ORIGINAL RESEARCH PAPER
Volume - 9 | Issue - 8 | August - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COMPARISON AND EVALUATION OF THE APPLICABILITY OF VARIOUS PREDICTION METHODS IN MIXED DENTITION ANALYSIS OF SOUTH INDIAN POPULATION

Dental Science

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ABSTRACT

Aim: This study aimed to compare & evaluate the validity of different Mixed dentition prediction methods in estimating the size of permanent canine and premolars.

Study Design: Comparative cross-sectional study

Materials And Methods: Dental casts of 520 maxillary & mandibular arches were obtained from South Indian school children. Different prediction methods were used to estimate mesiodistal widths (m-d widths) of the unerupted permanent canine and premolars.

Results: Paired t-test, independent t-tests, ANOVA, and Tukey HSD multiple comparison tests used to analyze the results. The prediction equations demonstrated diverse validity in predicting the size of canines and premolars. At the 50th percentile, the Moyers method displayed high significance.

Conclusion: Prediction equations showed varied validity. Overall, the prediction equation proposed by Sujala Ganapathi et al. and Moyers prediction tables closer to a probability level of 50 % showed high efficacy.

KEYWORDS

Mixed dentition analysis, Prediction equations, Tooth width prediction

INTRODUCTION:

The critical aspects of the Mixed dentition period are the utilization of the arch perimeter and adaptive changes that occur in occlusion during the transition from one dentition to another. Hence constant vigilance is essential during this period of tooth exchange. Arch length tooth size discrepancy is one of the disruptive processes that occur during this period. Mixed dentition analysis helps to estimate the amount of space required for the alignment of unerupted permanent canines & premolars in the dental arch.[1] To ensure proper growth and facial development, it is essential for initial perception and consequent interception of potential malocclusions. Mixed dentition analysis is an essential tool in determining different treatment approaches such as serial extractions, the guidance of eruption, space maintenance, space regaining, or just by periodic observation of the patient.[2]

Several studies have been conducted in this context in different regions of India, and various regression equations have been proposed for specific populations. The purpose of the present study is to compare and assess for the South Indian population, the reliability, and applicability of Moyers probability tables & various regression equations proposed among several Indian populations.

MATERIALS & METHODS

The sample of the present study comprised of 520 subjects (343 males & 177 females) selected randomly from South Indian school children aged 12-18 years with fully erupted permanent dentition (barring the 2 nd & 3 rd molars) during school dental health camps. Written consent was obtained from parents of all subjects who underwent examination. The inclusion criteria for the selection of sample are: fully erupted permanent incisors, permanent canines and premolars in both maxillary and mandibular arches, free of malformations, restorations, fractures, congenital defects, tooth wear, impactions, missing teeth, absence of previous orthodontic treatment and patients free of any systemic disease or serious ill-health. Alginate impressions were taken from the selected subjects that met the inclusion criteria, and dental casts were prepared immediately using standard mixing procedures. Impression disinfection was performed to avoid distortion.

The m-d widths of all four mandibular incisors, canines, premolars, and 1 st molars were measured to the nearest of 0.01mm with a digital Vernier caliper.[3] Measured values are compared to those formulated for Indian children with the help of Moyers table and nine regression equations, as shown in table 1.

Table :1 The Regression Equations Used In The Study

s.no	Geo graphical area	Proposed by	Prediction equation
Study 1	Punjab population	Pooja Ahluwalia et al.(2011)[4]	Males:Maxilla-14.439+Md2-2×0.336;Mandible-14.576+Md2-2×0.315 Females: Maxilla-13.288+Md2-2×0.368 Mandible-13.189+Md2-2×0.344
Study 2	Himachal population	Vinithsingh etal.(2013)[5]	Male:Maxilla-Y=9.79+0.99x Mandible:Y=12.97+0.82x Female:Maxilla-Y=8.99+0.81x Mandible- Y=11.4+.50x
Study 3	West Bengal population	Barun Dasguptha etal.(2012)[6]	Maxilla:Y-9.5+0.488(x) Mandible:Y-10.3+0.493(x)
Study 4	Maharashtra population	Sonawane et al.(2008)[7]	MandibleY=10.830+0.563(x) Maxilla Y=12.143+0.481(x)
Study 5	Karnataka population (Belgaum)	Sujala Ganapati Durgekar et al. (2009)[8]	Male:Maxilla-Y=10.52+0.48x Mandible - Y = 9.46 + 0.50x Female: Maxilla - Y = 11.73 +0.41x Mandible - Y = 11.67 + 0.39x
Study 6	Gujarat population	Shalin shah etal.(2013)[9]	Male:Y=10.417+0.705X Female:Y=9.802+0.725X Both: Y=10.692+0.702X

