



EVALUATING THE RELATIONSHIP BETWEEN MAXILLARY MOLAR ROOTS AND MAXILLARY SINUS FLOOR – A RETROSPECTIVE STUDY USING CONE-BEAM COMPUTERIZED TOMOGRAPHY

Dr. Nilesh Pagariya¹, Dr. Radheshyam Chourasiya², Dr. Praveer Kumar Banerjee^{3*}, Dr. Priyadershini Rangari⁴

^{1,2} MDS, (Oral and Maxillofacial Surgeon), ¹ Associate Professor, Department Of Oral and Maxillofacial Surgery, Dentistry, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh
^{2*} Consultant, Maxillofacial Surgeon, Shri Krishna Hospital, Raipur, Chattisgarh.

^{3*} MBBS, DLO, DNB, MNAMS, Consultant, Department of Otorhinolaryngology, ⁴ MDS, (Oral Medicine And Radiology), ^{2,4} Assistant Professor, Department Of Dentistry, ^{1,3,4} Sri Shankaracharya Medical College, Bhilai, Durg, Chhattisgarh.

ABSTRACT:

Objectives: The aim of the present study was to assess the relationship between the maxillary sinus floor and the maxillary molar root tips using CBCT. The relation of maxillary posterior teeth roots to the maxillary sinus floor is important for diagnosing and planning of many surgical procedures.

Methods: A total of 45 maxillary first molars and 45 maxillary second molars from 50 patients were examined with CBCT. For each root the shortest distance to the maxillary sinus was determined in sagittal, coronal and axial planes, using in-built measurement tools. Means, standard deviations, minimum and maximum values and frequency of root protrusion were calculated for all roots.

Results: The distance between sinus floor and root tip was longest for the first molar mesiobuccal root and shortest for the second molar distobuccal root.

Conclusions: Knowledge of the anatomical relationship between the maxillary sinus floor and the maxillary posterior teeth root tips is important for the preoperative treatment planning of maxillary posterior teeth.

Keywords: CBCT, Maxillary molar roots, Maxillary sinus, Endodontic implications

Introduction:

The floor of the maxillary sinus is made up of the alveolar process of the maxilla and the hard palate. The adult sinus varies considerably in its extension. In about half of the population, the sinus floor extends between adjacent teeth or individual roots. These elevations in the floor of the maxillary sinus are referred to as 'hillocks'.¹ The projection of roots of the maxillary premolars, molars and canine teeth into the maxillary sinus has been well documented. This close proximity between maxillary teeth and the maxillary sinus has several clinical implications

during endodontic procedures. Thus, it becomes imperative for the clinicians to be aware of and to critically analyze this relationship before endodontic treatment.² The primary objective of the present study was to perform a detailed analysis of the radiographic relationship between the apices of maxillary molars and the floor of the maxillary sinus using CBCT imaging. The maxillary sinus varies in its extension. It is essential to understand the anatomic relationship between the maxillary sinus floor and the root of the maxillary molar for planning preoperative treatments for maxillary posterior teeth. The close relationship of the maxillary sinus and the roots

of the maxillary molars can lead to accidental oroantral communication.^{2,3} The topographical relationship of the roots of the posterior maxillary teeth and the maxillary sinus floor is an important determinant in the prognosis of orthodontic tooth movement.⁴ Sinusitis can result from the spread of a periapical or periodontal infection to the sinus or iatrogenic perforation of the sinus floor.^{3,5} It has been reported that the anatomical relationship between the root and the cortical plates might influence the spread of odontogenic infection originating in the maxillary molars.⁶ The thickness of the bone between the root and the alveolar cortical plate might be important in predicting the spread of infection as well as in treatment planning.

