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EVALUATION AND APPLICABILITY OF MOYERS MIXED DENTITION ARCH ANALYSIS IN HIMACHAL POPULATION

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ABSTRACT

Introduction: The determination of a tooth-size to arch length discrepancy in mixed dentition requires an accurate prediction of the mesiodistal width of the unerupted permanent teeth. The Moyers mixed dentition space analysis is the non-radiographic method for detecting tooth-size arch length discrepancies. Moyers analysis was developed for North American children. Anthropological studies reveal that tooth size varies among different races and ethnicities. **Aim:** The present study was aimed to determine the applicability of Moyers mixed dentition arch analysis in children of Baddi, Himachal Pradesh. **Materials and methods:** Dental study models of 120 children in age group of 13- 16 years, were analysed who presented with complete eruption of permanent mandibular incisors, maxillary and mandibular canines & premolars. All dentitions were required to be free of any signs of dental pathology or anomalies. Measurements of the mesiodistal dimensions of the mandibular and maxillary teeth were made using a digital caliper with a Vernier scale that was calibrated to the nearest 0.01mm. The values were then subjected to statistical analysis. **Results:** All tooth groups showed highly significant differences ($p<0.001$) between mesiodistal widths in male and female subjects. Significant differences ($p<0.05$) were found between actual widths and the Moyers tables at almost all percentile levels, including the recommended 75%. **Conclusion:** The differences noted between predicted values from the Moyers tables and that of the present investigation might be the result of racial and ethnic diversity.
Key words: Arch length, Mixed dentition, Moyers analysis, Non- radiographic method, Tooth-size.

INTRODUCTION

Mixed dentition period is the most dynamic phase in terms of changes in occlusion and final outcome of dento-skeletal relationship. During the mixed dentititon period, the orthodontist or paediatric dentist is often asked to provide an accurate diagnosis and treatment of any developing malocclusions. Early intervention of the developing malocclusions can be done by a proper space assessment in mixed dentition phase.[1] Thus, mixed dentition arch analysis forms an essential part of diagnostic procedures. It is an important criterion in determining whether the treatment plan is going to involve serial extraction, guidance of eruption, space maintenance, space regaining or just periodic observation of the patient.[2] The determination of tooth size arch length discrepancy in the mixed dentition requires an accurate prediction of the mesiodistal width of the unerupted permanent teeth.

Various approaches have been applied to estimate the mesiodistal crown dimensions of unerupted maxillary and mandibular canines & premolars in mixed dentition patients.[3] Statistical methods employing linear regression equations were first used by Moyers and results were published in the form of the well known Prediction tables in his textbook in 1958.[4]

It is also noteworthy that Moyers has provided two sets of data tables for mixed dentition space analysis, one for sexes

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combined given in 1973[5], which does not correlate with his sexes separated data published in 1988.[6] Mixed dentition analysis using Moyers tables is widely used[7-9] and has several advantages.[10] It requires no specific equipment or radiographic projections; used for both arches and, is best done on dental casts. Moyers analysis was however, developed from data obtained from North American children. Anthropological studies reveal that tooth size varies among different races and ethnicities. So, there is a need for studying such racial trends and verifying the authenticity of standard prediction tables in different populations. The present study was conducted with an aim to determine the applicability of Moyers mixed dentition arch analysis in children of Baddi. At the same time, new prediction equations were also formulated with an objective to provide an accurate mixed dentition analysis among Himachal population.

MATERIALS AND METHODS

A sample of 120 subjects in the age range of 13 –16 years were selected from various schools within 10 km radius from Bhojia Dental College and Hospital, Baddi. The study was approved by institutional ethics committee. After explaining the nature of the study, permission was taken from the Principal of the schools who in turn took permission from the parents of selected children. Dental study casts of the selected children were made from dental impressions taken with alginate impression material (Marieflex, Septodont Health Care India) and immediately poured with dental stone (Gypstone, Type III, Prevest Denpro Limited) to avoid any dimensional changes.

