International Journal of Health Sciences and Research
Volume 14; Issue: 9; September 2024
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

CBCT Assessment of the Proximity of the Maxillary Posterior Teeth to the Maxillary Sinus Floor Before Orthodontic Treatment and After Alignment and Levelling

Dr Bhavya Gupta[1], Dr Vijay Agarwal[2], Dr Shiva Gupta[3], Dr Karamdeep Singh Ahluwalia[4], Dr Pranav Sapawat[5], Dr Shourya Bhardwaj[6]

[1]Post- Graduate student, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India
[2]Professor and Head, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India
[3]Professor, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India
[4]Professor, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India
[5]Reader, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India
[6]Post- Graduate student, Department of Orthodontics and dentofacial Orthopaedics, Jaipur Dental College, Jaipur, Rajasthan, India

Corresponding Author: Dr Bhavya Gupta

DOI: https://doi.org/10.52403/ijhsr.20240920

ABSTRACT

Introduction: When teeth travel horizontally over the sinus floor and their roots extend into the maxillary sinus, they may experience apical root resorption and tipping. Cone-beam computed tomography (CBCT) three-dimensional pictures provide precise, distortion-free data. Before orthodontic treatment and after alignment and levelling, this study used CBCT to assess the connections between the maxillary sinus floor and the apices of the maxillary tooth roots.

Method: Thirty CBCT samples were categorized into two groups:
1. Group I: 15 CBCT scans in the sagittal view, taken before orthodontic treatment and after alignment and leveling.
2. Group II: 15 CBCT scans in the coronal view, taken before orthodontic treatment and after alignment and leveling.

Sagittal and coronal CBCT images were used to thoroughly assess the positional relationships between the inferior wall of the maxillary sinus and the apices of the maxillary tooth roots, including molars and premolars. Measurements of distances were made concurrently in both planes.

Results: Compared to prior orthodontic treatment, CBCT images in the sagittal and coronal planes showed that the roots of posterior teeth protruded substantially more into the maxillary sinus following alignment and leveling.

Conclusion: By helping to forecast the prevalence and severity of root resorption, this study offers important insights for organizing orthodontic tooth movement via the maxillary sinus

Keywords: Sagittal plane, maxillary posterior teeth, maxillary sinus, and coronal plane.

INTRODUCTION

The maxillary sinus is the first paranasal sinus to form. It normally reaches its full size at the age of twenty, coinciding with the eruption of the third molars. A curving structure makes up the buccoalveolar wall and the lower part of the medial wall, while the maxillary alveolar process forms the inferior sinus floor [1]. The balance between the tension side and pressure side bone deposition and resorption of the periodontal ligament is a prevalent theory for orthodontic tooth movement [2]. Orthodontists have used this approach to reposition teeth into the alveolar bone with good results. Because of the possible connection between teeth and soft tissues or the cortical bone, applying this notion to the maxillary sinus is more complicated.[2]

In the past, orthodontists assessed treatment outcomes and the hard tissues of the craniofacial region using 2D cephalometric measurements, both lateral and anteroposterior. 2D radiographs revealed negligible root resorption when a maxillary tooth was pushed via the sinus; this finding could not be confirmed radiologically, but histologically. Examining the molar's 3D root resorption, however, was difficult.[3] Cone Beam Computed Tomography (CBCT) has made it feasible to perform 3D analysis and get accurate, distortion-free, and overlap-free data. Accurate examination of maxillary teeth is possible with CBCT.[3]

The purpose of this study was to assess using CBCT, both coronal and sagittal, the relationship between the maxillary sinus floor and the root apices of the posterior maxillary teeth before receiving orthodontic treatment. After alignment and leveling, the study also attempted to evaluate this connection in sagittal and coronal views.

