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# Comparison And Correlation of Radiographic And Non Radiographic Methods of mixed Dentition Space Analysis With The Formulation of Linear Regression Equation In Children of Mandi District, Himachal Pradesh

Dr. Haritima Kahol[1]
Dr. Vinay Bal Singh Thakur[2], Dr. Kanika Gupta[3], Dr. Pallavi Mishra[4]

[1]*MDS in Pediatric and Preventive Dentistry, Sundernagar, District Mandi, Himachal Pradesh University, India*
[2]*Assistant Professor, Department Of Pediatric And Preventive Dentistry, Himachal Dental College, Sundernagar, District Mandi, Himachal Pradesh University, India*
[3]*Post graduate student, Department of Pediatric and Preventive dentistry, Himachal Dental college, Sundernagar, District Mandi, Himachal Pradesh University, India*
[4]*House surgeon, Himachal dental college, Sundernagar, District Mandi, Himachal Pradesh University, India*

***Abstract:***
***Introduction:*** *Predicting the size of unerupted teeth during the mixed dentition period is a critical factor in managing the developing occlusion. The Nance radiographic method, Moyers mixed dentition space analysis and Johnston Tanaka method are among the most commonly used in clinical practice for detecting tooth size-arch length discrepancies. In view of reported secular trends, racial, and sex differences in tooth sizes, the purposes of this study were to compare and correlate the radiographic and non radiographic mixed dentition space analysis in children of Mandi district, Himachal Pradesh and to formulate a regression equation using the best variable predictors.*
***Method:*** *Odontometric data were collected from 52 male and 48 female subjects of Himachal descent, aging from 8-11 years who had fully erupted mandibular permanent incisors and first molar and unerupted permanent canines and premolars. The measurements of mesiodistal crown widths were made with Vernier scale digital calipers. The odontometric values obtained were then subjected to statistical and linear regression analysis.*
***Results:*** *All tooth groups showed no significant differences (P>0.001) between mesiodistal widths of male and female subjects. Very high correlation was found between the two non radiographic methods i.e. Moyer's and Johnston –Tanaka method with their r values of 0.990. Correlation of Nance radiographic method with Moyer's and Johnston Tanaka method was fair showing r values of 0.661 and 0.673 respectively.* ***Conclusion:*** *Estimation of tooth width in early mixed dentition is best made by means of radiographs of the yet unerupted teeth. The non radiographic methods as given by Moyers and Johnston Tanaka give reasonable approximation for prediction width of crown width when it is impossible to obtain satisfactory image.*
***Keywords:*** *Arch length discrepancies, Mixed dentition analysis, Radiographic methods, Non radiographic methods*

## I. Introduction

The early mixed dentition period of occlusion, which house both primary and permanent teeth, is much more prone to localized factors which trigger the development of severe malocclusion if left undetected.[1] This period will show crowding in the mandible or maxilla or both the arches, thus early assessment is needed in this period. Presence of maximum orthodontic problems in this particular period is due to the inadequacy of space for erupting permanent teeth. The mixed dentition space analysis helps in early orthodontic evaluation and treatment planning[2]. This type of analysis is a fundamental part of early orthodontic assessment and helps in determining any tooth size-arch length discrepancy. If discrepancy is present, it forms a useful diagnostic aid in determining whether the treatment plan is going to involve serial extraction, guidance to eruption, space maintenance, space regaining or just periodic observation of patient[3].

The dental literature is replete with investigations focusing on the comparative accuracy, reliability, and reproducibility of various mixed dentition space analysis techniques. G. V Black[4] in 1897 attempted to predict the mesiodistal widths of unerupted teeth based on tables of average mesiodistal widths of teeth. Classically mixed dentition analysis techniques rely on one of the following methods:

1. The estimation of unerupted tooth size by radiographic measurement (e.g. de Paula [5] Nance[6], Cohen[7]);
2. Predictions based on correlations between the sizes of different types of teeth within a dentition (e.g. Tanaka and Johnston[8]; Moyer[9]);
3. A combination of both methods (e.g. Hixon and Oldfather[10]; Staley and Kerber[11]).