Study 7	Cosmopolitan Indian population (NASIK)	Krishnakumar et al. (2012)[10]	Males: Maxilla : Y = 11.65 + 0.725X Mandible : Y = 12.22 + 0.663X Females; Maxilla : Y = 19.44 0.553X Mandible: Y = 16.13 + 0.678X
Study 8	Nalgonda population	M. Manjula et al. (2013)[11]	Males: Maxilla: Y = 11.0 + 0.500(X) Mandible :Y = 10.4 + 0.506(X) Females: Maxilla : Y = 11.1 + 0.495(X) Mandible: Y = 10.4 + 0.502(X)
Study 9	North Indian population	Tripti tikku et al. (2013)[12]	Males :Y =7.70+0.7386X Females:Y = 13.00 + 0.6065X Both :Y = 7.15 + 0.7450X

Md2- Sum of Mesiodistal width of all four mandibular incisors.
Y- Predicted sizes of canines and premolars.
X- Sum of Mesiodistal width of all four mandibular incisors.

Statistical analysis was carried out using SPSS software. Descriptive statistics including mean, standard deviation, standard error, minimum and maximum values were calculated for the predictive sizes (canines and premolars), and actual tooth sizes. An independent *t*-test was used to compare the measured values of male and female subjects. A paired *t*-test was used to check the significance of the difference between the predicted values obtained from Moyers mixed dentition analysis and measured values. ANOVA& Tukey HSD carried out to compare and evaluate the predicted values obtained from different prediction equations and actual values. Pearson correlation coefficient performed to assess the correlation between measured and predicted values.

RESULTS:

Since significant bilateral asymmetry has not demonstrated in the present data, an average m-d width of both left and right sides was taken for analysis. The mean values of m-d widths of the individual teeth obtained for male and female subjects tabulated in Table 2. Table 3-shows the descriptive statistics of the measured m-d values in male and female subjects. Independent sample t-test performed to compare m-d widths of male and female subjects.

Table 2: Measurement Of Individual Teeth In Males And Females

Teeth	Maxilla						Mandible					
(mean ±SD)	CI	LI	C	Pm1	Pm2	M	CI	LI	C	Pm1	Pm2	M
Males	8.75 ± 0.51	7.04 ± 0.48	7.88 ± 0.38	7.12 ± 0.38	6.66 ± 0.46	10.29 ± 0.53	5.49 ± 0.36	6.09 ± 0.46	6.93 ± 0.39	7.19 ± 0.35	7.08 ± 0.38	11.21 ± 0.55
Females	8.54 ± 0.44	6.79 ± 0.50	7.50 ± 0.34	6.68 ± 0.28	6.34 ± 0.28	10.10 ± 0.55	5.38 ± 0.28	5.98 ± 0.40	6.69 ± 0.36	6.87 ± 0.29	6.78 ± 0.37	10.94 ± 0.52

Table 3: Descriptive Statistics Of The Sum For The Measured Values For Analysis (*n*=520)

	Sex		P value
	Male	Female	
UR	21.66±0.95	20.52±0.56	< 0.001
UL	21.65±0.91	20.48±0.50	< 0.001
LR	21.20±0.87	20.34±0.74	< 0.001
LL	21.28± 0.89	20.44±0.79	< 0.001
SLI	23.18± 1.43	22.75±1.25	< 0.001

UR = Sum of upper right canine and premolars, UL = Sum of left canine
and premolars, LR = Sum of lower right canine and premolars, LL = Sum of lower left canine and premolars, SLI = Sum of lower incisors

Table-4-7-shows the descriptive statistics including mean, standard deviation, standard error, 95% confidence interval, maximum and minimum values, range of predicted m-d width of both arches in males and females and the results of ANOVA test.

