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**ORIGINAL ARTICLE**

# A New Regression Equation Proposed For Mixed Dentition Analysis in Chhattisgarh, Central India Population

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**Abstract**

**Objective:** To develop and propose a new regression for mixed dentition analysis in Chhattisgarh, Central India population. **Material and Methods:** The permanent dentition dental casts of 800 (400 males and 400 females) Chhattisgarh subjects were selected. Digital caliper was used to measure the mesiodistal crown widths of teeth. The linear regression equations and correlation between four mandibular incisors and the canine-premolars segments of maxillary and mandibular arches were developed (modified Tanaka-Johnston equation) and proposed for Chhattisgarh population. **Results:** New standardized regression equations were formulated to predict the mesiodistal widths of unerupted canines and premolars especially for Chhattisgarh, Central India population. The equation in males for maxillary arch was Y = 11.90 + 0.39 (X) and for mandibular arch was Y = 12.23 + 0.36 (X). Similarly, the equation in females for maxillary arch was Y = 14.40 + 0.26 (X) and for mandibular arch was Y= 10.26 + 0.43 (X). A significant sexual dimorphism in teeth sizes was seen with higher mesio distal dimension in males in Chhattisgarh population. **Conclusion:** Sum of the mesiodistal diameter of permanent mandibular incisors can be used reliably to predict/estimate the sum of mesiodistal diameters of unerupted canines and premolars with the new regression equations.

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

**Introduction**

The inconsistency between the tooth size and the tooth arch space is the condition, which requires early attention. For proper treatment plan, it is important to predict the deficiency in the arch space so that the indicated treatment could be performed as early as possible [1]. The first reference in the literature to estimate the mesiodistal widths of the tooth was made by Black in 1897, who proposed tables based on average widths [2].

Three main approaches used in mixed dentition analysis can be classified into three groups: a) based on measuring the unerupted teeth on the radiographs [1,3,4], b) based on usage of regression equations that relate the widths (mesiodistal) of erupted teeth in the oral cavity to the widths (mesiodistal) of unerupted teeth [5,6] and c) blend of measurements from erupted teeth and radiographs of unerupted teeth [7-9].

Most common method to predict/estimate the mesiodistal dimensions of unerupted canines and premolars have been decided by Tanaka and Johnston method by measuring the erupted permanent mandibular incisors [5] or calculated using Moyers probability charts [6]. These prediction/estimation techniques were developed using a population of "probable" North European ancestry.

Because of changing developments in tooth size and malocclusion, racial specific mixed dentition space analysis requires reconsideration [10-12]. New regression equation for Chennai population [13], Marwari Rajasthan population [14], Bangalore population [15] and Punjabi population [16] are described in the literature.

However, there are no studies on estimation of mesiodistal widths of unerupted canine and premolars for Chhattisgarh, Central India population reported in the literature. Hence, the present study aims to determine linear regression equations to predict/estimate the sum of mesiodistal width of unerupted permanent canines and premolars in the Chhattisgarh, Central India population by using the sum of four permanent mandibular incisors.

**Material and Methods**

Eight hundred dental casts (400 males and 400 females) of 14 to 21 years old orthodontic patient's residents of Chhattisgarh (born and brought up in Chhattisgarh, India) were selected from the records of Pedodontic and Orthodontic Department of three different dental colleges of Chhattisgarh. All casts fulfilled following selection criteria such as: fully eruption of permanent first molar to first molar in both jaws, no interproximal caries and restorations, no pervious orthodontic treatment, no alteration in teeth size, shape or number, no attrition, normal to mild crowding or spacing. The sample included different types of occlusion. All dental models were constructed from high-quality orthodontic dental stone.

Greatest mesiodistal crown widths of permanent teeth from 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 [17]. Therefore, the maximum width of the tooth between the interproximal contact points was measured parallel to the occlusal surface and perpendicular to the tooth long axis.

Data Analysis

To determine the error of the method, all the measurements were repeated by the same investigator five days later and the student's t-test revealed no statistical difference. All statistical analysis was carried out by using IBM SPSS Statistics Software, version 15 (IBM Corp., Armonk, NY, USA).

