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ORIGINAL RESEARCH

Assessment of Positional Variation of Maxillary Permanent First Molar with respect to the Infrazygomatic Crest (Key Ridge) in Skeletal Class I, II and III Cases

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ABSTRACT

Introduction: To assess the positional variations of maxillary first permanent molar in horizontal and vertical plane with respect to infrazygomatic crest (key ridge) in skeletal class I, II and III cases.

Materials and methods: A total of 103 lateral cephalograms comprising of 40 skeletal class I (control group), 35 class II and 28 class III cases were selected and analyzed. Six parameters were chosen to compare the vertical and the horizontal variations of first permanent molars.

Results: The angulation of maxillary first molar with respect to key ridge in class II and III was 2.42° and 6.97° as compared to class I which was 5.35°. The mesiobuccal cusp tip of maxillary first molar from key ridge in class II and III was 2.11 and 5.46 mm respectively as compared to class I (1.62 mm). The mesiobuccal root tip of maxillary first molar from key ridge in class II and III was 2.14 and 2.82 mm as compared to class I (1.27 mm).

Conclusion: The maxillary first molar was not directly under the infrazygomatic crest and was ahead of the key ridge in all the groups. The maxillary first permanent molar was placed more mesially in class II and III cases as compared to the class I cases but, in class III, it was more upright as compared to class I and II.

Keywords: Occlusion, Infrazygomatic crest (key ridge), Mesiobuccal cusp tip, Mesiobuccal root tip.

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INTRODUCTION

In the speciality of orthodontics the classification of malocclusion plays a very important role. It helps in diagnosis and treatment planning of malocclusion and to determine the magnitude of the problem. Secondly, classification facilitates communication between specialists. Many clinicians have developed classification system for describing the malocclusion *viz* Kingsley,[1] Angle,[2-4] Case,[5] Deway,[6] Anderson,[7] Hellman,[8] Bennet,[9] Simon,[10] Ackreman and Profit,[11] etc. but the most universally accepted classification system\still in use today is EH Angles method which was developed in 1889, and was based on the position of maxillary permanent first molar in the craniofacial anatomy.[12]

All teeth are essential, yet in function and influence; some are of greater importance than others, the most important of all being the maxillary first permanent molar, which often called as 'keys to occlusion'. Angle (1906) published his classic article in dental items of interest entitled 'the upper first molars as a basis of diagnosis in orthodontics' where he proposed the virtues of the maxillary first molar.[2] George Risse suggested that the upper first molars were the key to occlusion because of following virtues:

- Largest teeth
- Are the firmest in their attachment
- Have a key location in the arches
- Occupy normal position in the arches far more often than any other teeth because they are the first permanent teeth to erupt
- Broadest spread of roots and the widest base.[13]

Angle gave his classification of malocclusion on the assumption that maxillary first permanent molar is unchanging in its position and it lies on the key ridge. In order to support this broad cranial base, nature has furnished with correspondingly broad buttress of bone on which upper first molar rests. This is known as key ridge (infrazygomatic crest). However, at that time when angle gave this classification there was no radiographic evidence to support his assumption.[14] Key ridge was given by Atkinson in 1923 and was a dependable aid to the diagnosis of the mesiodistal relationship of the apical bases.[13] This key ridge in craniofacial anatomy is shown by Sicher and DruBrul as a pillar of trajectories. Saul M Bien et al showed that this strong ridge of bone projects downward from the anterior end of the zygomatic arch and normally extends over the mesiobuccal root of the upper first permanent molar. At 3 years of age the mesiobuccal root of the second deciduous molar is under the key ridge and as the denture develops, the first permanent molar moves forward and at the age of 18 take its place under the key ridge.[15] A very interesting method of recording the key ridge radiographically has been demonstrated by Weingart.[16] This key ridge act as a pillar on which the long axis of roots of the upper molar is resting and this bony background may be the reason for the greater stability of maxillary first molar.[13] The key ridge remains constant to the bones of the cranium throughout the life regardless of race or type and regardless of what happens to teeth or alveolar process. Moreover, it is found true to form in all animals.[17,18]

