Original Article

Applicability of Two Universally Accepted Mixed Dentition Analysis on a Sample from Southeastern Region of Andhra Pradesh, India

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Abstract

Background: Most of the universally accepted mixed dentition analyses are based on the data derived from northwestern European descent. However, the accuracy of these methods when applied to different ethnic population is questionable. **Aim:** The present study is aimed to evaluate the applicability of Tanaka and Johnston (TJ) and Moyers (50th and 75th percentile) mixed dentition analysis in a sample from south-eastern region of Andhra Pradesh, India.**Subjects and Methods:** Study models were prepared from a sample of 100 patients (50 males and 50 females) in the age range of 13-15 years. The mesio-distal dimension of the teeth was measured using a Digital Vernier calipers. The actual values of permanent canine and premolars on the casts were compared with the predicted values from TJ and Moyers analysis. The values derived from this study were statistically analyzed using SPSS version 17.0 (IBM, Chicago, USA). Pearson's coefficients were used to evaluate the correlations between the groups of teeth. **Results:** Overestimated values were noticed in males and females of both arches with TJ equation; Males showed no significant difference at Moyers 50th percentile (50/100), in both the arches where as females showed higher values in mandibular arch and underestimated values in maxillary arch. At Moyers 75th percentile, overestimated values were noticed in males for both the arches whereas in females lesser values were observed. **Conclusion:** As the values showed significant deviation from TJ and Moyers both at 50 and 75 percentile, its applicability to the present population is limited. So, new regression equations were derived.

Keywords: Mixed dentition analysis, Tanaka Johnston analysis, Moyers analysis

Introduction

Malocclusions were observed frequently during the mixed dentition stage, which spans from the 6th to 12th year of life. Most of these developing malocclusions may be reduced in severity or even eliminated entirely by timely intervention. Space evaluation is an important aspect in making decisions during orthodontic treatment, which are based on differences involving very few millimeters.

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A variety of mixed dentition analysis were proposed which include Ballard and Wylie (1947); Hixon and Old Father (1958); Bull (1959); Moyers (1973, 1988); Tanaka and Johnston (1974); Staley and Hoag (1978); and Ingervall and Lennnartson (1978). However, all these methods used three main approaches – measurement of the unerupted teeth using radiographs; application of regression equations that relate

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the mesiodistal width of erupted teeth to those of unerupted teeth; a combination of measurements from erupted teeth and radiographs of unerupted teeth.[1]

Moyers' analysis uses the sum of the widths of the mandibular incisors to predict the sum of both the mandibular and maxillary canines and premolars at various probability levels (5–95%),[2] whereas Tanaka and Johnston's analysis uses the sum of mesiodistal width of the mandibular central and lateral incisors to develop regression equations for predicting the sizes of the unerupted canines and premolars. They established that the mesiodistal widths could be predicted by halving the width of the mandibular incisors and adding 10.5 mm for the mandibular teeth and 11.0 mm for the maxillary teeth.[3]

Despite the questionable reliability of both, Tanaka and Johnston's approach is still widely accepted because they do not require radiographs and are simple and quick to perform. However, one of the drawbacks of these methods is that they were specifically developed based on the observations on American White subjects of Northwestern European descent.[1] A review of the literature revealed that mixed dentition analyses were varied between different racial and population groups: Schirmer and Wiltshire[4] for black Africans; Lee-Chan *et al*.[5] for Asian-Americans; Bishara and Jakobsen[6] for population samples from Egypt, Mexico, and the USA; Flores-Mir *et al*.[7] for Peruvians; Nourallah *et al*.[8] for Syrians; Jaroontham and Godfrey[9] for Thai population; Diagne *et al*.[10] for Senegalese and within Indian population; and Sonahita *et al*.[11] and Philip *et al*.[12] for contemporary India. Populations of different racial origins generally had average values that were significantly different from those reported for Whites; however, in most cases, the clinical significance was questionable. In addition, there is some evidence of secular trends of changing dimensions of the teeth and jaws which may require progressive modifications of mixed dentition space analysis.[1] Studies on various populations have found sexual, racial, as well as ethnic variations in tooth size. Applicability of these analyses in studies conducted globally resulted in slight modification of the regression equations that would better suit their population.

