A NEW EQUATION FOR PREDICTING THE WIDTH OF UNERUPTED PERMANENT CANINES AND PREMOLARS FOR COSMOPOLITAN INDIAN POPULATION

Authors:
Dr. Krishnakumar R. Jaju *( Corresponding Author)*
Post Graduate student
Dept. Orthodontics and Dentofacial Orthopaedics
M.G.V’s K.B.H. Dental College and Hospital
Nashik, Maharashtra - 422003, India.
E-mail : drkjaju@gmail.com
Mobile No. : 09665863863

Dr. Nitin D. Gulve
Professor & Guide
Dept. Orthodontics and Dentofacial Orthopaedics
M.G.V’s K.B.H. Dental College and Hospital
Nashik, Maharashtra - 422003, India.

Dr. Shrikant S. Chitko
Professor & Head of the Department
Dept. Orthodontics and Dentofacial Orthopaedics
M.G.V’s K.B.H. Dental College and Hospital
Nashik, Maharashtra - 422003, India.

Abstract: Predicting the size of unerupted teeth during the mixed dentition period is a critical factor in managing the developing occlusion of a growing child. The most commonly used prediction method of Tanaka and Johnston is based on data from a sample of children of Northern European descent. The accuracy of this method when applied to a different ethnic population is questionable. This study aimed to determine a linear regression equation that would predict the sum of the mesiodistal widths of unerupted mandibular and maxillary permanent canines and premolars based on the sum of the widths of the four mandibular permanent incisors and first permanent molars. Tanaka and Johnston’s equations were modified in order to improve the accuracy of the prediction for the cosmopolitan Indian population. Dental casts of 100 subjects were used to formulate the linear regression equation. A paired Student t test was used to compare the actual and predicted sums of the permanent canines and premolars. The difference found between the actual and predicted values of the canine and premolars was not found to be significant. The method showed good prediction accuracy and was easy to use.

Keywords: Mixed dentition space analysis, Tanaka and Johnston equation.

INTRODUCTION:
Predicting the size of unerupted teeth during the mixed dentition period is a critical factor in managing the developing occlusion of a growing child. The ability to predict the sizes of unerupted canine and premolars in the mixed dentition is of prime importance.¹

Many methods of predicting the mesiodistal width of unerupted canines and premolars in the mixed dentition have been reported. These methods use three distinct ways to achieve their purposes. The first employs direct measurements of the teeth from radiographs with or without the use of a prediction formula as reported by Nance ², Moorrees et al ³, and Staley et al ⁴. The second uses prediction tables based on measurements of other erupted permanent teeth, as reported by Ballard and Wylie ⁵, Carey ⁶, Moyers ⁷, Huckaba ⁸, Tanaka and Johnston ⁹, Ferguson et al ¹⁰. The third method involves...
a combination of the previous two methods, i.e., the use of prediction tables associated with measurements of erupted and unerupted teeth, as recommended by Hixon and Oldfather 11, Staley and Kerber 12, Bishara and Staley 13, Ingerval and Lennartsson 14, Staley et al 15. Paula et al 16.

Tanaka and Johnston 9 Space Analysis is a simple and widely used method to predict the sizes of unerupted canines and premolars in mixed dentition for both jaws and for both the genders. Al-Khadra et al in 1993 showed that the Tanaka and Johnston analysis overestimates the sizes of unerupted canines and premolars in the majority of cases 17. Later, Nourallah et al included maxillary first permanent molar in addition to mandibular incisors. They found correlation between the sum of width of mandibular incisors and maxillary permanent first molar with sum of width of mandibular canine and premolars was higher 1. Camilo et al found the correlation between sum of width of mandibular canine and premolar with sum of width of permanent mandibular incisors and mandibular first molars with maximum correlation coefficient among non- radiographic methods. Also found the regression equation to predict the width of unerupted canines and premolars.

Our aim in this study was to determine the group of teeth which represent the maximum correlation with the width of permanent canines and premolars in the cosmopolitan Indian population and also to formulate the regression correlation equation for the same. A separate equation to be formulated for male and female for both the jaws, as the literature shows significant difference in the width of the teeth in males and females 18.

