Evaluation of mixed dentition analyses in north Indian population: A comparative study

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Abstract

Introduction: Mixed dentition regression equations analyses (Moyers, Tanaka-Johnston) are based on European population, reliability of these methods is questionable over other population. **Materials and Methods:** The present study was conducted on total 260 study models. This study was done in two phases. In the first phase, linear regression equations were made. In the second phase, comparison of actual values of sum of mesiodistal width of canine, first and second premolars with the predicted values proposed by Moyers, Tanaka-Johnston, and the new proposed mixed dentition analysis for North Indian population were made. **Results:** Set of four linear regression equations for predicting sum of mesiodistal width of permanent canine, first premolar and second premolar in North Indian population from sum of mesiodistal width of mandibular incisors and mandibular first molars, were proposed as; (a) for males, maxillary arch, Y = 2.9 + 0.40X, (b) mandibular arch Y = 3.91 + 0.37X (c) for females, maxillary arch Y = 0.56 + 0.45X (d) mandibular arch Y = 1.14 + 0.42X. Moyers and Tanaka-Johnston, mixed dentition analysis, is found to be overestimating the mesiodistal width of unerupted canine and premolars in North Indian population.

Keywords: Mixed dentition analysis, North Indian population, Estimation of mesiodistal width of canine and premolar

Introduction

Prediction of mesiodistal tooth dimension of the unerupted permanent canines and premolars are the essential part of diagnosis and treatment planning for accurate estimation that allows the dentist to better manage tooth/arch length discrepancies in mixed dentition period.[1] There are three basic approaches that have been used to estimate the combined mesiodistal width of unerupted canine and premolars in mixed dentition stage.[2]

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(1) Measurement of the unerupted teeth on radiographs. (2) Use of regression equations. (3) Combination of regression equation and radiographs, in which first and third approach of mixed dentition analyses uses the radiographs as suggested by many authors[3-7] carry considerable accuracy but it is time consuming, requires an expensive setup and a trained operator which makes these prediction method difficult to be applied to assertain the exact mesiodistal widths of unerupted canine and premolars. Moreover its technique sensitive, distortions of the image and misinterpretation of rotated tooth in their crypts.[8] So these are not reliable accurate methods. Whereas, use of regression equations, mixed dentition analysis can be done with minimum systemic error, ease of use by any person, less time consuming and with minimum armamentarium required.[9,10]

Purpose of this study was to evaluate a new proposed mixed dentition analysis and to identify the possible sexual dimorphism in North-Indian population by use of regression equations and also to compare it with the most widely used mixed dentition analyses.[10,11]

Materials and Methods

The present study was conducted on total 260 study models (i.e. 130 subjects). The impression were taken those subjects randomly come to the OPD of the Institute. This study was done in two phases, First phase of the study consisted of 160 study models (i.e. 80 subjects) of North–Indian subjects to evaluate the mixed dentition analysis and to formulate the new proposed linear regression equations for maxillary and mandibular arches in male and female separately by correlating the mesiodistal width of canines

and premolars with various combinations of mandibular incisors and mandibular and maxillary first molars in the age group of 14-22 years which were collected randomly from the pre-treatment patient records and from the patients attending the OPD of the Institute.

The criteria for the selection of samples were decided according to the previous studies done by Tanaka and Johnston,[11] which were as follows:

- The subjects were of North Indian background for at least one prior generation, that is both the parents had to be of North Indian origin
- The subjects of sample were in the age group of 14-22 years with a mean age of 18 years, because at this age permanent canine and premolars usually erupt completely and to preclude any discrepancies based on significant proximal wear
- Complete eruption of permanent incisors, canines, premolars and first molars in maxillary and mandibular arches
- The teeth measured were free of proximal restorations, fractures, and proximal caries
- There was no evidence of hypoplasia or anomalies of the teeth
- No developmentally missing or supernumerary teeth
- Subjects with severe crowding were excluded to facilitate the accurate measurement.