Even though many studies were reported in the literature regarding the applicability of these mixed dentition analysis from different parts of India,[11,12] the data from this region of India were sparse. Many studies on various populations have found differences in the tooth sizes between male and female subjects.[13] Hence, the present study is aimed with an objective to evaluate the applicability of two universally accepted mixed dentition analysis (Moyer and Tanaka and Johnston), to find out whether the predicting equations differ by sex, and to determine an appropriate regression equations for predicting the size of the unerupted canines and premolars on a group of sample from Southeastern region of Andhra Pradesh, India.

Subjects and Methods

In this observational, randomized, cross-sectional study, a total of 900 patients in the age ranging from 13 to 15 years without sex predilection and visited as outpatients to the Department of Pedodontics and Preventive Dentistry from October 2010 to August 2012 were screened based on the following these selection criteria – (i) The subjects should have all the first permanent molars fully erupted. (ii) Teeth that are to be measured should be free of restorations, fractures, or proximal caries. (iii) There should be no evidence of hypoplasia or anomalies of the teeth. (iv) Subjects with Angle's Class I molar and canine relationship and minor malocclusions such as rotation, crowding, or spacing were acceptable. (V) The subjects should not have undergone prior orthodontic treatment. To avoid selection bias, all the subjects were randomly selected. The appropriate sample size for this study is calculated by keeping confidence level at 95% and confidence interval at 10% for a population of one lakh. The level of accuracy is made to 50% which is estimated to be 96. The sample size for the present study is 115. After attaining the institutional ethical clearance, a thorough explanation was given to the 300/900 patients regarding the study purpose and procedure who have fulfilled the selection criteria; out of which, only 115 patients have given their willingness to participate in the study. After thorough oral prophylaxis, alginate impressions were made for both the arches with appropriate-sized rim lock trays. Measurements were obtained from each dental cast using the electronic digital caliper (Baker SDN 10, India) calibrated to the nearest 0.01 mm, according to the method described by Jensen *et al*.,[14] in which the caliper was held at the tooth's greatest mesiodistal diameter (anatomical contact points), parallel to the occlusal surface, and perpendicular to the long axis of the tooth [Figure 1]. The whole procedure was carried out under natural light by a single operator. To avoid interexaminer variability and determine the reliability of the measurements, twenty study models were randomly measured by a separate investigator who was unaware of the

Figure 1: Measuring mesiodistal diameter using electronic digital caliper

prior measurements. As the correlation coefficient was very high ($r = 0.95$), all the subsequent measurements were taken only once. Tanaka and Johnston and Moyer's prediction methods at 50th and 75th percentile were calculated on the present cluster of the sample.

The values derived from this study were statistically analyzed using SPSS version 17.0 (IBM, Chicago, IL, USA). Paired *t*-tests were performed to examine the bilateral symmetry of the mesiodistal widths of all measured individual tooth and teeth in each arch and to test the significance of the differences between the measured and predicted values. Unpaired *t*-tests were carried out to compare data between male and female subjects. Pearson's coefficients were used to evaluate the correlations between the groups of teeth. Simple regression analyses were implemented to develop possible regression equations for the present sample.

Results

A high intraclass correlation coefficient = 0.95 ensured measurement reliability. Statistical significant difference was noticed between right and left sides, so an average of both the sides was taken. Further, there was statistically significant difference between the sexes, with the males having larger teeth in comparison to females [Table 1].

In the present study, the highest correlation coefficient (r) was observed for female subjects in the maxillary arch ($r = 0.49$) and the mandibular arch ($r = 0.38$) and the least for male subjects in both the arches ($r = 0.33$) [Table 2].

The standard error of estimate (SE) indicates the error in the use of prediction equations; the lower the SEE, the better the prediction equation. The SEE in the present study ranged from 0.79 mm for males in maxillary arch and 0.99 mm for females in mandibular arch [Table 2].

