Evaluation of Moyer’s mixed dentition space analysis in Indian children

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Received: 28-03-16 Accepted: 26-04-16 Published: 24-10-16

Abstract

Aim and Objectives: Tooth size prediction values are not universal for all ethnic and racial groups. The present study evaluated the applicability of Moyer’s mixed dentition space analysis in the Marwari community of Rajasthan, India.

Materials and Methods: The mesiodistal dimension of permanent mandibular incisors, maxillary and mandibular canine, and premolars of both sides were measured and averaged in 200 adolescents (100 males and 100 females) of the Marwari population in Rajasthan using digital Vernier caliper. Data were statistically analyzed using Student’s t-test. The data were then compared with Moyer’s predicted values. The tooth measurements of male and female participants were compared with unpaired t-test. Results: Moyer’s prediction chart was not comparable with the study population group. The coefficient of correlation and coefficient of determination in our study was 0.57 and 0.25, respectively. Mesiodistal width of measured teeth was lesser in females compared to males for both canine and premolars (P = 0.471 and P = 0.0001, respectively). Conclusion: There was significant statistical difference between values of the present study and Moyer’s prediction values. Hence, new regression equation and prediction table can be used to predict mesiodistal dimensions of canine and premolars in Marwari children of Rajasthan.

Key words: Mixed dentition, Moyer’s analysis, prediction table, space analysis

INTRODUCTION

In most of the cases, malocclusion starts during mixed dentition stage. Earlier diagnosis and management of developing malocclusion helps to resolve the problem effectively. Unerupted maxillary and mandibular canine and premolars can be assessed with the mesiodistal width of the erupted permanent mandibular incisors. Prediction of the unerupted teeth size in mixed dentition stage is a key factor for establishing treatment plans and management of developing malocclusion.¹⁻⁴ Mixed dentition space analysis (MDSA) helps in identifying the space discrepancy. MDSA also helps in determining treatment plan and assessing tooth eruption, space maintenance, space regaining, serial extraction, or for periodic evaluation.⁵⁻⁶

MDSA to predict the width of unerupted permanent canines and premolars can be based on four basic...
principles, i.e., the measurement of unerupted teeth on periapical radiographs, from prediction tables and equation, a combination of prediction tables and radiographs, and regression equation methods. Various MDSA have been advised such as Moyer’s, Tanaka–Johnston’s, and radiographic methods. All these methods have one or the other drawbacks. However, regression equation method seems to be relatively accurate.

Moyer’s analysis is the most widely used method. This MDSA is used to assess the mesiodistal width of unerupted canine and premolars using probability chart at the 75th percentile. However, this prediction was based on North American Caucasian children. It is not applicable to all racial groups because it has been observed that tooth dimension varies in different ethnicities, races, and genders.

Various studies have shown that Moyer’s prediction table is not applicable to all the races, and they have developed different prediction tables. Agarwal et al., Thimmegowda et al., Singh et al., and Durgekar and Naik found different tooth size measurements, and created prediction tables for Indian children of different locations; similarly, new regression equations were developed for tooth size prediction by Hammad and Abdellatif for Egyptian children, Al-Bitar et al. for Jordanian population, and Toodehzaeim et al. for Iranian population.

If the predicted values of unerupted canine and premolar are wrong, then the whole treatment may be a failure. Hence, the present study was undertaken to evaluate tooth width in males and females and to assess the applicability of Moyer’s probability tables in the Marwari children of Rajasthan as well as to formulate a more appropriate mixed dentition prediction chart.

**MATERIALS AND METHODS**

The Marwari community in Rajasthan has a rich cultural heritage, with limited racial mixing due to strong family bonds. School children belonging to the Marwari community and residing in Jodhpur city were included for this study. Children’s domicile and community were confirmed from school records, by questionnaire, and certificate issued from the Tashildar office. A total of 200 school children (200 males and 100 females) of age group 13–16 years were randomly selected from the Marwari community from 6 schools in Jodhpur city who met the selection criteria. 173 samples were selected from 1492 total strength at 95th confidence level with a confidence interval of 7; the sample size was then adjusted to 200. The nature of the study was clarified to the participants and parents, and written informed consent was obtained from the school authority and parents of the participating children. The study was carried out from July 2014 to October 2014.

