

Comparative Evaluation of the Relationship between the Root-Tips of Maxillary Posterior Teeth and Floor of Maxillary Sinus using Digital Orthopantomogram in Chhattisgarh Individuals with Different Cephalic Indices

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Abstract

Background and Aims: Cephalic index has significant importance in the field of forensic science and variation in the cephalic index affects the facial dimensions and growth of the maxillary sinus in an individual. Knowledge of the anatomical relationship between maxillary posterior teeth and the floor of the maxillary sinus is very important for preoperative treatment planning in dentistry. The aim of the study is a comparative evaluation of the relationship and the distances between maxillary posterior teeth root tips and the floor of the maxillary sinus in different cephalic index subjects using a digital orthopantomogram. **Materials and Methods:** 210 subjects were categorized as Brachycephalic, Mesocephalic and Dolichocephalic according to their cephalic index. Orthopantomograms of these subjects were taken for assessment of vertical relationships between the maxillary posterior teeth and the floor of the maxillary sinus followed by distance measurement. Recorded data were statistically analyzed. **Results:** Significant difference in vertical distance was observed in all three cephalic groups in the case of 1st premolars, distobuccal roots of 1st molars and mesiobuccal roots of 2nd molars. **Conclusion:** The study concluded variation in the cephalic index affects the relationship and vertical distance between the maxillary sinus floor and the roots of maxillary posterior teeth.

Keywords: Cephalic Index, Maxillary Sinus, Maxillary Posterior Teeth, Orthopantomogram

Introduction

The maxillary sinus (Antrum of Highmore) is a pyramid-shaped air-filled osseous cavity with its base at the lateral nasal wall and apex towards the zygomatic process of the maxilla¹. It is the first paranasal sinus to appear in the facial skull as it starts developing during the intrauterine fetal life and continues to develop even after birth. Its growth ends by approximately 20 years of age. The size

and shape of the adult maxillary sinus are variable and may differ according to the age of an individual, their size and the degree of pneumatization². The cephalic index has a close relationship with facial dimensions. Enlargement of the maxillary sinus in an individual is concomitant to facial growth. The maxillary sinus often expands in the maxillary posterior teeth region and results in close proximity between the roots³.

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The close anatomical proximity between the floor of the maxillary sinus and maxillary posterior teeth is quite challenging for dental clinicians, especially during the endodontic, and prosthetic procedures and surgical extractions involving the removal of maxillary posterior teeth⁴. It can cause accidental oroantral communication and lead to the displacement of roots into the maxillary sinus⁵. Therefore, the knowledge of the anatomical relationship between the maxillary posterior teeth and maxillary sinus guides us in proper preoperative dental treatment planning.

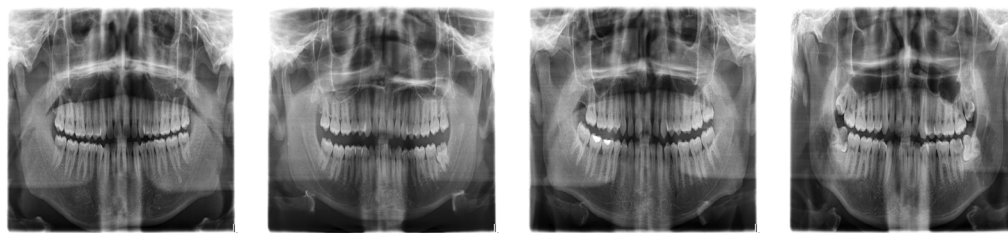
Previous studies have assessed the vertical relationship between the root apex of maxillary posterior teeth and the maxillary sinus floor using different imaging modalities. But very few studies focused on evaluating the distance of maxillary posterior teeth with a floor of the maxillary sinus in subjects with different cephalic indices using panoramic radiographs, as variation in cephalic index affects the facial dimensions and growth of maxillary sinus in an individual⁶. Therefore, the present study was undertaken to study this relationship in the Chhattisgarh population using a digital Orthopantomogram (OPG).

Materials and Methods

This was an observational and cross-sectional type of study. 210 subjects (105 males and 105 females), of the local Chhattisgarh population, were selected within an age range of 20-55 years. The study was approved by the Institution's scientific and ethical committee. All subjects were explained the entire procedures of the study and included after taking informed consent from them. Subjects having normally erupted and aligned complete dentition were included and those having periodontal diseases, any pathologies or developmental anomalies of skull/face, previous history of maxillofacial trauma,

orthognathic/reconstructive surgery, implant procedures in the posterior maxilla, history of endocrinal, hereditary and nutritional disorders were excluded from the study.

