

A Newly Proposed Regression Equation for Mixed Dentition Analysis Using the Sum of the Width of Permanent Mandibular Central Incisors and Permanent Mandibular First Molars as a Predictor of Width of Unerupted Canine and Premolars

Raghavendra M. Shetty¹, Pragya Daga², Hanumanth Reddy³, Sunaina Shetty Yadadi⁴, Laxmi Lakade⁵, Shishir Ram Shetty⁶, Venkataramana Vannala⁷, Manchala Sesha Reddy⁸

¹Department of Preventive and Pediatric Dentistry, Gulf Medical University, Ajman, United Arab Emirates.  0000-0003-1209-7295

²Department of Pedodontics and Preventive Dentistry, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh, India.  0000-0003-4981-4104

³Department of Orthodontics, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh, India.

 0000-0001-5670-9842

⁴Department of Periodontics, Maitri Dental College, Durg, Chhattisgarh, India.  0000-0002-7616-4840

⁵Department of Pedodontics and Preventive Dentistry, Bharahi Vidyapeeth Dental College & Hospital, Pune, India.

 0000-0003-3678-7952

⁶Department of Oral Medicine, Gulf Medical University, Ajman, United Arab Emirates.  0000-0002-8097-6024

⁷Department of Orthodontics, Gulf Medical University, Ajman, United Arab Emirates.  0000-0001-7075-7883

⁸Department of Periodontics, Gulf Medical University, Ajman, United Arab Emirates.  0000-0002-2441-6479

Author to whom correspondence should be addressed: Dr. Raghavendra M. Shetty, Department of Preventive and Pediatric Dentistry, College of Dentistry, Gulf Medical University, Ajman, United Arab Emirates, P.O. Box: 4184. Phone: +971 56 3019421. E-mail: draghavendra77@gmail.com.

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Abstract

Objective: To determine linear regression equation to predict the mesiodistal widths of the permanent canines and premolars based on the sum of the widths of the two permanent mandibular first molars and two mandibular central incisors. **Material and Methods:** The sample consisted of 800 (400 males and 400 females) permanent dentition casts of Chhattisgarh population. Mesiodistal crown widths of teeth were measured with digital caliper. The correlation and linear regression equations between the calculated four teeth (two permanent mandibular first molars and two central incisors) and the canine-premolars segments of both the arches were developed. **Results:** No significant differences were found in right and left side of the arch. Sexual dimorphism was significant in teeth sizes with higher mesiodistal dimension in males. A good correlation values varying from 0.51 to 0.67 was found. New standardized regression equations were formulated for the prediction of the mesiodistal widths of unerupted canines and premolars for Chhattisgarh population. **Conclusion:** Calculating mesiodistal widths of unerupted canine and premolars with help of two permanent mandibular molars and two mandibular central incisors, which erupt early in the oral cavity, can be an alternative and best predictor for the mixed dentition analysis.

Keywords: Malocclusion; Linear Models; Dentition, Mixed; Orthodontics.

Introduction

Mixed dentition space analysis is an important aspect is to supervise the development of functionally stable occlusion and treatment planning. It indicates preventive measures that are essential to prevent a potential irregularity from progressing into severe malocclusion. Most children will be benefited if early diagnosis and treatment is carried out in such developing malocclusion. Discrepancy between the space required and space available is one of the orthodontic complications in mixed dentition. Prediction of arch length deficit or discrepancy is the most important step in planning a treatment protocol for such clinical situations. This allows the treatment to be initiated and executed swiftly yielding better results [1,2].

Various methods of estimating the sizes of unerupted permanent canines and premolars have been reported in the literature. G. V. Black and others attempt, of predicting tooth sizes were based on the tables of average mesiodistal width [3,4], whereas other methods are based on estimating the size of permanent teeth on radiographs alone [1,4] or in combined method of using radiograph and crown diameters measured on dental casts [5-7]. The widely used methods usually associates the mesiodistal crown width of erupted mandibular permanent incisors as the predictor for the mesiodistal crown width of unerupted canines and premolars [8]. Earlier in the year 1946 it was discovered that there was a significant association between two parameters – the sum of width of permanent mandibular incisors and width of unerupted mandibular permanent canines and premolars [9]. Some of the studies have reported that, sum of the lower permanent incisors only is not the best predictor [10-12]. In 2007 for the first time introduced a new method by including mesiodistal width of first molar along with the sum of mesiodistal width of four incisors [13].

However, the accurateness of these prediction methods could possibly be in query when applied to other population groups because it has been well documented in literature that tooth size varies significantly between the racial/ethnic groups. Therefore, the present study aims to determine new regression equations to predict the sum of mesiodistal width of permanent canines and premolars in Chhattisgarh, Central India population by using two permanent first permanent mandibular molar and two permanent mandibular central incisors as predictor.