In 1947, Nance [6] first suggested the use of periapical radiographs for measurement of the width of unerupted teeth. The Moyer's probability tables[8] were developed at the University of Michigan in 1973 based on odontometric data of American white subjects of Northwestern European descent. Tanaka and Johnston[9] developed tables comparable with Moyer's, but realized that simplifying mixed dentition space analysis would widen its clinical application. They introduced simple, easily remembered and applied regression equations for estimating summed dimensions of the maxillary and mandibular canine and premolar segments.
There have been several studies about the applicability of two non-radiographic methods i.e. Moyer's, (1973, 1988) and Tanaka and Johnston, (1974) in other population groups, which concluded that both methods underestimated the tooth dimensions in the non-Caucasian samples.[12,13,14] Since the Himachal is lacking the formulation of such prediction tables for its own populations, keeping in view of the racial, geographical differences, this study was designed to evaluate the applicability of Nance (radiographic), Moyer's (non radiographic) and Tanaka and Johnston (non radiographic) methods in assessing the size of permanent canines and premolars in Himachal population children. The present study was conducted in the Department of Pedodontics & Preventive Dentistry of Himachal Dental College, Sundernagar, H.P. The sample consisted of 100 subjects of which 52 were males and 48 were females.

## II. Materials And Method

All children were stratified according to age, sex and subjected to clinical examination at the start of the study with detailed medical and dental histories taken and recorded in a prescribed Performa. The inclusion criteria include:

1. Indigenous Himachali patients of North Indian descent.
2. The patients had to be free of any systemic disease or serious health problems (calcium-phosphate deficiency, Vitamin D deficiency, hypothyroidism, hypopituitarism, Gardner Syndrome, Down Syndrome, Cleidocranial Dysplasia, CLP etc).
3. Patients with teeth free from restorations, proximal wear, fractures or proximal caries as determined by clinical examination.
4. Patients with teeth free from any hypoplasia or other dental anomalies as in number, size and shape of the tooth
5. High quality dental study casts and radiographs free from any distortions.
6. No history of previous orthodontic treatment.

A Vernier gauge calibrated with digital micrometer with sharpened measuring beaks, were used to measure the m-d widths of the individual teeth from unsoaped mandibular study casts and intra-oral periapical radiographs. The sliding caliper was adjusted to the greatest mesiodistal diameter of the teeth, parallel to the occlusal surface and perpendicular to the long axis.

In the international agreement for Unification of Anthropometric Measurements to be made on living subjects, prepared during the Physical Anthropologists Congresses held in Monaco in 1906 and in Geneva 1912, the decision was made that the assessment on living persons should be performed on the left side of body. In previously conducted studies, it was determined that differences between the two sides of body were sufficiently minor, such that they would not lead to errors in assessment of measurements. Thus, the measurements were taken in the left quadrant of the mandibular arch and since the arches were well aligned it could be reasonably assumed that measurements for one side of the arch would be similar to that of opposite side of arch. This was also done to reduce the radiation exposure to the patients.[3,11]

The reproducibility and reliability of the method used to record the measurement of the teeth was determined by using Cronbach's alpha test in 30 sets of sample. Concordance between the groups was high with values which ranged from minimum to maximum of 0.973 to 0.999. This ensured that the study had minimum observer or instrument bias.

## III. Results

The sums of the following groups of teeth were pooled and the mean mesiodistal diameter was calculated for each sex, and the whole sample:

1. the four permanent mandibular incisors
2. the mandibular deciduous canine and molars
3. the mandibular deciduous canines and molars measured on radiograph

**4.** the mandibular permanent canine and premolar measured on radiograph

Data collected was then subjected to statistical analysis. Descriptive statistics calculated includes mean, standard deviations, and minimum and maximum values (Table1). To study the relationship between different variables Pearson or Spearman Correlation coefficient was applied. All the statistical tests were two-sided and were performed at a significance level of $\alpha$=0.05. Analysis was conducted using IBM SPSS STATISTICS (version 22.0).

To compare the mesiodistal width of teeth in 52 males and 48 females, t test for equality of means was applied. The test showed that there was no significant difference in the mesiodistal width of teeth between the male and female subjects as depicted by p value>0.05 (Table 2).

To determine the relation between the radiographic width of permanent canine and premolars and erupted permanent incisors, Pearson's Correlation Coefficient was calculated (Table 3). The correlation between the sum of incisors with the radiographic sum of canine and premolars was 0.79 whereas the correlation of sum of incisors with the sum of canine and premolars as predicted by Moyer's and Tanaka Johnston was comparatively low with r values which were 0.76 and 0.78 respectively. All the above values were significant with p value < 0.01.

