

A Comparative Evaluation of Moyers Mixed Dentition Analysis among Bengali and Keralite Population

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Abstract:

Background: This study was undertaken to evaluate the applicability of Moyers' mixed dentition analysis to Bengali and Keralite population, to assess the percentage probability to be used for the two populations Bengali and Keralite.

Materials and Methods: Record casts of 100 Bengali (50 - Males; 50 - Females) of 12-14 years were selected, and mesiodistal width of permanent incisors canines premolars was measured on study models. Similarly, 100 samples were drawn from Keralite population. Study models of 50 males and 50 females were prepared, and measurements were made. Paired *t*-test was performed to test the significance of the difference between the actual value (measured value) and the predicted value at each percentage level, as well as to test the difference between the Bengali and Keralite samples for both upper and lower teeth in male and female, respectively. The correlation coefficient for the actual mesiodistal width of canine and premolar with their predicted values were calculated for both Bengali and Keralite population.

Results: Paired *t*-test of difference between actual and predicted values for Bengali samples were least in case of the 65th percentile of the level of significance in upper arch and in lower arch it was the 50th percentile level of significance. For females, mean difference of upper arch was least at 65th percentile level and for lower arch at 50th percentile level of significance. For Keralite population, it was at 50th percentile level of significance in upper and lower arch for male and female it was at 65th percentile level in upper arch and 50th percentile level in the lower arch. The predicted value and the actual value were significantly correlated and may be used with much confidence in estimating the width of permanent canine, first premolar, and second premolar.

Conclusion: Moyers' prediction values at 75th percentile level over predicted width of canine and premolars. Moyers prediction values at 65th percentile level of significance may be accepted for predicting the combined width of canine and first and second premolars in case of upper for Bengali male and female and also

for upper teeth in Keralite females. In the case of lower arch, values should be accepted at 50th percentile level of significance to get a more accurate prediction.

Key Words: Bengal population, Keralite, Moyers mixed dentition analysis, model analysis

Introduction

Malocclusion is the disharmony of the teeth and their supporting tissues, which affect self-image, interpersonal transaction, and functional integrity of the stomatognathic system in the patient. It is well-recognized fact that correct teeth position is an indispensable aspect of health, function, and longevity of the system. The teeth should be uncrowded and in proximal contact, and different components of stomatognathic, system should be within physiological harmony. Among them, the teeth position is an important factor in establishing balance in the stomatognathic system.

The etiology of malocclusion is quite complex since it directly involves at least three tissue system *viz.* teeth, bone, and soft tissue. Abnormality of any one or a combination can result in malocclusion. Children inherit attributes from their parents, which are modified by the child's prenatal and post-natal environment, and subsequently reflect in the dentofacial skeleton. Dental crowding is one of the common complaints of an orthodontic patient, less frequent but of equal concern is that of the mesio-distal diameters of the teeth versus space available.

Teeth size is a determinant of normal occlusion because the crown diameters of the maxillary and mandibular teeth must be in perfect harmony to develop correct interdigitations. For proper alignment, the teeth size should be in coordination with arch size.¹ Crowding of teeth is frequently genetic in origin.² Racial groups in which intermarriage with other races has not occurred; generally, show a low incidence of malocclusion. As the racial mixture increase, so does the incidence of teeth size, jaw size discrepancies, and the occlusal disharmonies. Where there is a higher mixing of a racial group, the possibility of incidence of the malocclusion will be proportionately higher.

Variation in permanent mesio-distal teeth size has been established within³ and among the population. Variation in teeth size is influenced by genetic and environmental factors. Genetic basis for the variation is the best explained by the polygenic model of inheritance. Teeth size and potential jaw

development are predetermined genetically. Hence, two basic factors are important in determining the outcome of mixed dentition crowding, (1) Arch growth, (2) the difference in size between deciduous canine, first and second molar and their permanent successors. It is a well-recognized fact that a large percentage of malocclusion has their genesis during the mixed dentition stage. Most of these difficulties could be mitigated in severity or even eliminated by timely management.

The measurement of spacing⁴ or crowding of the teeth is frequently associated with the measurement of the mixed dentition because the accurate and specific prediction of future dental developmental events can be made at that stage and approximate interceptive action taken. In the mixed and permanent dentition, a clinical decision frequently begins with a numerical evaluation and there is no substitute for careful and accurate measurement.