Thus, determination of the position of upper denture in relation to the key ridge has the most important bearing on the strategy of the treatment. Atkinson said that 'the first permanent molar is directly under the key ridge and the position I may safely say it always occupies under normal condition when the denture is fully developed'. According to Atkinson 'One important and dependable aid to the diagnosis of the mesiodistal relationship is the key ridge'.[15]

However, the position of the upper denture in general and maxillary first permanent molar in particular in relation to the key ridge has an important issue on the strategy of treatment. To assess this hypothesis, a study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Sharad Pawar Dental College, Wardha, with following aims and objectives:

AIM

- To assess the position of maxillary first permanent molar with respect to infrazygomatic crest (key ridge) in skeletal class I, II and III cases.
- To check whether there is any angular variation and linear variations of long axis of maxillary first permanent molar with respect to the key ridge.
- To check whether there is any variation in horizontal distance between key ridge and mandibular first permanent molar in skeletal class I, II, III cases.

MATERIALS AND METHODS

- Sample comprised of total 103 lateral cephalograms, 40 skeletal class I, 35 skeletal class II and 28 skeletal class III from the outpatient Department of Orthodontics and Dentofacial Orthopedics, Sharad Pawar Dental College, DMIMS University.
- The selection criteria were well aligned arches, no rotation of molars, no spacing or crowding in posterior region, individuals with post pubertal growth status, average growth pattern and no dental anomalies.
- The sample was grouped in class I, II and III depending on angle ANB, Wits appraisal and beta angle.
- The exclusion criteria for the study were the cases of severe high angle and low angle mandibular plane angle, with skeletal deformities, e.g. cleft lip and palate, patients with syndromes, patients with any trauma or surgery of face during childhood.

METHODS

All the lateral cephalograms collected, were traced and analyzed by three different observers. The tracings and analysis were cross checked by senior staff members to rule out of manual errors. Following landmarks were selected:

1. Nasion point
2. Point A
3. Point B
4. Occlusal plane (passing through the intercuspation of molars, premolars and bisecting the overbite)
5. Point KR (representing key ridge or infrazygomatic crest)
6. Point KO (point of intersection of perpendicular line from key ridge on occlusal plane)
7. Line KO' (perpendicular line from KR to occlusal plane)
8. Long axis of the molar [line joining mesiobuccal cusp tip (MBCT) and mesiobuccal root tip (MBRT)] (Fig. 1).

Point KR was marked on the key ridge. Point KO was marked on the occlusal plane perpendicular to point KR and KO' line was drawn joining these two points. A long axis passing through the MBRT and MBCT was drawn and the angular variation between the KO' and the long axis of mesiobuccal root was calculated (Fig. 2).

Vertical linear distance between the point KR and the point on the MBCT and MBRT of maxillary first molar was measured on the lateral cephalograms. Variation in this linear distance was measured for all the samples (Fig. 3).

The horizontal linear distance between the lines KO' and mesiobuccal cusp tip of upper and lower molar (MBCT) and MBRT of maxillary first molar were measured on lateral cephalograms. Variation in this linear distance was measured in class I, II and III cases (Fig. 4).

Descriptive statistics and Tukey's multiple comparison test was carried out for statistical analysis for comparing the values of three groups.

RESULTS

Tables 1 and 2 show the mean values and standard deviation of KR-KO to the long axis in all the three groups and Tukey multiple comparison test. The values of class II ($p = 0.000$) and class III ($p = 0.046$) showed significant difference when compared with the control group.