Material and Methods

Study Design and Sample

In this cross-sectional study, four hundred dental casts of males and four hundred dental casts of females of 14 to 21 years old orthodontic patient's residents of Chhattisgarh were chosen from the records of Pedodontic and Orthodontic Department. The casts with fully eruption of permanent first molar to first molar in both jaws, with no interproximal caries and restorations, with no pervious orthodontic treatment, with no alteration in teeth size, shape or number, with no attrition, with normal to mild crowding or spacing were included in the study. The sample included different types of occlusion. All study models were constructed from high-quality orthodontic dental stone.

Data Collection

Greatest mesiodistal crown widths of all the permanent teeth up to the first molar to first molar in upper and lower arches were measured. The measurements were carried out according to the method previously described using a digital sliding caliper (Aerospace Co., California, USA) with an accuracy of 0.01 mm [14]. Therefore, the maximum width of the tooth between the interproximal contact points was measured parallel to the occlusal surface and perpendicular to the long axis of the tooth. As there was no statistical difference in the width between left and right side in both the arches, the actual widths of the maxillary and mandibular canines and premolars were calculated for the left and right sides, the mean value obtained was added to presume the actual combined width of permanent canines and premolars. To determine the error of the method, all measurements were repeated by the same investigator five days later and the student's t-test revealed no statistical difference.

Data Analysis

Linear regression was used to drive equations for the prediction of the sum of the widths of the canine, first and second premolars in either jaw. The regression equation was expressed as $Y = a + b(X_1 + X_2)$. The constants 'a' and 'b' were calculated for both sexes combined and for males and females separately. In addition, the standard errors of the estimates (SEE), the coefficients of correlation (r) and the coefficients of determination (r^2) were calculated. r^2 values represents the estimating accuracy of the regression equation for Y based on values of X_1 and X_2 . The new equations were developed to estimate the mesiodistal width of unerupted canine and premolars for Chhattisgarh population.

Results

The descriptive statistics for the sum of widths of the canine-premolars segments, sum of mandibular central incisors-mandibular first molar for both males and females. The values were larger in males than females in both arches and the difference was statistically significant in all the teeth groups (Table 1).

Table 1. Sum of the mesiodistal widths of the maxillary and mandibular canine/premolars segments and the mandibular central incisors/mandibular first molars.

Teeth Measured	Sex	N	Mean (SD)	p-value
Maxillary Canine and Premolars	Male	400	21.80 ± 2.11	<0.001*
	Female	400	20.60 ± 1.83	
Mandibular Canine and Premolars	Male	400	21.41 ± 1.77	<0.001*
	Female	400	20.24 ± 1.65	
Mandibular Central Incisors and Mandibular First Molars	Male	400	8.41 ± 2.50	<0.001*
	Female	400	7.91 ± 2.46	

SD = Standard Deviation; * = Statistically significant.

The correlation coefficients (r), determination coefficients (r^2), constants 'a' and 'b' and the standard error of estimate (SEE) for both males and females are determined. The correlation

coefficients between the sum of mandibular central incisors-mandibular first molars widths and sum of the canine-premolars widths ranged from 0.51 to 0.67. Highest r² value was 0.45 in males' maxillary arch and lowest one was 0.26 in females' mandibular arch (Table 2).

Table 2. Coefficient of correlation (r), coefficient of determination (r²), Standard error of estimation, regression constants (a, b) for various tooth groups.

Teeth Measured	Sex	Correlation	Determination	SEE	Constants	
		Coefficient (r)	Coefficient (r ²)		a	b
Maxillary Canine and Premolars	Male	0.67	0.45	1.56	5.31	0.42
	Female	0.52	0.27	1.56	7.20	0.35
	Combined	0.64	0.41	1.58	5.14	0.41
Mandibular Canine and Premolars	Male	0.63	0.40	1.38	8.47	0.33
	Female	0.51	0.26	1.42	8.53	0.31
	Combined	0.61	0.37	1.43	7.42	0.35

SEE = Standard Error of Estimation.

The new linear regression equations were derived from the sum of widths of mandibular central incisors-mandibular first molars and sum of widths of canine-premolars segments. Therefore, new regression equations in the form of $Y = a + b (X_1 + X_2)$.

$$\text{Maxillary arch, } Y = 5.14 + 0.41 (X_1 + X_2)$$

$$\text{Mandibular arch, } Y = 7.42 + 0.35 (X_1 + X_2)$$

Y represented the estimate of the sum of canine and premolars widths in millimeters on either the right or left side. X₁ indicating the sum of the two mandibular central incisors widths in millimeters, X₂ indicating the sum of the two mandibular first molars were formulated in male and female separately, the constant "a" is the Y intercepts and the slope of the regression is represented by constant "b". So, the regression equation based on sum of four teeth i.e., permanent two mandibular first molars and two mandibular central incisors for both males and females for Chhattisgarh population were formulated (Table 3). The regression equation for maxillary arch, in males was $Y = 5.31 + 0.42 (X_1 + X_2)$ and in females was $Y = 7.20 + 0.35 (X_1 + X_2)$. The regression equation for mandibular arch, in males was $Y = 8.47 + 0.33 (X_1 + X_2)$ and in females was $Y = 8.53 + 0.31 (X_1 + X_2)$.