Measurement of Cephalic Indices of the subjects was performed by calculating the ratio between the maximum width (biparietal diameter) and maximum length (occipito frontal diameter) of the head multiplied by 100. These head measurements were done using Spreading Caliper. The subjects were categorized into three groups (35 males and 35 females i.e., 70 subjects in each group) according to their cephalic index values as mentioned by Arabion H et al in their study⁷. Group 1: Brachycephalic - CI > 80; Group 2: Mesocephalic - CI 75-80; Group 3: Dolichocephalic - CI < 75. The orthopantomograms of the subjects were taken on SIRONA ORTHOPHOS XG5 machine using standard technique and exposure parameters and viewed using Sidexis software. These radiographs were then assessed for determining the vertical relationship between root tips of maxillary 1st and 2nd premolars and 1st and 2nd molars with a floor of the maxillary sinus. Each root tip was classified into four types: Type 1, 2, 3 and 4 (Figure 1) according to the classification used by Arabion H *et al.*⁷ Type 1: Root located at a distant position from the sinus floor; Type 2: close contact between root tip and sinus floor; Type 3: Projection of root into the sinus cavity without actual penetration; Type 4: Protrusion of roots into the sinus cavity. Undisrupted continuity of lamina dura was used to distinguish between Type 3 and Type 4. Perpendicular lines were then drawn connecting the deepest point of the maxillary sinus floor to the root tips of the maxillary posterior teeth (1st and 2nd premolars and 1st and 2nd molars) in orthopantomograms and the distances were measured and recorded in all the three groups using measuring tool in Digimizer image analysis software (Figure 2).



Type 1 - Root apex located at distant position from the floor of sinus.

Type 2 - Root apex in contact with floor of sinus.

Type 3 - Projection of root into the sinus cavity without actual penetration.

Type 4 - Protrusion of roots into the sinus cavity.

Figure 1. Cropped OPG images showing Type 1, Type 2, Type 3, Type 4 relations between maxillary posterior teeth root apex and maxillary sinus floor.

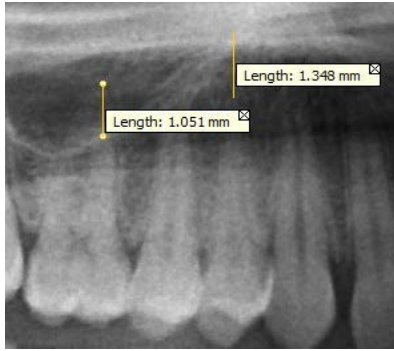


Figure 2. Cropped OPG image showing distance measurement from root tip to maxillary sinus floor in 1st premolar (Type 1 relation) and palatal root of 1st molar (Type 3 relation).

Statistical Analysis

The recorded data were statistically analyzed using SPSS software (Statistical Package for the Social Sciences) version 24. The statistical analysis was carried out to evaluate and compare these parameters in brachycephalic, mesocephalic and dolichocephalic groups using the Chi-square test, Wilcoxon signed rank test and ANOVA. The results were tested at a 95% confidence interval and a 5% level of significance (P -value ≤ 0.05).

Results

In the present study, the mean Cephalic Index value was observed more in the brachycephalic group followed by mesocephalic and dolichocephalic groups. Types of the relationship between the root tips and maxillary sinus floor were recorded for a total number of 840 premolar teeth including 1st and 2nd premolars on both the right and

left sides (Tables 1 and 2). Type 1 was the most common relationship among root tips of 1st and 2nd premolars and Type 4 was the least commonly observed relation in them. Similarly, qualitative vertical relationships between the maxillary 1st and 2nd molar root tips and the maxillary sinus floor were recorded for both the right and left sides (Tables 3 & 4). Statistical analysis for variation among the 1st and 2nd premolars and 1st and 2nd regarding their qualitative relationship of root tips with the maxillary sinus floor revealed a significant difference as obtained P -value < 0.001 .

Gender Discrimination Analysis was performed for 1st and 2nd premolars and 1st and 2nd molars for both right and left sides. Results showed no significant differences in the relation between the maxillary sinus floor and root tips for both premolars and molars in male and female subjects as P -value > 0.05 .

The mean value of the distance from root tips to the maxillary sinus floor was observed greater in 1st premolars than 2nd premolars (Table 5). Similarly, the mean distance observed was more in 1st molars than 2nd molars (Table 6). Results showed highly significant differences among Brachycephalic, Mesocephalic and Dolichocephalic groups in 1st and 2nd premolars and mesiobuccal roots of 2nd molars as observed P -value was 0.001 (Table 7). No significant differences were found among Brachycephalic, Mesocephalic and Dolichocephalic groups in mesiobuccal, palatal, and distobuccal roots of 1st molars and palatal and distobuccal roots of 2nd molars.

