccal root of the second molar (0.36±1.17 mm) and the palatal root of the first molar (0.45±1.10 mm) and the widest in buccal roots of the first premolars (5.47±4.43 mm). Significant differences were observed between the distance of MSF to the root apices of single-rooted first and second premolars. The cortical thickness ranged from 0.65±0.41 mm over the mesiobuccal root of the second molar to 1.28±0.42 mm over the buccal root of the first premolar. The most observed vertical and horizontal relationships were type II and 2H, respectively. The maxillary molar roots showed greater proximity to the MSF. The thickness of the MSF cortical bone closest to the apices and furcation regions was found to be similar only for premolars.

Akhavan H *et al.* [8] assessed the distance between the maxillary sinus floor and the maxillary first and second molar root tips in Iranian population using Cone-beam computed tomography.. The longest distance between maxillary sinus floor and maxillary posterior root tips belonged to mesiobuccal root of maxillary first molar (1.42 +- 0.72) and palatal root of maxillary second molar (1.42+- 0.83), the shortest distance belonged to distobuccal root of maxillary second molar (0.98+- 0.68) and the difference was significant ($P<0.001$). There was a close relationship between maxillary sinus floor and maxillary posterior root tips specially distobuccal root of maxillary second molar.

Kosumarl W *et al* [1]. determined and compared the distances from the maxillary root apices of posterior teeth to the floor of the maxillary sinus, or maxillary sinus distances (MSDs) in Thai subjects with skeletal open bite and skeletal normal bite. Results showed that the greatest mean MSDs were from the root apex of the second premolars in both groups, whereas the least mean MSDs were from the mesiobuccal root apex of the second molars.

Table 1: Search Strategy

S.No.	Search Strategy	No. of articles	Selected by Title	Selected by Abstract	Duplicates	Final Selection	Full Text
1	Maxillary molars and maxillary sinus and CBCT	79	8	8	0	8	5
2	Maxillary sinus floor and maxillary first molar and cone beam computed tomography	39	9	9	6	3	0
4	Posterior teeth and maxillary sinus and cone beam computed tomography	66	13	12	8	4	1
5	Relation and sinus and roots and cone beam computed tomography	10	3	3	2	1	1
6	Distance and roots and sinus and cone beam computed tomography	14	8	8	6	2	1
7	Others	2			0	2	2
							Total=10