Inclusion criteria for sample selection were the following:

1. Fully erupted mandibular permanent incisors, mandibular and maxillary permanent canines and premolars.
2. No obvious loss of tooth material mesiodistally as a result of caries, fractures, congenital defects, or inter proximal attrition.
3. No previous history of orthodontic treatment.
4. Similar ethnic background.
5. Subjects with no or minimal crowding.
6. The dental impressions and study casts were of high quality and free of distortions.

Exclusion criteria for sample selection were:

1. Physically or medically compromised children
2. Migratory population

The teeth measured were the mandibular permanent central and lateral incisors, the mandibular and maxillary permanent canines, and first and second premolars of both arches. The values obtained for the right and left canine premolar segments in each arch were averaged, so that there would be one value for the mandibular canine- premolar segment (LCPMs) and one value for the maxillary canine-premolar segment (UCPMs) for each value of the combined mandibular incisors (LI). Measurements of the mesiodistal crown dimensions of the mandibular and maxillary teeth were made by using a digital caliper with a Vernier scale (Aerospace industries - Figure 1), calibrated to the nearest 0.01 mm. The tips of the calipers were precision engineered to ensure the greatest accuracy while measuring the various tooth groups. A standardized method proposed by Moorrees and Reed[11] was used to measure the mesiodistal crown dimensions. The greatest mesiodistal crown dimension of each tooth was measured between its contact points, with the sliding caliper placed parallel to the occlusal and vestibular surfaces.

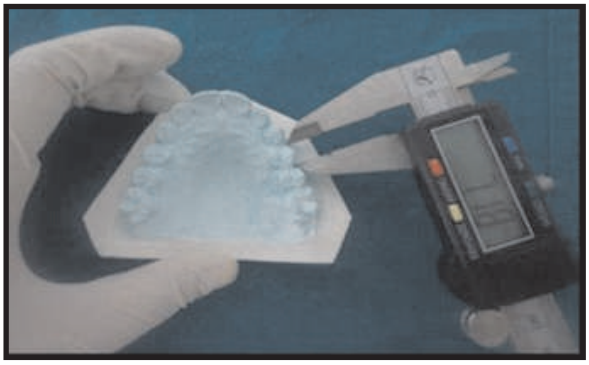

Figure 1: Measurement of M-D crown dimensions.

RESULTS

A total of 120 sets of dental casts were obtained from 66 male subjects and 54 female subjects with the mean age of 14.20+1.166 years and 14.33+166 years, respectively. Descriptive statistics, including the mean, standard deviation, and minimum and maximum values of mesiodistal dimensions of mandibular

incisors, maxillary and mandibular canines and premolars were calculated. The mesiodistal crown dimensions of mandibular incisors ranges from 18.64–25.36 mm and 17.92 – 25.50 mm separately for males and females, respectively. Mesiodistal dimensions of the maxillary canine & premolars for the males and females ranges from 18.07 -23.29 mm and 17.18 – 23.18 mm, respectively and mesiodistal crown dimensions of the mandibular canine & premolars were 18.17-22.5 and 17.38-22.42 for males and females, respectively.

Mandibular incisors mesiodistal crown dimensions for the males showed a mean of 22.339±1.4644 and for females, it was found to be 21.504±1.5140 (t=3.127). Means for mesiodistal crown dimensions of maxillary canine & premolars for males was 20.64±1.008 and for females, it was 19.88±1.17 (t=3.762). Means for mesiodistal crown dimensions of mandibular canine & premolars for males and females were 20.365±1.0235 and 19.45±1.164, respectivly (t=4.606).

All the three tooth groups (LI, UCPMs and LCPMs) showed sexual dimorphism with significant differences in the mesiodistal crown dimensions for males and females.