MATERIALS & METHODS

The Oral Radiology Department collaborated with the Jaipur Dental College Department of Orthodontics and Dentofacial Orthopaedics to conduct this cross-sectional study for CBCT evaluation. It was authorized by the Maharaja Vinayak Global University Institutional Ethical Committee. Prior to their involvement in the trial, all patients provided written informed consent.

Thirty patients made up the sample, split into two groups: Group I comprised 15 CBCT scans in the sagittal view, before orthodontic treatment and after alignment and levelling. Group II comprised fifteen CBCT scans obtained before orthodontic treatment and after alignment and levelling in the coronal view. The patients ranged in age from fifteen to thirty years.

Inclusion criteria:

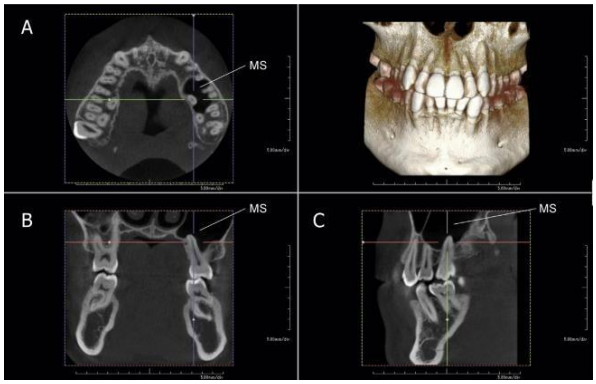
- An ANB angle of less than or equal to 4 degrees designates Skeletal Class I, which is the inclusion criterion.
- A well formed root structure with an undamaged crown form and no obvious abrasions.
- There is no medical history of periodontitis, cavities, fillings, restorations, functional orthopedic therapy, orthodontic treatment, cleft lip palate, or orthognathic surgery.

Exclusion criteria:

- Past orthodontic treatment history is an exclusion criterion.
- Lesion in the maxilla that is cystic or traumatic.
- Serious anomalies involving the jaw or birth defects such cleft lip and palate.
- Individuals who, when measurements were made on the totally dentulous side of the maxilla, had at least one missing tooth or more than two missing teeth on each side.

CBCT Analysis: Patients receiving orthodontic treatment who had a Skeletal Class I pattern on their CBCT scans served as the study's basis. The samples were collected from the Jaipur Dental College's Department of Oral Medicine and Radiology archives. A total of fifteen patients were chosen according to the given standards. Using the Carestream Dental LLC, Atlanta, GA CS 8200 3D CBCT, CBCT pictures were acquired with the following settings: 20 seconds of scanning time, 90 kV tube voltage, 4 mA tube current (pulsed mode), and 150 µm x 150 µm x 150 µm voxel dimensions.

The spatial relationships and measurements between the maxillary sinus and the apices of the maxillary roots were evaluated by scrutinizing CBCT images in both the sagittal and coronal planes. The use of reference planes—axial, sagittal, and coronal—ensured consistency in the CBCT images (Figure 1).



As illustrated in Figure 1, CBCT provides simultaneous axial (A), coronal (B), and sagittal (C) images. The coronal plane (B) and sagittal plane (C) of the maxillary tooth's root apex are shown in the CBCT images. maxillary sinus, or MS.

Classification of Relationships: The relationship between the root apex of the maxillary teeth (molar and premolar) and the inferior wall of the maxillary sinus was evaluated using two cross-sectional CBCT images (sagittal and coronal planes). There were four distinct types of vertical associations identified by the cross-sectional CBCT scans:

• Type 0: The inferior wall of the maxillary sinus ends before the root apices.
• Type I: The inferior wall of the sinus and its root are divided.
• Type II: There is contact between the inferior wall of the sinus and its root.
Type III: The sinus is where the root projects. (Figures 2 and 3 show how these categories are organized.)