Digital caliper with ground tip (Baker RD-10), of accuracy 0.01 mm were used for accurate measurement and to avoid eye fatigue. The mesio-distal width of a tooth was obtained by measuring the maximum distance between contact points on the proximal surfaces. Digital caliper was held parallel to the occlusal surface if the tooth appeared to be in normal alignment as described by Hunter and Priest.[12] Otherwise, the mesio-distal crown diameter was obtained by measuring between the points where contact with the adjacent tooth would normally occur.[8] Values obtained for the right and left posterior segments were averaged so that there would be one value for the maxillary canine and premolars and one value for the mandibular canine and premolars.

The study models of first phase (160 study models), were divided into Group I males ($n = 80$) and Group II females study models ($n = 80$), which were further subdivided into maxillary (Sub Group Ia and IIa, $n = 40$) and mandibular study models (sub Group Ib and IIb, $n = 40$) [Table 1].

The linear regression equations ($Y = A + B [X]$) were made, where Y is a dependent variable and X is an independent variable while A and B are constants, which can be used clinically for the evaluation of combined mesiodistal width of unerupted canine and premolars.

The study models of second phase (100 study models), were divided into Group III males ($n = 50$) and Group IV females study models ($n = 50$), which were further subdivided into maxillary (sub Group IIIa and IVa, $n = 25$) and mandibular study models (sub Group IIIb and IVb, $n = 25$) [Table 2].

Comparison of actual values of sum of mesiodistal width of canine, first premolar and second premolar in both maxillary and mandibular arches as taken from study models with the predicted values proposed by Moyers,[9,10] Tanaka and Johnston,[11] and the new proposed mixed dentition analysis on the North Indian population were made.

Moyers[9,10] used the sum of the widths of the four mandibular incisors to predict the combined width of canines, first premolar and second premolar of maxillary and mandibular arches for male and female separately at 50% probability level by use of probability chart. Probability level, of 50% was taken for more precise prediction as recommended by Moyers.

Tanaka and Johnston[11] predicted the combined mesiodistal width of unerupted canine and premolars with the help of two linear regression equations of maxillary and mandibular arches. He found that the size in millimeters of unerupted canine and premolars can be predicted by taking half the width of mandibular incisors and adding 11.0 mm for maxillary teeth and 10.5 mm for the mandibular teeth.

Observations

Data were summarized as mean ± standard deviation and ± standard error with range (minimum and maximum) in Tables 3 and 4. Correlation among all studied variables was done by Karl–Pearson correlation coefficient. Relative association of dependent variable with independent variables was done by simple linear regression analysis. A two tailed ($\alpha = 2$) probability $P < 0.05$ was considered to be statistically significant, $P < 0.01$ as highly significant and $P > 0.05$ the not significant. MS-Excel (MS Office 97-2007) and Statistica (version 6, Chicago, US) were used for the analysis.

Table 1: Distribution of 160 study models of first phase

Group I		Group II	
Male study models (*n*=80)		Female study models (*n*=80)	
Sub group Ia	Sub group Ib	Sub group IIa	Sub group IIb
Maxillary study models (*n*=40)	Mandibular study models (*n*=40)	Maxillary study models (*n*=40)	Mandibular study models (*n*=40)

Table 2: Distribution of 100 study models of second phase

Group III		Group IV	
Male study models (*n*=50)		Female study models (*n*=50)	
Sub group IIIa	Sub group IIIb	Sub group IVa	Sub group IVb
Maxillary study models (*n*=25)	Mandibular study models (*n*=25)	Maxillary study models (*n*=25)	Mandibular study models (*n*=25)

In the first phase of the present study new proposed equations were made by correlating two dependent variables (1) sum of mesiodistal width of mandibular canine and premolars (2) sum of mesiodistal width of maxillary canine and premolars with four independent variables, (1) sum of mesio-distal width of mandibular incisors. (2) Sum of mesio-distal width of mandibular incisors and mandibular first molars. (3) Sum of mesiodistal width of right and left mandibular first molars and (4) sum of mesiodistal width of right and left maxillary first molars in Table 5 for male and in Table 6 for female subjects.

In the second phase of study the new proposed equations along with two mixed dentition analyses by Moyers and Tanaka-Johnston was used for the prediction of width of permanent canine and premolars which were compared with actual measurements of combined mesiodistal width of permanent canine and premolars from the study models in Table 7 for male and in Table 8 for female subjects.

