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MIXED DENTITION ANALYSIS: A REVISED EQUATION FOR NEW GENERATION

Varun Dua[1], Avninder Kaur[2], Manjeet Kaur[3]

[1]Sr. Lecturer, Department of Pediatric and Preventive Dentistry, Darshan Dental College and Hospital, Rajasthan, India

[2]Professor & Head, Department of Pediatric and Preventive Dentistry, Bhojia Dental College and Hospital, Himachal Pradesh, India

[3]Professor, Department of Pediatric and Preventive Dentistry, BRS Institute of Dental Sciences, Haryana, India

ABSTRACT

Abstract: Aim: Racial difference is an important factor in tooth size variability. The present study was thus aimed to assess the applicability of Tanaka and Johnston method for predicting the mesiodistal dimensions of canine and premolars in children of Panchkula, Haryana. **Methods:** Dental study models of 200 children were analysed to check the applicability of Tanaka and Johnston method of mixed dentition analysis. **Results:** Differences have been found in the means of actual dimensions of canine & premolars and values derived by regression equation of Tanaka and Johnston by Student's t-test and therefore formulated a new equation. **Conclusion:** Tooth size differences amongst races are an important variable that must be considered before the formulation of prediction equation. The proposed new prediction equations derived in the present study are possibly more appropriate to be used for mixed dentition analysis in a population of Panchkula, Haryana.

Key Words: Tanaka and Johnston, mixed dentition analysis, tooth sizes, mesiodistal dimensions, prediction equation.

INTRODUCTION

Pediatric dentistry is increasingly shifting from a conservative-restorative approach, towards a concept of total pediatric patient care, including early diagnosis and correction of malocclusion, developing during the early or mixed dentition period.[1] During this crucial period, the pediatric dentist is responsible to provide an opinion of the effect of this malocclusion, if any, on the ultimate occlusal status of the permanent dentition.

Fundamental to orthodontic diagnosis and treatment planning during mixed dentition period is an assessment of the degree of future crowding or spacing in the teeth.[2] If this prediction is accurately made, many of the malocclusions developing in the mixed dentition period can be mitigated in severity or eliminated altogether by early and timely intervention. An accurate mixed dentition analysis requires accurate prediction of the mesiodistal crown dimensions of the unerupted maxillary and mandibular canines & premolars. Two broad approaches have been used for predicting the mesiodistal crown dimensions of unerupted teeth; the radiographic method and non-radiographic methods. The radiographic methods are based on the measurement of the unerupted teeth on radiographs.[3,4,5] The non-radiographic methods are based on the measurement of already erupted teeth on dental study casts, or directly in the mouth and co-relating them to the mesiodistal dimensions of the unerupted canines & premolars using prediction tables.[6,7,8,9,10,11]

Although some studies have shown the radiographic methods to be more accurate.[12,13] but they have inherent limitations which may result from the quality of the X-ray films and the radiographic technique used. Ballard and Wylie[6] stated that unless an exact radiographic technique with good quality films is used, an accurate estimate of the unerupted tooth widths will be difficult to

Corresponding Author:
Avninder Kaur
Email:
Avninder21@yahoo.com
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obtain. Even when these limitations are reduced to a minimum, the teeth may be rotated in their crypts, impeding an accurate measurement of their true mesiodistal widths from a two dimensional X-ray image.

These disadvantages can be largely overcome by a variety of regression schemes in which tooth size is predicted from permanent teeth that are fully erupted in the mouth and can be easily measured, either directly in the mouth or from the study models.

Tanaka and Johnston[8] have suggested a mixed dentition analysis method in which the combined mesiodistal dimension of the unerupted canines and premolars of both maxillary and mandibular arch can be obtained from the combined dimensions of permanent mandibular incisors, using a regression equation. This method is based on data from a sample of children from North European descent and the accuracy of this method could possibly be in question when applied to population groups of different ethnic and racial origins. Research to date, supports the view that racial differences are likely to be important factors in tooth size variability. Documented literature is considerably lacking in information on similar mixed dentition tooth size prediction aids that are specifically developed for Indian children.[14] This emphasizes the need to re-evaluate earlier developed prediction equations or tables for different contemporary populations. Aim of the present study was thus to assess the applicability of Tanaka and Johnston method for predicting the mesiodistal dimensions of canine and premolars in children of Panchkula, Haryana.

