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Unlocking Implant Planning: A Retrospective Cone Beam Computed Tomography Study of Inter-Radicular Septum in Immediate Maxillary Molar Implant Placement

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KEYWORDS

Inter-Radicular Septum, Maxillary Molar, Immediate Implant Placement, CBCT

ABSTRACT:

This study highlights the assessment of inter radicular septum (IRS) on cone beam computed tomography (CBCT) as an important pre-treatment tool for immediate maxillary molar implant (IMI) placement. Aim: To evaluate the suitability of inter radicular septum (IRS) of the maxillary first and second molars using cone beam computed tomography to receive immediate implant placement. Objectives: To measure and compare IRS dimensions of the first and second molars and to assess the suitability to house an immediate implant. Method: A total OF 120 CBCT scans that displays IRS completely were selected for the study. The IRS was analyzed in all three dimensions and apex to floor of maxillary sinus dimension is also analyzed. Result: This study concludes more significant IRS in maxillary first molars when compared to the second molars, hence first molars were eligible sites for IMI placement.

Introduction

After molar extraction, there is a noticeable volumetric reduction in alveolar bone. Rarely, maxillary sinus pneumatization is the cause of this, and bone remodeling is the main factor. When a molar is lost in the maxillary posterior area together with another tooth, bone remodeling becomes more noticeable. As a result, IMI placement maybe a therapeutic choice where Molar preservation is good. But taking IMI location into consideration has become difficult due to a lack of adequate provided data[2]. The bone structure that divides the tooth roots from the furcation line to the apical limit of the roots is called the interradicular septum, and it is found between dental sockets. The septal bone between upper molars often exhibits triangular morphologies because these teeth are typically multi-rooted, primarily having three roots. In certain situations, inadequate interradicular bone septum dimensions can imped implant placement operations, even though the interradicular bone septum is the best location for rapid implant insertion in the posterior area[1]. Cone beam computed tomography has rendered it feasible to virtually analyze craniofacial structures at submillimeter dimensions. Implantologists

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are specifically intrigued by the CBCT study of the interradicular septum (IRS) as it is the best location for IMI implantation in the first and second maxillary molars [2]. It is widely agreed upon that the use of cone beam computed tomography (CBCT) has improved the examination of this maxillary area. Regarding the most widely utilized radiographic diagnostic techniques in dentistry, CBCThas overcome the drawbacks of other radiological techniques, such as 2D radiography's distortions and superimpositions, computed tomography's restricted access, poor resolution, challenges with dental interpretation, longer scanning times, high costs, metal artifact disruption, and high radiation exposure from computed tomography and multi-sliced computed tomography. Furthermore, by collimating the source X-ray beam to the area of interest, CBCT reduces radiation; the image's submillimeter resolution precision is accurate enough for implant planning.The application of CBCT technology has already demonstrated exceptional qualities for the detailed morphometric characterization of structures that might be useful for implant placement planning processes[2].

Material and Methods

In total, 120 anonymized scans from the Department of Oral Radiology's archive of St. Joseph Dental College & Hospital that solely disclosed the patient's age and sex were chosen. By using G*power with an alpha level of 0.05, power of 80%, a minimum sample size of 120 was considered efficient. A retrospective observational study.The study received approval from the Institutional Ethical Committee of St.Joseph Dental College and Hospital. [IEC PROTOCOL NUMBER: SJDC/CEC/OMR/2025/001].

Inclusion Criteria

The presence of at least one fully erupted molar with fully formed root apices and two maxillary posterior teeth (1 premolar and/or 1 molar) with good bone quality.

Exclusion Criteria

1. Scans showing radiographic evidence of poor bone density, periapical and maxillary sinus pathology, periodontal diseases, residual roots.