Discussion

Commonly used regression equations were based on European population (Moyers and Tanaka-Johnston). A considerable amount of literature is available which says that the tooth size varies from population to population and the same prediction equations cannot be used for different populations as shown in the study of Al-Khadra,[13] 1993, Schirmer and Wiltshire[14] in 1997. Similar studies were done in over twelve different populations[15-24] and the common finding was that there is considerable difference in tooth size in various populations with sexual dimorphism.

So far there has been no data reported for North Indian population, although it is densely populated. Hence the purpose of this study was to evaluate new proposed prediction method and to identify the possible sexual dimorphism in North Indian population by use of regression equations and also compare it with most widely used mixed dentition analyses (Moyers and Tanaka-Johnston).

Among four set of regression equations by each independent variable, the equation by second independent variable "sum of mesiodistal width of mandibular incisors and mandibular first molars" showed strongest association with highest coefficient of determination, minimum standard error and maximum regression ANOVA F-ratio, ($P < 0.01$) Figure 1a and b and Figure 2a and b. Suggesting it to be most reliable for the predictions among independent variables for the dependent variable (sum of mesiodistal width of canine, first premolar and second premolar).

New proposed regression equation line (bold line) of sum of mesiodistal width of maxillary (a) and mandibular (b) canine, first premolar and second premolar from sum of mesiodistal

Table 3: Descriptive statistics (mean±SD) of dependent variables

Dependent variables	Mean (mm)	SD	SE	Minimum	Maximum	Range
Male study models (*n*=80, Group I)						
Sum of mesiodistal width of mandibular canine, first premolar and second premolar	19.87	1.04	0.16	18.04	22.35	4.31
Sum of mesio distal width of maxillary canine, first premolar and second premolar	20.34	1.19	0.19	18.17	23.36	5.20
Female study models (n=80, Group II)						
Sum of mesiodistal width of mandibular canine, first premolar and second premolar	19.27	1.19	0.19	17.20	21.43	4.23
Sum of mesio distal width of maxillary canine, first premolar and second premolar	19.80	1.29	0.20	17.56	22.67	5.11

SD: Standard deviation; SE: Standard error

Table 4: Descriptive statistics (mean±SD) of independent variables

Independent variables	Mean (mm)	SD	SE	Minimum	Maximum	Range
Male study models (*n*=80, Group I)						
Sum of mesio-distal width of mandibular incisors	22.08	1.28	0.20	19.65	24.52	4.87
Sum of mesiodistal width of mandibular incisors and mandibular first molars	43.54	2.14	0.34	40.14	48.58	8.44
Sum of mesiodistal width of right and left mandibular first molars	21.61	1.24	0.20	19.47	24.64	5.17
Sum of mesiodistal width of right and left maxillary first molars	20.10	1.03	0.16	18.14	22.64	4.50
Female study models (*n*=80, Group II)						
Sum of mesiodistal width of mandibular incisors	21.52	1.27	0.20	19.19	24.54	5.35
Sum of mesiodistal width of mandibular incisors and mandibular first molars	43.15	2.51	0.40	38.02	47.95	9.93
Sum of mesiodistal width of right and left mandibular first molars	21.45	1.11	0.18	18.75	23.84	5.09
Sum of mesiodistal width of right and left maxillary first molars	20.02	1.32	0.21	17.15	22.68	5.53

SD: Standard deviation; SE: Standard error

Table 5: Simple linear regression equations for each independent variable of males (Group I)