Alginate impression of the upper and lower arch of all participating children was made and poured immediately in dental stone (Type III) to prevent dimensional changes. A digital Vernier caliper with a resolution of 0.01 mm was used to measure the mesiodistal width of the individual teeth (mandibular permanent incisors and canine and premolars of maxillary and mandibular arch) [Figure 1]. Mean values of the misiodistal width of the lower incisors (LI), upper canine and premolars (UCPM), and lower canine and premolars (LCPM) were recorded. Values of the left and right side were averaged to obtain a single mean value. The measurements were made between two contact points of each tooth, parallel to the occlusal and vestibular surfaces, as described by Jensen et al. The teeth on the model cast were measured manually by a single trained researcher. The reliability of coefficient of the test was confirmed from the pilot sample study. To facilitate accuracy in measurement, participants with an arch length discrepancy of ±2 mm were included. To check the reliability of measurements, two obtained measurements were compared, and if they varied by 0.2 mm or less, the values were averaged. If values varied by 0.2 mm, teeth were again measured and the nearest of the three measurements were averaged.

**Inclusion criteria**

- All fully erupted permanent teeth except third molars should be present in both the arches
• Both the patient and their parent should be a domicile of Jodhpur, Rajasthan, for a minimum of 20 years and the parents of the participants should belong to the Marwari community
• Subjects should be in the age range of 13–16 years.

Exclusion criteria
• Tooth loss mesiodistally as a result of interproximal caries, interproximal attrition, fracture, or congenital defects
• Participants who have undergone orthodontic treatment
• Any congenital craniofacial anomalies

All the measurements were recorded in an Excel spreadsheet and subjected to statistical analysis. Student’s t-test and standard linear regression was evaluated using the Statistical Package for the Social Sciences software version 18.0, (Chicago: SPSS Inc., 2009) Student’s t-test was used to compare Moyer’s prediction chart with the present values. The tooth width of all subjects were compared with unpaired t-test. The standard linear regression equation of the form \( Y = a + b(X) \) was used to prepare new probability tables,[11,14] where \( X \) is the combined mesiodistal width of the mandibular permanent incisor, \( Y \) is the mesiodistal width of the canine and premolar segments, \( a \) is the \( Y \)-intercept, and \( b \) is the slope of the regression line.

RESULTS
In our samples, Moyer’s probability chart was not an accurate method to predict tooth dimension. Table 1 indicates the mean and standard deviation values for selected teeth. Table 2 indicates a difference in predictive values. In our study, Moyer’s prediction table at the 75\(^{th}\) percentile overestimates the dimension whereas at the 50\(^{th}\) and 35\(^{th}\) percentile it underestimates the actual values in both the genders [Table 2].

Table 1: Mean and standard deviation for various tooth groups

| Teeth Group | Gender | Total number | Mean (mm) | SD (mm) |
|-------------|--------|--------------|-----------|---------|
| LI          | Male   | 100          | 22.10     | 1.886   |
| UCPM        | Male   | 100          | 21.42     | 1.342   |
| LCPM        | Male   | 100          | 20.86     | 1.512   |
| LI          | Female | 100          | 21.98     | 1.824   |
| UCPM        | Female | 100          | 20.84     | 1.248   |
| LCPM        | Female | 100          | 20.25     | 1.479   |

SD= Standard deviation, LI=Lower incisor width, LCPM=Lower Canine Premolar width, UCPM=Upper Canine Premolar width

Table 3 indicates the coefficient of correlation \( (r) \), regression constants \( (a, b) \), and coefficient of determination \( (r^2) \) for various tooth groups in different groups of participants. The \( r \) and \( r^2 \) in our study was 0.57 and 0.25, respectively [Table 3]. Mesiodistal width of measured teeth was more in males compared to females for both canine and premolars \( (P = 0.471 \) and \( P = 0.0001, \) respectively) [Table 4]. Tables 5-8 are the prediction tables of Moyer’s at 75\(^{th}\), 50\(^{th}\), and 35\(^{th}\) percentile along with the present 75\(^{th}\) percentile prediction for the Marwari community for both genders.