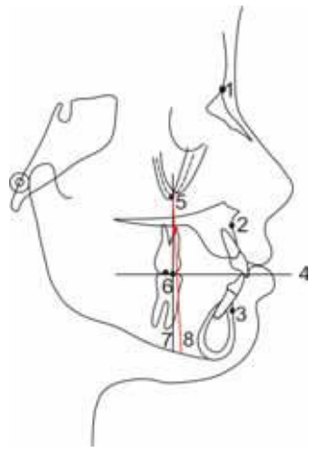


Fig. 1: Landmarks used in analysis: (1) Nasion, (2) Point A, (3) Point B, (4) Occlusal plane, (5) KR, (6) KO, (7) Line KO', (8) Long axis of first maxillary molar

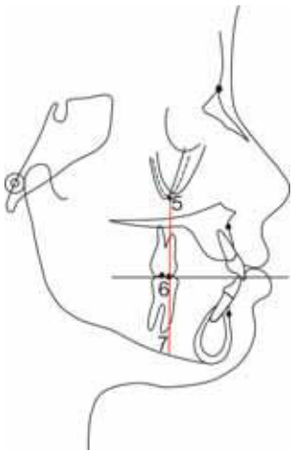
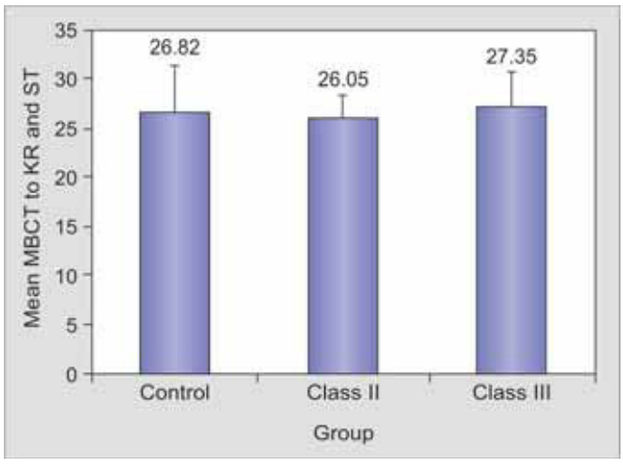


Fig. 2: Angular variation of maxillary first molar with key ridge



Graph 1: MBCT to KR (vertical dimension)

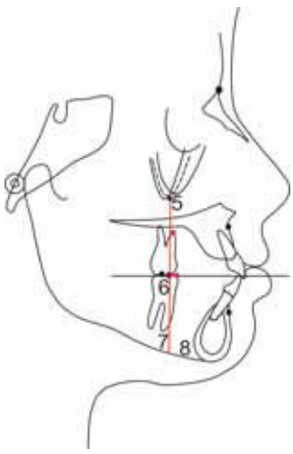
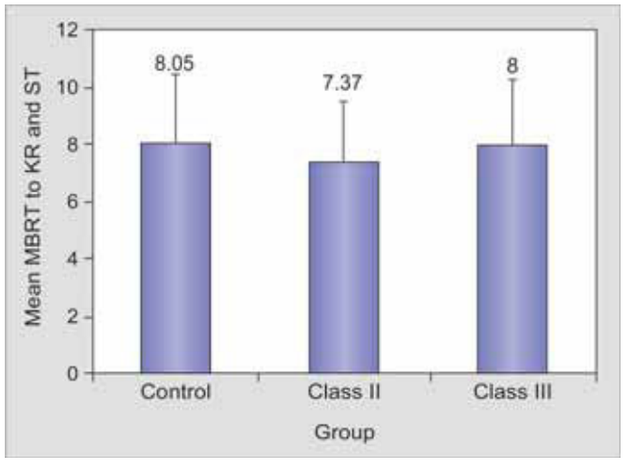


Fig. 3: Vertical measurment between MBCT and MBRT of maxillary first molar



Graph 2: MBRT to KR (vertical dimension)