Table 4: Descriptive Statistics Of The Sum For The Maxillarypredicted Values In Males For Analysis

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	RANGE	F value	P value
					Lower Bound	Upper Bound					
Measured	343	21.655	0.950	0.051	21.554	21.756	19.590	25.280	5.690	5946.981	0.000
Study 1	343	22.226	0.482	0.026	22.175	22.277	20.974	23.185	2.211		
Study 2	343	32.734	1.419	0.077	32.583	32.885	29.045	35.560	6.515		
Study 3	343	21.726	0.707	0.038	21.651	21.801	19.889	23.133	3.244		
Study 4	343	23.291	0.690	0.037	23.217	23.364	21.498	24.663	3.165		
Study 5	343	21.644	0.688	0.037	21.571	21.717	19.856	23.014	3.158		
Study 6	343	21.357	0.798	0.043	21.272	21.441	19.523	23.303	3.780		
Study 7	343	21.658	0.817	0.044	21.571	21.745	19.343	23.602	4.259		
Study 8	343	22.588	0.717	0.039	22.512	22.664	20.725	24.015	3.290		
Study 9	343	20.562	0.846	0.046	20.472	20.652	18.620	22.632	4.012		
Total	3430	22.944	3.441	0.059	22.829	23.059	18.620	35.560	16.940		

ANOVA, - *P* >0.05 (not significant), * *P* <0.05 (less significant), ** *P* <0.01 (moderately significant), *** *P* <0.001 (highly significant)

Table 5: Descriptive Statistics Of The Sum For The Mandibular Predicted Values In Males For Analysis

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	RANGE	F value	P value
					Lower Bound	Upper Bound					
Measured	343	21.200	0.870	0.047	21.107	21.292	18.940	24.520	5.580	6192.304	0.000
Study 1	343	21.873	0.454	0.025	21.825	21.921	20.703	22.775	2.072		
Study 2	343	31.966	1.182	0.064	31.841	32.092	28.919	34.315	5.396		
Study 3	343	20.805	0.703	0.038	20.730	20.880	18.992	22.203	3.211		
Study 4	343	23.872	0.812	0.044	23.786	23.959	21.780	25.485	3.705		
Study 5	343	21.043	0.721	0.039	20.966	21.120	19.185	22.475	3.290		
Study 6	343	21.351	0.798	0.043	21.266	21.436	19.523	23.303	3.780		
Study 7	343	21.230	0.753	0.041	21.150	21.310	19.499	23.070	3.571		
Study 8	343	22.122	0.729	0.039	22.044	22.199	20.242	23.571	3.329		
Study 9	343	20.566	0.844	0.046	20.476	20.655	18.620	22.632	4.012		
Total	3430	22.603	3.343	0.057	22.491	22.715	18.620	34.315	15.695		

Table 6: Descriptive Statistics Of The Sum For The Maxillarypredicted Values In Females For Analysis

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	Minimum	Maximum	RANGE	F value	P value

					Lower Bound	Upper Bound					
Measured	177	20.523	0.560	0.052	20.419	20.626	18.790	22.030	3.240	1176.820	0.000
Study 1	177	21.659	0.460	0.043	21.574	21.744	20.435	22.896	2.461		
Study 2	177	27.415	1.013	0.094	27.228	27.602	24.720	30.139	5.419		
Study 3	177	21.514	0.617	0.058	21.400	21.628	19.874	23.172	3.298		
Study 4	177	23.084	0.602	0.056	22.973	23.196	21.484	24.702	3.218		
Study 5	177	21.056	0.513	0.048	20.962	21.151	19.692	22.435	2.743		
Study 6	177	20.997	0.665	0.062	20.874	21.120	19.446	22.931	3.485		
Study 7	177	21.584	0.549	0.051	21.483	21.686	19.928	22.810	2.882		
Study 8	177	22.360	0.619	0.058	22.245	22.474	20.713	24.024	3.311		
Study 9	177	20.184	0.705	0.066	20.054	20.315	18.538	22.237	3.699		
Total	1770	22.038	2.066	0.061	21.918	22.157	18.538	30.139	11.601		