Regression equations are shown in Table 3, where the least square regression equations are in the form of Y = a + b (X); "Y" denotes the predicted mesiodistal size of canine and premolars (maxillary and mandibular) in one quadrant in millimeters and "X" equals the measured mesiodistal width of the four permanent mandibular incisors in millimeters. "a" and "b" are the constants to be derived ("a" is the Y-intercept and "b" the slope of the regression).

Discussion

In the present study, the nonradiographic method was chosen because the results of the radiographic method depend on the quality of the X-ray film available, the technique followed and position of the crypts.[9,10] Calibration of the mesiodistal diameter of the teeth can be done by a pair of dividers or sliding calibrated calipers, digital calipers, MagicScan image analysis, digital method, etc. In the present study, the measurements of the teeth were done by contact method indirectly on the casts using digital calipers since it is easy, fast, accurate and also, the errors were less with this method.[15]

The combined mesiodistal diameter of the lower incisors, maxillary, mandibular canines and premolars was larger in males than females in the present study, which was statistically significant.[9,10]

Statistically significant differences were observed between the actual values and those predicted by Tanaka and Johnston method. Tanaka and Johnston prediction in the maxillary arch overestimated the combined mesiodistal width of permanent canine and premolars by 0.9 mm in males and 0.76 mm for the female group when compared to the actual values. These results are in agreement with the studies done by Sonahita *et al*.[11] However, underestimated values in females were noticed by Abu Alhaija and Qudeimat.[16]

In the mandibular arch, overestimated values were observed in both males and females by 1.2 mm and 1.13 mm, respectively. These results are in harmony with the studies by Chandna *et al*.,[17] Buwembo *et al*.,[18] and Sonahita *et al*.[11] Contrary

Table 1: Comparison of mesiodistal widths in male and female samples

Sum of the teeth	Sex	Mean (SD)*	*P*
Sum of LI*	Male	24.69 (0.76)	<0.001 Significant
	Female	22.65 (0.82)	
Sum of UCPM*	Male	22.44 (0.83)	<0.001 Significant
	Female	21.56 (1.1)	
Sum of LCPM*	Male	21.62 (0.96)	<0.001 Significant
	Female	20.69 (1.15)	

*LI: Lower incisors, UCPM: Upper canine and premolars, LCPM: Lower canines and premolars, SD: Standard deviation

Table 2: Regression parameters for the selected sample

Canine premolar segment	Sex	Correlation coefficient (*r*)	Coefficients of determination	Constants		SE*
				A	B	
Maxillary arch (UCPM)*	M	0.33	0.11	13.22	0.37	0.795
	F	0.49	0.24	6.68	0.65	0.969
	M + F	0.56	0.31	10.95	0.46	0.886
Mandibular arch (LCPM)*	M	0.33	0.1	11.25	0.42	0.917
	F	0.38	0.15	8.28	0.54	0.99
	M + F	0.523	0.27	10.06	0.69	0.991

*UCPM: Mesiodistal width of upper canine and premolars, *LCPM: Mesiodistal width of lower canine and premolars, *SE: Standard error, M: Male, F: Female

Table 3: Regression equations

Estimated equations	Maxillary	Mandibular
Males	Y=13.22+0.37 (X)	Y=11.25+0.42 (X)
Females	Y=6.68+0.65 (X)	Y=8.28+0.54 (X)
Combined	Y=10.95+0.46 (X)	Y=10.06+0.69 (X)

to this, underestimated values were detected by Abu Alhaija and Qudeimat.[16]

Moyers' prediction at the 50th percentile in the maxillary arch showed no difference between the actual values and predicted values in males. A similar outcome was observed in the work done by Memon and Fida.[19] Underestimated values were observed in the study done by Abu Alhaija and Qudeimat[16] and Nik Tahere *et al*.,[20] whereas overestimated values were observed in the study by Hammad and Abdellatif.[21]

At the 50th percentile of Moyers' prediction in the maxillary arch of females, an underestimation of 1.06 mm was observed which was correlating with the study by Jaroontham and Godfrey[9] and Sonahita *et al*.[11] An overestimation of 0.2 mm was observed by Jaiswal *et al*.[22]

At the 75th percentile of Moyers' prediction in the maxillary arch of males, an overestimation of 0.33 mm was observed. Results were alike to the work done by Durgekar and Naik.[23] On the other hand, underestimated values were found by Chandna *et al*.[17] In females, an underestimated value of 0.37 mm was observed which is analogous to the studies done by Hammad and Abdellatif,[21] Philip *et al*.,[12] and Chandna *et al*.[17] On the contrary, Nik Tahere *et al*.,[20] Memon and Fida,[19] and Buwembo *et al*.[18] found its applicability for predicting values.