If the permanent incisors are crowded growth⁵ cannot be expected to provide space for them since growth is minimal at the best. It is advantageous to intercept potential arch space deficiency problem at an early stage of occlusal development, i.e., before the eruption of all permanent teeth. Accurate assessment of space problem may allow implementation of a wider choice of management than if the situation is ignored until it matures into an established malocclusion. Hixon-Oldfather prediction method⁶ is a step-by-step approach for a mandibular mixed dentition tooth size-arch length space analysis.

Moyers developed one of the most frequently used methods of estimating the combined width of the unerupted cuspid and bicuspid teeth. It was based on the fact that there is a correlation in size between permanent teeth. Mandibular permanent incisor has been found to be the most reliable indices for the size of the remaining permanent teeth of both arches thus obtaining the sum of the width of the mandibular central and lateral incisors the width of the cuspid bicuspid segments in both the maxillary and mandibular arches could be calculated.

Moyers mixed dentition analysis⁷ is used to predict the probability of aligning the permanent teeth in the existing arch space. It also predicts a high probability level, the amount of space required for proper alignment of the permanent dentition. One of the most critical factors in dental arch development and the relation of arches to one another is mesio distal teeth size. The size and the shape of the jaws are dependent on the inter relation of genetic factors and functional environment. Size and morphology of the teeth are known to vary according to race.⁸ There for correlation coefficients and regression constant derived from one ethnic group may not suffice for the prediction of unerupted teeth size of another group.⁹

The present study was undertaken to evaluate:

1. Applicability of the Moyers' mixed dentition analysis for Bengali and Keralite population.
2. To assess the percentage probability to be used for the two population, i.e., - Bengali and Keralite
3. To find out the correlation between two population groups.

Materials and Methods

Samples were drawn from Bengali and Keralite population. The samples for Bengali population included patients who attended in the Department of Orthodontics, Dr. R. Ahammed Dental College, and Hospital, Kolkata. Samples included an equal number of both males and female subjects.

The criteria used for selecting the subjects and dental casts were as follows:

1. No obvious loss of teeth material mesiodistally because of caries or fracture
2. Fully erupted permanent teeth on both sides of dental arches
3. No congenitally missing, defective, or deformed teeth.

50 females and 30 males, fulfilled the above criteria, were selected. The age for the subjects ranged between 12 and 14 years. Record casts were examined, and 20 casts of male subjects were selected.

For Keralite population, approximately 150 boys and girls were examined in high school at Iritty in Cannanore district in Kerala state. 45 males and 37 females met the selection criteria. The mean age for males and females were 13.5 and 13 years, respectively. Another group of subjects were selected from Keralite, who were living at S N Nagar, Sankarpool, in Kolkata. Of the 35 boys and girls, examined 5 males and 13 females were selected the mean age were 13 and 12 years, respectively.

For Keralite population, study models were made using commercially available base former as suggested by White *et al.*¹⁰ The specification for model preparation was maintained. Measurements were made directly from dental casts using a vernier caliper. Mesio distal crown diameter of the teeth were obtained by measuring the greatest distance between the contact point on its proximal surfaces using the caliper held parallel both to the occlusal and vestibular surfaces. This technique could only be employed when the teeth were in a normal position in the dental arch.¹¹ Teeth showing impression flaws were excluded from the study.

In the mandible, the incisors are the widest just below their incisal edges and were measured at that point. Mandibular canine contact is about one quarter down the crown mesially and nearly half way down the distally. Mesio distal width of mandibular incisors canines and premolars were obtained with a pointed vernier caliper, and they were read to the

nearest 0.01 mm according to the methods outlined by Jensen *et al.*,¹² and Hunter.¹¹ Mesiodistal crown width of incisors, canines, and premolars, were measured on the both sides of the arch.

Results and Observation

The number of subjects was 100, of these, 50 were males and 50 females, respectively, for Bengali and Keralite population. The data obtained were subjected to following statistical analyses.

Table 1a shows the mean values of the sum of lower incisors ($\Sigma 2112$). Keralite male and female do not differ significantly, but the Bengali male average value is significantly higher than that of females. Table 1b shows mean value of sum of 345 for Keralite sample, the difference between male and female are not significant.

Table 2 presents the paired *t*-test of difference between actual and predicted values for Bengali sample of both male and female the mean difference for Bengali male upper arch is least in the case of 65th percentile level of significance and in lower arch it was 50th percentile level of significance. For females, mean difference of upper arch was least at 65th percentile level and lower arch at 50th percentile level of significance.