The strength of association between the radiographic and non radiographic method for estimation of width of unerupted permanent mandibular canine and premolars was also determined. Very high correlation was found between the two non radiographic methods i.e Moyer's and Tanaka Johnston method with their r values of 0.990. Correlation of Nance radiographic method with Moyer's and Tanaka Johnston method was fair showing r values of 0.661 and 0.673 respectively (Table 4)

## IV. Discussion

An arch length analysis in lower arch of mixed dentition entails more than prediction width of unerupted canine and premolars, the assessment of the space available to accommodate them in the developing arch, is essential for early diagnosis and treatment planning during the mixed dentition period [16]. The need of establishing a prediction method that utilizes jaw and tooth dimensions after eruption of lower incisors arises, because primary crowding is usually noticeable only after the eruption of incisors and the jaw development by then rarely provides the required space to accommodate primary crowding.[15,17]

Morphologic differences in arch dimension among various populations have been found. [18,19]. Tooth morphology is under rigid genetic control and the tooth size is affected primarily by the process of genetic transmission and secondarily by environmental factors. Some of the factors that contribute to variability of permanent tooth size are race, sex, heredity, environment, secular changes and bilateral asymmetry. Different racial and ethnic differences in tooth sizes have been highlighted in several studies. [12,13,16, 20, 21] Because of the changing secular trends and the influence of sex on the mesiodistal diameter, there is need to reevaluate the applicability of the mixed dentition analysis in Himachal population.

The minimum age range of 8-11 years was selected as it ensures that mandibular permanent incisors have fully erupted along with erupted deciduous canine and molars which makes estimation of unerupted canine and premolars possible through both radiographic and non radiographic method.

For both the Moyer's method and Tanaka and Johnston methods, the permanent mandibular incisors were chosen for predicting the size of unerupted canine and premolars in both the arches, since the mandibular permanent incisors will erupt early in the mouth and were easily and accurately measured both in the mouth and on the dental casts.[22] There is limitation on the inclusion of other teeth because of local implicating factors such as lower first permanent molars which may be still covered by gingiva over the distal groove or maxillary lateral incisors whose morphological variability results in lower correlation values with other group of teeth.[23]

When the mesiodistal tooth dimensions of erupted teeth for males and females were measured in the cast and their means were compared a small difference was found which statistically was not significant (p >0.05) (Table1 ) . Also, the means of sum of the radiographic mesiodistal tooth widths of canine and premolars showed no significant difference (p>0.05) in males subjects than females(Table 2). The present findings thus showed no statistical significant presence of sexual dimorphism in Himachal population, and this study is in accordance with various studies.[11,24,28,29]

The means of sum width of lower incisors in our study sample was found to be considerably less than the means of sum width of lower incisors as estimated by Moyer and Johnston –Tanaka method which were obtained from North Caucasian population. Hence, the applicability of these two non radiographic methods could adversely affect the space assessment in Himachal population.

In the present study, the coefficient of correlation( r value) between the sum of four mandibular incisors and the sum of canine and premolars as estimated by Moyer's table at 75 percentile and Johnston method was 0.765.and 0.78 respectively while for Nance radiographic method was 0.79. It concludes that radiographic width of sum of canine and premolars is the good predictor in early mixed dentition. It is also supported by the

studies conducted by de Paula S et al[5] , Hixon and Oldfather [10], Kaplan RG et al[25], Zilberman Y et al[26], Staley RN et al [27].

Coefficient of determination ($r^2$) which indicate the predictive accuracy of non radiographic method, were between 0.57-0.60 for canine and premolar region (Table 3). this means that 57- 62% of total variance in canine – premolar widths are accounted for by knowing the sum of mandibular incisors. These values indicate the applicability of proposed non radiographic methods as given by Moyers and Johnston Tanaka cannot be used to present representative sample of Himachal population. Moreover, the use of predictive equations however accurate it might be is no substitute for a good set of intraoral films used in Nance radiographic methods. These values thereby depict that the accuracy of two non radiographic methods for tooth prediction is fairly comparable but are not as accurate as the radiographic method for tooth size prediction.

There was significant correlation between the two non radiographic methods with r values of 0.99 whereas their correlation with the radiographic method was 0.661. This finding may be explained by the fact that both the non radiographic analysis use the sum of mandibular incisors as an independent variable and measured width of unerupted canines and premolars at the confidence level of 75%.

The average Leeway space found in females is 3.42 mm in mandible. The average Leeway space found in males is 3.3mm in mandible. The present study revealed that females having larger Leeway space than males. In agreement with previous studies it also became evident that females have a larger Leeway Space than males. [6,12,28] In general small individual variations of the Leeway Space were found. Even though the variation is quite small, it may become clinically important if it is underestimated as it may lead to unacceptable space conditions leading to uneventful stripping or even extractions.