MATERIAL AND METHODS

Out of the total number of patients who already had undergone CBCT scans from various private imaging centers, for different clinical pathologies, referred by Department of Dentistry, Chandulal Chandrakar Memorial Medical College and Hospital, Durg, Chhattisgarh, 50 scans were selected which satisfied inclusion criteria for the study. The study was conducted in the period of one year from July 2016 to June 2017. CBCT images of the maxilla taken in our department were retrospectively evaluated. Because of the retrospective nature of the evaluation, the study was exempt from formal approval by the ethical committee. A total of 45 maxillary first molars and 45 maxillary second molars from 50 patients

were included. The data was reconstructed with slices at an interval of 0.09 mm. Subsequently, the roots of the molars were identified, and for each root, the sagittal, coronal, and axial planes for measurements were determined as follows: (Figure A, B and C)

- Sagittal image: Through the central long axis of the root (anteroposteriorly)
- Coronal image: Through the central long axis of the root (mediolaterally)
- Axial image: Through the apex of the root (horizontally)

The following analyses and measurements were performed using specialized computer software (CS3D): 1. Shortest distance from the apex of the root to the closest border of the maxillary sinus (in sagittal views and coronal views) (assigned a negative value if the root tip was located above the floor of the maxillary sinus) 2. Shortest horizontal distance from the apex of the root to the closest border of the maxillary sinus (in axial view) (assigned a negative value if the root tip was located inside the border of the maxillary sinus)

RESULTS

Means, standard deviations, minimum and maximum values obtained from first and second molars in each plane and the frequency of roots protruding into the sinus floor are given in Tables 1 and 2, respectively.

Table 1: Measurements of Distances (mm) between the Apices of Molar Roots and the Maxillary Sinus.

PLANE	ROOT	MEAN	STANDARD DEVIATION	MAX	MIN
SAGGITAL	1M- MB	2.92	3.33	6.53	-2.73
SAGGITAL	1M-DB	2.21	3.00	7.59	-1.21
SAGGITAL	1M-P	1.22	4.31	6.37	-6.67
SAGGITAL	2M-MB	-0.18	2.15	3.28	-2.35
SAGGITAL	2M-DB	-1.51	2.39	1.77	-2.78
SAGGITAL	2M-P	-0.17	2.35	2.09	-4.98
CORONAL	1M- MB	1.91	3.91	7.21	-4.11
CORONAL	1M-DB	1.28	2.78	6.13	-2.87
CORONAL	1M-P	0.95	3.61	7.21	-4.41
CORONAL	2M-MB	-0.36	2.54	3.12	-3.76

CORONAL	2M-DB	-0.48	1.87	2.18	-2.84
CORONAL	2M-P	-0.18	2.38	2.78	-2.79
AXIAL	1M- MB	-0.69	1.79	0.84	-3.77
AXIAL	1M-DB	-0.30	1.59	1.39	-2.93
AXIAL	1M-P	0.06	1.40	1.45	-2.03
AXIAL	2M-MB	-0.89	2.29	3.01	-4.35
AXIAL	2M-DB	-2.11	1.81	0.87	-4.43
AXIAL	2M-P	-2.51	1.82	0.57	-3.56

Table 2: Frequency of roots protruding into maxillary sinus.

ROOT	FREQUENCY
1M- MB	12
1M-DB	7.7
1M-P	14
2M-MB	13
2M-DB	13.6
2M-P	6.9



Figure 1: CBCT images showing maxillary sinus and maxillary molar relation

DISCUSSION

The maxillary sinus is typically pyramidal in shape. The base of the pyramid is formed by the lateral nasal wall and the apex extends into the zygoma. The floor of the sinus is made up of the alveolar process of the maxilla and partially by the hard palate.³ In nearly 50% of the population, the maxillary sinus floor extends into the alveolar process of the maxilla, forming an alveolar recess. In such cases the maxillary sinus comes in close relation to the roots of the maxillary posterior teeth, particularly the second premolar and the first and second permanent molars⁴. According to Lang,⁵ the deepest point of the