Table 7: Descriptive Statistics Of The Sum For The Mandibular Predicted Values In Females For Analysis

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	RANGE	F value	P value
					Lower Bound	Upper Bound					
Measured	177	20.337	0.737	0.069	20.201	20.473	18.350	21.960	3.610	463.696	0.000
Study 1	177	21.014	0.430	0.040	20.935	21.094	19.869	22.171	2.302		
Study 2	177	22.774	0.626	0.058	22.658	22.889	21.110	24.455	3.345		
Study 3	177	20.601	0.611	0.057	20.488	20.713	18.977	22.242	3.265		
Study 4	177	23.637	0.704	0.066	23.507	23.767	21.763	25.530	3.767		
Study 5	177	20.541	0.488	0.045	20.451	20.632	19.244	21.853	2.609		
Study 6	177	20.997	0.665	0.062	20.874	21.120	19.446	22.931	3.485		
Study 7	177	23.181	0.642	0.060	23.062	23.299	21.683	25.049	3.366		
Study 8	177	21.819	0.628	0.059	21.703	21.935	20.149	23.507	3.358		
Study 9	177	20.184	0.705	0.066	20.054	20.315	18.538	22.237	3.699		
Total	1770	21.508	1.355	0.040	21.430	21.587	18.350	25.530	7.180		

Tukey HSD test was used to compare measured value with predicted values for each study. Table 8-11 shows the results ofTukey HSD test for males and females.

Table 8 - Comparison Of Measured Value With Maxillary Predicted Values In Males

	GROUPS	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Measured value	Study 1	-.57078(*)	0.064	0.000	-0.775	-0.367
	Study 2	-11.07868(*)	0.064	0.000	-11.283	-10.875
	Study 3	-0.070	0.064	0.986	-0.275	0.134
	Study 4	-1.63526(*)	0.064	0.000	-1.839	-1.431
	Study 5	0.011	0.064	1.000	-0.193	0.215
	Study 6	.29861(*)	0.064	0.000	0.094	0.503
	Study 7	-0.003	0.064	1.000	-0.207	0.202
	Study 8	-.93259(*)	0.064	0.000	-1.137	-0.728
	Study 9	1.09288(*)	0.064	0.000	0.889	1.297

Table 9 - Comparison Of Measured Value With Mandibular Predicted Values In Males

Mean Difference	Std. Error	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
-.67356(*)	0.061	0.000	-0.868	-0.479
-10.76634(*)	0.061	0.000	-10.961	-10.572
.39474(*)	0.061	0.000	0.200	0.589
-2.67270(*)	0.061	0.000	-2.867	-2.478
0.157	0.061	0.242	-0.038	0.351
-0.151	0.061	0.290	-0.346	0.043
-0.030	0.061	1.000	-0.225	0.165
-.92225(*)	0.061	0.000	-1.117	-0.728
.63384(*)	0.061	0.000	0.439	0.828

Table 10- Comparison Of Measured Value With Maxillary Predicted Values In Females

	GROUPS	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Measured value	Study 1	-1.13607(*)	0.085	0.000	-1.406	-0.866
	Study 2	-6.89231(*)	0.085	0.000	-7.163	-6.622
	Study 3	-.99147(*)	0.085	0.000	-1.262	-0.721
	Study 4	-2.56150(*)	0.085	0.000	-2.832	-2.291
	Study 5	-.53345(*)	0.085	0.000	-0.804	-0.263
	Study 6	-.47395(*)	0.085	0.000	-0.744	-0.204
	Study 7	-1.06155(*)	0.085	0.000	-1.332	-0.791
	Study 8	-1.83696(*)	0.085	0.000	-2.107	-1.567
	Study 9	.33839(*)	0.085	0.003	0.068	0.609

Table 11 - Comparison Of Measured Value With Mandibular Predicted Values In Females