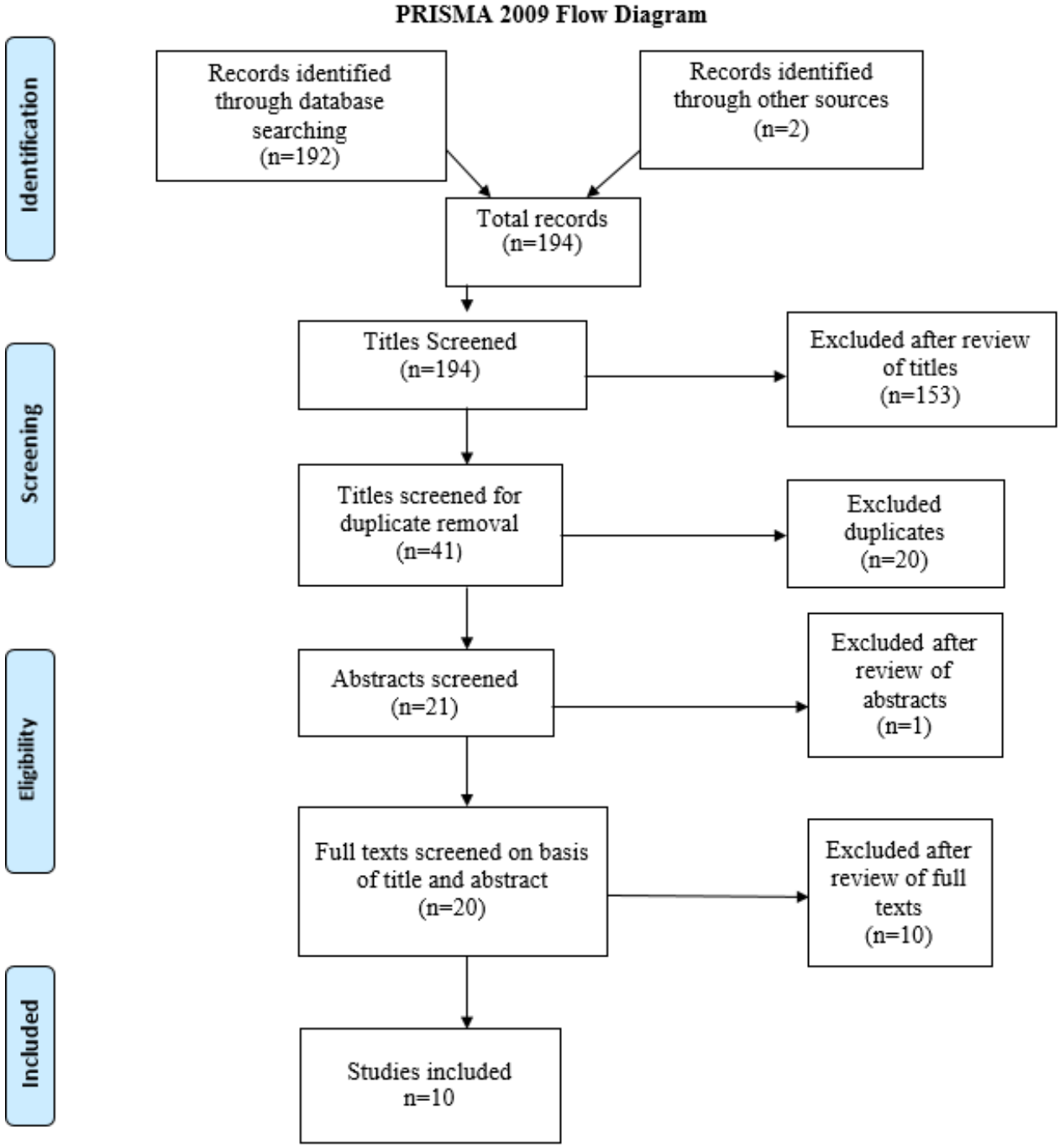

Fig 1: Prisma Flow Chart

Table 2: Data Extraction Sheet

Study Id	Authors	Year of Publication	Sample Size	Setting	Age Group	Outcome Variable	Outcome Value	Result	Conclusion
1	Kosumarl W et al	2017	30	Oral and Maxillofacial Radiology Clinic, Dental Hospital, Faculty of Dentistry, Chiang Mai University, Thailand.	14-28 years	Shortest and longest distance between maxillary sinus floor (MSF) and root apices of maxillary posterior teeth (second premolar, first and second molars) in subjects with skeletal open bite and skeletal normal bite.	The mean maxillary sinus distances (MSDs) for the maxillary second premolars, first molars, and second molars in the skeletal normal bite group ranged from 0.19±1.82 mm to 2.44±3.15mm. The greatest mean MSD was from the root apices of the second premolars, whereas the least mean MSD was from the mesiobuccal root apices of the second molars. The mean MSD from the palatal root apices was greater than the mean MSDs from the mesiodistal and distobuccal root apices in both the first molars and second molars. The mean MSDs for the maxillary second premolars, first molars, and second molars in the skeletal open bite group ranged from 0.35±1.01 mm to 1.92±2.21 mm. The greatest mean MSD was from the root apices of the second premolars, whereas the least mean MSD was from the mesiobuccal root apices of the second molars.	The greatest mean MSD was from the root apices of the second premolars, whereas the least mean MSD was from the mesiobuccal root apices of the second molars, in both the groups. The mean MSD from the palatal root apices was greater than the mean MSDs from the mesiodistal and distobuccal root apices in both the first molars and second molars, in both the groups.	There were no differences in the mean MSDs for the maxillary second premolars, first molars, and second molars between the skeletal normal bite group and the skeletal open bite group.
2	Akhavan H et al	2016	100	Private dentomaxillofacial radiology center, Tehran, Iran	Mean age of 43.3 years	The closest distance between each root tips of maxillary molars and floor of maxillary sinus were recorded.	Mean distance from the maxillary sinus floor: Maxillary First Molar: MB=1.43+0.72, DB=1.26+0.65, P=1.31+0.72 Maxillary Second Molar: MB=1.1+0.63, DB=0.98+0.68,	The longest distance between maxillary molar root tips and maxillary sinus floor were mesiobuccal root tip of maxillary first molar (1.42 +-0.72) and palatal root of maxillary	MB root tip of maxillary first molar and palatal root tip of maxillary second molar were the farthest from the MSF. DB root of maxillary second molar was closest to the MSF.