maxillary sinus is normally located in the region of the molar roots with the first and second molars the two most commonly dehiscent teeth in the maxillary sinus at 2.2% and 2.0%, respectively. Therefore, the present study focused on assessing the relation between roots of molar roots and maxillary sinus floor. The relationship of maxillary sinus and roots of maxillary teeth has been studied by periapical radiographs, panoramic views, CT, CBCT and MRI⁶. Intraoral and panoramic radiography provide a 2-dimensional picture of a 3 – dimensional object and are hence not reliable methods to study sinus position. CT, CBCT and MRI provide multiple sections through the sinus at different planes and

therefore depict an accurate 3-D picture. One drawback of using these systems is the exposure of patients to radiation. CBCT uses a limited FOV and hence uses minimum patient exposure while having all the advantages of tomographic system⁶. Thus in the present study CBCT was used to measure the distance between the maxillary molar roots and the maxillary sinus in all three planes. Previous studies^{7,8} have focused only on the vertical relationship (Sagittal plane) between the maxillary sinus floor and the root tips. These vertical relationships are significant in non-surgical endodontic therapy. But during endodontic surgery, the coronal and axial relations are also significant as they describe the buccolingual and the horizontal relationship of the sinus to the root tips. Therefore, the present study included all three planes to get 3 – dimensional analyses. Analyzing the data regarding measurements between the molar roots and the floor of the maxillary sinus floor, the following statements can be made: 1. The mean distances of first molars were always greater than those of second molars regardless of the root, side, or plane. Other authors^{9,10} have suggested in previous CT studies that the distance between the maxillary posterior teeth root apex and the inferior wall of the maxillary sinus had a tendency to reduce toward the posterior region, although they excluded evaluation of the third molar region.² In the first molars, palatal roots were always located closer to the sinus than buccal roots. While in the second molars, buccal roots were located closer to the sinus than palatal roots.³ The measurements obtained in the coronal planes were lesser than those in the sagittal planes for all roots. This is explained by the fact that the shortest distance from the apex to the sinus on the coronal image was mostly taken in an oblique direction, but the corresponding sagittal section was perpendicular relative to the coronal section, explaining the higher values of measurements obtained with sagittal images.⁴ The measurements obtained in the axial planes were shorter than sagittal and coronal planes for all roots, showing that the maxillary sinus is closer to the molar apices in the horizontal than in the vertical dimension.⁵ The DB root of second molar was closest [S: 1.51±2.39, C: -0.48±1.87, A: -

2.11±1.81] followed by second molar MB root [S: -0.18±2.15, C: -0.36±2.54, A: -0.89±2.29], second molar palatal root [S: 0.17±2.35, C: -0.18±2.38, A: -2.51±1.82], first molar palatal root [S: 1.22±4.31, C: 0.95±3.61, A: 0.06±1.40], first molar DB root [S: 2.21±1.00, C : 1.28±2.78, A : 0.30±1.59], first molar MB root [S: 2.92±3.33, C: 1.91±3.91, A: -0.69±1.79]. Previous studies^{7,10} have shown that the second molar DB root was the closest one to the maxillary sinus floor, which corroborates with our findings. Others^{9,11} have found evidence that the second molar MB root was the closest one to the sinus floor by its mean value. The difference between the studies may be attributed to different methodologies, and the race and age of our respective subjects. According to our findings, 9.4% of all root apices were closely related to the maxillary sinus floor by close contact or by protrusion into the sinus. It is proposed that these root apices are covered by an extremely thin bony lamella (that may be absent sometimes) and the sinus membrane. This close proximity should be taken into consideration during endodontic planning. Close proximity of the maxillary sinus and root tips can have several endodontic implications. Symptoms associated with acute or subacute maxillary sinusitis could be mistaken for those of pulpal origin.¹² The teeth affected by sinusitis will generally be sensitive to palpation and/or percussion, but will respond within normal limits to pulp vitality tests. Pain of pulpal origin will manifest as thermal sensitivities, spontaneous episodes of sharp pain and possibly swelling and cellulitis. The direct extension of dental sepsis into the sinus was shown for the first time in a study by Bauer.¹³ They showed the destruction of the bone separating the sinus from the teeth, with particular loss of the cortical bone normally found on the sinus floor. In addition, the sinus mucosa was seriously altered showing swelling with inflammation, granulation tissue, hypertrophy, fibrous changes, hyalinization or complete necrosis. Mélen et al reported varying frequency of sinusitis of dental origin, between 4.6 and 47% of all sinusitis cases.¹⁴ The spread of pulpal disease beyond the limits of the dental supporting tissues into the maxillary sinus was termed Endo-antral syndrome (EAS) by Selden.^{15,16} It has been