From our study, we have developed the following new regression equations for the Marwari community of Rajasthan to predict tooth width of unerupted teeth

Male: Maxilla- \( Y = 10.52 + 0.46x \),
Mandible- \( Y = 9.45 + 0.48x \)

Female: Maxilla- \( Y = 11.67 + 0.45x \),
Mandible- \( Y = 11.58 + 0.32x \)

DISCUSSION
MDSA is used to estimate the width of unerupted permanent teeth for the diagnosis of developing malocclusion.[2] Improper space analysis could lead to a negative decision for extraction, which can affect the patient’s facial profile.[11,12] Globally, Moyer’s mixed dentition prediction table at the 75\(^{th}\) percentile with sum of mesiodistal dimension of the erupted lower permanent incisors is used to calculate the width of unerupted permanent teeth.[11] Use of mandibular permanent incisor for prediction is advantageous because it erupts early in mixed dentition, is easy to measure, and has minor size variations. Use of digital caliper with a standard error of \( \pm 0.03 \) mm has shown to be a more accurate to measure tooth dimension. Maxillary incisors were not used in any predictive procedure because they have variable size and lower predictive values.[11,12]

Moyer’s prediction was not applicable in all races because it was based on the North American population, and tooth dimensions and craniofacial characteristics differ among populations of various ethnicities, racial origins, genetics and genders.[1,5,11,12] This is in agreement with several researchers who have provided different regression analysis for prediction.[2,5,11] Revision in racial- and gender-based space analysis is required once in every generation because of the changing trends in malocclusion and tooth size.[11]
Table 2: Comparison of actual and predictive values using student ‘t’ test

| Gender | Arch     | 75th percentile | 50th percentile | 35th percentile |
|--------|----------|-----------------|-----------------|-----------------|
|        | ‘t’      | P               | ‘t’             | P               | ‘t’             | P               |
| Male   | Maxillary| 2.7893          | 0.0100          | 4.8767          | 0.0001          | 6.1657          | 0.0001          |
| Male   | Mandibular| 2.9856          | 0.0070          | 4.3451          | 0.0003          | 5.0125          | 0.0001          |
| Female | Maxillary| 4.1854          | 0.0003          | 6.4566          | 0.0001          | 7.1234          | 0.0001          |
| Female | Mandibular| 5.8956          | 0.0001          | 7.7889          | 0.0001          | 8.6567          | 0.0001          |

Table 3: Coefficient of correlation (r), Regression constants (a, b), Coefficient of determination (r²) for various tooth groups in different groups of subjects

| Teeth groups | Gender | r     | a     | b     | r²     |
|--------------|--------|-------|-------|-------|--------|
| UCPM         | Male   | 0.3867| 17.657| 0.197| 0.1355 |
| LCPM         | Male   | 0.4355| 13.770| 0.267| 0.2466 |
| UCPM         | Female | 0.3899| 17.446| 0.192| 0.1247 |
| LCPM         | Female | 0.5778| 12.789| 0.556| 0.2578 |

LCPM=Lower Canine Premolar width, UCPM=Upper Canine Premolar width

Table 4: Comparison of mesiodistal width of group of teeth between male and females

| Teeth groups | Gender | Mean | SD    | SE    | P     |
|--------------|--------|------|-------|-------|-------|
| LI           | Male   | 22.10| ±1.849| 0.572| 0.0138+|
|              | Female | 21.83| ±1.485| 0.566| 0.0001++|
| UCPM         | Male   | 21.36| ±1.342| 0.179| 0.0471+|
|              | Female | 20.94| ±1.254| 0.192|        |
| LCPM         | Male   | 20.99| ±1.485| 0.256| 0.0001++|
|              | Female | 20.15| ±1.458| 0.0001++|