Dependent variable	Independent variable (X)	*r*	Coefficient of determination	SE	ANOVA '*F*'	Regression equation Y=A+BX	New proposed equation
Maxillary arch (sub group Ia)							
Sum of mesio distal width of maxillary canine, first premolar and second premolar (Y)	Sum of mesio-distal width of mandibular incisors	0.52**	27.29	1.03	14.26**	9.60+0.49X	
	Sum of mesiodistal width of mandibular incisors and mandibular first molars	0.72**	51.68	0.84	40.65**	2.90+0.40X	
	Sum of mesiodistal width of right and left mandibular first molars	0.62**	37.92	0.95	23.21**	7.55+0.59X	
	Sum of mesiodistal width of right and left maxillary first molars	0.50**	25.36	1.05	12.91**	8.62+0.58X	
Mandibular arch (sub group Ib)							
Sum of mesiodistal width of mandibular canine, first premolar and second premolar (Y)	Sum of mesio-distal width of mandibular incisors	0.58**	33.15	0.86	18.85**	9.57+0.47X	
	Sum of mesiodistal width of mandibular incisors and mandibular first molars	0.76**	57.16	0.69	50.70**	3.91+0.37X	
	Sum of mesiodistal width of right and left mandibular first molars	0.57**	32.44	0.87	18.25**	9.58+0.48X	
	Sum of mesiodistal width of right and left maxillary first molars	0.58**	33.75	0.86	19.36**	8.11+0.59X	

**P<0.01. SE: Standard error

Table 6: Simple linear regression equations for each independent variable of females (Group II)

Dependent variable	Independent variable (X)	*r*	Coefficient of determination (%)	SE	ANOVA '*F*'	Regression equation Y=A+BX	New proposed equation
Maxillary arch (sub group IIa)							
Sum of mesio distal width of maxillary canine, first premolar and second premolar (Y)	Sum of mesio-distal width of mandibular incisors	0.61**	37.39	1.04	22.69**	6.41+0.62X	
	Sum of mesiodistal width of mandibular incisors and mandibular first molars	0.87**	74.93	0.66	113.59**	0.56+0.45X	
	Sum of mesiodistal width of right and left mandibular first molars	0.64**	41.49	1.00	26.94**	3.67+0.75X	
	Sum of mesiodistal width of right and left maxillary first molars	0.50**	25.45	1.13	12.97**	9.93+0.49X	
Mandibular arch (sub group IIb)							
Sum of mesiodistal width of mandibular canine, first premolar and second premolar (Y)	Sum of mesio-distal Width of mandibular incisors	0.74**	55.02	0.81	46.59**	4.30+0.70X	
	Sum of mesiodistal width of mandibular incisors and mandibular first molars	0.89**	78.42	0.56	138.05**	1.14+0.42X	
	Sum of mesiodistal width of right and left mandibular first molars	0.69**	47.33	0.88	34.15**	3.40+0.74X	
	Sum of mesiodistal width of right and left maxillary first molars	0.49**	24.32	1.05	12.21**	10.38+0.44X	

**P<0.01. SE: Standard error

width of mandibular incisors and mandibular first molars in females with 95% confidence for β (broken lines). Scatter points denotes predicated value for each observed value [Figure 2].

New proposed regression equation line (bold line) of sum of mesiodistal width of maxillary (a) and mandibular (b) canine, first premolar and second premolar from sum of mesiodistal width of mandibular incisors and mandibular first molars

Table 7: Comparison of three mixed dentition analyses by RSS for males (Group III)

Mixed dentition analyses	Mean predicted value of sum of mesiodistal width for canine first premolar and second premolar (mm)	Mean actual value of sum of mesiodistal width for canine first premolar and second premolar (mm)	Mean difference between predicted and actual value (mm)	RSS
Maxillary arch (*n*=25, Group IIIa)				
Moyers	20.78	20.26	0.52	1.3068
Tanaka-Johnston	21.86		1.6	3.8805
New proposed method	20.02		−0.24	1.1514*
Mandibular arch (*n*=25, Group IIIb)				
Moyers	20.49	19.74	0.75	1.3331
Tanaka-Johnston	21.36		1.62	3.7307
New proposed method	19.75		0.01	0.5646*

*Minimum RSS. RSS: Residual sum of square

Table 8: Comparison of three mixed dentition analyses by RSS for females (Group IV)