							P=1.42+0.83	second molar (1.42+- 0.83) and the shortest distance was distobuccal root of maxillary second molar (0.98+- 0.68)	
3	Estrela C et al	2016	202	Private radiologic center, TCO, Goiânia, GO, Brazil	15-80 years	Shortest and longest distance between Maxillary sinus floor(MSF) and root apices of maxillary posterior teeth	Shortest distance between MSF and root apices were in mesiobuccal root of second molar(0.36± 1.17 mm) and the palatal root of the first molar (0.45± 1.10 mm) and the longest in buccal roots of first premolars (5.47 ± 4.43 mm)	Mesiobuccal root of second molar and the palatal root of the first molar were closest to the MSF whereas buccal roots of first premolars were at the farthest distance from the MSF.	The roots of the maxillary molars showed greater proximity with the MS when compared with premolars.
4	Goller-Bulut D et al	2015	205	Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Erciyes University, Turkey	16-77 years	Kwak's Classification Type I: Buccal and palatal roots apices were not in contact with the inferior wall of the maxillary sinus. Type II: Buccal and palatal roots apices were in contact with the cortical borders of inferior wall of the maxillary sinus. Type III: Buccal root apices were projecting into the sinus cavity over the inferior wall of the maxillary sinus. Type IV: Palatal root apices were projecting into the sinus cavity over the inferior wall of the maxillary sinus. Type V: Buccal and palatal root apices were projecting into the sinus cavity over the inferior wall of the maxillary sinus.	Maxillary 1st and 2nd premolars and maxillary 2nd molars had highest incidence of Type I. Maxillary 1st molars had highest incidence of Type II.	Maxillary 1st and 2nd premolars and maxillary 2nd molars were not in contact with the MSF whereas maxillary 1st molars had highest incidence of contact with the cortical borders of MSF.	The study revealed that there was a positive correlation between mucosal thickness (MT) of maxillary sinus and age of the patient and periodontal bone loss. The anatomic relationship between root apices or periapical lesions and the maxillary sinus floor influenced the likelihood of maxillary sinus MT development.
5	Lanzer M et al	2015	430	Department of Dento-Maxillofacial Radiology of the Center of Dental Medicine, Zurich Switzerland	10-84 years	Five categories were defined: No relationship to the maxillary sinus (category I); the root tip protrudes at most 2 mm into the maxillary sinus (category II); up to half of the root protrudes into the sinus (category III); more	Category I: 179 (25.1%) Category II: 284 (39.8%) Category III: 110 (15.4%) Category IV: 42 (5.9%) Category V: 98 (13.7%) Bone covering of roots to max. sinus, 0 mm: 325 (45.6%), 1 mm: 266 (37.3%),2mm:72 (10.1%),	Maximum third molars had their root tips protruding at most 2 mm into the maxillary sinus. Only a few third molars had more than half of their root protruding into	The study revealed that the inclination of the third molars was significantly associated with their relationship to the maxillary sinus. Thus, with increasing inclination in the sagittal plane both to

