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ORIGINAL ARTICLE

Comparison of Three Mixed Dentition Analysis Methods in Orthodontic Patients at AKUH

Sarwat Memon and Mubassar Fida

ABSTRACT

Objective: To compare the actual sum of canine and premolars and that predicted from three mixed dentition prediction methods in orthodontic patients at the Aga Khan University Hospital (AKUH), Karachi.

Study Design: Cross-sectional comparative study.

Place and Duration of Study: Orthodontic clinic at the Aga Khan University Hospital from June 2002 to December 2007.

Methodology: Data were collected using pretreatment records including orthodontic files and plaster casts of 121 orthodontic patients. Digital caliper was used to measure the mesiodistal widths of permanent teeth from 1st molar to 1st molar in mandibular arch, and central incisors and 1st molars in maxillary arch. The methods of Tanaka and Johnston, Moyers, and Bernabé and Flores-Mir were used to predict the mesiodistal widths of the canine and premolars. Comparison between the actual and predicted sum of the mesiodistal widths of canine and premolars was made for each prediction method, using paired sample t-test.

Results: There were 45 males and 76 females with average ages of 13.3±1.3 and 13.4±0.8 years respectively. For males statistically significant differences were found for Moyers at the 75th percentile and Bernabé and Flores-Mir method whereas for females only the Bernabé and Flores-Mir's method showed significant results. However, no significant difference was found in both genders for Tanaka and Johnston method.

Conclusion: In the studied orthodontic patients for males Moyers 50th percentile and Tanaka and Johnston methods could be used; while for females Moyers 75th percentile and Tanaka and Johnston methods were applicable for mixed dentition analysis.

Key words: *Mixed dentition analysis. Tooth width prediction. Orthodontic. Percentile Moyers prediction tables. Tanaka and Johnston equation.*

INTRODUCTION

Mixed dentition analysis forms a crucial part of an early orthodontic evaluation and treatment planning.[1] This analysis helps to predict the widths of unerupted canine and premolars and determine the difference between the amount of space available in dental arch and the amount of tooth material that should be accommodated.[2-6] If the result is significantly negative, future crowding can be predicted. During the transition from the mixed to permanent dentition arch length is generally diminished in the mandibular arch. Therefore, the mixed dentition analysis is commonly performed in the mandibular arch.[3] Furthermore, this analysis helps in determining whether the treatment plan may involve serial extraction, guidance of eruption, space maintenance, space regaining or just the periodic observation of the patient.[1]

Some basic principles for mixed dentition analysis are: known minimum systemic error, ease of use by anyone with basis training, speed of use, no special equipment needed, directly measured in the mouth and used in both dental arches.[7]

Three most commonly used methods to estimate the mesiodistal widths of unerupted permanent canine and premolars in mixed dentition are radiographic methods, based on periapical and cephalometric radiographs.[3,8] Non radiographic methods are based on correlation and prediction equations, as prediction tables.[2,4,5,9] A combination of both methods can be also be used.[10] Among the different mixed dentition analysis methods reported in the literature, the regression equations based on the already erupted permanent teeth in the early mixed dentition are broadly used to predict the widths of unerupted canine and premolars, especially the Moyers prediction tables and the Tanaka and Johnston equations.[2,5] Since these prediction tables and equations were developed for white North American children, their applicability in other populations is questionable as tooth sizes differ within different population groups and between genders (males have generally larger teeth than females). Few recent studies reported that only mesiodistal width of lower permanent incisor is not the best predictor.[11,12] Recent advances in statistical software have permitted complex calculations of multiple regression models that could simultaneously evaluate several explanatory variables. Bernabé and

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Floris-Mir developed a multiple regression equation using sum of lower and upper central incisors plus the widths of upper first molar, and gender as an additional variable.[4] They found the highest predictive value (determination coefficient of 60%) for the mesiodistal widths of canine and premolars.

A review of orthodontic literature reveals variability in tooth size in different population and ethnic groups.[13-15] Some of the most commonly used methods to predict the widths of unerupted canine and premolars were developed for United States children. Studies to confirm the applicability and effectiveness of these methods in different population are appropriate since failure to consider tooth size and racial variations would render the interpretation of as misleading. Therefore, the aim of this study was to compare the actual sum of canine and premolars and that predicted from three mixed dentition prediction methods (Moyers, Bernabé and Floris-Mir, and Tanaka and Johnston's) in orthodontic patients at AKUH.

METHODOLOGY

A cross-sectional comparative study was conducted at the Orthodontic Clinic at the Aga Khan University Hospital, Karachi from June 2002 to December 2007. Data were collected using pretreatment records including orthodontic files and plaster casts of orthodontic patients with an age range of 12-20 years. A sample size of 121 subjects with four observations per subject achieves 80% power to detect an intraclass correlation of 0.955 under the alternative hypothesis when the intraclass correlation under the null hypothesis is 0.950 using an F- test with a significance level of 0.05.