METHOD

Eight hundred and sixty three children were examined from a contemporary population of Panchkula which included children studying in the different schools of Panchkula and also patients seen in the Out Patient Department of Pediatric and Preventive Dentistry of BRS Institute of Medical Sciences. Out of these examined children total of 200 subjects (100 males and 100 females), who presented with complete eruption of permanent mandibular incisors, canines & premolars, as well as, the permanent maxillary canines & premolars were selected. The study was approved by Institutional ethics committee. The selection of the subjects was based on the following criteria:

Inclusion Criteria:

1. All the subjects were natives of Panchkula, Haryana.
2. The teeth to be measured were free of restorations, fractures, malformations or caries.
3. There was no evidence of Enamel hypoplasia.
4. No or mild malocclusion.

Exclusion Criteria:

1. Children with moderate to severe malocclusion.
2. Children who were undergoing or had undergone an orthodontic treatment.
3. Children with congenitally missing or impacted permanent teeth.

Impression making and pouring procedure

Dental study models of 200 children were analysed to check the applicability of Tanaka and Johnston method of mixed dentition analysis.

Muscle moulded rim lock trays were used to make the impressions. Trays were selected for each patient by checking the last molar coverage by tray and rims of the trays were 2 mm short of sulcus. Alginate impressions were made for both maxillary and mandibular arches. After the complete setting of the alginate, tray was removed from the mouth and impression was washed under cold running water and disinfected by immersing it in 2% gluteraldehyde solution for 10 minutes and washed again. Before it was poured excess water and disinfecting solution was removed with light stream of air. The dental model was then poured immediately with a proper mix of dental stone. The models were checked for any distortions or voids. After trimming the models, bases were made with plaster of Paris with teeth in occlusion.

Method of measurement

A standard method was used to measure the mesiodistal dimensions of different tooth groups on dental cast. Measurements of the mesiodistal dimensions of the mandibular and maxillary teeth were made using a digital caliper (Aerospace) with a vernier scale that was calibrated to the nearest 0.01mm (Figure1). The examiner was trained by one of the supervisors. The sliding calipers were placed parallel to the occlusal surface of the teeth and measured the greatest mesiodistal dimensions of teeth at their contact points. The eye, instrument and light source lay approximately

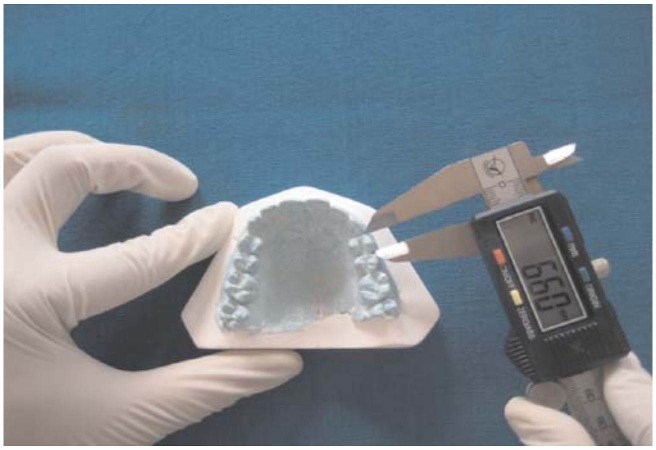


Figure 1 : Digital Vernier Caliper used for measuring the mesiodistal dimensions of teeth

in a straight line, thus reducing errors of parallax to a minimum.

An average value for the canine & premolars was calculated from the values obtained individually for the right and left segments of the arch, for both the maxillary as well as the mandibular arch, respectively. This was done to attain one value for the mandibular canine & premolars and one value for the maxillary canine & premolars, for each value of the mandibular incisors.

Mesiodistal dimensions of maxillary and mandibular canines & premolars were also predicted by Tanaka and Johnston method using the following equation;

For each of the maxillary left and right permanent canines & premolars dimensions:

$$Y = 11 + 0.5(X)$$

For each of the mandibular left and right permanent canines & premolars dimensions:

$$Y = 10.5 + 0.5(X)$$

Y is the estimate of mesiodistal dimensions of unerupted permanent canine and premolars for each side.