These data were then used to develop regression equations
$y = a + bx$
a and b are regression coefficients
y = dependent variable (predicted width of canine and premolars)
x = independent variable (summed width of mandibular incisors)

The coefficient of co-relation(r) was derived to find the co-relation between the sums of canine and premolars in both the arches with that of sum of mandibular incisors. The coefficient of determination (r2) was found to determine the accuracy of the formulated regression equations [Table 1]. The standard error of estimate (SEE) was calculated to determine the validity of the proposed equations. Student's unpaired t-test was applied to compare tooth dimensions between male and female subjects. The actual measurements were compared with the predicted values obtained with the Moyers probability tables at the 35th, 50th, and 75th percentile confidence levels [Table 2-5]. P- value of ≤ 0.05 was considered statistically significant.

With the help of the data obtained, new regression equations were derived separately for male and female subjects to be used to predict tooth dimension.

Male: Maxilla - $y = 10.761 + 0.442 (x)$
Mandible – $y = 9.524 + 0.485 (x)$

Female:
Maxilla – $y = 10.135 + 0.442 (x)$
Mandible – $y = 9.142 + 0.479 (x)$

DISCUSSION

In this study, Himachal population is chosen for the study which is racially different from the population selected by Moyers for making prediction tables. It has also been well established in the literature that tooth sizes vary considerably between racial groups, therefore, the accuracy of these prediction methods might be in question when applied to population groups other than white people.[7,11-17] Nanda and Chawla[18] found a significant disparity between the leeway space of North Indian children and the leeway space that was reported by Nance[19] for American children. Singh and Nanda[20] derived a mixed dentition prediction scale for North Indian population which is different from prediction tables developed by Ballard and Wylie[21] for American white people. The reasons for the tooth size variation in different racial groups have not been clearly elucidated, but obviously, genetic factors play a major role. Nutrition and environmental exposure during tooth development might have secondary role.

The use of digital calipers has been shown to be more accurate method of measuring mesiodistal tooth dimension on dental study models. Hence, they were chosen for this study. The excellent measurement accuracy reduces the possibility of introducing systemic and random errors in measurements. This method was reported to be highly reproducible and

accurate for measuring mesiodistal crown widths by Doris et al.[22] For measurement reliability, teeth were measured manually and independently by two investigators and mean of 2 values was taken.

In addition to the racial difference in tooth size, the descriptive statistics showed that the mesiodistal crown widths of all tooth groups measured in this study were significantly larger in males than in females ($p<0.001$). Similar sex dimorphisms in tooth sizes have been noted in other odontometric studies.[13-17, 23] The significant sex difference in mesiodistal tooth dimensions emphasizes the importance of developing mixed dentition prediction aids separately for male and female patients, so that a more accurate tooth size prediction can be made during the mixed dentition period. This sex difference in tooth sizes was also considered by Moyers[5,6] while modifying his original probability tables that were based on pooled odontometric data.

The correlation coefficients obtained in this study (Table 1) are similar to those of several other studies; Hixon and Oldfather[24] (0.69), Tanaka and Johnston[25] (0.65), Ballard and Wylie[21] (0.64), and Lee-Chan et al[15] (0.66). Relatively consistent correlations (0.60-0.70), were found between the combined mesiodistal widths of the mandibular permanent incisors and that of the canine premolars segment. This may implicate that 60% to 70% of the polygenes that determine tooth size are shared between the mandibular incisors and the canines and the premolars.[25] This common genetic code gives theoretical justification for the estimation of unerupted canine & premolar widths based on the mesiodistal dimensions of already erupted mandibular incisors, even though these teeth belong to different morphologic classes. Using the mandibular permanent incisors as a predictor variable has several advantages: they erupt early in the mixed dentition, can be easily measured, show little variability in size, and are directly in the midst of most space-management problems.[6]

Coefficients of determination, which indicate the predictive accuracy of the regression equations, were between 0.36 and 0.47 for the different canine premolar segments (Table 1). This means that 36% to 47% of the total variances in canine-premolar widths are accounted for by knowing the combined mandibular incisor widths. The error involved in the use of the regression equations is indicated by the SEE; the lower the SEE, the better the prediction equation.