Table 3 presents paired *t*-test of difference between actual and predicted width Keralite population mean difference for Keralite male upper arch was least at 50th percentile level of significance and in the lower arch was in 50th percentile level. For females, the mean difference in the upper arch was least at 65th percentile level and lower arch at 50th percentile level.

Table 4a presents the paired *t*-test of difference between the actual and predicted width at 75th percentile significance. The difference between the predicted and the actual width were all statistically significant ($P < 0.001$) for most cases ($P < 0.01$ for both Keralite and Bengali females upper teeth). The predicted width far exceeded the actual width in case of lower teeth for both Bengali and Keralite population.

Table 1a: Mean value of $\Sigma 2112$ in different sample.			
$\Sigma 2112$			
Kerala		Bengali	
Male	Female	Male	Female
22.6	22.58	23.31	22.74
Kerala male and female do not differ significantly but the Bengali male average 2112 value is significantly higher than that of female ($t=2.38$, $P<0.05$)			

Table 4b shows the difference between the mean of measured width of 345, standard errors *t* value in Bengali and Keralite samples. The difference between the mean of the measured width of 345 were not significant ($P > 0.05$) indicating that the difference does not vary from one another, i.e. Keralite and Bengali populations are to a great extent similar in nature in relation to characteristics.

Table 5 shows mean standard deviation (SD) and coefficient of correlation between the actual and predicted values (accepted in the present study). The predicted values and the actual values were all significantly correlated ($P < 0.01$), thus it may be concluded that predicted values may be fairly used with much confidence in estimating the width of permanent canine, first and second premolar for incisor measurement.

Discussion

Sex dimorphism in teeth size is well-established for the human group.¹³ Bailit² stated that "teeth size variation exists within the population." This is seen in the two sexes, where the male teeth are larger than the female. Variation of teeth size between male and female was also shown by Jensen *et al.*,¹² Noss *et al.*,¹⁴ Buschang *et al.*¹⁵

In a study by Singh and Nanda, on 104 sets of dental casts, 52 males and 52 females showed that there was no significant difference due to sex in teeth size. They disregarded segregation of teeth sizes data on the basis of gender.

Studies by Kaplan *et al.* evaluation¹⁶ statistically insignificant difference between sexes and sides, so they combined the measurements of their samples for statistical evaluation.

Our study was based on two population groups belonging to two states of India, i.e., Bengalis from West Bengal and Keralites from Kerala. The reason for selecting these two population groups despite their significant geographical distance from each other is their commonly shared customs and traditions, which includes lifestyle, food, and ideology and whether these factors had any significance on our final results.

The mesiodistal size difference between the male and female samples in the present study in the case of incisors (lower incisor) in Kerala were not significant (0.02 mm) but in the case of Bengali samples it was significant (0.61) (Table 1a).

In the case of the sum of canine and premolars in Kerala sample difference between male and female in upper arch, it was 0.43 mm and 0.30 mm in the case of lower arch (Table 1b).

Table 1b: Mean value of $\Sigma 345$ in different sample.								
$\Sigma 345$	Kerala				Bengali			
	Male	Female	Difference	<i>t</i>	Male	Female	Difference	<i>t</i>
U	21.35	20.92	0.43	1.835	21.81	20.98	0.83	4.3
L	20.72	20.42	0.30	1.585	21.03	20.43	0.60	3
For Keralite difference between male and female are not significant ($P>0.05$)								

Table 2: Paired *t*-tests of difference between actual and predicted values for Bengali samples of both sex.

Percentile level	<i>d</i>	SD	<i>t</i>	<i>P</i>
Bengali male				
Upper teeth				
35	0.507	0.841	4.26	<0.001*
50	0.155	0.720	1.52	>0.01**
65	0.130	0.684	1.35	<0.01**
75	0.371	0.724	3.63	<0.001*
Lower teeth				
35	0.379	0.775	3.459	<0.001*
50	0.119	0.804	1.047	>0.01**
65	0.628	0.812	5.471	<0.001*
75	0.898	0.902	7.041	<0.001*
Bengali female				
Upper teeth				
35	0.84	0.773	7.69	<0.001*
50	0.436	0.767	4.01	<0.001*
65	0.087	0.760	0.806	>0.01**
75	0.297	0.727	2.89	<0.01**
Lower teeth				
35	0.452	0.800	3.99	<0.001*
50	0.081	0.758	0.759	>0.01**
65	0.481	0.833	4.083	<0.001*
75	0.789	0.771	7.23	<0.001*