2. Patients receiving orthodontic treatment or orthognathic surgery, embedded teeth and fractures.

Method of Data Collection

A total of 120 scans made for orthodontic purposes, canal configuration of molars or premolars, or immediate implant placement and fitting the inclusion criteria were selected for this study. The methodology in our study was based on previous studies done by Karmarkar, et al.[1]and Zlata et al. First, the images were oriented such that the long axis of the first or second molar was perpendicular to the x-axis. Three axes (x, y, and z) were implemented to evaluate the three parameters (height and width): The y-axis was used to determine the distance between the root bifurcation and the sinus floor, or the furcation to sinus distance (FSD)/height of the IRS. In order to provide for a fair assessment of IRS, planes designated on the coronal section were used to measure the parameters of IRS in the x and z axes. First, a location 0.5 mm apical to the root bifurcation was designated as the crestal plane. A point 0.5 mm coronal to the line connecting the two shortest roots or a tangent drawn to the maxillary sinus floor, whichever was longer, was then designated as the apical plane.Finally, a middle plane was marked at a point in the middle of the crestal and apical planes. The buccopalatal width of the IRS was measured as follows. The CBPW, ABPW, and MBPW (buccopalatal width at the crestal, apical, and middle planes, respectively) were measured. The mesiodistal width of the IRS was measured as follows. CMDW, AMDW, and MMDW (mesiodistal width at the crestal, middle, and apical planes, respectively) were noted down. All the data were recorded in tabular format for the IRS of the first and second molars. And to evaluate the distance from apex of root to floor of maxillary sinus is measured. A comparative analysis was performed between the IRS dimensions of the first and second molars. Parameters – a) Furcation sinus distance[FSD]b)Buccal to palatal width at coronal, middle and apicallevels [CMDW, MMDW, and AMDW] c)Mesial to distal width at coronal, middle and apical levels [CBPW, MBPW, and ABPW] d)Root apex to maxillary floor.

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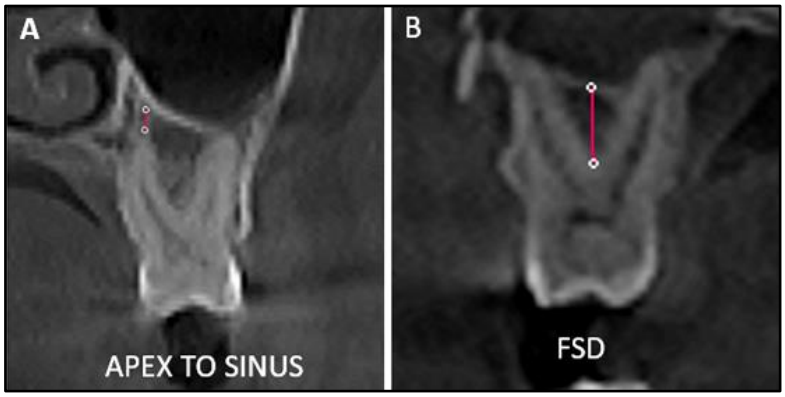

Figure-1 A) Measurement of the height of the apex (root tip) to floor of maxillary sinus. **B)** Measurement of the height of the IRS (FSD in the vertical plane)

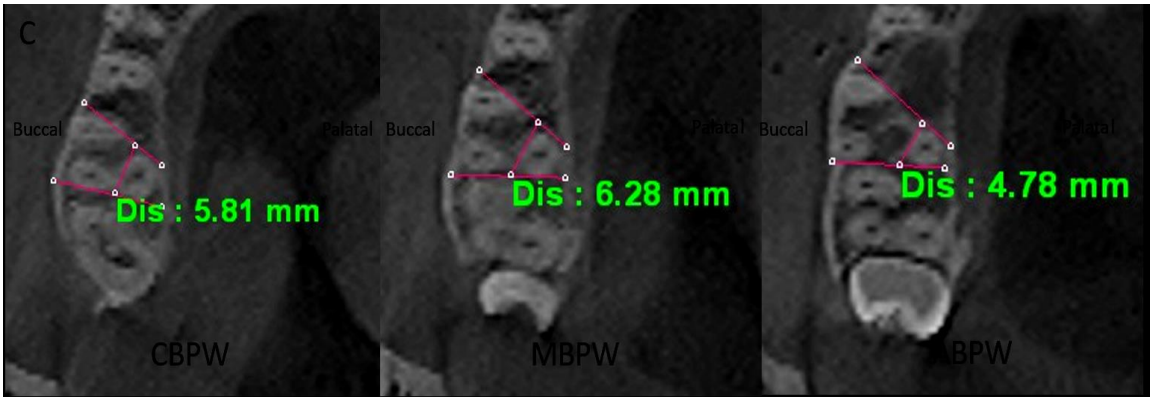

Figure-2 C) Bucco-palatal measurements (CBPW, MBPW, and ABPW in crestal, middle, and apical planes, respectively)