The new mixed dentition prediction aids (regression equations and probability tables) developed in this study are presented in Tables 2, 3, 4 and 5. The use of these prediction aids for estimation of unerupted canine- premolar widths is likely to result in a more accurate mixed dentition space analysis among Himachal children.

Significant differences ($p<0.05$) were found between the predicted mesiodistal tooth dimensions in the present study and that of the Moyers probability tables at almost all percentile confidence levels. This study revealed that the Moyers charts at the 75th and 50th percentile confidence level overestimates tooth dimensions. When actual values were compared with Moyers chart at the 35th percentile, it showed varied results. Al- Khadra[8] found that the recommended 75% confidence level of the Moyers probability tables overestimated the sizes of canines and premolars of a Saudi Arab population. Probability tables on the Moyers pattern have also been derived by Priya and Munshi[14] (South Indians), Schirmer[16] (black South Africans) and Singh and Singla[26] (Himachal population, North India) and Philip and Prabhakar[27] (Punjab population, North India). Priya and Munshi[14] concluded that the Moyers probability tables underestimated the tooth sizes of South Indian children. Schirmer[16] tested the applicability of the Moyers tables in black South Africans and found highly significant differences ($p<0.001$) at all percentile confidence levels, in the arches of both male and female subjects, except at the 75%, 85%, and 95% levels in the maxillary arch of females. Singh and Singla conducted a study in the population from the interior of Himachal state and they concluded that the Moyers tables tend to underestimate the mesiodistal canine-premolar widths, including at the recommended 75% level.26 Philip and Prabhakar also found significant differences ($p<0.05$) between the

predicted mesiodistal tooth widths of their study and that of the Moyers probability tables at almost all percentile confidence levels.[27] They concluded that the Moyers tables tend to underestimate the mesiodistal canine-premolar widths including at the recommended 75% and 50% levels.

The present study showed that mesiodistal dimensions of permanent canine & premolars calculated from sum of permanent mandibular incisors more closely approximate at 35th percentile compared to 75th percentile level of probability as suggested by Moyers. Rani and Goel[28] also showed that 35th percentile is more accurate than 75th percentile level of probability suggested by Moyers in South Indian population.

Table 1: Regression parameters for prediction of mesiodistal dimensions of canine premolar segments based on the sum of mandibular incisors

Tooth group	Sex	r (coefficient of correlation)	Regression constants		r^2 (coefficient of determination)	SEE (standard error of estimate)
			a	b		
UCPM (Maxillary canine and premolars)	M F	0.652 0.600	10.761 10.135	0.442 0.455	0.425 0.360	1.439 1.813
LCPM(Mandibular canine and premolars)	M F	0.685 0.637	9.524 9.142	0.485 0.479	0.470 0.406	1.441 1.733

Table 2: Actual value and Predicted values at 35th, 50th and 75th percentiles of Moyers chart for Males in mandibular arch

LI (sum of mandibular incisors)	Predicted values at			Actual value (LCPM)
	35th percentile	50th percentile	75th percentile	
19.5	19.0	19.5	20.4	19.60
20	19.3	19.7	20.6	18.395
20.5	19.5	20.0	20.8	18.95
21	19.7	20.2	21.0	19.87
21.5	20.0	20.4	21.2	19.65
22	20.2	20.6	21.4	20.45
22.5	20.4	20.9	21.6	20.55
23	20.67	21.1	21.9	20.50
23.5	20.9	21.3	22.1	21.37
24	21.1	21.5	22.3	21.11
24.5	21.3	21.7	22.5	20.49
25	21.5	22.0	22.8	21.72
25.5	21.7	22.2	23.0	22.49

Table 3: Actual value and Predicted values at 35th, 50th and 75th percentiles of Moyers chart for Males in maxillary arch