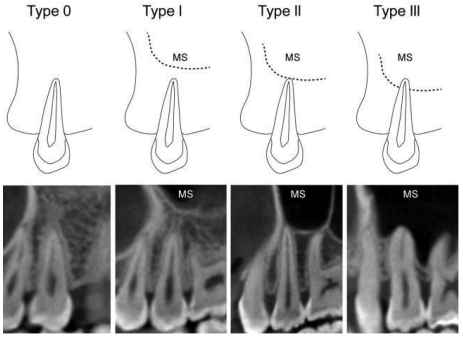


Fig 2: Classification of the MS's inferior wall and the maxillary tooth's root apex's vertical connectionsin the sagittal section (dotted line). MS stands for maxillary sinus.

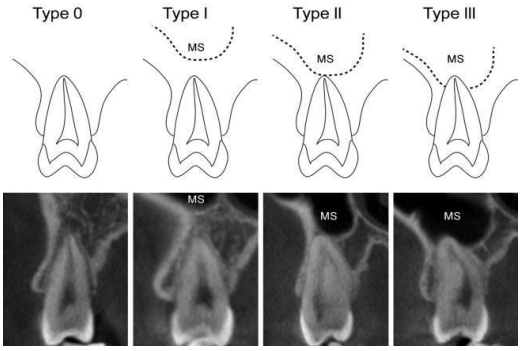


FIG 3: Categorization of the dotted line in the coronal section between the inferior wall of the MS and the root apex of the maxillary tooth. The maxillary sinus is known as MS.

A set of parameters Measured:

The apex-sinus distance (ASD) between the tooth's root apex and the inferior wall of the maxillary sinus was ascertained using sagittal and coronal images. For Type I, where the roots were not in contact with the wall, the shortest distance was measured from the root apex to the sinus wall. Since the root of Type II was in contact with the inferior wall, the distance was taken to be zero.

For Type III, the measurement was made of the length between the apex of the root and

the middle point of the surrounding root sites and the sinus floor, where the root extended into the maxillary sinus. A positive distance was recorded if the root reached into the sinus; a negative distance was measured if the root did not contact the maxillary sinus floor (Figure 4).

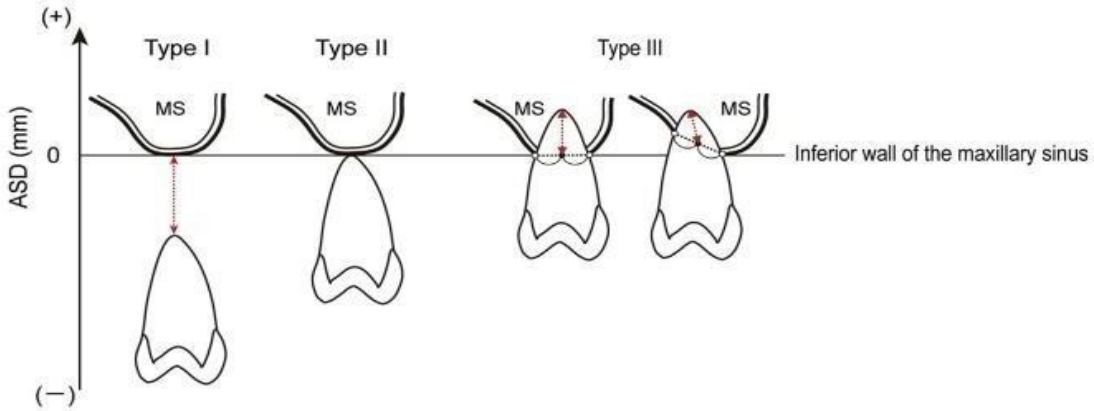


Fig 4 In both the sagittal and coronal pictures, the distances (mm) were measured simultaneously.