At the 75th percentile of Moyers' prediction in the mandibular arch of males and females, an overestimation of 0.92 mm and 0.46 mm was observed, respectively. These results are in consistent with the study done by Chandna *et al*.[17] In contrary, study by Hammad and Abdellatif[21] exhibited under prediction.

In the present study, overestimated values were noticed with Tanaka and Johnston method when compared to Moyers' 50th and 75th percentile, in the mandibular arch for both the genders.

Under and over-prediction values were observed when Tanaka and Johnston and Moyer's methods were applied to the present contemporary population, which could be due to variation in sample size, racial, ethnic, and secular trends. Thus, emphasizing the fact that one prediction method may not be applicable universally.[4,6,8]

Even though the exact etiology for variations in tooth size of different racial groups is not known, genetics along with nutrition and environment plays an important role during the tooth development.[24,25]

Variable results in tooth size prediction could also be due to armamentarium and methodology followed by different investigators.[15] Sexual dimorphisms in tooth sizes have been noted in various odontometric studies.[4,9,10] There is strong evidence that tooth size is expressed through X-linked inheritance where 2X chromosomes in females might provide a measure of control which is lacking in males.[24,25]

Significant sex differences in mesiodistal tooth size highlight the importance of developing mixed dentition prediction aids, separately for both the genders. Secular trends in tooth size suggest the need for frequent updating of mixed dentition prediction aids which were developed from odontometric data of previous generations thereby avoiding under-/over-estimated values for the present day children.[12] A clear secular trend in tooth sizes could not be established in this study because of the lack of odontometric data from previous generations of this ethnic group. However, the proposed new prediction equation might be more accurate to calculate the tooth size in the present population. Disparity in coefficient values between the different ethnic studies illustrates tooth size variability between diverse ethnic groups.[9,10] The research till date, as well as the present study, supports the view that racial difference is important in tooth size prediction.

Although many studies have reported the need for specific regressions for different racial and ethnic groups, very few have addressed about the clinical significance.[8-10] Authors anecdotally claimed that with a combined mesiodistal width of canines and premolars within 1 mm of the predicted value derived from Tanaka and Johnston and Moyer's techniques should be considered clinically acceptable.[6] The clinical significance of the difference between predicted and actual teeth width in the growing child, however, remains unsubstantiated by any scientific evidence. Therefore, the results of Tanaka and Johnston and Moyer's space analysis techniques when applied for growing children other than Northwestern European origins should be interpreted with caution.

The prediction equations formulated, based on the data from the present sample in Southeastern region of Andhra Pradesh, may be a guide for prediction of mesiodistal widths of unerupted canines and premolars. However, further investigation with a larger sample size is required to collect more representative odontometric data.

Conclusion

- Significant sexual dimorphism in tooth size exists in the present population
- The commonly used Tanaka and Johnston and Moyer's prediction methods were not accurate when applied to the current sample since it tends to over/under estimate the actual measurements
- The values were more for Tanaka and Johnston than for Moyers' (50th and 75th percentile)
- The new derived regression equations were more promising in predicting the mesiodistal widths of canines and premolars for males and females separately.

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Conflicts of interest

There are no conflicts of interest.