**Material and Methods:**

Pre-treatment plaster models of 100, 16- to 25-year-old patients (50 men and boys, 50 women and girls) were selected from the records of the Orthodontic Department at M.G.V’s K.B.H Dental College & Hospital, Nashik. All the casts had all relevant teeth (ones used for comparison) fully erupted and presented with no proximal caries or fillings, morphological anomalies, missing teeth, proximal or occlusal abrasion, or attrition. A Digital Vernier Caliper (0.01 mm accuracy) with modified pointed beaks was used to measure the mesiodistal widths of all the teeth (Fig:1). The caliper beaks were inserted from the buccal (labial), and held occlusally parallel. The beaks were then closed until gentle contact with the contact points of the tooth was made. The measurements included the mesiodistal width of all the twelve maxillary and mandibular teeth from the right first permanent molar to the left first permanent molar. The measurements were made as carefully as possible to avoid any damage to the casts. The data was collected, the correlation values were calculated using below mentioned groups with sum of width of maxillary and mandibular permanent canine and premolars -

1. Sum of width of mandibular incisors.
2. Sum of width of mandibular incisors and mandibular first molar.
3. Sum of width of mandibular incisors and maxillary first molar.

Further regression correlation equation was formulated separately for male and female, maxillary and mandibular permanent canine and premolars. The equations were subjected to statistical analysis to check the accuracy. The actual values and predicted values were compared using paired t-test.

**RESULTS:**

The correlation values for three groups with sum of width of permanent mandibular and maxillary canine and premolars determine (Table I) and the results showed the positive correlation with all the three groups.

1. Sum of width of mandibular canine and premolars showed higher correlation with sum of mandibular incisors and mandibular molar.
2. Sum of width of maxillary canine and premolars showed higher correlation with sum of mandibular incisors and maxillary molar.

Correlation coefficient for male and female (Table II) was calculated separately between sum of width of mandibular incisors and mandibular first molar with sum of width of permanent mandibular canine and premolars and between sum of width of mandibular incisors and maxillary first molar with sum of width of permanent maxillary canine and premolars.

The regression correlation equation was derived to predict sum of width of permanent mandibular and maxillary canine and premolars for both the jaws for Male and Female.

The regression equation is:

\[ Y = a + bx \]

In which \( Y \) (dependent variable, \( Y_1 \) – sum of width of maxillary canine and premolars, \( Y_2 \) - sum of width of mandibular canine and premolars) equals the predicted
sum of the mesiodistal widths in the millimeter of the mandibular/maxillary permanent canines and premolar on both sides, X (independent variable) equals the sum of the mesiodistal width of the 4 mandibular permanent incisors plus the mesiodistal width of the 4 mandibular permanent incisors plus the mesiodistal width of permanent maxillary/mandibular first molars (X1 - sum of width of mandibular incisors and maxillary/mandibular first molars, X2 - sum of mandibular incisors and mandibular first molars). The constant a is the y intercept, and the constant b is the slope of the regression.

The values of constant a and b are as follows.

Estimated equations for males:
1. Upper canine and premolar: Y = 11.65 + 0.725X
2. Lower canine and premolar: Y = 12.22 + 0.663X

Estimated equations for the females:
1. Upper canine and premolar: Y = 19.44 + 0.553X
2. Lower canine and premolar: Y = 16.13 + 0.678X

Using the formulae sum of width permanent canine and premolar for mandibular and maxillary arch. The calculated or predicted values were compared with actual measured values. The difference was not found to be statistically significant (Table III).

**DISCUSSION:**

For the Indian population it was found that when the maxillary and mandibular 1st molars were included along with the sum of incisors there was more correlation seen with the respective sum of width of permanent maxillary and mandibular canine and premolars (maxilla r = 0.6751; mandible r = 0.6651). These values were greater than the Tanaka and Johnston values obtained by Sable et al for Indian population (maxilla r = 0.619; mandible r = 0.663)\(^9\) and also by the original Tanaka and Johnston study (maxilla r = 0.63; mandible r = 0.65)\(^9\).