*Significant, **Insignificant. *d*: Mean difference, SD: Standard deviation**Table 4a: Paired *t*-tests of difference between actual and predicted width at 75th percentile level of significance.**

Mean	SD	<i>t</i>	<i>P</i>
Bengali			
Male			
Upper teeth			
0.1304	0.7238	3.627	<0.001
Lower teeth			
0.898	0.9017	7.041	<0.001
Female			
Upper teeth			
0.2974	0.7271	2.89	<0.01
Lower teeth			
0.789	0.7711	7.23	<0.001
Keralite			
Male			
Upper teeth			
0.441	0.67142	4.64	<0.001
Lower teeth			
-1.0386	0.632	11.65	<0.001
Female			
Upper teeth			
0.273	0.7501	2.575	<0.01
Lower teeth			
0.745	0.6215	8.475	<0.001

SD: Standard deviation

Table 3: Paired *t*-test of difference between actual and predicted width for Keralite population.

Percentage level	<i>d</i>	SD	<i>t</i>	<i>P</i>
Keralite male				
Upper teeth				
35	0.4048	0.6527	4.385	<0.001*
50	0.0692	0.6503	0.752	>0.01**
65	0.2608	0.5839	3.158	<0.01*
75	0.441	0.6714	4.64	<0.01*
Lower teeth				
35	0.256	0.531	3.41	<0.01*
50	0.1806	0.554	2.30	>0.01**
65	0.598	0.580	7.29	<0.001*
75	1.0386	0.632	11.65	<0.001*
Keralite female				
Upper teeth				
35	0.8116	0.7590	7.56	<0.001*
50	0.3156	0.6937	3.216	<0.01*
65	0.028	0.7056	0.2805	>0.05**
75	0.213	0.7501	2.575	<0.01*
Lower teeth				
35	0.5304	0.6359	2.89	<0.001*
50	0.17	0.7123	1.687	>0.01**
65	0.3976	0.6389	4.400	<0.001*
75	0.745	0.6215	8.475	<0.001*

*Significant, **Insignificant. *d*: Mean difference, SD: Standard deviation**Table 4b: Difference between the averages of measured width of 345 in Bengali's and Keralite samples.**

Sex	Mean±SE		<i>t</i>	Inference
	Keralite	Bengali		
Male	Upper teeth			
	21.35±0.159	21.82±0.147	0.3709	<i>P</i> >0.05*
	Lower teeth			
	20.698±0.125	201.05±0.154	1.0483	<i>P</i> >0.05*
Female	Upper teeth			
	20.92±0.133	20.96±0.123	0.37198	<i>P</i> >0.05*
	Lower teeth			
	20.44±0.118	20.45±0.133	0.61372	<i>P</i> >0.05*

*Insignificant. SE: Standard error

In Bengali samples, these differences were found to be 0.83 mm in upper arch and 0.60 mm in the lower arch (Table 1b).

In Bengali samples, these differences were found to be 0.83 mm in upper arch and 0.60 mm in lower arch (Table 1b).

The mean values of right and left sides were used for statistical analysis. These findings were similar to observations made by Moyers', Garn and Lewis and Gupta.¹⁷ In Garn's study, mean value of corresponding teeth on opposite sides of midline proved to be similar within 0.03 mm.

Predicted values for the sum of the mesiodistal widths of permanent canine first and second premolars were calculated from the Moyers' prediction table 35th percentile, 50th percentile, 65th percentile, and 75th percentile and analyzed. The mean difference (*d*), SD, and *t* values found out were as shown in Tables 2 and 3. The mean difference for Bengali male in the upper arch was least in the case of 65th percentile level of significance. In the case of lower arch, it was 50th percentile level of significance in Moyers' prediction table (Table 3).

Table 5: Mean, SD, and coefficient of correlation between actual and predicted values.