Data were collected using non-probability purposive sampling technique with inclusion criteria for sample selection were subjects with all permanent teeth in each arch at least upto first permanent molar,[6] no obvious loss of tooth material mesiodistally as a result of caries, fractures, interproximal stripping, congenital defects, extracoronal restorations or impression flaws and no previous history of orthodontic treatment.

Digital caliper (0-150 mm ME 00183, Dentaurm, Pforzheim, Germany) with an accuracy of ±0.02 mm and repeatability of ±0.01 mm (manufacturer specification) was used to measure the mesiodistal widths of permanent teeth from 1st molar to 1st molar in mandibular arch, and central incisors and 1st molars in maxillary arch. All measurements were taken perpendicular to the long axis of the tooth, with digital caliper entering the interproximal area from either the buccal or the occlusal side. The preferred method was from the buccal side unless the tooth appeared severely rotated. A total of 20 subjects were randomly selected by the principal examiner after one month and their dental casts were reanalyzed for mesiodistal widths of teeth. Bland-Altman analysis was used to assess the intra-examiner reliability for the measurements for mesiodistal widths of canines and premolars.[16]

Three different mixed dentition analysis methods were used in this study. In Moyer's prediction method: mesiodistal widths of permanent canine and premolars were estimated by using probability tables at 50th and 75th percentile.[2] In Tanaka and Johnston method,[5] mesiodistal widths of permanent canine and premolars in one quadrant were estimated by summing 10.5 mm to the half of the sum of the lower four permanent incisors. In Bernabé and Flores-Mir method,[4] mesiodistal widths of permanent canine and premolars were estimated by the following regression equation:

$$Y = 3.763 \times X0 + 1.057 \times X1 + 0.366 \times X2.$$

Where X0 is the sum of the upper and lower permanent central incisors plus the widths of the upper permanent first molars, X1 is 0 for mandible and 1 for maxilla, and X2 is 0 for female and 1 for male. The results of this study were based only on the mandibular arch and represent the average of the right and left sides.

Statistical analysis was carried out using SPSS for windows (version 16.0). Descriptive statistics, including means and standard deviations were calculated for age, actual and predicted widths of canine and premolars of mandibular arch. To assess gender dimorphism between actual and predicted values, independent sample t-test was used. Comparison between the actual and predicted sum of the mesiodistal widths of canine and premolars was made for each prediction method, using paired sample t-test. P-value of ≤ 0.05 was considered to be significant.

RESULTS

The sample consisted of 121 dental casts (45 males, 76 females; average ages 13.3±1.3 and 13.4±0.8 years respectively).

Table I shows the descriptive statistics for the sums of the actual mesiodistal widths of lower four incisors, upper and lower central incisors and upper first molars and the average of the right and left mandibular canine and premolar segment divided according to gender.

Table I: Descriptive statistics for summation of actual mesiodistal widths.

	Males (n=45) Mean±SD	Females(n=76) Mean±SD
MdCLI	22.16±1.57	21.20±2.01
MxCI and MdCI and MxFM	54.68±6.62	51.21±10.46
MdCP	20.96±1.37	20.31±9.88

n= 121; MdCLI: Mandibular central and lateral incisors; MxCI: Maxillary central incisors; MdCI: Mandibular central incisors; MxFM: Maxillary first molars; MdCP: Mandibular canine and premolars.

The gender dimorphism for actual and predicted values of canine and premolars was analyzed using independent sample t-test as depicted in Table II. Although gender

Table II: Gender dimorphism for actual and predicted values.

	Gender of patient	Mean ± SD	Significance (p-value)
Actual values of permanent canine and premolars	Male (n=45)	20.3 ± 1.30	0.29
	Female (n=76)	20.96 ± 5.06	
Moyers 50%	Male (n=44)	20.68 ± 0.68	≤ 0.01*.
	Female (n=67)	19.81 ± 0.66	
Moyers 75%	Male (n=45)	21.43 ± 0.69	0.96
	Female (n=68)	21.38 ± 6.07	
Bernabé and Flores-Mir	Male (n=45)	24.24 ± 2.33	0.77
	Female (n=76)	24.04 ± 4.38	
Tanaka and Johnston	Male (n=44)	21.09 ± 2.42	0.43
	Female (n=76)	20.56 ± 2.25	

*n=121; *Statistical significance p ≤ 0.05; Independent sample t-test.*

differences were apparent in the actual and predicted values of lower canines and premolars however, significant gender differences was present only for Moyers 50% (t-statistics=6.73; p ≤ 0.01).