Mixed dentition analyses	Mean predicted value of sum of mesiodistal width for canine first premolar and second premolar (mm)	Mean actual value of sum of mesiodistal width for canine first premolar and second premolar (mm)	Mean difference between predicted and actual value (mm)	RSS
Maxillary arch (*n*=25) subgroup IVa				
Moyers	20.00	19.42	0.58	1.3116
Tanaka-Johnston	21.47		2.05	5.6479
New proposed method	19.22		−0.20	1.0421*
Mandibular arch (*n*=25) subgroup IVb				
Moyers	19.43	18.91	0.52	0.7752
Tanaka-Johnston	20.97		2.06	5.4632
New proposed method	18.56		−0.35	0.6014*

*Minimum RSS. RSS: Residual sum of square

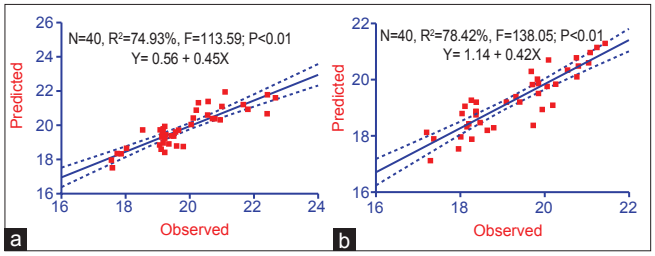

Figure 1: New proposed regression equation line (bold line) of sum of mesiodistal width of maxillary (a) and mandibular (b) canine, first premolar and second premolar from sum of mesiodistal width of mandibular incisors and mandibular first molars in males with 95% confidence for β (broken lines). Scatter points denotes predicated value for each observed value

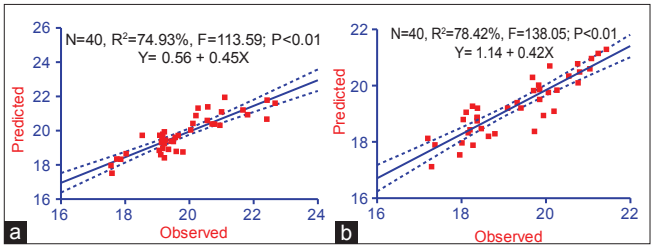

Figure 2: New proposed regression equation line (bold line) of sum of mesiodistal width of maxillary (a) and mandibular (b) canine, first premolar and second premolar from sum of mesiodistal width of mandibular incisors and mandibular first molars in females with 95% confidence for β (broken lines). Scatter points denotes predicated value for each observed value

in males with 95% confidence for β (broken lines). Scatter points denotes predicated value for each observed value [Figure 1].

Although second set of four regression equations (by independent variable "Sum of mesiodistal width of mandibular incisors and mandibular first molars") is selected as new proposed regression equations for mixed dentition analysis, but regression equations made by other independent variables is also statically significant and hence can be use for prediction of combined width of unerupted canine and premolars where ever clinical situation doesn't permit the use of second independent variable that is, Sum of mesiodistal width of mandibular incisors and mandibular first molars.

In the present study after formulating the new proposed regression equations of males and females for both maxillary and mandibular arches separately, for North Indian population, the second phase of study was done for evaluating and comparing it with the most widely used mixed dentition analyses by Moyers[9,10] and Tanaka and Johnston.[11]

In the second phase of study the new proposed equations along with two widely used mixed dentition analyses by Moyers and Tanaka-Johnston was used for the prediction of width of permanent canine and premolars which were compared with actual measurements of combined mesiodistal width of permanent canine and premolars from the study models.

Because data is distributed on both side of the regression equation line (positive and negative) for better comparison of three mixed dentition analyses residual sum of square (RSS) test was done. Better the line fits, smaller will be the RSS value [Figures 3-6].

Linear graph of maxillary archin males from Moyers, Tanaka and Johnston and new proposed also showed new proposed the best because its all predicted value (n = 25) scatter nearest to the actual [Figure 3].