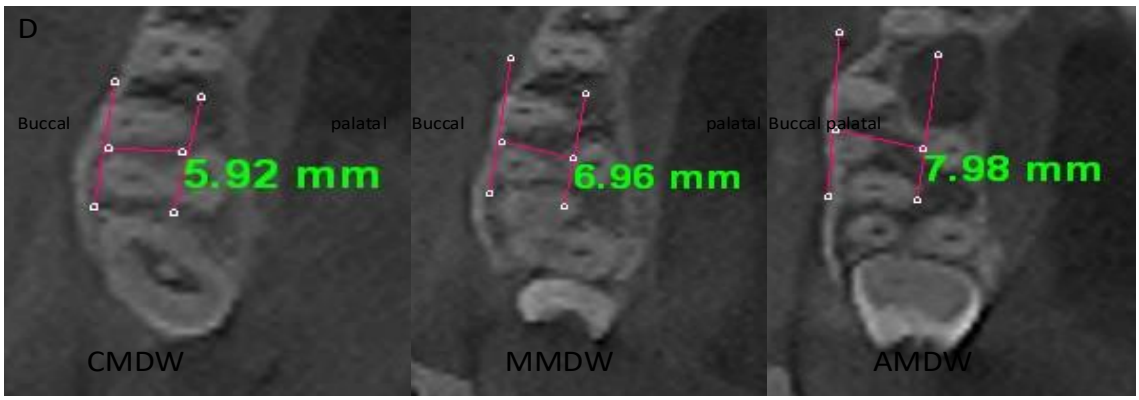

Figure-3 D) Mesiodistal measurements (CMDW, MMDW, and AMDW in crestal, middle, and apical planes, respectively)

Data Analysis

The mean values for each parameter were considered for statistical analysis. SPSS version 20 is used for analysis and paired t test is done.

Results

The mean values for both first and second molars were considered separately, and a comparative analysis was done. All results are shown in the graphical format to visualize the statistically significant difference more clearly.

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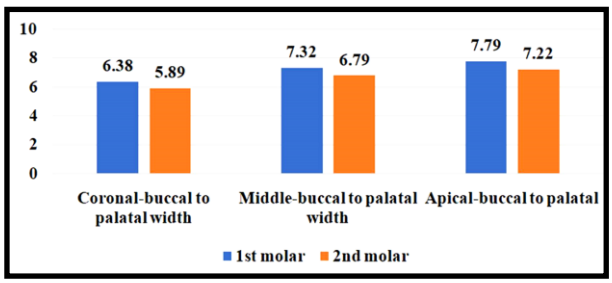
Table 1: Comparison of Anatomical Dimensions for Immediate Implant Suitability Between Maxillary First and Second Molars

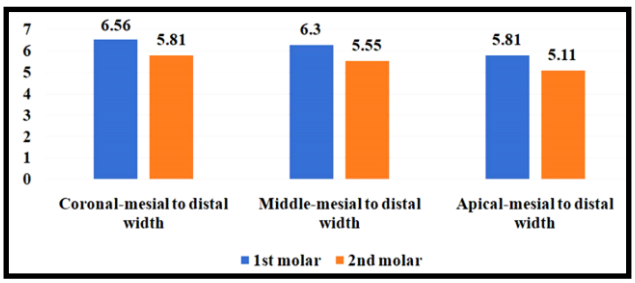
	GROUPS	Mean	Std. Deviation	Std. Error Mean	t	P value
Furcation sinus distance	1ST MOLAR	5.3125	1.75944	0.16154	3.943	< 0.001*
	2ND MOLAR	4.7023	1.59540	0.14503		
Coronal-buccal to palatal width	1ST MOLAR	6.3840	0.76565	0.06960	5.319	< 0.001*
	2ND MOLAR	5.8988	0.81556	0.07414		
Middle- buccal to palatal width	1ST MOLAR	7.3292	0.90744	0.08249	5.796	< 0.001*
	2ND MOLAR	6.7935	1.03177	0.09379		
Apical- buccal to palatal	1ST MOLAR	7.7990	1.36235	0.12384	4.416	< 0.001*
	2ND MOLAR	7.2290	1.34292	0.12207		
Coronal- mesial to distal width	1ST MOLAR	6.5602	1.04572	0.09506	7.663	< 0.001*
	2ND MOLAR	5.8150	0.95742	0.08703		
Middle- mesial to distal width	1ST MOLAR	6.3022	0.90076	0.08188	7.648	< 0.001*
	2ND MOLAR	5.5568	0.85922	0.07811		
Apical- mesial to distal width	1ST MOLAR	5.8102	1.02347	0.09304	6.060	< 0.001*
	2ND MOLAR	5.1153	1.05761	0.09614		
Root apex to maxillary floor	1ST MOLAR	1.5105	1.12048	0.10185	4.187	< 0.001*
	2ND MOLAR	0.9937	0.64457	0.05859		
Paired t test *statistically significant						

Graph-1. Comparison of Buccal to Palatal Widths at Coronal, Middle, and Apical Levels for First and Second Molars



The coronal, middle, and apical buccal to palatal widths are all greater for the first molar (6.38 mm, 7.32 mm, and 7.79 mm, respectively) compared to the second molar (5.89 mm, 6.79 mm, and 7.22 mm, respectively). The difference is most pronounced at the middle level, where the first molar measures 7.32 mm versus 6.79 mm for the second molar. (Graph 2) mean values of buccal-palatal width, the first molar demonstrated greater coronal (6.38 mm and 5.90 mm for first and second molars, respectively), middle (7.33 mm and 6.79 mm), and apical (7.80 mm and 7.23 mm) dimensions, all with P-values of less than 0.001.