As the correlation of the sum of incisors was found to be high with the radiographic measurements, a multiple linear regression equation was developed using the radiographic widths of mandibular central and lateral incisors. The equation is

$$Y = 7.63 + 0.98^* X_1 + 0.96^* X_2$$

Where y is the sum of canine and premolar to be estimated, $X_1$ is the mesiodistal width of central incisor and $X_2$ is the mesiodistal width of lateral incisors.

Further study is to be carried to evaluate the applicability of the above regression equation in the estimation of unerupted sum of mandibualar canine and premolars.

## V. Conclusion

Based on study we can conclude

1. No significant sexual dimorphism in tooth sizes is evident in Himachal population.
2. The correlation and determination coefficients for non radiographic methods used in this study are low as compared to radiographic method. Thereby concluding that in present study, estimation of tooth width in early mixed dentition is best made by means of radiographs of the yet unerupted teeth. The non radiographic methods as given by Moyers and Tanaka Johnston give reasonable approximation for prediction width of crown width when it is impossible to obtain satisfactory image.
3. The multiple linear equation developed from the present data can be applied to determine width of unerupted canine and premolars while the present data can be used as a baseline for comparison to increase accuracy in predicting the mesio distal widths of unerupted canines and premolars in Himachal population.

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**Table 1**: Descriptive Mean Of Sum Of Canine And Premolars Obtained By Radiographic And Non-Radiographic Methods For Total Sample

| | MEAN ± S.D |
|---|---|
| Nance (R/G) | 42.09 ± 1.39 |
| Moyers (Nr/G) | 43.31 ±1.86 |
| Johonston –Tanaka (Nr/G) | 43.18 ±1.57 |

**Table 2**: T Test For Equality Of Means Between Two Gender

| | T | Df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Central | .832 | 98 | .908 | .07200 | .08657 | -.09980 | .24380 |
| Lateral | .074 | 98 | .941 | .00678 | .09159 | -.17499 | .18854 |
| dec canine | .658 | 98 | .512 | .02048 | .03111 | -.04125 | .08221 |
| dec molar 1 | .093 | 98 | .926 | .00380 | .04075 | -.07707 | .08466 |
| dec molar 2 | -1.161 | 98 | .248 | -.05490 | .04728 | -.14874 | .03893 |
| r/g canine | -.998 | 98 | .321 | -.02146 | .02149 | -.06411 | .02119 |
| r/g molar 1 | -.778 | 98 | .438 | -.0545 | .0701 | -.1936 | .0846 |
| r/g molar 2 | -.665 | 98 | .507 | -.0535 | .0804 | -.2129 | .1060 |
| r/g 3 | -1.028 | 98 | .306 | -.06175 | .06005 | -.18091 | .05741 |
| r/g 4 | -1.186 | 98 | .238 | -.05784 | .04875 | -.15459 | .03891 |
| r/g 5 | -1.001 | 98 | .319 | -.05380 | .05373 | -.16041 | .05282 |

**Table 3:** Pearson's Correlation Coefficient Between Width Of Sum Of Incisors (Si) And The Sum Of Canine And Premolars (Scp) As Estimated By Radiographic ( R/G) And Non Radiographic (Nr/G) Method

| Correlation | Correlation Coefficients (R) | Determination Coefficients ($R^2$) |
|---|---|---|
| Si - R/G Scp | 0.79 | 0.62 |
| Si- Nr/G Moyers | 0.76 | 0.57 |
| Si- Nr/G J-T | 0.78 | 0.60 |

**Table 4**: Pearson's Correlation Coefficient between the Radiographic and Non-Radiographic Method of Estimation of Width of Sum of Canine and Premolars

| Correlation | | | | |
|---|---|---|---|---|
| | | Nance | Moyers | Jt |
| Nance | Pearson Correlation | 1 | .0.661 (*) | .673(*) |
| | Sig. (2-Tailed) | | .039 | .032 |
| | N | 100 | 100 | 100 |
| Moyers | Pearson Correlation | .661(*) | 1 | .990(**) |
| | Sig. (2-Tailed) | .039 | | .000 |
| | N | 100 | 100 | 100 |
| J-T | Pearson Correlation | .673(*) | .990(**) | 1 |
| | Sig. (2-Tailed) | .032 | .000 | |
| | N | 100 | 100 | 100 |
| * Correlation Is Significant At The 0.05 Level (2-Tailed). | | | | |
| ** Correlation Is Significant At The 0.01 Level (2-Tailed). | | | | |

**Correlation Of Sum Of Canine And Premolar As Estimated By Moyers , Nance And Johnston Tanaka Method**