Conclusions

Based on the results of the study following conclusion were drawn from the study:

- Set of four linear regression equations for predicting sum of mesiodistal width of permanent canine, first premolar and second premolar in North Indian population from Sum of mesiodistal width of mandibular incisors and mandibular first molars, are as follows; (a) For males, in maxillary arch, Y = 2.9 + 0.40X, (b) For males, in mandibular arch Y = 3.91 + 0.37X (c) For females, in maxillary arch Y = 0.56 + 0.45X (d) For females, in mandibular arch Y = 1.14 + 0.42X
- New proposed mixed dentition analysis is better for prediction of sum of mesiodistal width of canine, first premolar and second premolar than the commonly used mixed dentition analyses (Moyers and Tanaka-Johnston) in North-Indian population, when compared with actual measurements from study models

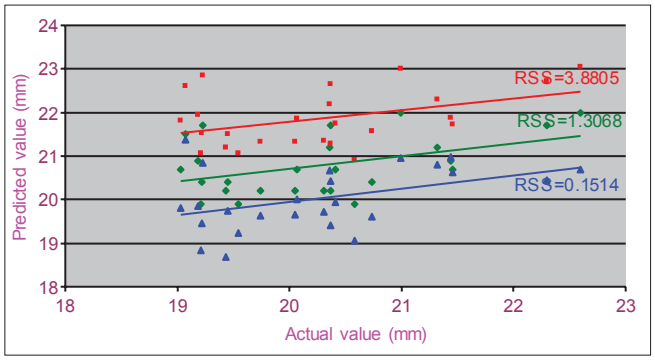

Figure 3: Linear graph of maxillary arch in males from Moyers, Tanaka and Johnston and new proposed also showed new proposed the best because its all predicted value (n = 25) scatter nearest to the actual. Tanaka & Johnston: ———, Moyers: ———, New proposed: ———

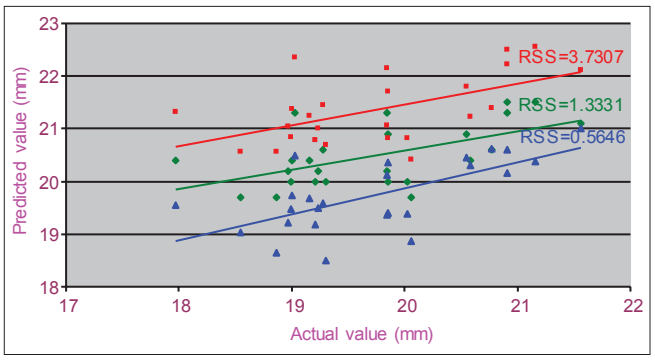

Figure 4: Linear graph of mandibular arch in males from Moyers, Tanaka and Johnston and new proposed also showed new proposed the best because its all predicted value (n = 25) scatter nearest to the actual. Tanaka & Johnston: ———, Moyers: ———, New proposed: ———

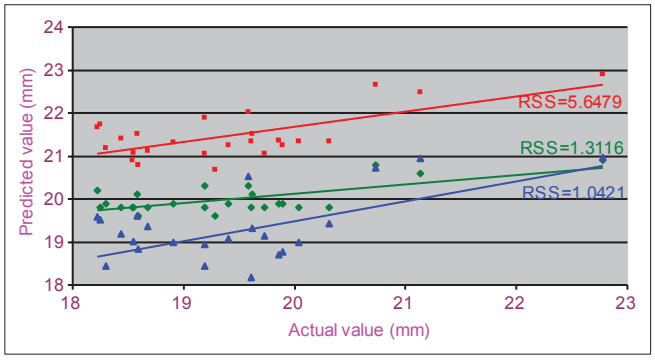

Figure 5: Linear graph of maxillary arch in females from Moyers, Tanaka and Johnston and new proposed also showed new proposed the best because its all predicted value (n = 25) scatter nearest to the actual. Tanaka & Johnston: ———, Moyers: ———, New proposed: ———

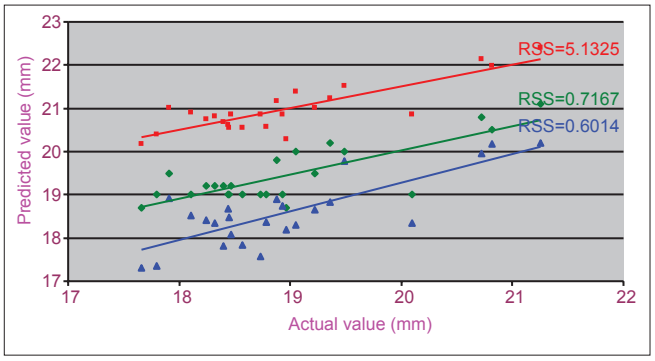

Figure 6: Linear graph of mandibular arch in females from Moyers, Tanaka and Johnston and new proposed also showed new proposed the best because its all predicted value (n = 25) scatter nearest to the actual. Tanaka & Johnston: ———, Moyers: ———, New proposed: ———