X is the sum of mesiodistal dimensions of four permanent mandibular incisors.

The actual measurements taken from the dental casts were then compared to those predicted using the Tanaka and Johnston method and discrepancy between the two values was calculated.

Statistical analysis

Descriptive statistics for the four permanent mandibular incisors, the maxillary canine & premolars, and mandibular canine & premolars were computed and evaluated separately for males and females, as regards to their mean mesiodistal dimensions and standard deviations (S.D). A student's t-test was done to check for any statistical difference between the mean of actual mesiodistal dimensions of males than those of females and also the mean mesiodistal dimensions predicted by Tanaka & Johnston method in males and females. In order to find the magnitude of association, Pearson's coefficients of correlation were calculated between the mesiodistal widths of the permanent mandibular incisors and the mesiodistal widths of the maxillary and mandibular canine & premolars. P value of <0.05 was considered statistically significant.

RESULTS

The mean of mesiodistal dimensions of mandibular incisors for males was 21.91 ± 1.31mm and for females it was 21.79 ± 1.17 mm. The difference between the two groups was found to be statistically insignificant with p value of 0.518. The mean of mesiodistal dimensions of mandibular canine & premolars for

Table 1: Comparison of difference of means of actual dimensions of canine & premolars and values derived by regression equation of Tanaka and Johnston by Student's t-test

Gender	Canine & premolars	Difference of means of actual measurements and by Tanaka & Johnston method	Standard Deviation SD	p-value
Male	Mandibular	-1.179	0.846	0.000
	Maxillary	-1.013	1.100	0.000
Female	Mandibular	-1.156	0.800	0.000
	Maxillary	-1.001	0.933	0.000
Combined (Males and Females)	Mandibular	-1.167	0.822	0.000
	Maxillary	-1.006	1.017	0.000

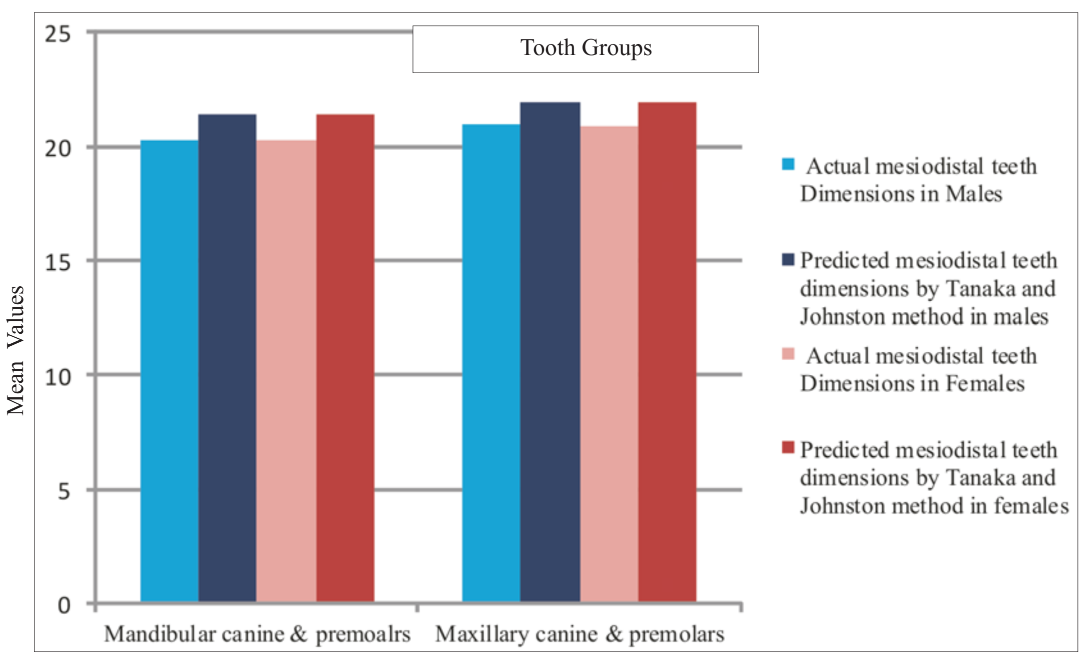
males was 20.27 ± 1.14 mm and for females was 20.24 ± 0.96 mm. The difference was statistically insignificant with p value of 0.821. The mean of mesiodistal dimensions of maxillary canine & premolars for males and females was 20.94 ± 1.19 mm and 20.90 ± 1.03 mm, respectively. The difference was statistically insignificant with p value of 0.778.