References

1. Al-Bitar ZB, Al-Omari IK, Sonbol HN, Al-Ahmad HT, Hamdan AM. Mixed dentition analysis in a Jordanian population. Angle Orthod 2008;78:670-5.
2. Moyers RE. Handbook of Orthodontics. 4th ed.. Chicago, IL: Year Book Medical Publishers; 1988. p. 577.
3. Tanaka MM, Johnston LE. The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population. J Am Dent Assoc 1974;88:798-801.
4. Schirmer UR, Wiltshire WA. Orthodontic probability tables for black patients of African descent: Mixed dentition analysis. Am J Orthod Dentofacial Orthop 1997;112:545-51.
5. Lee-Chan S, Jacobson BN, Chwa KH, Jacobson RS. Mixed dentition analysis for Asian-Americans. Am J Orthod Dentofacial Orthop 1998;113:293-9.
6. Bishara SE, Jakobsen JR. Comparison of two nonradiographic methods of predicting permanent tooth size in the mixed dentition. Am J Orthod Dentofacial Orthop 1998;114:573-6.
7. Flores-Mir C, Bernabé E, Camus C, Carhuayo MA, Major PW. Prediction of mesiodistal canine and premolar tooth width in a sample of Peruvian adolescents. Orthod Craniofac Res 2003;6:173-6.
8. Nourallah AW, Gesch D, Khordaji MN, Splieth C. New regression equations for predicting the size of unerupted canines and premolars in a contemporary population. Angle Orthod 2002;72:216-21.
9. Jaroontham J, Godfrey K. Mixed dentition space analysis in a Thai population. Eur J Orthod 2000;22:127-34.
10. Diagne F, Diop-Ba K, Ngom PI, Mbow K. Mixed dentition analysis in a Senegalese population: Elaboration of prediction tables. Am J Orthod Dentofacial Orthop 2003;124:178-83.
11. Sonahita A, Dharma RM, Dinesh MR, Amarnath BC, Prashanth CS, Akshai S, *et al.* Applicability of two methods of mixed dentition analysis in a contemporary Indian population sample. Eur J Paediatr Dent 2012;13:29-34.
12. Philip NI, Prabhakar M, Arora D, Chopra S. Applicability of the Moyers mixed dentition probability tables and new prediction aids for a contemporary population in India. Am J Orthod Dentofacial Orthop 2010;138:339-45.
13. Burhan AS, Nawaya FR. Prediction of unerupted canines and premolars in a Syrian sample. Prog Orthod 2014;15:4.
14. Jensen E, Kai-Jen Yen P, Moorrees CF, Thomsen SO. Mesiodistal crown diameters of the deciduous and permanent teeth in individuals. J Dent Res 1957;36:39-47.
15. Al-Dashti AA, Cook PA, Curzon ME. A comparative study on methods of measuring mesiodistal tooth diameters for interceptive orthodontic space analysis. Eur J Paediatr Dent 2005;6:97-104.
16. Abu Alhaija ES, Qudeimat MA. Mixed dentition space analysis in a Jordanian population: Comparison of two methods. Int J Paediatr Dent 2006;16:104-10.
17. Chandna A, Gupta A, Pradhan K, Gupta R. Prediction of the size of unerupted canines and premolars in a North Indian population – An *in vitro* study. J Indian Dent Assoc 2011;5:329-33.
18. Buwembo W, Kutesa A, Muwazi L, Rwenyonyi CM. Prediction of width of un-erupted incisors, canines and premolars in a Ugandan population: A cross sectional study. BMC Oral Health 2012;12:23.
19. Memon S, Fida M. Comparison of three mixed dentition analysis methods in orthodontic patients at AKUH. J Coll Physicians Surg Pak 2010;20:533-7.
20. Nik Tahere H, Majid S, Fateme M, Fard K, Javad M. Predicting the size of unerupted canines and premolars of the maxillary and mandibular quadrants in an Iranian population. J Clin Pediatr Dent 2007;32:43-7.
21. Hammad SM, Abdellatif AM. Mixed dentition space analysis in Egyptian children. Pediatr Dent J 2010;20:115-21.
22. Jaiswal AK, Paudel KR, Shrestha SL, Jaiswal S. Prediction of space available for unerupted permanent canine and premolars in a Nepalese population. J Orthod 2009;36:253-9.
23. Durgekar SG, Naik V. Evaluation of Moyers mixed dentition analysis in school children. Indian J Dent Res 2009;20:26-30.
24. Garn SM, Lewis AB, Kerewsky RS. X-linked inheritance of tooth size. J Dent Res 1965;44:439-41.
25. Garn SM, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. J Dent Res 1967;46:963-72.