- Moyers[9,10] mixed dentition analysis according to 50% probability levels of prediction chart, is found to be overestimating the mesiodistal width of unerupted canine and premolars in North Indian population
- Tanaka-Johnston[11] mixed dentition analysis, overestimates the mesiodistal width of unerupted canine and premolars in North Indian population by 3.2 mm per arch in males and 4.0 mm/arch in females.

References

1. Huckaba GW. Arch size analysis and tooth size prediction. Dent Clin North Am 1964;8:431-40.
2. Staley RN, Hoag JF. Prediction of the mesiodistal widths of maxillary permanent canines and premolars. Am J Orthod 1978;73:169-77.
3. Nance HN. The limitations of orthodontic treatment; mixed dentition diagnosis and treatment. Am J Orthod 1947;33:177-223.
4. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted cuspid and bicuspid teeth. Angle Orthod 1958;28:236-40.
5. Cohen MI. Recognition of developing malocclusion. Dent Clin North Am 195;96:299-304.
6. Kaplan RG, Smith CC, Kanarek PH. An analysis of three mixed dentition analyses. J Dent Res 1977;56:1337-43.
7. Staley RN, Kerber PE. A revision of the Hixon and Oldfather mixed-dentition prediction method. Am J Orthod 1980;78:296-302.
8. Lee-Chan S, Jacobson BN, Chwa KH, Jacobson RS. Mixed dentition analysis for Asian-Americans. Am J Orthod Dentofacial Orthop 1998;113:293-9.
9. Moyers RE. Handbook of Orthodontics. 4th ed. Chicago, Ill: Year Book Medical Publishers; 1973.
10. Moyers RE. Handbook of Orthodontics. 4th ed. Chicago, Ill: Year Book Medical Publishers; 1988.
11. 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.
12. Hunter WS, Priest WR. Errors and discrepancies in measurement of tooth size. J Dent Res 1960;39:405-14.
13. al-Khadra BH. Prediction of the size of unerupted canines and premolars in a Saudi Arab population. Am J Orthod Dentofacial Orthop 1993;104:369-72.
14. 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.
15. Otuyemi OD, Noar JH. A comparison of crown size dimensions of the permanent teeth in a Nigerian and a British population. Eur J Orthod 1996;18:623-8.
16. Santoro M, Ayoub ME, Pardi VA, Cangialosi TJ. Mesiodistal crown dimensions and tooth size discrepancy of the permanent dentition of Dominican Americans. Angle Orthod 2000;70:303-7.
17. Yuen KK, Tang EL, So LL. Mixed dentition analysis for Hong Kong Chinese. Angle Orthod 1998;68:21-8.
18. 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.
19. 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.
20. Ferguson FS, Macko DJ, Sonnenberg EM, Shakun ML. The use of regression constants in estimating tooth size in a Negro population. Am J Orthod 1978;73:68-72.
21. Bernabé E, Flores-Mir C. Are the lower incisors the best predictors for the unerupted canine and premolars sums? An analysis of a Peruvian sample. Angle Orthod 2005;75:202-7.
22. Ling JY, Wong RW. Tanaka-Johnston mixed dentition analysis for southern Chinese in Hong Kong. Angle Orthod 2006;76:632-6.
23. Altherr ER, Koroluk LD, Phillips C. Influence of sex and ethnic tooth-size differences on mixed-dentition space analysis. Am J Orthod Dentofacial Orthop 2007;132:332-9.
24. Melgaço CA, de Sousa Araújo MT, de Oliveira Ruellas AC. Mandibular permanent first molar and incisor width as predictor of mandibular canine and premolar width. Am J Orthod Dentofacial Orthop 2007;132:340-5.

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