Fig 5: measurement in first premolar root both sagittal and coronal plane in pre treatment

Fig 6: measurement in first premolar root both sagittal and coronal plane in post alignment and levelling

RESULT

Table No. 1: Comparison of Pre vs post values

	Mean	Std. Deviation	Z value	P value of Wilcoxon Signed Ranks Test
I ST PREMOLAR ROOT pre Sag I ST PREMOLAR ROOT POST SAGITTAL	-.88667 .31333	1.007023 .980428	-3.062	0.002**
I ST PREMOLAR ROOT PRE-CORONAL I ST PREMOLAR ROOT POST CORONAL	-1.11333 .01333	1.262575 1.151934	-3.207	0.001**
IInd PREMOLAR ROOT pre Sag IInd PREMOLAR ROOT POST SAGITTAL	-.03333 .39333	.480575 .716606	-2.677	0.007**

IInd PREMOLAR ROOT PRE-CORONAL IInd PREMOLAR ROOT POST CORONAL	-.05333 .36667	.206559 .471573	-3.078	0.002**
1St molar mesial ROOT pre Sag 1St molar mesial ROOT POST SAGITTAL	1.07333 1.56667	.708587 .657557	-3.414	0.001**
1St molar mesial ROOT PRE-CORONAL 1St molar mesial ROOT POST CORONAL	.80667 1.22000	.979407 .743736	-2.565	0.010*
1St molar distal ROOT pre Sag 1St molar distal ROOT POST SAGITTAL	.98667 1.49366	.903064 .738475	-3.088	0.002**
1St molar distal ROOT PRE-CORONAL 1St molar distal ROOT POST CORONAL	.70667 1.25352	.919990 1.080026	-3.366	0.001**
I ST MOLAR PALATAL ROOT pre Sag I ST MOLAR PALATAL ROOT POST SAGITTAL	1.15333 1.70676	.753910 .724302	-3.433	0.001**
I ST MOLAR PALATAL ROOT PRE-CORONAL I ST MOLAR PALATAL ROOT POST CORONAL	1.12000 1.14000	1.056409 .624271	-2.527	0.011*
II NDMOLAR MESIAL ROOT pre Sag II NDMOLAR MESIAL ROOT POST SAGITTAL	2.18667 2.52000	.693713 .575946	-2.637	0.008**
II NDMOLAR MESIAL ROOT PRE-CORONAL II NDMOLAR MESIAL ROOT POST CORONAL	1.63333 1.99333	.739369 .649689	-3.423	0.001**
II ND MOLAR DISTAL ROOT pre Sag II ND MOLAR DISTAL ROOT POST SAGITTAL	.96667 1.93333	.842332 .534077	-3.424	0.001**
II ND MOLAR DISTAL ROOT PRE-CORONAL II ND MOLAR DISTAL ROOT POST CORONAL	.74667 1.27333	.722957 .575036	-3.426	0.001**
II ND MOLAR PALATAL ROOT pre Sag II ND MOLAR PALATAL ROOT POST SAGITTAL	1.67333 2.00000	.547027 .529150	-2.621	0.009**
II ND MOLAR PALATAL ROOT PRE-CORONAL II ND MOLAR PALATAL ROOT POST CORONAL	1.05333 1.42000	.523541 .549285	-3.321	0.001**

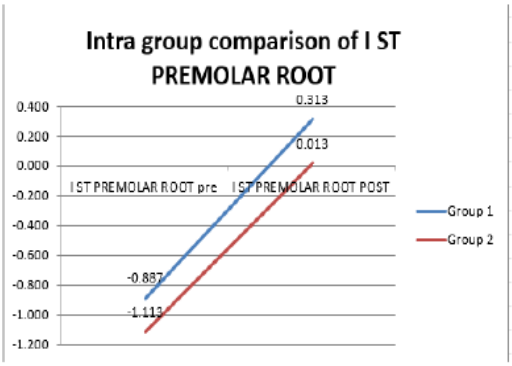
Comparison of Pre- vs. Post-Alignment and Leveling:

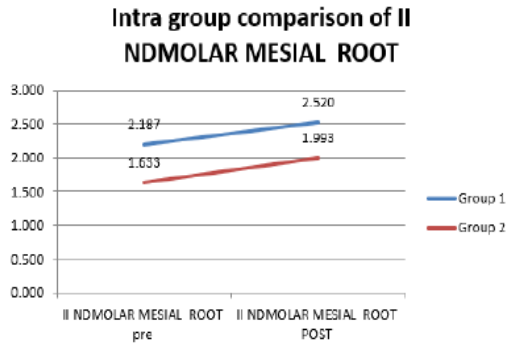
1. CBCT scans in the sagittal and coronal planes showed that the roots of the posterior teeth protruded much more into the maxillary sinus after alignment and leveling than they had before orthodontic treatment.
2. The maxillary first and second premolars displayed a type I relationship (root detached from the inferior wall of the maxillary sinus) on CBCT images collected in the sagittal and coronal planes prior to orthodontic treatment.
3. After alignment and leveling, CBCT images in the sagittal and coronal planes revealed that the maxillary first and

second premolars exhibited a higher prevalence of type III connections, or roots projecting into the maxillary sinus.

4. Type III connections, or roots that extend into the maxillary sinus, were more frequently observed for the maxillary first and second molars in both sagittal and coronal plane CBCT images obtained both before orthodontic treatment and after alignment and levelling.

Graph no. 1: GRAPHS OF INTRA COMPARISON OF POSTERIOR TEETH ROOT





DISCUSSION

Advanced imaging technology called cone-beam computed tomography (CBCT) has several practical uses in dentistry. When compared to traditional CT scans, the radiation dose from CBCT during craniofacial exposure is 10 times lower. Furthermore, coronal, sagittal, and axial planes three-dimensional volumetric data with exceptional accuracy can be obtained with CBCT.[5] In orthodontics, CBCT imaging is advised selectively to evaluate complex dentoskeletal relationships, as certain the link between neighboring roots and other anatomical structures, and locate supernumerary and impacted teeth, which helps plan the movement of succeeding teeth.[6]

Late in fetal development, the multipurpose bone chamber known as the maxillary sinus develops. Its volume is around 144 mm^3 at birth, and as one ages, it grows pyramidically. In addition to pneumatizing the alveolar cavity and expanding to the posterior alveolar process, the sinus also occasionally allows the apices of molar roots to enter it.[7]The paranasal sinuses, which include the sphenoid, frontal, maxillary, and ethmoidal sinuses, take up a large amount of the skull and perform vital tasks such air filtering and the creation of immunological barriers.[8]

The resorption and apposition of surrounding bone allows the migrating root to be relocated inside the alveolar bone when the teeth erupt and the maxillary sinus widens during orthodontic therapy. This mechanism responds to orthodontic force by keeping things balanced. Mechanisms that rebuild and repair alveolar bone can rapidly compensate for mechanical strain variations. On the sinus floor, orthodontic tooth movement may even encourage the growth of new bone. [9]

Analysis of CBCT images in this study using mean values from the sagittal and coronal planes revealed that the roots of posterior teeth protruded much deeper into the maxillary sinus after alignment and leveling than they did prior to orthodontic treatment.

In particular, after alignment and leveling, the mesiobuccal root of the second molar protruded deeper into the maxillary sinus, according to comparisons of mean values from CBCT scans in the sagittal and coronal planes.

Comparable results have been obtained by similar investigations. According to Purmal et al., thesinus has its highest point between

the left premolars and its lowest point between the right molars. Most studies indicates that the maxillary sinus is closest to the buccal roots of the maxillary second tooth.[10] Eberhardt et al., Georgescu et al, Jung and Cho found that the maxillary sinus was the closest anatomical structure to the second molar's mesiobuccal root. [11] Studies on Chinese individuals by Tian et al., Gu et al., and Zhang et al. also showed that the mesiobuccal root of the second molar is usually the one closest to the maxillary sinus floor (MSF).[12] Kilic et al. discovered that the MSF is closest to the second molar's distobuccal root.[1]