LI (sum of mandibular incisors)	Predicted values at			Actual value (UCPM)
	35th percentile	50th percentile	75th percentile	
19.5	19.3	19.7	20.3	18.07
20	19.6	19.9	20.5	19.50
20.5	19.9	20.2	20.8	19.34
21	20.1	20.4	21.0	20.36
21.5	20.4	20.7	21.3	20.00
22	20.6	20.9	21.5	20.84
22.5	20.9	21.2	21.8	21.00
23	21.1	21.5	22.0	21.14
23.5	21.4	21.7	22.3	21.35
24	21.6	22.0	22.5	21.15
24.5	21.9	22.2	22.8	21.04
25	22.1	22.5	23.0	20.73
25.5	22.4	22.7	23.3	23.30

Table 4 : Actual value and Predicted values at 35th, 50th and 75th percentiles of Moyers chart for Females in mandibular arch

LI (sum of mandibular incisors)	Predicted values at			Actual value (LCPM)
	35th percentile	50th percentile	75th percentile	
19.5	18.2	18.7	19.6	18.33
20	18.5	19.0	19.8	18.78
20.5	18.8	19.2	20.1	19.07
21	19.0	19.5	20.3	19.24
21.5	19.3	19.8	20.6	21.8
22	19.6	20.0	20.8	19.75
22.5	19.8	20.3	21.1	20.27
23	20.1	20.5	21.3	18.77
23.5	20.3	20.8	21.6	20.24
24	20.6	21.1	21.9	22.03
24.5	20.9	21.3	22.1	20.88
25	21.1	21.6	22.4	21.30
25.5	21.4	21.8	22.7	20.51

Table 5 : Actual value and Predicted values at 35th, 50th and 75th percentiles of Moyers chart for Females in maxillary arch

LI (sum of mandibular incisors)	Predicted values at			Actual value (UCPM)
	35th percentile	50th percentile	75th percentile	
19.5	19.2	19.6	20.4	18.64
20	19.4	19.8	20.5	19.51
20.5	19.5	19.9	20.6	19.74
21	19.7	20.1	20.8	19.81
21.5	19.8	20.2	20.9	19.75
22	19.9	20.3	21.0	19.64
22.5	20.1	20.5	21.2	20.20
23	20.2	20.6	21.3	20.78
23.5	20.4	20.8	21.5	21.49
24	20.5	20.9	21.6	22.09
24.5	20.6	21.0	21.8	20.58
25	20.8	21.2	21.9	21.75
25.5	20.9	21.3	22.1	20.30

The observation of present study reaffirm that the Moyers probability tables overestimate tooth sizes of unerupted canine and premolars of Himachal population. Developing new probability tables on the Moyers pattern, specifically for different population groups, can aid in achieving more accurate estimation of unerupted tooth sizes, thus enabling clinicians in early diagnosis and timely intervention of developing malocclusions.

CONCLUSION

The following conclusions were drawn from this study -

1) The prediction methods suggested by Moyers over estimated the actual tooth size of unerupted canine and premolars in Himachal population, therefore these prediction methods are not completely applicable in this population.
2) Moyers chart at 35th percentile confidence level gives more appropriate estimate of width of unerupted canine and premolars as compared to 75th percentile confidence level.

The newly formed regression equations provided more precise results. Further studies on a larger population are recommended to get a more accurate result.