Comparison of difference in means of actual dimensions of canine & premolars and values derived by regression equation of Tanaka and Johnston by Student's t-test are shown in Table 1 and Graph 1. Pearson's coefficients of correlation of mesiodistal dimensions of mandibular incisors with canine & premolars in males and females are given in table 2. Regression coefficients and prediction equations for mesiodistal dimensions of canine & premolars in males and females, Combined Regression coefficient (Males and Females) and prediction equations for mesiodistal dimensions of canine & premolars are depicted in Table 3.

DISCUSSION

Equal distribution of males and females has been taken as there is strong evidence that tooth sizes are expressed through X-linked inheritance since sister-sister correlations are higher than brother-brother and brother-sister correlations. Garn et al[15] hypothesized that possession of two X-chromosomes in females provide a higher measure of control which is lacked by males with only one X-chromosome. While comparing the mesiodistal tooth sizes of males and females, marked sexual dimorphism was seen in all three tooth groups measured. There were consistently higher values for males showing larger incisors, canines and premolars but were statistically insignificant. Many authors (Al-Khadra[16], Lee-Chan et al[17], and Tanaka and Johnston[8]) have found similar results between males and females when comparing the odontometric data while others (Priya & Munshi,[14] Schrimer & Wiltshire[18] and Jaroontham & Godfrey[19]) found statistically significant differences between male and female measurements.

Racial and ethnic differences in tooth sizes have been emphasized by many authors (Jaroontham and Godfrey,[19] Richardson and Malhotra[20] Lavelle,[21] Otuyemi & Noar,[22] Singh and Nanda,[23] Lee-Chan et al,[17] Diagne et al[24]). The reason for tooth size variation in different racial groups has not been clearly elucidated. According to Garn[25] and Potter et al[26] mesiodistal tooth size is determined primarily by genetic factors, while factors like nutrition and environmental exposure during tooth development are believed to play a secondary role.



Graph 1: Bar diagram showing comparison of the mesiodistal dimensions of teeth between actual and those predicted by Tanaka and Johnston method in males and females

Table 2: Pearson's coefficients of correlation of mesiodistal dimensions of mandibular incisors with those of canine & premolars in males and females

Gender	Tooth Groups	Correlation coefficient (r)	Regression coefficients		95% Confidence interval C.I	p-value
			A	B		
Male	Mandibular canine & premolars	0.675	7.44	0.586	0.266-0.495	<0.001
	Maxillary Canine & premolars	0.404	12.94	0.367	0.439-0.625	<0.001
Female	Mandibular canine & premolars	0.561	10.11	0.465	0.200-0.533	<0.001
	Maxillary Canine & premolars	0.448	12.23	0.398	0.457-0.714	<0.001
Combined (Males and Females)	Mandibular canine & premolars	0.626	8.64	0.532	0.238-0.557	<0.001
	Maxillary Canine & premolars	0.424	12.60	0.381	0.327-0.602	<0.001

Table 3: Regression coefficients and prediction equations for mesiodistal dimensions of canine & premolars in males

Tooth Groups	Regression coefficient		Prediction equation: Y= a+b(X)
Mandibular canine & premolars (males)	a=7.44	b=0.586	Y_{1M} =7.44 + 0.586 (X)
Mandibular canine & premolars (females)	a=10.11	b=0.465	Y_{1F}=10.11 + 0.465 (X)
Mandibular canine & premolars (combined)	a = 8.638	b = 0.532	Y_{1C}=8.638 + 0.532 (X)
Maxillary canine & premolars(males)	a=12.94	b=0.367	Y_{2M}=12.94 + 0.367 (X)
Maxillary canine & premolars(females)	a=12.23	b=0.398	Y_{2F}=12.23 + 0.398 (X)
Maxillary canine & premolars (combined)	a=12.604	b=0.381	Y_{2C}=12.604 + 0.381 (X)

Y = predicted mesiodistal dimension of canine & premolars.
X= sum of the measured mesiodistal dimensions of four permanent mandibular incisors.