When calculating the distance between the two anatomical characteristics, Von Arx et al. discovered that the angle between the root and maxillary sinus resulted in projection inaccuracies since the sagittal plane did not contain a horizontal component along the primary axis of the tooth.[15] When teeth are repositioned during orthodontic therapy, mechanical overloading frequently results in undesirable root resorption.[13] Although it was previously thought to be impossible, a recent case study demonstrated that sealing a hole left by the extraction of an orthodontic tooth could be accomplished by sliding the body into the maxillary sinus.[9] Using implant anchors, molars have been shifted toward the maxillary sinus without causing a large amount of root resorption.[14] Previous animal study suggests that bone loss and root resorption in the maxillary sinus may not occur when the optimal force is applied.[16] These studies demonstrated that when teeth are moved through the maxillary sinus, minimal orthodontic force does not cause root resorption. [13, 9,14] But not every patient has root resorption to the same extent. The amount of root resorption a person may encounter following orthodontic treatment cannot currently be predicted using an objective measure or categorization.[17, 18] An extensive examination of the anatomical characteristics of the inferior wall of the maxillary sinus and its surrounding tissues, including the tooth roots, is therefore necessary before attempting orthodontic tooth movement.[4]

CONCLUSION

Using sagittal and coronal plane CBCT imaging, we investigated the relationships between the apices of the maxillary roots and the inferior wall of the maxillary sinus. We saw that after alignment and leveling, the roots of the posterior teeth extended much further into the maxillary sinus, in contrast to previous orthodontic treatment.

Prior to orthodontic treatment, the maxillary first and second premolars showed a type I connection on sagittal and coronal plane CBCT images, indicating that their roots were not in contact with the inferior wall of the maxillary sinus.

The maxillary first and second premolars exhibited a higher prevalence of type III connections, with the roots extending into the maxillary sinus, according to CBCT images acquired in the sagittal and coronal plane after alignment and leveling.

CBCT images in the sagittal and coronal plane showed a higher frequency of Type III connections for the maxillary first and second molars, with the roots extending into the maxillary sinus before orthodontic treatment and after alignment and levelling.

We found that the roots of the mesiobuccal second molar had the deepest penetration into the maxillary sinus by comparing CBCT images recorded in the sagittal and coronal planes before orthodontic treatment and after alignment and leveling.

Declaration by Authors

Ethical Approval: Approved

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Kilic C, Kamburoglu K, Ozen T. An Assessment of the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using Dental Cone-beam Computerized Tomography. Eur J Dent. 2010; 4(4):462-67. DOI: *10.1055/s-0039-1697866*