REFERENCES

1. Abu Alhaija ES, Qudeimat MA. Mixed dentition space analysis in a Jordanian population: comparison of two methods. Int J Paediatr Dent. 2006;16(2):104-10.
2. Bishara, S. E., Staley, R. N. Mixed-dentition mandibular arch length analysis: A step-by-step approach using the revised Hixon-Oldfather prediction method. Am J Orthod. 1984;86:130-35.
3. Staley RN, Hoag JF. Prediction of the mesiodistal widths of maxillary permanent canines and premolars. Am J Orthod. 1978;73(2):169-77.
4. Moyers RE. Handbook of orthodontics. 4th edn. Chicago: Year Book Medical Publishers; 1958.
5. Moyers RE. Analysis of dentition and occlusion. In: Moyers RE, editor. Handbook of orthodontics. 3rd ed. Chicago: Year Book Medical Publishers; 1973.
6. Moyers RE. Analysis of dentition and occlusion. In: Moyers RE editor. Handbook of orthodontics. 4th ed. Chicago: Year Book Medical Publishers; 1988:p. 235-40.
7. Ferguson FS, Marco DJ, Sonnenburg EM and Shakun M.L. The use of regression constants in estimating tooth size in the Negro population. American Journal of Orthodontics. 1978;73(1):68-72.

8. Al-Khadra BH. Prediction of the size of un-erupted canines and premolars in a Saudi Arab population. Am J Orthod Dentofacial Orthop. 1993;104(4):369-372.
9. Yuen KK, Tang EL and So LL. Mixed dentition analysis for Hong Kong Chinese. The Angle Orthodontist. 1998;68(1):21-28.
10. Proffit WR, Fields HW. Contemporary orthodontics (3rd ed). St Louis, Mo: Mosby; 1961;p167-70.
11. Bishara SE, Jakobsen JR, Abdallah EM, Fernandez Garcia A. Comparisons of mesiodistal and buccolingual crown dimensions of the permanent teeth in three populations from Egypt, Mexico, and the United States. Am J Orthod Dentofacial Orthop. 1989;96:416-22.
12. Lavelle CLB. Maxillary and mandibular tooth size in different racial groups and in different occlusal categories. Am J Orthod. 1972;61:29-37.
13. Jaroontham J, Godfrey K. Mixed dentition space analysis in a Thai population. Eur J Orthod. 2000;22:127-34.
14. Priya S, Munshi AK. Formulation of a prediction chart for mixed dentition analysis. J Indian Soc Pedod Prev Dent. 1994;12:7-11.
15. Lee-Chan S, Jacobson BN, Chwa KH, Jacobson RS. Mixed dentition analysis for Asian-Americans. Am J Orthod Dentofacial Orthop. 1998;113:293-9.
16. 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.
17. 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.
18. Nanda RS, Chawla JM. Variability of leeway space. J Indian Dent Assoc 1973;45:99-108.
19. Nance HV. Limitations of orthodontic treatment. Mixed dentition diagnosis and treatment. Am J Orthod Oral Surg. 1947;33:177-223.
20. Singh M, Nanda RS. Prediction of tooth size and its clinical application. J Indian Dent Assoc. 1972;44:5-8.
21. Ballard ML,Wylie WL. Mixed dentition case analysis: estimating sizes of unerupted permanent teeth. Am J Orthod. 1947;33:754-9.
22. Doris JM, Bernard BW, Kuftinec MM, Stom D.A biometric study of tooth size and dental crowding.Am J Orthod. 1981;79:326-35.
23. de Paula S, Almeida MA, Lee PC. Prediction of mesiodistal diameter of unerupted lower canines and premolars using 45 degrees cephalometric radiography. Am J Orthod Dentofacial Orthop. 1995;107:309-14.
24. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted cuspids and bicuspids. Angle Orthod. 1958;28:236-40.
25. Tanaka MM, Johnston LE. The prediction of the sizes of unerupted canines and premolars in a contemporary orthodontic population. J Am Dent Assoc. 1974;88:798-801.
26. Singh V, Singla A, Mahajan V, Jaj HS, Bawa T. Development Of A Prediction Equation For The Mixed Dentition In A Himachal Population. Indian journal of Dental Sciences. 2013;5:40-43.
27. Philip N.I, 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
28. Rani MS, Goel. Evaluation of Moyers mixed dentition analysis for south Indian population. J Indian Dent Assoc 1989;60:253-55.

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