	GROUPS	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Measured value	Study 1	-.67688(*)	0.083	0.000	-0.940	-0.413
	Study 2	-2.43643(*)	0.083	0.000	-2.700	-2.173
	Study 3	-.26347(*)	0.083	0.050	-0.527	0.000
	Study 4	-3.29950(*)	0.083	0.000	-3.563	-3.036
	Study 5	-0.204	0.083	0.293	-0.468	0.059
	Study 6	-.65968(*)	0.083	0.000	-0.923	-0.396
	Study 7	-2.84361(*)	0.083	0.000	-3.107	-2.580
	Study 8	-1.48193(*)	0.083	0.000	-1.745	-1.218
	Study 9	0.153	0.083	0.712	-0.111	0.416

Table 12-15 shows the correlations between the measured and predicted value of male and female subjects in both arches.

Table-12- Correlations Between The Measured And Maxillary Predicted Values In Males.

	N	Correlation	Sig.
Measured &study 1	343	0.745	0.000
Measured &study 2	343	0.745	0.000
Measured & study 3	343	0.745	0.000
Measured & study 4	343	0.745	0.000
Measured & study 5	343	0.745	0.000
Measured & study 6	343	0.755	0.000
Measured & study 7	343	0.637	0.000
Measured & study 8	343	0.745	0.000
Measured & study 9	343	0.756	0.000

Table-13- Correlations Between The Measured And Mandibular Predicted Values In Males

	N	Correlation	Sig.
Measured & study 1	343	0.739	0.000
Measured & study 2	343	0.739	0.000
Measured & study 3	343	0.739	0.000
Measured & study 4	343	0.739	0.000
Measured & study 5	343	0.739	0.000
Measured & study 6	343	0.773	0.000

Measured & study 7	343	0.771	0.000
Measured & study 8	343	0.739	0.000
Measured & study 9	343	0.778	0.000

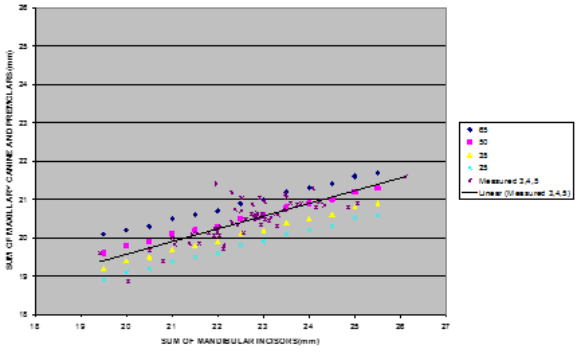
Table-14 Correlations Between The Measured And Maxillary Predicted Values In Females

	N	Correlation	Sig.
Measured & study 1	177	0.759	0.000
Measured & study 2	177	0.759	0.000
Measured & study 3	177	0.759	0.000
Measured & study 4	177	0.759	0.000
Measured & study 5	177	0.759	0.000
Measured & study 6	177	0.666	0.000
Measured & study 7	177	0.723	0.000
Measured & study 8	177	0.759	0.000
Measured & study 9	177	0.666	0.000

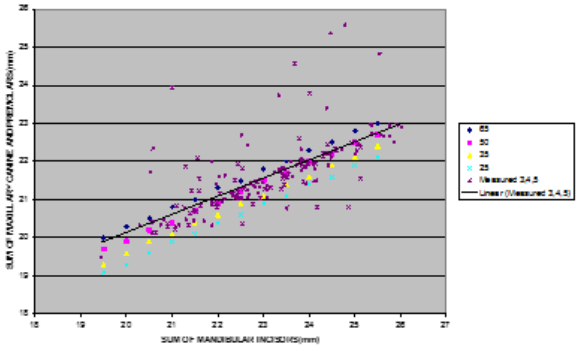
Table-15- Correlations Between The Measured And Mandibular Predicted Values In Females

	N	Correlation	Sig.
Measured & study 1	177	0.864	0.000
Measured & study 2	177	0.864	0.000
Measured & study 3	177	0.864	0.000
Measured & study 4	177	0.864	0.000
Measured & study 5	177	0.864	0.000
Measured & study 6	177	0.721	0.000
Measured & study 7	177	0.721	0.000
Measured & study 8	177	0.864	0.000
Measured & study 9	177	0.721	0.000