Discussion

Cephalometry is the study and measurement of a human head. It is used in the fields of forensic medicine, archaeology, and orthodontics for personal identification

Table 1. Assessment of qualitative vertical relationship between maxillary 1st and 2nd premolar root tips and the maxillary sinus floor of left side

Study Variables	Categories	Frequency Per Category (Number)	Frequency Per Category (%)	Chi-Square Test
1 st Premolar	Type 1	171	81.43	P < 0.0001*
	Type 2	27	12.86	
	Type 3	11	5.24	
	Type 4	1	0.48	
2 nd Premolar	Type 1	111	52.86	
	Type 2	55	26.19	
	Type 3	43	20.48	
	Type 4	1	0.48	

Table 2. Assessment of qualitative vertical relationship between maxillary 1st and 2nd premolar root tips and the maxillary sinus floor of right side

Study Variables	Categories	Frequency Per Category (Number)	Frequency Per Category (%)	Chi-Square Test
1 st Premolar	Type 1	183	87.14	P < 0.0001*
	Type 2	11	5.24	
	Type 3	14	6.67	
	Type 4	2	0.95	
2 nd Premolar	Type 1	118	56.19	
	Type 2	38	18.09	
	Type 3	53	25.24	
	Type 4	1	0.47	

Table 3. Assessment of qualitative vertical relationship between maxillary 1st and 2nd molar root tips and the maxillary sinus floor of left side

	Study Variables	Categories	Frequency Per Category (Number)	Frequency Per Category (%)	Chi-Square Test
1 st Molar	Mesiobuccal Root	Type 1	53	25.24	Chi-Square Test < 0.0001*
		Type 2	61	29.05	
		Type 3	95	45.24	
		Type 4	1	0.47	
	Palatal Root	Type 1	13	6.19	
		Type 2	26	12.38	
		Type 3	55	26.19	
		Type 4	116	55.24	
	Distobuccal Root	Type 1	51	24.29	
		Type 2	71	33.81	
		Type 3	80	38.09	
		Type 4	8	3.81	
2 nd Molar	Mesiobuccal Root	Type 1	41	19.52	
		Type 2	83	39.52	
		Type 3	85	40.47	
		Type 4	1	0.47	
	Palatal Root	Type 1	6	2.86	
		Type 2	31	14.76	
		Type 3	56	26.67	
		Type 4	117	55.71	
	Distobuccal Root	Type 1	50	23.81	
		Type 2	83	39.52	
		Type 3	73	34.76	
		Type 4	4	1.90	

Table 4. Assessment of qualitative vertical relationship between maxillary 1st and 2nd molar root tips and the maxillary sinus floor of right side

	Study Variables	Categories	Frequency Per Category (Number)	Frequency Per Category (%)	Chi-Square Test < 0.0001*
1 st Molar	Mesiobuccal Root	Type 1	54	25.71	
		Type 2	58	27.62	
		Type 3	96	45.71	
		Type 4	2	0.95	
	Palatal Root	Type 1	17	8.09	
		Type 2	21	10.0	
		Type 3	62	29.52	
		Type 4	110	52.38	
	Distobuccal Root	Type 1	61	29.05	
		Type 2	70	33.33	
		Type 3	71	33.81	
		Type 4	8	3.81	
2 nd Molar	Mesiobuccal Root	Type 1	38	18.09	
		Type 2	93	44.28	
		Type 3	78	37.14	
		Type 4	1		
	Palatal Root	Type 1	4	1.91	
		Type 2	26	12.38	
		Type 3	58	27.62	
		Type 4	122	58.09	
	Distobuccal Root	Type 1	53	25.24	
		Type 2	98	46.67	
		Type 3	58	27.62	
		Type 4	1	0.47	

Table 5. Comparison of the mean value of distance from root tips to the maxillary sinus floor between the 1st & 2nd Premolars

Study Variables	Mean Distance with SD	Wilcoxon signed rank test
1 st Premolar	1.20 ± 0.64	< 0.001*
2 nd Premolar	0.78 ± 0.54	< 0.001*

Table 6. Comparison of the mean value distance from root tips to the maxillary sinus floor between the 1st and 2nd Molars

Study Variables	Mean Distance with SD	Wilcoxon signed rank test
1 st Molar	Mesiobuccal Root	0.61 ± 0.45
	Palatal Root	0.63 ± 0.29
	Distobuccal Root	0.35 ± 0.34
2 nd Molar	Mesiobuccal Root	0.46 ± 0.45
	Palatal Root	0.58 ± 0.28
	Distobuccal Root	0.24 ± 0.266

Table 7. Assessment of vertical distance between Maxillary Molar and Premolar Root tips and the maxillary sinus floor among Brachycephalic, Mesocephalic and Dolichocephalic groups