Linear regression was used to derive equations for the prediction of the sum of the widths of the canine, first premolar and second premolars in both the jaws. The regression equation was expressed as Y = a + b (X). The constants 'a' and 'b' were calculated for both genders 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 (r2) were calculated. r2 values represents the predictive accuracy of the regression equation for Y based on values of X. The new equations were developed to optimize the Tanaka-Johnston method for the children of Chhattisgarh.

**Results**

The descriptive statistics for the sum of widths of the mandibular four incisors, the canine-premolars segments for males and females separately were tabulated. The values were generally larger in males than females in both arches and the difference was statistically highly significant (Table 1).

**Table 1. Sum of the mesiodistal widths of the four mandibular incisors, the maxillary and mandibular canine-premolars segments.**

| Teeth Measured | Gender | No. of Samples | Mean (mm) ± SD | p-value |
|---|---|---|---|---|
| Mandibular Incisors | Male | 400 | 25.09 ± 2.91 | <0.001 |
| | Female | 400 | 23.19 ± 2.80 | |
| Maxillary Canine Premolars | Male | 400 | 21.80 ± 2.11 | <0.001 |
| | Female | 400 | 20.60 ± 1.83 | |
| Mandibular Canine Premolars | Male | 400 | 21.41 ± 1.77 | <0.001 |
| | Female | 400 | 20.24 ± 1.65 | |

Correlation coefficients and equations of prediction were derived from the sum of the widths of mandibular four incisors and canine-premolars segments. The modifiedTanaka-Johnston equation was adjusted for Rajnandgaon Chhattisgarh population using following linear regression equation Y = a + b (X).

Y represented the estimate of the sum of canine and premolars widths in millimeters on either the left or right side. X indicated the sum of the four mandibular incisors widths in millimeters, the constant 'a' was the Y intercept andthe constant 'b' was the slope of the regression. Correlation coefficients (r), determination coefficients (r2), constants 'a' and 'b' and the standard

error of estimate (SEE) for both males and females were calculated separately and combined. The correlation coefficients ranged from 0.40 to 0.72. Highest r2 value was 0.53 in females' mandibular arch and lowest one was 0.16 in females' maxillary arch (Table 2).

**Table 2. Coefficient of correlation (r), coefficient of determination ($r^2$), Standard error of estimation, regression constants (a and b) for various tooth groups measured.**

| Teeth Measured | Gender | Correlation coefficient (r) | Determination coefficient ($r^2$) | SEE | Constants | |
|---|---|---|---|---|---|---|
| | | | | | a | b |
| Maxillary Canine and Premolars | Male | 0.54 | 0.29 | 1.78 | 11.90 | 0.39 |
| | Female | 0.40 | 0.16 | 1.68 | 14.45 | 0.26 |
| | Combined | 0.52 | 0.27 | 1.76 | 12.44 | 0.36 |
| Mandibular Canine and Premolars | Male | 0.60 | 0.36 | 1.42 | 12.23 | 0.36 |
| | Female | 0.72 | 0.53 | 1.13 | 10.26 | 0.43 |
| | Combined | 0.69 | 0.48 | 1.30 | 10.71 | 0.41 |

So, the new regression equation based on sum of four mandibular permanent incisors for both males and females and combined were formulated (Table 3). The equation in males for maxillary arch was Y = 11.90 + 0.39 (X) and for mandibular arch was Y = 12.23 + 0.36 (X). Similarly, the equation in females for maxillary arch was Y = 14.40 + 0.26 (X) and for mandibular arch was Y= 10.26 + 0.43 (X).

**Table 3. New regression equation for Chhattisgarh, Central India population.**

| Gender | Maxillary Arch | Mandibular Arch |
|---|---|---|
| Male | Y = 11.90 + 0.39 (X) | Y = 12.23 + 0.36 (X) |
| Female | Y = 14.40 + 0.26 (X) | Y= 10.26 + 0.43 (X) |
| Combined | Y = 12.44 + 0.36 (X) | Y =10.71 + 0.41 (X) |

## Discussion

In mixed dentition period, calculating and estimation of the mesiodistal width of unerupted permanent canines and premolars is of clinical importance in early diagnosis and treatment planning. Precise assessment of the size of the canines and premolars allows the pedodontist/orthodontist to better accomplish management of tooth size or arch length discrepancies. Amongst the various mixed dentition analysis methods reported in the literature (radiographic approaches, regression equations, or amalgamation of both techniques), the regression equations are most extensively used [18]. Therefore, the present study was conducted to see the applicability of simple equations based on summation of mesiodistal width of permanent lower incisors.