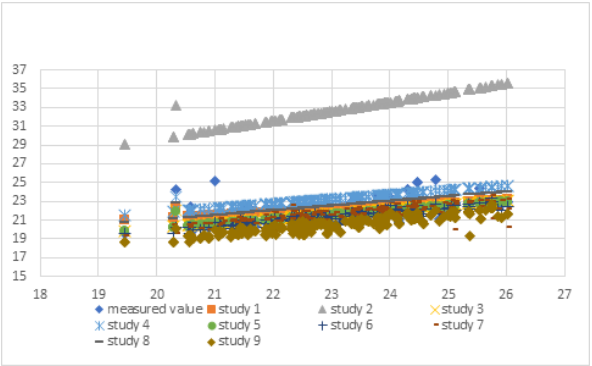
Graphic representation was used since the sample size was more and it is a simple representation for the comparison of predicted and measured values. Graphs 1-6 shows scatter plot of predicted and measured values. The sample showed high statistical significance with values obtained at 50% level of Moyers probability chart and less significance at 85%,5%,15%,75%, and 85%. Hence, they were not used in graphic representation.



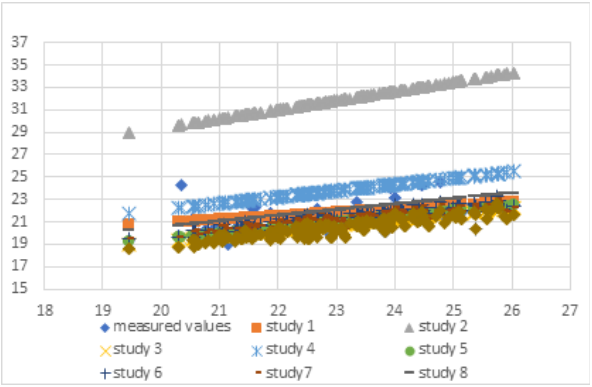
Graph.1: Graphic Comparison Of Predicted Values Of Unerupted Maxillary Canine And Premolars Derived From Moyer's Prediction Chart At Various Probability Levels And The Measured Values Of Female Subjects.



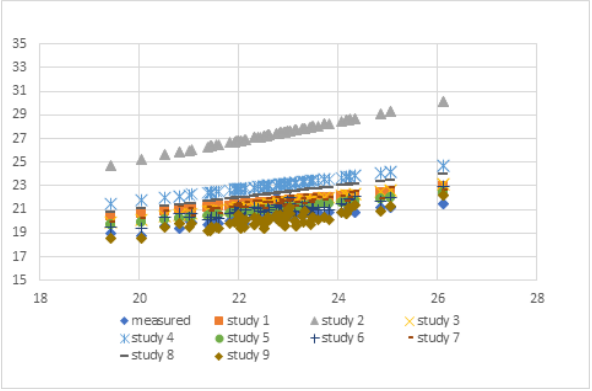
Graph.2: Graphic Comparison Of Predicted Values Of Unerupted Maxillary Canine And Premolars Derived From Moyer's Prediction Chart At Various Probability Levels And The Measured Values Of Male Subjects.



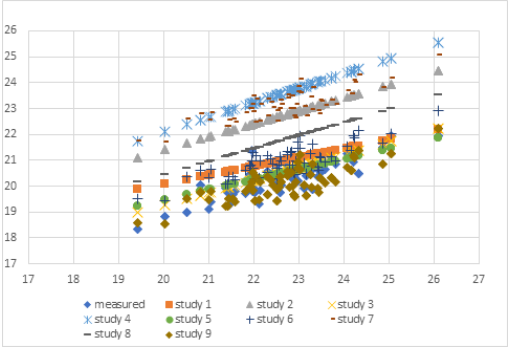
Graph 3-graphic Comparison Of The Predicted Values Of Unerupted Maxillary Canine And Premolars Derived From Various Prediction Equations And Measured Values Of Male Subjects.