Unpaired ‘t’ test. SD=Slandered deviation, SE=Slandered error, LI= Lower incisor width, UCPM=Upper canine Premolar width, LCPM=Lower Canine Premolar width, +=Significance, ++=Highly significance

Table 5: Prediction table for maxillary arch in males with Moyer’s probability chart

| L* | 75th percentile | 50th percentile | 35th percentile | Present 75th percentile |
|----|-----------------|-----------------|-----------------|-------------------------|
| 19.5| 20.3            | 19.7            | 19.3            | 19.84                   |
| 20.0| 20.5            | 19.9            | 19.6            | 20.14                   |
| 20.5| 20.8            | 20.2            | 19.9            | 20.52                   |
| 21.0| 21.0            | 20.4            | 20.1            | 20.62                   |
| 21.5| 21.3            | 20.7            | 20.4            | 20.86                   |
| 22.0| 21.5            | 20.9            | 20.6            | 21.02                   |
| 22.5| 21.8            | 21.2            | 20.9            | 21.35                   |
| 23.0| 22.0            | 21.5            | 21.1            | 21.61                   |
| 23.5| 22.3            | 21.7            | 21.4            | 21.82                   |
| 24.0| 22.5            | 22.0            | 21.6            | 22.15                   |
| 24.5| 22.8            | 22.2            | 21.9            | 22.34                   |
| 25.0| 25.0            | 22.5            | 22.1            | 22.61                   |
| 25.5| 25.3            | 22.7            | 22.4            | 22.78                   |

L*=Sum of mandibular incisors

Table 3 presents the r, a and b, and r² for various tooth groups in different groups of subjects. The r and r² in our study was 0.57 and 0.25, respectively

These values are in agreement with the values reported in the study by Agarwal et al.,[1] and are higher than those reported in the studies by Jaroontham and Godfrey[15] (0.29 and 0.34), Durgekar and Naik[11] (0.56 and 0.25 r²), and Hammad and Abdellatif[4] (0.78 and 0.89 in male and 0.63 and 0.87 in female, respectively).

Mesiodistal width of the measured teeth was lesser in females compared to males for both canine and premolars (P = 0.471 and P = 0.0001, respectively) [Table 4]. This is in accordance to the studies conducted by Agarwal et al. and Durgekar and Naik.[1,11,15] The degree of accuracy (SE) for new equation ranges from 0.179 to 0.572 mm [Table 4]. This is in near range compared to study by Agarwal et al. (0.186–0.544 mm), and lower to results from Chandan et al. study (0.63–0.83 mm).[11,16]

Our results indicate that Moyer’s prediction chart is not accurate for the present study group. Hence, new regression equations and prediction table has been formulated for the Marwari community. The differences noted in Moyer’s prediction chart with that of our study are because of the changes in the racial and ethnic diversity [Tables 5-8]. Tooth dimension is associated with gender. Mesiodistal crown dimension in the buccal segment of the mandibular arch is lesser in females compared to males.

Multiple regressions equation method using mandibular permanent incisors as a predictor value is nonradiographic, easy to assess, practical, and precise method for assessing the mesiodistal dimension of unerupted canine and premolars.[11] Different studies
have shown the variations in prediction and regression equation to evaluate unerupted teeth.\cite{1,3,4,11,12}

A limitation of the study was smaller group selection. This method can be applied in the study population with the new regression formula and prediction table. Further research is required to evaluate more appropriate prediction charts on larger and different racial groups.