In the present study superior quality dental casts made from dental stone was used. Digital vernier caliper was used as it could significantly help to reduce eye exhaustion and the likelihood of reading inaccuracy [19]. Prearrangement of inter-examiner and intra-examiner consistency at 0.2 mm was set as suggested by other authors [20]. The maximum age included in the study was 21 years as it has been reported that beyond 21 years individual teeth may be reduced considerably by interproximal attrition [21] and this could alter the outcomes of the study.

Differences in tooth size are very much noticeable amongst the population of different races and ethnicity [20,22,23]. The precise reason of tooth size variation is not evidently revealed, but genetics trailed by nutrition and environment seems to be one of the influential factors. However, differences exist in permanent tooth/teeth size amongst different races. Evidence of racial tooth size unevenness suggests that forecast/predicting techniques based on a sole racial sample may not be considered worldwide [24].

The proposed new estimation equation of this study might be more precise for tooth dimension prediction in the children of Chhattisgarh because they were derived from contemporary odontometric data. Sexual dimorphism has also been reported to effect tooth size [25,26]. Comparable sexual dimorphism was seen in the present study with the larger mesiodistal dimensions in males. Conversely, no differences were found between the right and left sides in both the arches.

The sum of the mesiodistal widths of the four mandibular incisors are correlated with the sum of the mesiodistal diameters of the maxillary and mandibular canines and premolars in Tanaka and Johnston mixed dentition analysis formula. The regression equation given by them is Y = 10.5 + 0.5 (X) (Mandibular canine-premolar segment) and Y = 11.0 + 0.5 (X) (Maxillary canine-premolar segment) where Y = the estimate of the sum of the mesiodistal widths of the unerupted canines and premolars on either the right or left side and X = the sum of the mesiodistal widths of the four mandibular incisors [5].

The sum of four mandibular incisors as the best predictor for estimating the mesiodistal width of unerupted permanent canine and premolars [1,5,22]. According to the results the r values for prediction of canine-premolars sections by fours mandibular incisors widths as predictors are: maxillary r= 0.52 and mandibular r= 0.69 which are near to those of Tanaka-Johnston's study (r= 0.62, 0.64).

In the present study, the correlation coefficient (r) ranged from 0.40-0.72 with the maximum correlation for female subjects in the mandibular arch and minimum correlation coefficient for female subjects in the maxillary arch (standard error 1.13-1.78). The regression coefficients of the present study was different from those published by Tanaka and Johnston. The interpretation of the Chhattisgarh subjects specified that the four mandibular incisors validated a slightly lower correlation, r= 0.52 (Tanaka-Johnston r= 0.62) and slightly larger correlation r= 0.69 (Tanaka-Johnston r= 0.65) for maxillary and mandibular segments respectively.

## Conclusion

Based on the result of the present study we can determine that tooth dimension shows sexual dimorphism. Mesiodistal crown width of the teeth in the mandibular arch is greater in males than in females. The simplified equations proposed are easy, practical, and precise non-radiographic method for predicting the mesiodistal width of unerupted teeth in Chhattisgarh population.