Graph 4-graphic Comparison Of The Predicted Values Of Unerupted Mandibular Canine And Premolars Derived From Various Prediction Equations And Measured Values Of Male Subjects.



Graph-5-graphic Comparison Of The Predicted Values Of Unerupted Maxillary Canine And Premolars Derived From Various Prediction Equations Of Female Subjects.



Graph 6-graphic Comparison Of The Predicted Values Of Unerupted Mandibular Canine And Premolars Derived From Various Prediction Equations Of Female Subjects.

DISCUSSION

A gender discrepancy is seen in the present study, with males showing significantly greater m-d width than that of female subjects in both maxillary and mandibular arches. This sexual dimorphism is consistent with the other reported studies.[13-15] Mandibular incisors revealed smallest differences between sexes and this was consistent with the results reported by Al-Bitar,[2] Jensen,[16] Bishara *et al*.,[17] Hattab *et al*.,[18] and Yeun *et al*. [19] Thus it necessitates the need to propose separate prediction formula and probability tables for both males and females. Intra examiner variability ranged from 0.01-0.19, and the error of measurement observed was ≤0.11 in all teeth except for maxillary central incisor, lateral incisor, first molar and mandibular first molar where it measured ≤ 0.19. These values can be compared with reports obtained by other investigators. [16,20-21]

From the results obtained in the present study, Moyers's 50% probability level was closer to the actual measured values of the m-d diameter of canines and premolars. Slight overestimation was seen in maxilla when the sum of m-d width of permanent mandibular incisors was >24mm. The estimate was found to be more accurate for mandibular buccal segments at 50% probability values of Moyers. Similar results were reported by Zilberman *et al*.,[22] for Israeli children and Al-Khadra [23] for Saudi Arabian populations. For the South Indian population, to compare the statistical difference between predicted values from all nine studies and measured value, the ANOVA test was performed. It was found that a statistically significant difference was seen between predicted values from all nine studies and measured values in both maxillary and mandibular arches.

Maxillary measured values of males showed higher significance with predicted values obtained from studies 3,5,7[6,8,10] and the remaining studies have shown a significant difference from the measured values. Standard Error(SE) ranged from 0.061-0.085 was reported, which was comparable to the errors reported in other studies. [24-25] SE of females was consistently greater than that of males in both the arches, which was also confirmed by Keith Kwok-wah Yuen for the Hong Kong Chinese population.[26] The mandibular measured values of males showed no significant difference with the predicted values obtained from studies 5,6,7[8,9,10] and the remaining studies have shown significant differences. Statistically, there was a huge difference between predicted maxillary values of females from all studies and measured value. Mandibular measured values of female subjects showed no significant difference with predicted values from studies 5 and 9.[8,12]

In order to determine the extent to which the sum of maxillary and mandibular canines and premolars varies Correlation coefficient was performed between measured values and predicted values from all studies. A positive correlation was observed between measured and predicted values from all studies for both arches in male and female subjects. Correlation coefficient ranged from 0.637-0.756 between maxillary predicted and measured values in males, and for mandibular values, it ranged from 0.739-0.778, which represents a good correlation with the measured values. The correlation coefficient between measured and maxillary predicted values of females were 0.723-0.759, except for study 6[9] and 9[12], which was measured around 0.666, and for mandibular values, it was 0.721-0.864 except for study 7 which was measured around 0.637. There exists a good correlation with the measured values.

CONCLUSION

A gender discrepancy was observed in the present study, with male subjects having significantly greater values. Moyers prediction tables can be used to estimate the m-d widths of unerupted canines and premolars closer to the 50% probability level. The prediction equations showed varied applicability in predicting the size of canines and premolars. Prediction equations proposed by Barun Dasguptha et al.[6], Sujala Ganapathi et al.[8], and Krishna Kumar et al. [10] have shown high validity for maxillary values in males. Prediction equations proposed by Sujala Ganapathi et al. [8], Shalin Shah et al. [9] and Krishna Kumar et al. [10] revealed high validity for mandibular values in males and prediction equations proposed Sujala Ganapathi et al. [8], Tripti tikku et al. [12] showed high efficacy for mandibular values in females.

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