						than half of the root protrudes into the sinus (category IV); the crown or coronal portions bear a relation to the sinus (category V).The space between the root tip and the sinus floor was determined quantitatively in millimeter. The inclination of the third molars in both the sagittal and transversal plane was measured using an angle scale superimposed on the image.	> 2 mm: 50 (7.0%) In the saggital plane, 12.5% teeth were mesially inclined and 56.6%teeth were distally inclined. In the transverse plane, 65.8% vestibular inclination and 12.0% palatal inclination was found.	the sinus.	the mesial and distal, the positional relationship to the sinus became closer, insofar as larger portions of the tooth exhibited a direct contact with the antrum.
6	Georgiev T et al	2015	909 teeth (10 canines)	UMDC, Varna	16-82 years	Group I comprised teeth positioned at a distance of 2-4 mm from the maxillary sinus; Group II included teeth at 0-2 mm from the maxillary sinus (with no visible penetration); Group III consisted of teeth with penetrating apices 0-2 mm into the sinus; Group IV comprised teeth with apices penetrating 2-4 mm into the sinus.	The distribution in groups is as follows: Group I: 163 teeth in total (2 canines, 31 first premolars, 60 second premolars, 30 first molars, 27 second molars, 13 wisdom teeth) Group II: 590 teeth in total (8 canines, 22 first premolars, 143 second premolars, 173 first molars, 192 second molars, 52 wisdom teeth) Group III: 141 teeth in total (14 second premolars, 50 first molars, 61 second molars, 16 wisdom teeth) Group IV: 15 teeth in total (1 second premolar, 5 first molars, 9 second molars)	Most of the maxilary posterior teeth were at a distance of 0-2 mm from the maxillary sinus. The chances of apices penetrating 2-4 mm into the sinus was the least with all the posterior teeth.	The study established that the tooth most likely to have root apices penetrating the maxillary sinus is the second molar followed by first molar.
7	Shokri A et al	2014	110	Radiology department of Hamadan Dental School, Hamadan,Iran.	21-65 years	The vertical relationship between each root of the molar and the sinus floor was classified into four types based on the CBCT cross-sectional images: Type 0: the root was not in contact with the cortical borders of the sinus. Type1: the root was in contact with the cortical	Type 0 was more frequently observed with maxillary first and second premolars. Type 3 was most commonly observed with maxillary first and second molars. The most frequent horizontal relationships observed in Type 1 were: Type BP for maxillary first premolar,	For maxillary first and second premolars, the root was more frequently not in contact with the cortical borders of the sinus. For maxillary first and second molars, the root apex was more frequently projecting	This study showed that although most of the teeth did not have contact with the sinus floor, but the more posterior the maxillary teeth, the more probability for root protruding into the maxillary sinus. It also confirmed that