## References

1. Huckaba GW. Arch size analysis and tooth size prediction. Dent Clin North Am 1964; 11:431-40.

2. Black GV. Descriptive Anatomy of Human Teeth. 4th. ed. Philadelphia: S. S. White Dental Manufacturing; 1897.
3. Nance HN. The limitations of orthodontic treatment I - mixed dentition diagnosis and treatment. Am J Orthod Oral Surg 1947; 33:4:177-223.
4. Bull RL. Radiographic method to estimate the mesiodistal dimension of unerupted teeth. Am J Orthod 1959; 45(9):711-2. doi: 10.1016/0002-9416(59)90216-7.
5. Tanaka MM, Johnston LE. The prediction of the size of unerupted canine and premolars in a contemporary orthodontic population. J Am Dent Assoc 1974; 88(4):798-801. doi: 10.14219/jada.archive.1974.0158.
6. Moyers RE. Handbook of Orthodontics. 4th ed. Chicago: Yearbook Medical Publishers; 1988. pp. 235-240.
7. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted canines and premolar teeth. Angle Orthod 1958; 28:236-40.
8. Staley RN, Hoag JF. Prediction of the mesiodistal widths of maxillary permanent canines and premolars. Am J Orthod 1978; 73(2):169-77.
9. Staley RN, Kerber RE. A revision of the Hixon and Oldfather mixed-dentition prediction method. Am J Orthod 1980; 78(3):296-302.
10. 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(1):68-72.
11. Lavelle CL. Secular trends in different racial groups. Angle Orthod 1972; 42(1):19-25.
12. Harper C. A comparison of medieval and modern dentitions. Eur J Orthod 1994; 16(3):163-73.
13. Kommineni NK, Reddy CV, Chandra NS, Reddy DS, Kumar AK, Reddy MV. Mixed dentition analysis - Applicability of two non-radiographic methods for Chennai school children. J Int Soc Prevent Community Dent 2014; 4(2):133-8. doi: 10.4103/2231-0762.139847.
14. Baheti K, Babaji P, Ali MJ, Surana A, Mishra S, Srivastava M. Evaluation of Moyer's mixed dentition space analysis in Indian children. J Int Soc Prevent Community Dent 2016; 6(5):453-8. doi: 10.4103/2231-0762.184037.
15. Thimmegowda U, Sarvesh SG, Shashikumar HC, Kanchiswamy LN, Shivananda DH, Prabhakar AC. Validity of Moyers mixed dentition analysis and a new proposed regression equation as a predictor of width of unerupted canine and premolars in children. J Clin Diagn Res 2015; 9(8):ZC01-ZCO6. doi: 10.7860/JCDR/2015/13384.6269.
16. Philip NI, Prabhakar M, Arora D, Chopra S. Applicability of the Moyers mixed dentition tables and new prediction aids for a contemporary population in India. Am J Orthod Dentofacial Orthop 2010; 138(3):339-45. doi: 10.1016/j.ajodo.2008.09.035.
17. Moorrees CF, Reed RB. Correlation among crown diameters of human teeth. Arch Oral Biol 1964; 9:685-97.
18. Dasgupta B, Zahir S. Comparison of two non-radiographic techniques of mixed dentition space analysis and evaluation of their reliability for Bengali population. Contemp Clin Dent 2012; 3(Suppl 2):S146-50. doi: 10.4103/0976-237X.101069.
19. Zilberman O, Huggare JV, Parikakis KA. Evaluation of the validity of tooth size and arch width measurements using conventional and three-dimensional virtual orthodontic models. Angle Orthod 2003; 73(3):301-6.
20. Bishara SE, Jacobsen JR, Abdullah EM, Garcia AF. Comparisons of mesiodistal and buccolingual crown dimensions of the permanent teeth in 3 populations from Egypt, Mexico, and the United states. Am J Orthod Dentofacial Orthop 1989; 96(5):416-22. doi: 10.1016/0889-5406(89)90326-0.
21. Wangpichit K, Huntington NL, Kapala JT. Comparison of three methods of mixed dentition analysis in cleft lip and patients. Pediatr Dent 2001; 23(6):478-80.
22. Priya S, Munshi AK. Formulation of a prediction chart for mixed dentition analysis. J Indian Soc Pedod Prev Dent 1994; 12(1):7-11.
23. 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. doi: 10.1016/S0889-5406(97)70082-9.
24. Bailit HL. Dental variation among populations. Dent Clin North Am 1975; 19(1):125-39.
25. de Paula S, Almeida MA, Lee PC. Prediction of mesiodistal diameter of unerupted lower canines and premolars using 45 degrees cephalometric radiography. Am J Orthod Dentofacial Orthop 1995; 107(3):309-14. doi: 10.1016/S0889-5406(95)70147-8.
26. Frankel HH, Benz EM. Mixed dentition analysis for black Americans. Pediatr Dent 1986; 8(3):226-30.