The difference between male and female tooth widths is been shown in several studies\(^18\). So, the correlation coefficient of sum of width of mandibular incisors and mandibular first molar with sum of width of permanent mandibular canine and premolars; and sum of width of mandibular incisors and maxillary first molar with sum of width of permanent maxillary canine and premolars were calculated for each sex separately. More closer correlation was obtained for each sex (male- maxilla r = 0.716, mandible r = 0.656; female maxilla r = 0.641, mandible r = 0.6821). The literature shows difference between the right and left side were small and not statistically significant. So, both the sides were considered together for individual arch.

The ideal prediction method should determine no difference between predicted and actual widths of permanent canine and premolar and the standard deviation of the difference should be as small as possible. The formulated equation though overestimates the width of canine and premolar but the value predicted is very close to the actual values. The difference in means of the actual and predicted values showed no statistically significant difference and also the standard error was small (Table III).

Thus, the above method provides a good non radiographic prediction method. It is simple, practical, and specific for the population from which it is developed.

However no method is 100% precise. Similarly this method can overestimate or underestimate. Overestimating seems to be better to prevent lack of space, but this approach could suggest tooth extraction for some patients. Overestimation of only 1mm beyond the actual width of the permanent canine and premolar on each side of the arch would not affect the extraction or non-extraction decision\(^7,20\).

**CONCLUSION:**

1. The correlation coefficient obtained for-
   a. Sum of width of Mandibular incisors and mandibular first molar with sum of width of permanent mandibular canine and premolars.
   b. Sum of width of Mandibular incisors and maxillary first molar with sum of width of permanent maxillary canine and premolars.
   
   is higher than using only mandibular incisors to predict the mesiodistal width of canines and premolars.

2. The simplified regression equation predicts the sum of width of the permanent canine and premolar very close to the actual measurements. Thus, providing an easy and simple way for prediction of width of canine and premolars.

3. Further research for individual ethnic population groups for better predictability needs to be done with increased sample size to increase the accuracy of the equation.
REFERENCES:


Fig. 1: Digital Vernier Caliper with modified pointed beaks, used to measure the mesiodistal widths of all the teeth

Table I: Correlation coefficient values for the three groups of teeth with sum of width of maxillary and mandibular canine and premolar

<table>
<thead>
<tr>
<th>Sum of width of Mandibular incisors</th>
<th>Sum of width permanent Mandibular canine and premolars</th>
<th>Sum of width of permanent Maxillary canine and premolars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of width of Mandibular incisors</td>
<td>0.6247</td>
<td>0.5927</td>
</tr>
<tr>
<td>Sum width of Mandibular incisors and mandibular first molar</td>
<td>0.6551</td>
<td>0.6514</td>
</tr>
<tr>
<td>Sum of width of Mandibular incisors and maxillary first molar</td>
<td>0.648</td>
<td>0.6751</td>
</tr>
</tbody>
</table>
Table II: Correlation coefficient for male and female

<table>
<thead>
<tr>
<th>Sum of width of Mandibular incisors and mandibular first molar with sum of width of permanent mandibular canine and premolars</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.656</td>
<td>0.6821</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sum width of Mandibular incisors and maxillary first molar with sum of width of permanent maxillary canine and premolars</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.716</td>
<td>0.6417</td>
</tr>
</tbody>
</table>

Table II: Showing mean values of actual and predicted canines and premolars and their significance values.

<table>
<thead>
<tr>
<th>Actual value of canine + premolar (Mean)</th>
<th>Predicted value of canine + premolar (Mean)</th>
<th>Difference (actual predicted)</th>
<th>Standard error</th>
<th>Significance (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Male 50 Upper</td>
<td>42.5432 mm ± 2.12</td>
<td>42.8343 mm ± 1.52</td>
<td>-0.29 mm</td>
<td>1.46</td>
</tr>
<tr>
<td>Lower</td>
<td>41.665 mm ± 2.171</td>
<td>41.692 mm ± 1.417</td>
<td>-0.02 mm</td>
<td>1.62</td>
</tr>
<tr>
<td>Female 50 Upper</td>
<td>42.5478 mm ± 2.002</td>
<td>43.1375 mm ± 1.281</td>
<td>-0.58 mm</td>
<td>1.52</td>
</tr>
<tr>
<td>Lower</td>
<td>41.5974 mm ± 2.24</td>
<td>42.1567 mm ± 1.525</td>
<td>-0.55 mm</td>
<td>1.62</td>
</tr>
</tbody>
</table>