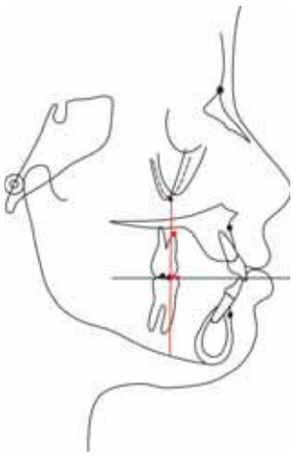


Fig. 4: Horizontal measurment between key ridge to MBRT (maxillary first molar) and MBCT (maxillary and mandibular first molar)

Tables 3 to 6 shows the standard deviation, mean values and Tukey multiple comparison test of MBCT to KO' and MBRT to KO' respectively in all the three groups. The values of class II MBCT ($p = 0.704$), MBRT ($p = 0.316$) when compared to control group showed no significant difference but class III MBCT ($p = 0.000$), MBRT ($p = 0.046$) showed a significant difference when compared to control group.

Tables 6 and 7 showed the standard deviation and mean values of MBCT of lower first permanent molar to KO and Tukey multiple comparison test. The values of class II ($p = 0.000$) and class III ($p = 0.000$) showed significant difference when compared to control group.

DISCUSSION

Angle in 1889 gave his classification system for dental malocclusion where he considered mesiodistal relationship of maxillary and mandibular first permanent molars. According to him all the teeth are essential but some teeth are of greater importance than others and the most important of all being the maxillary first permanent molar which is referred as the 'key to occlusion'. As the maxillary permanent molars are the largest teeth and their anchorage

Table 1: KR-KO to long axis in three groups

Descriptive statistics								
Groups	*N*	*Mean*	*Std. deviation*	*Std. error*	*95% confidence interval for mean*		*Minimum*	*Maximum*
					Lower bound	*Upper bound*		
Control	40	5.35	1.87	0.29	4.75	5.94	2.00	10.00
Class II	35	2.42	2.47	0.41	1.57	3.27	–7.00	7.00
Class III	28	6.97	3.86	0.73	5.47	8.47	–4.00	18.00

Angulation of maxillary first molar with respect to key ridge (the line joining points KR and KO with the line passing through the mesiobuccal root tip (MBRT) and mesiobuccal cusp tip (MBCT) of maxillary first molar

Table 2: Comparison of KR-KO to the long axis in all three groups

Tukey multiple comparison test						
Group		*Mean difference (I-J)*	*Std. error*	*p-value*	*95% confidence interval*	
					Lower bound	*Upper bound*
Control	Class II	2.92	0.63	0.000 (S) p < 0.05	1.41	4.42
	Class III	–1.62	0.67	0.046 (S) p < 0.05	–3.23	–0.02

Comparison of angulation of maxillary first molar in class II and III samples with the control group; S: Significant; NS: Nonsignificant

Table 3: MBCT to KO' in three groups

Descriptive statistics								
Groups	*N*	*Mean*	*Std. deviation*	*Std. error*	*95% confidence interval for mean*		*Minimum*	*Maximum*
					Lower bound	*Upper bound*		
Control	40	1.62	1.90	0.30	1.01	2.23	–2.00	6.00
Class II	35	2.11	2.78	0.47	1.15	3.07	–7.00	7.00
Class III	28	5.46	3.30	0.62	4.18	6.74	–2.00	13.00

Horizontal measurement of mesiobuccal cusp tip (MBCT) of maxillary first molar to the line KO' (line joining point KR and KO)

Table 4: Comparison of MBCT to KO' in all three groups

Tukey multiple comparison test						
Group		*Mean difference (I-J)*	*Std. error*	*p-value*	*95% confidence interval*	
					Lower bound	*Upper bound*
Control	Class II	–0.48	0.61	0.704 (NS) p > 0.05	–1.94	0.96
	Class III	–3.83	0.65	0.000 (S) p < 0.05	–5.38	–2.28

Comparison of mesiobuccal cusp tip (MBCT) of maxillary first molar to KO'(line joining KR and KO) in class II and III with the control group; S: Significant; NS: Nonsignificant