						borders of the sinus Type 2: the root was projecting laterally on the sinus cavity, but its apex was outside the sinus borders Type 3: the root apex was projecting into the sinus cavity. The horizontal relationship between the roots of the teeth and the sinus floor was classified into three types: Type B:the lowest point of the maxillary sinus floor is located on the buccal side. Type BP: the lowest point of the sinus floor is located between the buccal and palatal roots. Type P: the lowest point of the sinus floor is located on the palatal side of the palatal root.	first molar and second molar, and Type B for second premolar. The most frequent horizontal relationships observed in Type 3 were: Type B for maxillary first premolars and Type P for maxillary first and second molars.	into the sinus cavity.	protrusion of teeth roots into the maxillary sinus is more common in male than female.
8	Arx TV et al	2014	192	Department of Oral Surgery and Stomatology, School of Dental Medicine, University of Bern, Bern, Switzerland	19-81 years	1. Shortest vertical/oblique distance from the root apex of any buccal, palatal, or accessory root of first and second premolars to the closest border of the maxillary sinus (sagittal views and coronal views) (negative value if the root tip was located above the floor of the maxillary sinus) 2. Shortest horizontal distance from the root apex of any buccal, palatal, or accessory root of first and second premolars to the closest border of the maxillary sinus (axial view) (negative value if the root tip was located inside the border of the maxillary sinus)	In the sagittal plane, the mean distances from the buccal and palatal roots of the first premolars to the floor of the maxillary sinus were 5.15 $\pm$ 2.99 mm and 4.20 $\pm$3.69 mm, respectively. The palatal roots were about 1 mm closer to the maxillary sinus floor than the buccal roots. The values for the second premolars were 2.32 $\pm$ 2.19 mm and 2.68 $\pm$ 3.58 mm, respectively. In the coronal plane, the mean distances from the buccal and palatal roots of the first premolars to the floor of the maxillary sinus were 8.28 $\pm$ 6.27 mm and 7.17 $\pm$ 6.14 mm, respectively. The palatal roots were again about 1 mm closer to the maxillary sinus floor than	Palatal roots of first premolars were always located closer to the maxillary sinus than buccal roots (irrespective of the CBCT plane). Roots of second premolars were, on average, positioned much closer to the maxillary sinus than roots of first premolars. Protrusion of roots inside the maxillary sinus was rare in first premolars and low in second premolars.	Based on the calculated mean distances of the study, only few premolars (and if so second premolars) would present a risk of violating the border of the maxillary sinus during conventional or surgical endodontic treatment or in case of tooth extraction.

							the buccal roots. The values for the second premolars were 3.28 ± 3.17 mm and 3.69 ± 4.51 mm, respectively. In the axial plane, the mean distances from the buccal and palatal roots of the first premolars to the floor of the maxillary sinus were 5.86 ± 3.54 mm and 5.71 ± 3.89 mm, respectively. The values for the second premolars were 2.40± 2.71 mm and 3.80 ± 3.71 mm, respectively.		
9	Jung YH et al	2012	83	Pusan National University Hospital, Busan, South Korea	20-53 years	The vertical relationship between each root of the molar and the sinus floor was classified into four types based on the CBCT cross-sectional images: Type 0: the root was not in contact with the cortical borders of the sinus. Type1: the root was in contact with the cortical borders of the sinus Type 2: the root was projecting laterally on the sinus cavity, but its apex was outside the sinus borders Type 3: the root apex was projecting into the sinus cavity. In Types 2 and 3, the horizontal relationship between the roots of the teeth and the sinus floor was classified into three types: Type B: the lowest point of the maxillary sinus floor is located on the buccal side. Type BP: the lowest point of the sinus floor is located between the buccal and palatal roots. Type P: the lowest point of	Type 3 was more frequent in the buccal roots, including the mesiobuccal and distobuccal roots of the maxillary molars. Type 2 was most common in the palatal roots of the maxillary first molar (M1).Type 0 was most frequently observed in the palatal roots of the maxillary second molar (M2). The vertical relationship was classified in each molar, and Type 3 was shown to be most frequent in the molars with more than one root. In the horizontal relationship between the roots of molars and the sinus floor, Type BP was most frequent in molars and Type B was more frequent in M2 than M1.	The mean distance between the sinus floor and the root apex was the longest for the palatal roots of M2 and the shortest for the mesiobuccal roots of M2. The mesiobuccal roots of M1 were closest to the cortical plate, and the mesiobuccal roots of M2 were farthest from the cortical plate.	The relationship of the roots of the maxillary molars and the sinus floor differed between the buccal and palatal roots. A root protruding into the maxillary sinus was more frequent in the buccal roots of the maxillary molars. The mesiobuccal root of the maxillary second molar was closest to the maxillary sinus floor. The thickness of the bone buccal to the root was markedly thinner in the maxillary first molar than in the maxillary second molar.