Study Variables		Mean Distance			ANOVA test
		Brachycephalic	Mesocephalic	Dolichocephalic	P-Value
1 st Molars	Mesiobuccal Root	0.65 ± 0.39	0.56 ± 0.46	0.62 ± 0.49	0.19
	Palatal Root	0.63 ± 0.22	0.61 ± 0.27	0.64 ± 0.37	0.65
	Distobuccal Root	0.36 ± 0.288	0.32 ± 0.28	0.37 ± 0.42	0.30
2 nd Molars	Mesiobuccal Root	0.42 ± 0.39	0.38 ± 0.37	0.57 ± 0.55	0.001*
	Palatal Root	0.56 ± 0.23	0.57 ± 0.23	0.62 ± 0.36	0.17
	Distobuccal Root	0.35 ± 1.77	0.24 ± 0.23	0.27 ± 0.29	0.64
Pre Molars	1 st Premolar	1.16 ± 0.45	0.99 ± 0.39	1.45 ± 0.86	0.001*
	2 nd Premolar	0.76 ± 0.50	0.73 ± 0.47	0.86 ± 0.61	0.001*

and also be used to examine different races and ethnic groups⁸. The first classification based on cranial morphology was given by professor Anders Retzius (1840)⁹. The measures used by Retzius are called the cephalic index when applied to living individuals and are known as the cranial index when referring to dry skulls¹⁰. Both the cephalic and cranial indices are measures related to the shape of the skull. The base of the skull is considered a primarily stable structure, from which the face develops in an inferior and anterior direction and the cephalic index has a close relationship with facial dimensions. Thus, the head shape influences the shape of face¹¹.

There is a close relationship between maxillary posterior teeth and the floor of the maxillary sinus. According to certain studies, there is also a positive correlation between the length of root projection into the maxillary sinus and the amount of pneumatization that occurs after extraction¹². Sinus expansion following extraction can greatly decrease the amount of bone height available for implant placement¹³. The relationship between the dental roots and the inferior sinus wall is known to influence orthodontic tooth movements, like intrusion or bodily movement of the teeth across the sinus floor, as it has been associated with a risk of root resorption and a higher degree of tipping¹⁴.

In the present study, the relationship between the root of maxillary posterior teeth and maxillary sinus floor was evaluated using an orthopantomogram because of its easy availability, lower radiation dose and fairly

accurate results. The type of relationship between the root tips of 1st and 2nd premolars and 1st and 2nd molars with maxillary sinus floor was recorded for both right and left sides. Type 1 relation was most common in 1st premolar and 2nd premolar root tips. Type 4 was the least frequently observed relation in both cases. Similar results were observed by Gowrisankar C *et al.*, and Mattar E *et al* in their study^{15,16}. But Pertiwi AD *et al.*, found Type 1 relation in 1st premolars and Type 2 relation in 2nd premolars¹⁷. In case of 1st molars Type 3 relation was dominant in the mesiobuccal and distobuccal root tips. While Type 2 relation was commonly observed relation in the mesiobuccal and distobuccal root tips of 2nd molars. Type 4 relation was mostly found in the palatal root tips of 1st and 2nd molars.

According to the results of our study 1st premolars were located at a greater distance from the sinus floor as compared to the 2nd premolars. This was in accordance with the study done by Kwak HH *et al*¹⁸. The mean value of the distance between root tips and maxillary sinus floor was observed more in 1st molars as compared to 2nd molars. Thus, the molar root tips were observed to be located in close approximation with the maxillary sinus floor. Similar results were also observed by Arabion H *et al.*,⁷ Gowrisankar C *et al.*,¹⁵ and Mattar E *et al.*,¹⁶ in their studies.

Highly significant differences were observed in Brachycephalic, Mesocephalic and Dolichocephalic groups, while evaluating the mean vertical distance

between maxillary 1st and 2nd molars and 1st and 2nd premolars root tips and the maxillary sinus floor in the case of mesiobuccal root tips of 2nd molars and root tips of 1st and 2nd premolars as P value was 0.001. The possible explanation for this is the change in the cephalic index may affect maxillary vertical height and alter the distance between the maxillary sinus and the maxillary posterior teeth roots. This hypothesis was suggested by Farkas *et al*¹¹.

Conclusion

The present study concludes variation in the cephalic index affects the relationship and vertical distance between the maxillary sinus floor and the roots of maxillary posterior teeth. Dental clinicians should take into consideration the amount of protrusion of roots into the maxillary sinus in OPG, as it will guide them in the proper treatment planning of dental procedures involving maxillary posterior teeth, particularly molars due to their close proximity to the maxillary sinus floor. Even three-dimensional imaging can be done in these cases for better visualization of anatomic structures in future studies.

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