shown that the closer the apex of a pulpally involved tooth is to the floor of the sinus, the more likely and the greater the impact will be on the sinus tissues.¹⁷ According to Bauer,¹³ periapical infection spreads through the bone marrow, and follows the path of blood vessels and lymphatics. Most cases of EAS respond satisfactorily to nonsurgical root canal treatment. For refractory cases, a surgical approach is recommended. The maxillary sinus poses a special challenge when root canal treatment is to be performed on teeth with roots in close proximity to the maxillary sinus. It is an established guideline that all endodontic instruments and materials should be restricted to the confines of the root canal system during treatment, but it frequently happens that instruments and medicaments are introduced beyond the apical foramen. Inadvertent injection of sodium hypochlorite (NaOCl) into the periapical tissues may lead to complications such as severe pain, oedema and profuse hemorrhage both interstitially and through the tooth. Edema and ecchymosis occur, accompanied by tissue necrosis, paraesthesia and sometimes, secondary infection. The majority of cases show complete resolution within a couple of weeks while a few have been marked by long-term paraesthesia or scarring.^{18,19} Intracanal medicaments placed between visits may be extruded unintentionally into the sinus. Haanæs et al²⁰ injected Ca (OH)₂ into the maxillary sinus cavity of monkeys to evaluate its clinical, radiological and histological effect on the sinus mucosa. Results from this study showed that sinusitis can occur when Ca (OH)₂ is deposited into the sinus. The authors attributed the inflammatory response of the sinus mucosa to the material initially acting as a chemical irritant and later as a foreign body. The amount deposited into the sinus was also considered an important factor to the inflammatory response. Despite the stated effects of Ca (OH)₂ on the tissues, these cases have shown spontaneous healing. During obturation, sealer or solid materials such as gutta-percha or silver cones may invade the maxillary sinus. Mechanical irritation occurs from overfilling the root canal, thereby impinging foreign materials on the vital tissues. This produces an

inflammatory reaction with an area of rarefaction in the periapical tissues. Such inflammation is likely to persist until the foreign object is removed. Sinus aspergillosis may also be caused by overfilling of the root canal, with the zinc oxide in the root filling material inducing the infection.²¹ Oro-antral communication is a known complication of endodontic surgery of posterior teeth. Pathological exposure of the sinus floor predisposes many surgical endodontic procedures to similar maxillary sinus communication²². The thickness of bone separating the apices of the teeth in the lateral segments of the maxilla from the sinus is shown to be in the range of 0.8–7 mm.⁹ Perforations have been reported in 18% of 159 premolar and molar apicectomies.²³ Sinus membrane, complete with cilia, regenerates in about five months after total surgical removal. In view of the aforementioned implications, pre-operative assessment of the proximity of maxillary sinus is necessary to avoid any iatrogenic complications.

CONCLUSION

The close proximity of maxillary sinus floor to the molar roots can have several endodontic implications. The following conclusions regarding the proximity of molar roots to the maxillary sinus can be drawn from this CBCT-based investigation:

1. Roots of second molars were, on average, positioned much closer to the maxillary sinus than roots of first molars.
2. Mean distance of root from sinus floor was shortest for DB root of the second molar and highest for MB root of first molar.
3. Frequency of root tip protruding into the maxillary sinus was highest for DB root of second molar and lowest for DB root of first molar and palatal root of second molar.
4. If the distance between molar roots and the maxillary sinus appears to be critical, taking a CBCT scan is suggested for diagnosis, treatment planning, and surgical intervention.

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