**CONCLUSION**

Moyer’s mixed dentition prediction table is not universal for all racial groups; hence, individual regression analysis and prediction table is more useful.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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### Table 6: Prediction chart for mandibular arch in males with Moyer’s probability chart

| L* percentile | 75th percentile | 50th percentile | 35th percentile | Present 75th percentile |
|---------------|-----------------|-----------------|-----------------|------------------------|
| 19.5          | 20.4            | 19.5            | 19.0            | 19.31                  |
| 20.0          | 20.6            | 19.7            | 19.3            | 19.42                  |
| 20.5          | 20.8            | 20.0            | 19.5            | 19.68                  |
| 21.0          | 21.0            | 20.2            | 19.7            | 19.86                  |
| 21.5          | 21.2            | 20.4            | 20.0            | 20.18                  |
| 22.0          | 21.4            | 20.6            | 20.2            | 20.45                  |
| 22.5          | 21.6            | 20.9            | 20.4            | 20.72                  |
| 23.0          | 21.9            | 21.1            | 20.6            | 20.92                  |
| 23.5          | 22.1            | 21.3            | 20.9            | 21.15                  |
| 24.0          | 22.3            | 21.5            | 21.1            | 21.46                  |
| 24.5          | 22.5            | 21.7            | 21.3            | 21.83                  |
| 25.0          | 22.8            | 22.0            | 21.5            | 21.97                  |
| 25.5          | 23.0            | 22.2            | 21.7            | 22.18                  |

*L* = Sum of mandibular incisors

### Table 7: Prediction table for maxillary arch in females with Moyer’s probability chart

| L* percentile | 75th percentile | 50th percentile | 35th percentile | Present 75th percentile |
|---------------|-----------------|-----------------|-----------------|------------------------|
| 19.5          | 20.4            | 19.6            | 19.2            | 19.75                  |
| 20.0          | 20.5            | 19.8            | 19.4            | 19.92                  |
| 20.5          | 20.6            | 19.9            | 19.5            | 20.21                  |
| 21.0          | 20.8            | 20.1            | 19.7            | 20.46                  |
| 21.5          | 20.9            | 20.2            | 19.8            | 20.59                  |
| 22.0          | 21.0            | 20.3            | 19.9            | 20.81                  |
| 22.5          | 21.2            | 20.5            | 20.1            | 20.97                  |
| 23.0          | 21.3            | 20.6            | 20.2            | 21.15                  |
| 23.5          | 21.5            | 20.8            | 20.4            | 21.34                  |
| 24.0          | 21.6            | 20.9            | 20.5            | 21.54                  |
| 24.5          | 21.8            | 21.0            | 20.6            | 21.74                  |
| 25.0          | 21.9            | 21.2            | 20.8            | 21.95                  |
| 25.5          | 22.1            | 21.3            | 20.9            | 22.21                  |

*L* = Sum of mandibular incisors

### Table 8: Prediction chart for mandibular arch in females with Moyer’s probability chart

| L* percentile | 75th percentile | 50th percentile | 35th percentile | Present 75th percentile |
|---------------|-----------------|-----------------|-----------------|------------------------|
| 19.5          | 19.6            | 18.7            | 18.2            | 19.17                  |
| 20.0          | 19.8            | 19.0            | 18.5            | 19.38                  |
| 20.5          | 20.1            | 19.2            | 18.8            | 19.61                  |
| 21.0          | 20.3            | 19.5            | 19.0            | 19.82                  |
| 21.5          | 20.6            | 19.8            | 19.3            | 20.15                  |
| 22.0          | 20.8            | 20.0            | 19.6            | 20.28                  |
| 22.5          | 21.1            | 20.3            | 19.8            | 20.41                  |
| 23.0          | 21.3            | 20.5            | 20.1            | 20.68                  |
| 23.5          | 21.6            | 20.8            | 20.3            | 20.91                  |
| 24.0          | 21.9            | 21.1            | 20.6            | 21.06                  |
| 24.5          | 22.1            | 21.3            | 20.9            | 21.31                  |
| 25.0          | 22.4            | 21.6            | 21.1            | 21.46                  |
| 25.5          | 22.7            | 21.8            | 21.4            | 21.71                  |

*L* = Sum of mandibular incisors
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