Graph-2. Comparison of Mesial to Distal Widths at Coronal, Middle, and Apical Levels for First and Second Molars



At the coronal level, the first molar measures 6.56 mm, which is greater than the second molar at 5.81 mm. The middle level width is also larger in the first molar (6.3 mm) than the second molar (5.55 mm).At the apical level, the first molar is 5.81 mm, while the second molar measures 5.11 mm.(Graph 2) mean values of mesial-distal widths were also significantly larger for the first molar than second molar at all levels: coronal (6.56 mm and 5.82 mm), middle (6.30 mm and 5.56 mm), and apical (5.81 mm and 5.12 mm), each showing a highly significant difference ($P < 0.001$).

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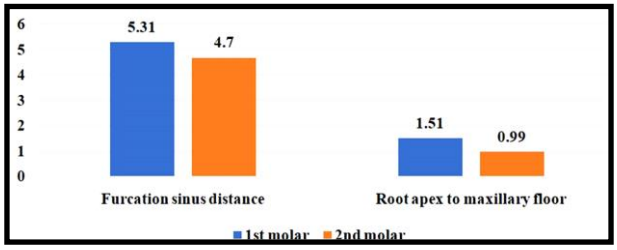
Graph-3. Comparison of Furcation Sinus Distance and Root Apex to Maxillary Floor Between First and Second Molars



The furcation sinus distance is greater in the first molar (5.31 mm) compared to the second molar (4.7 mm). Similarly, the distance from the root apex to the maxillary floor is longer in the first molar (1.51 mm) than in the second molar (0.99 mm).(Graph 3) mean value of furcation-to-sinus distance, the first molar had a mean of 5.31±1.76, while the second molar measured 4.70±1.60, with a statistically significant difference ($P < 0.001$). The distance from the root apex to the maxillary sinus floor was also greater for the first molar than second molar (1.5105 and 0.9937) with P-values of less than 0.001.

Discussion

After maxillary molar extraction, the IRS experiences a dynamic reduction, accelerated by the loss of adjacent posterior teeth in the same extant. A few millimeters are reduced from the IRS height as a result of maxillary sinus pneumatization. According to a literature review, indicates that the optimal method for restoring the edentulous maxillary posterior area is to place an immediate maxillary molar implant since the newly extracted socket has greater osteogenic potential. In a study conducted by karmarker et el. (2023), 89% first and 71% of second molars were eligible sites for IMI.This percentage is significantly greater than that found in our study for both the first and second molars.In a study conducted by Deporter et al. (2022), 94% of first molars and 93% of second molars were eligible for the placement of IMI. This percentage is significantly greater than that found in our study for both the first and second molars.Zlata et al. (2021) conducted a similar study in which they obtained lesser values of IRS mesiodistal and bucco-palatal widths and performed a comparison of left and right maxillary molars as well as gender-based analysis. They did not find any significant differences in IRS dimensions between various age groups, genders, and the right and left sides, which is in agreement with our study.

However, the CBCT is essential for the assessment of IRS for placing IMI. our study, being first reported study with total of eight parameters and one new parameter is added on the Indian population, can add value to the literature for further research and researchers.

Future Prospects

Generally, the roots of the maxillary first and second molars are located close to or encroaching into the sinus. Our study was mainly focused on the IRS as the site for IMI and apex of mesio-buccal root to floor of maxillary sinus distance. However, in addition to this, the distance between distobuccal, and palatal roots to the floor of the maxillary sinus should also be assessed for receiving dental implants for more accuracy.

Conclusion

The upper molars region is one of the most commonly reported for teeth loss and after extraction of maxillary molars, the IRS undergoes a dynamic reduction in size, which is accelerated by the loss of adjacent posterior teeth in the same extant. Maxillary sinus pneumatization results in a reduction in IRS height by a few millimeters. Placement of an immediate maxillary molar implant is the best way to restore the edentulous maxillary posterior region as the fresh extraction socket has more osteogenic potential. Further studies needed with more sample size to evaluate the suitability of inter radicular septum of the maxillary first and second molars**.**

Therefore, before placing IMI to replace maxillary molars, a standard investigation should include a CBCT evaluation of IRS.

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