Σ345	Actual width		Prediction width		<i>r</i>	<i>d</i>	Inference
	Mean	SD	Mean	SD			
Kerala							
Male							
Upper teeth	21.37	1.126	21.25	0.8056	0.016285	>0.05	Insignificant
Lower teeth	0.698	0.883434	20.898	0.704356	0.28109	>0.05	Insignificant
Female							
Upper teeth	20.917	0.9406821	20.898	0.321025	0.586	<0.01	Significant
Lower teeth	20.44	0.8316077	20.32	0.59739	0.5258	<0.01	Significant
Bengali							
Male							
Upper teeth	21.8148	1.042867	21.934	0.63394	0.70845	<0.01	Significant
Lower teeth	21.045	1.0916272	21.019	0.5867	0.04696	>0.05	Insignificant
Female							
Upper teeth	20.96	1.0672471	20.94	0.390269	0.5546	<0.01	Significant
Lower teeth	20.45	0.940576	20.41	0.71168	0.08097	>0.05	Insignificant

The predicted value and the actual values are the significantly correlated (at 10th percentile level of significance). Thus, it may conclude that the predicted value may be fairly used with much confidence in estimating the width of permanent canine first and second premolar from incisors measurement. SD: Standard deviation

The difference between the predicted and actual width were all statistically significant (Table 4a) ($P=0.001$) for most cases. It was also noticed that the predicted width far exceeds the actual widths in case of lower teeth for both Bengali and Keralite and for both sexes when compared to those upper teeth. Among the female samples, they were 66% and 68%, respectively.

The over estimation in the case of the lower arch were more compared to upper, which were evident from their increase in percentage, i.e., Bengali male, it was 84%, whereas in Kerala male it was 98% and in Bengali females it was 86%, but for Kerala females it was 90%. Results studied in terms of over and under-prediction showed that prediction equation based on the mesiodistal width of incisor consistently over-predicted the width of canine and premolars. In the present study, the difference is more in the case of the lower arch and more for both Bengali and Keralite in both sexes, when the prediction values were considered at 75th percentile confidence level (Table 4a). This indicates that statistically, 75th percentile level of significance value cannot be accepted for either population.

Moyers' prediction value at 65th percentile level of significance may be accepted for predicting the combined width of canine and first and second premolar in the case of upper teeth for both Bengali male and Female population and also for upper teeth of the Keralite females. Since the difference between the actual and predicted value is significant at 10th percentile level of significance as given by the paired *t*-tests. In the case of Keralite male, it was found to be 50th percentile level of significance.

Studies by Kaplan *et al.*¹⁸ showed an over estimation of combined width of canine and premolar in the 85.6th percentile of cases. Studies by Kaur *et al.*¹⁹ showed the same in Himachal population for them 35th percentile level of more significance more appropriate. Gardner study²⁰ of "A comparison of four

methods of predicting arch width" has shown that Moyers method tends to over predict the arch length by 1-3 mm. Hakanson has²¹ shown that Moyers analysis under predicts the combined mesiodistal dimension of canine and premolars²² and has suggested adjustments when using the table for Negro and oriental children. In the present study, few samples showed under estimation but compared to over prediction it was found to be insignificant. Studies conducted by Memon and Fida²³ has shown that Moyer's 50th percentile could be used for males while 75th percentile will give more accurate values in the case of females. Studies by Durgekar and Naik²⁴ found that Moyers prediction table is not an accurate method to estimate teeth dimension.

For practical purpose, under prediction should be eliminated by computing a confidence interval for each predicted values to include cases at the higher end of the distribution. Kaplan *et al.*¹⁸ have suggested the probability of under prediction can be reduced by adding 0.3 mm to values below 20 mm and 0.4 mm to value 20-22 mm and 0.5 mm to values 23 mm and above.

In the present study, values are accepted in 75th percentile level in an upper arch in Bengali male 68% over predicted values were obtained were as in Keralite male 70%. In the case of female, it was 66% and 68%, respectively. The over estimation in case of the lower arch in male sample were 84% and 98% and Keralite population for female samples it was 86% and 90%, respectively.

This was also shown by Rani and Goel²⁵ in their study in the South Indian population. An over prediction of arch length by 2-4 mm found when the prediction values accepted at 75th percentile level hence they also suggested that the prediction values should be more accurate if the values were accepted at 35th percentile level.

To find out the correlation between actual value and predicted value which is accepted for Bengali and Keralite population in the present study indicated that all predicted values were significantly correlated ($P < 0.01$) (Table 5). This shows that the predicted values may be used with much confidence in estimating the width of permanent canine first and second premolar from incisor measurements.

From the above study, it was clear that the prediction values at the 75th percentile in Moyers prediction table cannot be used for the Indian population and for more accurate prediction, values to be considered at 65th percentile level in cases of upper arch in both Bengali male and female population and also for Keralite female population. In the case of Keralite male, it was found to be 50th percentile. For lower teeth, the prediction values may be accepted at 50th percentile level to get a more accurate prediction of teeth size.

Meta-analysis by Buwembo and Luboga⁹ has shown that Moyer's prediction method has population variation, and hence it is better to develop prediction table for a specific population that is prediction table cannot be applied universally.