The greatest mesiodistal dimensions of the teeth at their contact points were measured with sliding vernier caliper tips placed parallel to the occlusal surface of teeth. Measurement reliability was checked according to the Dahlberg's method,[27] where one investigator carried out double determination of cast measurements. A range of measurement was then calculated which was considered normal for the first and second measurement. The range was calculated to be from 0.051 to 0.183 mm. Alhaija ESJ and Qudeimat MA[27] found the error values of mesiodistal teeth widths ranged from 0·1 mm to 0·25 mm which were considered clinically acceptable.

There were marked differences between means of mesiodistal dimensions of teeth measured in the present study and means found out by Tanaka and Johnston in North European population. When Tanaka and Johnston equation was applied in the present study and means of predicted values of canine & premolars determined, the predicted values were compared with original values, the former overestimated the latter and the difference was statistically significant. The inference from this study derived was that we need a separate equation for the population of Panchkula, Haryana.

Pearson's correlation coefficient of mandibular incisors with maxillary and mandibular canine & premolars was evaluated using their mesiodistal dimensions and it showed best correlation with mandibular canine and premolars in males and the least was found with maxillary canine and premolars in males (Table 2). The correlation was found to be higher for the mandibular arch than for the maxillary arch. This might be because of the fact, that the teeth measured belonged to the same arch, as had been reported by Moorrees and Reed.[28] Although the males reported slightly higher correlations than females, these differences were not statistically significant.

The correlation coefficients of the present study for mandible were in the range reported by Tanaka and Johnston[7], Ballard & Wylie[6], Lee-Chan et al[17] and Hixon & Oldfather[29] which indicated the relatively consistent relationship between the permanent mandibular incisors and the canines & premolars. Priya and Munshi[14] however reported lower correlation coefficients between permanent mandibular incisors and the canines & premolars in their study on a section of the South Indian population and such low correlations were found in the present study in case of maxilla. From the data found in majority of the studies it could be suggested that the relatively consistent correlation coefficients (0.55 to 0.70) found between the permanent mandibular incisors and the maxillary/mandibular canines & premolars which concludes that about 55 to 70 percent of the polygenes that determine the tooth size, are shared by mandibular incisors and the maxillary/mandibular canines & premolars. Tooth size is thus polygenetically determined and is continuously variable, i.e. a wide range of individuality exists in terms of any single tooth. That is why the average mesiodistal dimensions given by Black[30] are also not reliable in predicting unerupted tooth sizes. Thus, there exists a need to revise the prediction equations for different populations.

In the present study moderately high degree of linear correlation exists between the sum of mesiodistal dimensions of permanent mandibular incisors and of the maxillary/mandibular canines & premolars. Simple linear regression analysis, with the help of the equation Y=a + b (X), was chosen to fulfil the objectives of the present study. Correlation coefficients and regression coefficients for the canine and premolars of each dental arch are given in Table 2. The regression constant for 'a' and 'b' of the regression equation i.e. Y= a+b (X), for different tooth groups for males and females and for combined (males and females) are given in table 3.

The regression parameters were used to generate prediction equations that can be used clinically in tooth size predictions in much the same way as the Tanaka and Johnston[8] equations. Specifically, the present study derived different prediction equations, than those formulated by Tanaka and Johnston for mesiodistal dimensions of canine and premolars, in a population of Panchkula, Haryana. The equations are given in table 3 for males, females and combined (males and females), respectively.

Conclusion

Tooth size differences amongst races are an important variable that must be considered before the formulation of prediction equation. As the tooth sizes in the present study are different from those used by Tanaka & Johnston in their study of mixed dentition analysis, hence, a new prediction equation was formulated for this specific population. The proposed new prediction equations derived in the present study are possibly more appropriate to be used for mixed dentition analysis in a population of Panchkula, Haryana, which may ultimately prove a beneficial aid in achieving higher success in preventive and interceptive orthodontic procedures.

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