Table 5: MBRT to KO' in three groups

Descriptive statistics								
Groups	*N*	*Mean*	*Std. deviation*	*Std. error*	*95% confidence interval for mean*		*Minimum*	*Maximum*
					Lower bound	*Upper bound*		
Control	40	1.27	2.44	0.38	0.49	2.05	–3.00	8.00
Class II	35	2.14	2.28	0.38	1.35	2.92	–4.00	7.00
Class III	28	2.82	3.04	0.57	1.64	4.00	–3.00	8.00

Horizontal measurement of mesiobuccal root tip (MBRT) to the line KO' (line joining point KR and KO)

Table 6: MBRT to KO' in all three groups

Tukey multiple comparison test						
Group		*Mean difference (I-J)*	*Std. error*	*p-value*	*95% confidence interval*	
					Lower bound	*Upper bound*
Control	Class II	–0.86	0.59	0.316 (NS) p > 0.05	–2.28	0.54
	Class III	–1.54	0.63	0.043 (S) p < 0.05	–3.05	–0.03

Comparison of mesiobuccal root tip (MBRT) of maxillary first molar to KO'(line joining KR and KO) in class II and class III with the control group; S: Significant; NS: Nonsignificant

value is higher. They are the first teeth to erupt in the dental arch. Angle gave more emphasis on the position of maxillary first permanent molar as most stable landmark in the craniofacial anatomy.[12] According to Angle, maxillary first molar lies on the infrazygomatic crest (key ridge) on majority of cases.[13] This concept though accepted, but was questioned by his contemporaries.

The word key ridge was coined by Atkinson in the year 1925. According to Atkinson from birth to adulthood the structural elements of the masticatory apparatus are undergoing an orderly change in relationship. Various areas grow at different speed and amount.[15] The upper first molar has the broadest spread of roots and the widest base. In order to support this broad base, nature has furnished skulls with correspondingly broad buttress of bone on which first molar rest. This buttress of bone is known to anatomist as the zygomatic process of upper maxilla. Thus, Atkinson called it as key ridge and anterior to it is the canine fossa. This strong ridge of bone extends downward to the mesiobuccal root of the upper first permanent molar.[19] At 3 years of age the mesiobuccal root of deciduous second molar is under the key ridge, the permanent first molar are developing just posterior to it in the jugal buttress and comes forward as the individual grows. The key ridge remains constant to the bones of the cranium throughout the life regardless of the race and type.[15] Atkinson describes a simple technique for showing the key ridge on study models by means of a colloidal or modeling compound.[18] Weingart has demonstrated radiographically the key ridge.[16] However, a significant feature of the key ridge is that it can be oriented very easily by palpation of the index finger in the mucobuccal fold in the region of first molar.[15] Thus, determination of the position of the upper denture in relation to key ridge has a most important feature in the strategy of treatment.[15]

Total 103 lateral cephalograms comprising 40 skeletal class I (control) and 35 class II and 28 class III were selected based on, ANB angle, Wits appraisal and beta angle and were analyzed. Six different parameters were chosen to compare the vertical (MBRT and MBCT of maxillary first permanent molar to point KR) and horizontal variation of maxillary first permanent molar (MBCT and MBRT to line KO') from key ridge. Also the horizontal linear distance of mandibular first permanent molar to key ridge in class I, II and III cases were measured.