Summary and Conclusion

The prediction value 75th percentile level in Moyers prediction table over predicted the values. The difference between the predicted and actual width were all statistically significant ($P < 0.001$) for most cases. The predicted width was exceeded the actual width in case of lower teeth both for Bengali and Keralite population when compared to that of the upper arch.

The study showed that the Moyers prediction value at 65th percentile level of significance might be accepted for predicting the combined width of canine and first and second premolars, in the case of the upper arch for Bengali male and female and also for upper teeth in Keralite female. In the case of Keralite male value should be accepted at the 50th percentile for both upper and lower arch. The correlation for Moyers, method was more significant for both populations. This observation based on small sample size is insufficient to arrive at a concrete conclusion. So, further studies with a number of samples should be carried out to arrive at more accurate and meaningful decision.

References

1. Moorrees CF, Chaddah JM. Crown diameters of corresponding teeth groups in deciduous and permanent dentition, J Dent Res 1962;41:466-76.
2. Bailit HL. Dental variation among populations. An anthropologic view. Dent Clin North Am 1975;19(1):125-39.
3. Townsend GC, Brown T. Teeth characteristic of Australian Aborigines. Occasional Paper Hum Biol 1979;1:17-38.
4. Gianelly AA. Diagnosis of incipient malocclusions. J Am Dent Assoc 1969;79:658-61.

5. Hunter WS, Priest WR. Errors and discrepancies in measurement of tooth size. J Dent Res 1960;39:405-14.
6. Staley RN, Kerber PE. A revision of the Hixon and Oldfather mixed-dentition prediction method. Am J Orthod 1980;78(1):296-302.
7. Moyers RE. Handbook of Orthodontics. London: Yearbook Medical Publishers; 1988. p. 235-40.
8. Babbar AC. Arch Predetermination: a review. J Indian Dent Assoc 1963;35:87-104.
9. Buwembo W, Luboga S. Moyer's method of mixed dentition analysis: A meta-analysis. Afr Health Sci 2004;4(3):63-6.
10. White TC, Gardiner JH, Leighton BC. Orthodontics for Dental Students. Vol. 151. London: Staples Press; 1954. p. 194-5.
11. Hunter WS. Application of analysis of crowding and spacing of the teeth. Dent Clin North Am 1978;22(4):563-77.
12. 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(1):39-47.
13. Garn SM, Lewis AB, Kerewsky RS. Sex difference in tooth size. J Dent Res 1964;43:306.
14. Noss JF, Scott GR, Potter RH, Dahlberg AA, Dahlberg T. The influence of crown size dimorphism on sex differences in the Carabelli trait and the canine distal accessory ridge in man. Arch Oral Biol 1983;28(6):527-30.
15. Buschang PH, Demirjian A, Cadotte L. Permanent mesiodistal tooth size of French-Canadians. J Can Dent Assoc 1988;54(6):441-4.
16. Kaplan RG, Smith CC, Kanarek PH. An analysis of three mixed dentition analyses. J Dent Res 1977;56(11):1337-43.
17. Gupta DS. Size of first molar and teeth size prediction. J Indian Dent Assoc 1978;50:107-9.
18. Kaur A, Singh R, Mittal S. Evaluation and applicability of Moyers mixed dentition arch analysis in Himachal population. DJAS 2014;2(11):96-104.
19. Gardner RB. A comparison of our method of predicting arch length. Am J Orthod 1979;75(4):357-98.
20. Hakanson MR. The application of Moyers analysis to different races. Thesis, School of dentistry, Paediatric Dentistry, University of California, Los Angeles, 1979. Quoted by Stewart RE, Barber TK, Troutman K and Wei SHY. Paediatric dentistry, St. Louis, C.V. Mosby; 1982. p. 326.
21. Staley RN, Shelly TH, Martin JF. Prediction of lower canine and premolar width in mixed dentition. Am J Orthod 1979;76(3):300-9.
22. Memon S, Fida M. Comparison of three mixed dentition analysis methods in orthodontic patients at AKUH. J Coll Physicians Surg Pak 2010;20(8):533-7.
23. Durgekar SG, Naik V. Evaluation of Moyers mixed dentition analysis in school children. Indian J Dent Res 2009;20(1):26-30.
24. Rani MS, Goel S. Evaluation of moyers mixed dentition analysis for South Indian population. J Indian Dent Assoc 1989;60:253-5.