Table III shows the predicted values based on the methods of Moyers, Tanaka and Johnston and Bernabé and Flores-Mir methods in males using paired t-test. Moyers tables at 50th (p=0.36) and 75th percentile (p ≤ 0.01), Tanaka and Johnston (p=0.47) and Bernabé and Flores-Mir methods (p ≤ 0.01) overestimated the actual sum of canine and premolars.

The predicted values based on the methods of Moyers, Tanaka and Johnston and Bernabé and Flores-Mir methods in females were analyzed using paired t-test was shows to as shown in Table IV. Moyers tables at 75th percentile (p=0.82) and Bernabé and Flores-Mir methods (p ≤ 0.01) overestimated the actual sum of canine and premolars. Tanaka and Johnston method (p=0.51) and Moyers table at 50th percentile (p=0.36) underestimated the actual sum of canine and premolars.

Good agreement was seen between the two measurements as shown in Figure 1, with a mean difference of 0.0045 (95% confidence interval for the difference -0.002 to 0.011). Thus, these results showed that good intra-examiner reliability existed for the two measurements.

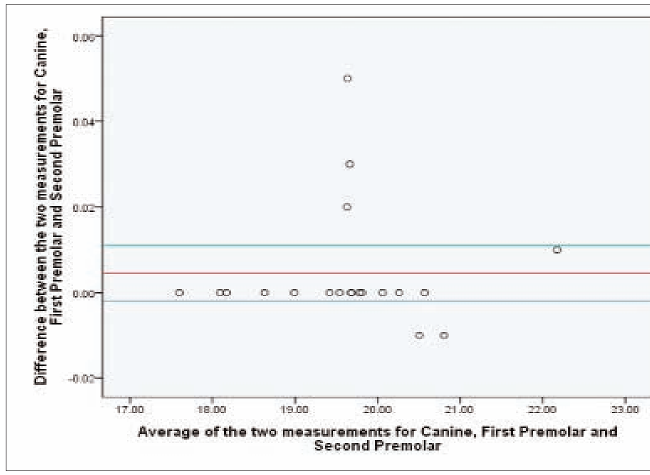

Figure 1: Scatter plot for assessing intraexaminer reliability.

DISCUSSION

During the mixed dentition, prediction of the mesiodistal dimensions of unerupted permanent canines and premolars is of clinical importance in the diagnosis and planning treatment. Correct assessment of the size of the canines and premolars allows the dentist to better deal with tooth size/arch length discrepancies. However, care must be taken to avoid letting numbers dictate the prediction of tooth size because dental arch perimeter may change with time.[17]

The results of three prediction methods used in this study were based on the mean widths of the complementary teeth as no difference was found between them. Several investigators found that there is a significant difference between male and female tooth widths,[2-4,12] with males showing greater size of teeth which necessitates distribution of subjects according to gender. However, other investigators did not consider gender's difference.[5,18] In this study gender dimorphism in tooth widths was indeed found.

None of the methods for predicting the widths of the unerupted canine and premolars is 100% accurate and

Table III: Predicted values based on the methods of Moyers, Tanaka and Johnston and Bernabé and Flores-Mir methods in males.

	Predicted values of permanent canine and premolars Mean (mm) ±SD	Actual values of permanent canine and premolar Mean (mm) ± SD	Difference predicted minus actual values Mean (mm) ± SD	Significance (p-value)
Moyers 50 % n=45	20.68 ± 0.68	20.36 ± 1.27	0.32 ± 0 .98	0.36
Moyers 75% n=45	21.43 ± 0.69	19.80 ± 1.30	1.11 ± 0.99	≤ 0.01*
Bernabé and Flores-Mir n=45	24.24 ± 2.33	20.31 ±1.30	3.93 ± 2.09	≤ 0.01*
Tanaka and Johnston n=44	21.09 ± 2.42	20.35 ± 1.29	0.73 ± 2.38	0.47

*n= 45; *Statistical significance P ≤ 0.05; Paired sample t- test.*

Table IV: Predicted values based on the methods of Moyers, Tanaka and Johnston and Bernabé and Flores-Mir methods in females.