2. Sun W, Xia K, Huang X, Cen X, Liu Q, Liu J. Knowledge of orthodontic tooth movement through the maxillary sinus: a systematic review. BMC Oral Health. 2018;18(1):1-9. DOI: *10.1186/s12903-018-0551-1*
3. Goyal S N, Karjodkar S N, Sansare K, Saalim M, Sharma S. Proximity of the Roots of Maxillary Posterior Teeth to the Floor of Maxillary Sinus and Cortical Plate: A Cone-Beam Computed Tomography Assessment. Indian J Dent Res. 2020; 31 (6): 911-15. DOI: *10.4103/ijdr.IJDR_871_18*
4. Oishi S, Ishida Y, Matasumura T, Kita S, Kuma T S, Imamura T, Ikeda Y et al. A cone - beam computed tomographic assessment of the proximity of the maxillary canine and posterior teeth to the maxillary sinus floor: lesson from 4778 roots. AJO-DO .2020;157(6):792-802. DOI: *10.1016/j.ajodo.2019.06.018*
5. Kumar M, Shanavas M, Sidappa A, Kiran M. Cone beam computed tomography - know its secrets. J Int Oral Health. 2015;7(2): 64–68. PMID*: 25859112*
6. Jain S, Choudhary K, Nagi R, Shukla S, Kaur N, Grover D. New evolution of cone-beam computed tomography in dentistry: combining digital technologies. Imaging Sci Dent. 2019;49(3):179–190. DOI: *10.5624/isd.2019.49.3.179*
7. Iwanaga J, Wilson C, Lachkar S, Tomaszewski KA, Walocha JA, Tubbs RS. Clinical anatomy of the maxillary sinus: application to sinus floor augmentation. Anat Cell Biol. 2019;52(1):17–24. DOI: *10.5115/acb.2019.52.1.17*
8. Tanaka E, Yamada H, Higashino M, Sawada M, Suetake S, Abe S. Influence of Orthodontic Treatment on Changes in the Maxillary Sinus Dimensions. Cureus .2024;16(2): 53363. DOI: *10.7759/cureus.53363*
9. Park JH, Tai K, Kanao A, Takagi M. Space closure in the maxillary posterior area through the maxillary sinus. Am J Orthod Dentofacial Orthop. 2014 Jan;145(1):95-102. doi: 10.1016/j.ajodo.2012.07.020.
10. Purmal K, Alam M, Pohchi A, Pohchi A, Abdul Razak NH , Muraoka R, Shoumura M et al. 3D measurement of maxillary sinus height for multidisciplinary benefit. J Hard Tissue Biol 2015; 24(2): 225–228. DOI: *10.2485/jhtb.24.225*
11. Eberhardt JA, Torabinejad M , Christiansen EL. A computed tomographic study of the distances between the maxillary sinus floor and the apices of the maxillary posterior teeth. Oral Surg Oral Med Oral Pathol. 1992; 73(3): 345–346. DOI: *10.1016/0030-4220(92)90133-b*
12. Tian XM, Qian L, Xin XZ, et al. An analysis of the proximity of maxillary posterior teeth to the maxillary sinus using cone-beam computed tomography. J Endod .2016; 42(3):371–377. DOI: *10.1016/j.joen.2015.10.017*
13. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: a systematic review. AJODO. 2010;137(4):462-76. DOI: *10.1016/j.ajodo.2009.06.021*
14. Park HS, Kwon OW, Sung JH. Nonextraction treatment of an open bite with microscrew implant anchorage. AJODO. 2006;130(3):391-402. DOI: *10.1016/j.ajodo.2005.07.014*
15. Von Arx T, Fodich I and Bornstein MM. Proximity of premolar roots to maxillary sinus: a radiographic survey using conebeam computed tomography. J Endod. 2014; 40(10): 1541–1548. DOI: *10.1016/j.joen.2014.06.022.*
16. Maeda Y, Kuroda S, Ganzorig K, Wazen R, Nanci A, Tanaka E. Histomorphometric analysis of overloading on palatal tooth movement into the maxillary sinus. AJODO. 2015; 148(3): 423-30. DOI: *10.1016/j.ajodo.2015.04.032.*
17. Nieto-Nieto N, Solano JE, Yanez-Vico R. External apical root-resorption concurrent with orthodontic forces: the genetic influence. Acta Odontol Scand. 2017;75(4):280-7. DOI: *10.1080/00016357.2017.1294260.*
18. Roscoe MG, Meira JB, Cattaneo PM. Association of orthodontic force system and root resorption: a systematic review. AJODO. 2015;147(5):610-26. DOI: *10.1016/j.ajodo.2014.12.026.*

How to cite this article: Bhavya Gupta, Vijay Agarwal, Shiva Gupta, Karamdeep Singh Ahluwalia, Pranav Sapawat, Shourya Bhardwaj. CBCT assessment of the proximity of the maxillary posterior teeth to the maxillary sinus floor before orthodontic treatment and after alignment and levelling. *Int J Health Sci Res.* 2024; 14(9):154-161. DOI: *https://doi.org/10.52403/ijhsr.20240920*

******