Table 3. New regression equation for Chhattisgarh population using sum of the widths of the two permanent mandibular first molars and two mandibular central incisors.

Sex	Maxillary Arch	Mandibular Arch
Males (M)	$Y = 5.31 + 0.42 (X_1 + X_2)$	$Y = 8.47 + 0.33 (X_1 + X_2)$
Females (F)	$Y = 7.20 + 0.35 (X_1 + X_2)$	$Y = 8.53 + 0.31 (X_1 + X_2)$
Combined (M + F)	$Y = 5.14 + 0.41 (X_1 + X_2)$	$Y = 7.42 + 0.35 (X_1 + X_2)$

Discussion

The primary step towards a successful orthodontic treatment is an early and correct diagnosis. The dentition analysis is an important step to make a proper diagnosis [15]. The mixed dentition analysis allows the identification of a tooth size-arch length discrepancy in an early stage and dictates different treatment approaches such as: space maintenance, space regaining, serial extractions, eruption guidance and observation without any intervention [16].

Traditionally mixed dentition analysis is performed by specific regression equations and radiographic evaluation of the dentition status. Sometimes a combination of both the methods is also employed to evaluate mixed dentition. Being a non-radiographic technique and relying solely on clinical measurements of erupted permanent tooth makes regression analysis one of the most popular analytic tools.

Based on these assumptions the current study applies an equation, which was proposed of late and is based on the totality of mesiodistal width of central incisors and first molars of the mandible. The idea was to generate a novel regression equation appropriate for Chhattisgarh population. However, the earlier linear regression equation formulated for Chhattisgarh population was based on Tanaka-Johnston equation using four mandibular incisors [17]. The permanent molars were not used in the earlier equation.

Various studies have been published on mixed dentition analysis highlighting the racial and ethnic differences in tooth dimensions [18,19], with differences between male and female tooth widths [12,20,21], although few studies did not consider gender differences [11,22,23]. In the present study, a statistical difference was found between mesiodistal width of male and female tooth with males having more mesiodistal width as compared to females. The analysis was done separately for male and female samples. Nevertheless, when subjects from both genders were evaluated simultaneously a good correlation was observed.

Another observation in the study was the lack of statistically significant differences between the arches on either side of the midline, a finding which was also confirmed by some other investigators [12,21]. A larger sample size (n=800) was included to minimize the bias and guarantee the reliability of the data. To regulate a more specific correlation and accurate result, both sides of the mandibular arch was considered, similar to the method previously used [24].

Using only the values of sum of mandibular first molars and mandibular central incisors to predict width of sum of canine and premolars without the incorporation of regression equations seems imprecise. Regression equations usually provides an accurate and precision results. Hence many investigators advocate multiple linear regression equations over the simple linear equations [15,25]. Higher correlation coefficients and better accuracy is seen in the multiple linear regression equations owing to the greater number of variables [10,15,23]. A good non-radiographic prediction method must be simple, fast, practical, precise, and definite for the population from which it was derived.

In the present study, only four teeth must be measured when compared to six teeth used by some authors [13]. The prediction can be made very early, as we need not wait for the lateral incisors to erupt. Like the use of mandibular incisors, the use of the first permanent molars has several advantages. They erupt early in the mixed dentition, are easily measured, and show little variability in size. Moreover, they are the first permanent teeth to erupt in the oral cavity and the relationship of maxillary and mandibular first permanent molars provides an early indication of the developing permanent occlusion [26]. It has been suggested the sum of permanent maxillary central

incisors (instead of mandibular) and mandibular first molars as best predictors [27]. In the present study, we did not use maxillary first molar because it erupts after the mandibular molars so may delay the mixed dentition analysis and crown in the distal area is usually covered by gingiva, so measuring its actual mesiodistal dimension may be difficult.

Although multiple regression equation is complex and difficult to memorize but they are the ones provide better accuracy for estimating the mesiodistal distal width of unerupted canines and the premolars. However, further studies on comparison with different regression equations and its accuracy need to be explored.

Conclusion

Determination of mesiodistal widths of unerupted canine and premolars with help of two permanent mandibular molars and two mandibular central incisors, which erupt early in the oral cavity, can be an alternative and best predictor for the mixed dentition analysis.

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Conflict of Interest: The authors declare no conflicts of interest.

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