	Predicted values of permanent canine and premolars Mean (mm) ±SD	Actual values of permanent canine and premolar Mean (mm) ±SD	Difference predicted minus actual values Mean (mm) ± SD	Significance (p-value)
Moyers 50 % n=67	19.81 ± 0.66	21.19± 5.35	-1.39 ± 5.23	0.36
Moyers 75% n=68	21.38 ± 6.07	21.15 ± 5.32	0.22 ± 7.97	0.82
Bernabé and Flores-Mir n=76	24.04 ± 4.38	20.96 ± 5.06	3.07 ± 6.23	≤ 0.01*
Tanaka and Johnston n=76	20.56 ± 2.25	20.96 ± 5.06	-0.39 ± 5.23	0.51

*n= 76; Paired sample t- test; *Statistical significance p ≤ 0.05.*

may overestimate or underestimate the widths of these unerupted teeth.[2] An ideal method is one which accurately determines no difference between actual and predicted widths of unerupted canine and premolars. Overestimation seems to be better to prevent lack of space in the dental arch. It has been reported in study that overestimation up to 1 mm beyond the actual widths of permanent canine and premolars do not adversely affect the decision of extraction or non-extraction.[2] There have been a few studies reported in literature that attempted to explore the error of tooth size prediction and its clinical significance.[4,19] Othman and Haradine recommended a threshold of 2 mm in expressing tooth size discrepancy affecting clinical importance.[19] Proffit suggested threshold of 1.5 mm in expressing error of tooth size prediction as anything less than this is rarely important.[20] Large variations create problems and must be incorporated in orthodontic problem list. Hence, the amount of threshold for clinical significance in the prediction of tooth size discrepancy in mixed dentition needs more research.

Different racial and ethnic groups can have variations in the tooth and facial characteristics.[3,4,6,13-15] This is demonstrated in this study by the statistically significant differences between the mean values of actual mesiodistal widths of permanent canines and premolars of the present sample patients and those derived from Moyers' prediction table and Tanaka and Johnston's equations for children from Northwestern European ancestry.[2,5] It was also demonstrated to be different from the regression equation derived by Bernabé and Flores-Mir from a Peruvian sample.[4]

When Moyer's tables at the 50th and 75th percentile were applied in the male sample, it overestimated the actual sum of canine and premolars especially at Moyer's 75th percentile. This is in agreement with the result of Al-Khadra's,[18] a study done in the Saudi Arabian population. However, some authors,[6,19] found underestimation when Moyer's tables at 50th and 75th percentiles were used. In the female sample, Moyer's tables at 50th percentile underestimated the sum of canine and premolars, however, the difference was not statistically significant. While Lee-Chan *et al.*[10] in Asian-Americans and Diagne *et al.*[17] in Senegalese population found an overestimation when this method was applied. Paula *et al.*[3] also found no considerable difference at Moyer's 75th percentile. Similarly, it was concluded by Buwembo and Luboga,[21] while conducting a meta-analysis on the applicability of Moyer's method in different ethnic groups that the same method is not applicable to different populations and it is advised to develop separate prediction tables for each population.

Findings from this study have shown no statistically significant difference when Tanaka and Johnston's equation was applied to the entire sample. However, Paula *et al.*,[3] and Melgaco *et al.*[22] found statistically significant difference with Tanaka and Johnston's equation. Mengal and Afzal,[23] found that actual widths of the mandibular canine and premolars showed a significant difference in size ($p < 0.000$) from the widths predicted by the Tanaka and Johnston's method. Thus, the data illustrated that Tanaka and Johnston prediction method does not accurately predict the mesiodistal diameters of unerupted canines and premolars in Pakistani population. However, the results of this study are contradictory to the Mengal and Afzal's,[23] study for Pakistani population. In this study Tanaka and Johnston's equation in both genders predicted very close to the actual values of canine and premolars so can be applied for mixed dentition analysis in our orthodontic patients. The difference in sample size may be one of the reasons for the variation in results.

Bernabé and Flores-Mir's,[4] method had not been tested in different populations. In this study, statistically significant difference was found between the predicted and actual sum of the lower permanent canine and premolars in the entire sample. Melgaco *et al.*[22] in their study found no statistically significant difference when method proposed by Bernabé and Flores-Mir's[4] was applied in the female sample. However, statistically significant difference was present in the male sample. The results of this study are contradictory with the result obtained by Melgaco *et al.*[22] in the Brazilian population.

The differences in ethnic origins and the different racial or population groups are the biggest reasons for the inconsistency of the results that were revealed, once all the above three methods were applied to our orthodontic patients. Furthermore, the result of this study cannot be generalized as the study sample was predominantly female (62.8%). It is recommended that a large sample size with equal gender distribution must be considered from our ethnic group to confirm the results of this study.

CONCLUSION

In males Moyers table at 50th percentile while in females Moyers table at 75th percentile predicted very close to the actual values of canine and premolars. Tanaka and Johnston equation in both genders predicted very close to the actual values of canine and premolars therefore, this method can be reliable for mixed dentition analysis in our orthodontic patients. There are limitations in the application of Bernabé and Flores-Mir method to our orthodontic patients.

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