						the sinus floor is located on the palatal side of the palatal root.			
10	Kilic C et al	2010	92	Private dentomaxillofacial radiology center, Ankara, Turkey.	10-66 years	Group 1: Root tips in contact with the sinus floor. Group 2; Root tips penetrating into the sinus. Group 3: Root tips below the sinus floor. Distances were measured for each side of each tooth and root tip. Root tips in Group 1 were numbered as zero, those in Group 2 were given negative numbers and those in Group 3 were given positive numbers.	For the right side 60% of the root tips were included in group 3, 30% in group 1 and 10% in group 2 whereas on the left side 68% were included in group 3, 21% in group 1 and 11% in group 2. Mean distance (in mm) of, Right(R) 1st PM: 8.42, R 2nd PM: 3.75, R 1st molar mb: 1.77, R 1st mo db: 0.70, R 1 st mo pal: 1.86, R 2nd mo mb: 0.42, R 2nd mo db: 0.25, R 2nd mo pal: 1.06, R 3rd mo mb: 1.63, R 3rd mo db: 0.62, R 3rd mo pal: 0.92. L(left) 1st pm: 6.58,L 2nd pm: 3.73, L 1st mo bm: 0.52, L 1st mo bd: 0.10, L 1st mo pal: 0.26, L 2nd mo bm: 0.31, L 2nd mo bd: 0.40, L 2nd mo pal: 0.78, L 3rd mo bm: 0.87, L 3rd mo bd: 0.81, L 3rd mo pal: 0.94	The distance between sinus floor and root tip was longest for the first premolar root tip and shortest for the second molar buccodistal root tip for both right and left sides.	In view of the proximity of the maxillary sinus floor and maxillary root tips, clinicians must be particularly cautious when performing dental procedures involving the maxillary posterior teeth. The measurements found in the present study highlight the need for preoperative treatment planning.

Discussion

The close proximity of maxillary posterior teeth root apices to the maxillary sinus floor makes it important to assess the anatomical relationship between them, so as to avoid the problems that occur during and after dental treatment. The reason for this importance is the potential risks associated with the penetration of teeth root tips into the maxillary sinus. Operative procedural errors during root canal therapy (overinstrumentation, overirrigation and overfilling) and aggressive surgical procedures represent potential risk factors for introduction of foreign material into the MS.This may favor the development of inflammatory, infectious and/or traumatic alterations in the maxillary sinus (MS) [2].

Disadvantages of conventional radiographic techniques include super imposition of anatomic structures, horizontal and vertical magnification and a lack of cross-sectional information. Anatomic structures are seen in clearer detail with the CBCT scanning. İt could be used in oral surgery, implant treatment planning, orthodontic evaluation, periodontal disease planning and apical periodontitis assessment. CBCT imaging is helpful in evaluating the preoperative and postoperative conditions of the maxillary sinuses and also in explaining the etiology and extent of the association between the dental pathology and the involved sinus [5].

Conclusion

Cone beam computed tomography (CBCT) scans prove essential in the proper diagnosis of the relationship between the root apices of maxillary posterior teeth and the maxillary sinus floor. When communication is suspected, a scan of the relevant region is imperative.

Dental treatments in these areas should be performed with caution. Teeth that have penetrated the maxillary sinus ought to be extracted by specialists in Oral surgery so that prompt local plastic surgery procedures could be performed for closure of the communication between the oral cavity and the maxillary sinus. Endodontic surgery of premolars and molars can result in accidental oroantral communication that can allow bacteria from infected periapical tissue, resected root tips, or bony drilling dust to be displaced into the sinus and cause acute or chronic sinusitis. With regard to the specific treatment of maxillary molars and premolars, careful aperture of the maxillary sinus wall or floor is necessary, and attention must be paid to avoid sinus membrane perforation. In order to avoid penetration by foreign bodies, it has been recommended to use gauze to block the maxillary sinus aperture.

Knowing the anatomical relation between posterior teeth and the maxillary sinus, help the clinician in preoperative treatment planning of maxillary posterior teeth, diagnosing pathologic conditions and avoiding problems that may arise during dental dental practice.

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