The angulation of maxillary first permanent molar with respect to key ridge was measured by drawing a line passing through the mesiobuccal root tip and mesiobuccal cusp tip of maxillary first permanent molar with respect to line KO' (line joining points KR and KO). It was seen that the angulation of maxillary first molar with respect to key ridge was 5.35° in the control group as compared to class II (2.42°) and class III (6.97°) (Table 1) suggesting that maxillary first permanent molar is not directly under the key ridge in class I, II and III cases. Also Tukey multiple comparison test revealed

Table 7: MBCT of lower molar to KO in three groups

Descriptive statistics								
Groups	*N*	*Mean*	*Std. deviation*	*Std. error*	*95% confidence interval for mean*		*Minimum*	*Maximum*
					Lower bound	*Upper bound*		
Control	40	3.80	1.85	0.29	3.20	4.39	1.00	9.00
Class II	35	0.45	2.50	0.42	–0.40	1.31	–4.00	5.00
Class III	28	11.71	4.41	0.833	10.00	13.42	0.00	23.00

Horizontal measurement of mesiobuccal cusp tip (MBCT) of lower first permanent molar to the line KO'(line joining point KR and KO)

Table 8: MBCT of lower molar to KO' in all three groups

Tukey multiple comparison test						
Group		*Mean difference (I-J)*	*Std. error*	*p-value*	*95% confidence interval*	
					Lower bound	*Upper bound*
Control	Class II	3.34	0.68	0.000 (S) p < 0.05	1.71	4.97
	Class III	–7.91	0.72	0.000 (S) p < 0.05	–9.64	–6.18

Comparison of mesiobuccal cusp tip (MBCT) of mandibular first molar to KO'(line joining KR and KO) in class II and III with the control group; S: Significant

that when class II ($p = 0.00 < 0.05$) and class III ($p = 0.046 < 0.05$) cases were compared with control group it showed statistically significant difference (Table 2).

In the vertical dimension maxillary cusp tip of first permanent molar was 26 to 27 mm and mesiobuccal root tip was 7 to 8 mm with respect to key ridge in all the three groups (Graphs 1 and 2). Thus, it will help to determine whether the maxillary first permanent molar is extruded or intruded with respect to infrazygomatic crest (key ridge).

In horizontal dimension mesiobuccal cusp tip of maxillary first molar in the control group was 1.62 mm to KO' line whereas in class II and III cases the MBCT from KO' was 2.11 and 5.46 mm respectively (Table 3) and the mesiobuccal root tip of maxillary first molar in the control group was 1.27 mm from KO', but in class II and III cases (2.14 and 2.82 mm respectively) (Table 5). The Tukey multiple comparison test revealed that the values of class II cases in both horizontal dimension were not statistically significant as compared to control group whereas the values of class III cases were statistically significant when compared to the control group (Tables 4 and 6).

It was seen that the maxillary first molars in class II and III cases are mesially placed as compared to class I cases. The ratio between MBCT to KO' in class I and II was 0.79 and MBRT to KO' in class I and II cases was 0.59 suggesting that there is mesial tipping of upper first molar with respect to key ridge with more movement of cusp as compared to the root tip in class II cases. There was a less root movement in class II cases.

The ratio between MBCT to KO' in class I and III cases was 0.35 and MBRT to KO in class I and III cases was 0.45 and suggesting that in class III cases the maxillary molar was mesial to key ridge but was more upright as compared to class I and II.

It was seen that the MBCT of lower first permanent molar was around 3.87 mm (SD: 1.87) ahead of the KO' line in class I cases as compared class II (0.45 mm) (SD: 2.50) and for class III it was 11.71 mm (SD: 4.41) (Table 7). Inference derived from Table 7 suggest that the lower molar was more mesial in class I cases as compared to class II cases whereas in class III cases, it was more mesial as compared to class I and II. Thus, the mandibular first molar showed more mesial migration as compared to maxillary first permanent molar. Also the Tukey multiple comparison test showed statistically significant difference when class II ($p = 0.00 < 0.05$) and class III ($p = 0.000 < 0.05$) sample were compared with control group (Table 8).

CONCLUSION

Following conclusions were drawn from the study:

- The maxillary permanent first molar was not directly under the key ridge and was ahead of key ridge and tipped mesially in all the three groups.

- The maxillary first permanent molar was placed more mesially in class II and III cases as compared to the class I cases but in class III it was more upright as compared to class I and II.

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