Evaluation of Maxillary Interpremolar, Molar Width by DRNA Indices and Arch Dimension, Arch Form in Maratha Population

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ABSTRACT

Background and objectives: The present study is conducted to ascertain whether or not Pont’s Index can be used reliably on Maratha individuals and if not, to establish the norms for the same. A mathematical model is also presented to individualize the nature of arch form. Materials and methods: Full mouth dental cast of 60 patients between ages 18 and 25 years were obtained belonging to Maharashtra and traced back to two generations. The different formulae were used to determine the premolar and molar indices of the maxillary arch width by using the sum of incisal widths of maxilla or mandible. Mathematical model was determined using fourth order polynomial. Results: Mean and standard deviation of premolar arch width and molar arch width for male is 37.59 ± 1.76 and 48.15 ± 2.16 and for females, it is 35.61 ± 1.66 and 46.12 ± 2.06 respectively. The premolar and molar indices derived from sum of maxillary incisors (SImax) are 80.29 ± 5.39 and 62.66 ± 4.0 for males and 82.33 ± 4.02 and 63.6 ± 3.62 for females respectively. The polynomial indicated that the arches were symmetrical. The arch dimensions showed variations in males and females. Conclusion: Significant correlation was found between the sum of maxillary incisors and interpremolar width but not with the intermolar width while sum of mandibular incisors showed significant correlation with the interpremolar and intermolar arch width. There is no single arch form unique to any of the ethnic groups. A new formula is proposed to determine the premolar and molar index. Keywords: Indices, Maratha, DRNA indices, Arch form.


INTRODUCTION

Pont1 had proposed an index in 1909 to estimate maxillary arch width depending upon the sum of mesiodistal dimensions of maxillary incisors in French population. Pont’s index can give an approximate indication of the degree of narrowness of the dental arches in a case of malocclusion, and also the amount of lateral expansion required in order that the arch be of sufficient size to accommodate the teeth in perfect alignment.2 Nevertheless, inferences that were derived on an ill-defined size to accommodate the teeth in perfect alignment.2 Nevertheless, inferences that were derived on an ill-defined French population may not hold true for other ethnicities. Investigators that are in corroboration with this view barring Pont’s himself, are Joondeph et al3, 1970; Worms et al4, Dalidjan et al5, Nimkarn et al6.

There is a lot of clinical variation in maxillary incisors width (Tancan Uysal et al7, Hayder Abdullah et al8 and Dalidjan et al9). In this study, we have derived the ratio by taking the sum of mandibular incisors to determine the arch width in premolar and molar region. The present study is conducted to ascertain whether or not Pont’s Index can be used reliably on Maratha individuals and if not, to establish the norms for the same. A new method for estimation of maxillary interpremolar and molar width—DRNA (Dungarwal, Rahalkar, Niketan and Amit) indices was established.

The achievement of a stable, functional and esthetic arch form has long been one of the prime objectives of orthodontics. It is commonly believed that the dental arch form is initially shaped by the configuration of the supporting bone and following eruption of teeth by the circumoral musculature and intraoral muscular forces.1 A number of investigators9,10 have noticed that variation in arch forms in different ethnic groups and have observed that normal measurements of one ethnic group should not be considered normal for other ethnic groups. A Maratha individual belongs to a group of people inhabiting the state of Maharashtra in west-central India,11 The Maratha caste consists of mainly rural cultivators, landowners and soldiers segregated during the medieval times and accounts for more than 50% of total Maharashtrian population,12 thereby providing a reliable...
sample to estimate the arch form and dimensions of this community. So this present study is carried out on Maratha population to collect the relevant data because till now no data had been traced out.

**AIMS AND OBJECTIVES**

- To find out the numerical correlation with the sum of maxillary incisors and maxillary dental arch width in the premolar and molar region (interpremolar and intermolar width) in Maratha population.
- To find out the numerical correlation with the sum of mandibular incisors and maxillary dental arch width in the premolar and molar region (interpremolar and intermolar width) in Maratha population.
- To evaluate the dental arch form in a sample of Maratha population.
- To investigate sexual difference between male and female dental arch forms.
- To determine the mathematical model for Maratha population.
- To measure the dimension of dental arches in a sample of Maratha population.

**MATERIALS AND METHODS**

**Source of Data**

Full mouth dental cast of 60 patients (30 males and 30 females) between ages 18 and 25 years were obtained from Pune. The subjects were selected by panel of three judges, including the researcher. An informed consent was taken from each patient for the same. The dental casts were obtained for 60 subjects belonging to Maratha caste inhabiting Maharashtra and traced back to two generations.

**Method of Collection of Data**

**Inclusion Criteria**

1. Subjects should be Maratha individuals.
2. Patients having full complement of natural teeth (with possible exception of third molar).
3. Patients having Class I occlusion.
4. No patients had been treated orthodontically.
5. No gross abnormality or severe crowding.
6. Absence of extensive restorations, cast restorations or restorations with cuspal coverage.
7. Absence of pathological periodontal conditions.

**Determination of Premolar and Molar Index**

Mesiodistal widths of upper and lower incisors were taken by a digital Vernier caliper (Fig. 1).

1. Interpremolar arch width (Wpm): Distance between the first premolar of the left side to the right side at the distal end of its occlusal groove.

**Premolar Index (Ipm)**

\[
I_{pm} = \frac{\text{Sum of maxillary incisal widths}}{\text{Interpemolar arch width (Wpm)}} \times 100
\]

**Molar Index (I_{max})**

\[
I_{max} = \frac{\text{Sum of mandibular incisal widths}}{\text{Intermolar arch width (W_{1})}} \times 100
\]

For arch form, 18 buccal cusps tips and midincisal edge points were marked on each maxillary and mandibular cast (Fig. 2). Each cast was photocopied at 1X (1:1 print) by placing the occlusal surface down on a photocopier machine (Fig. 3) (Canon IR5000-6000). A millimetric scale was included in the each print to guard against magnification. A cardboard mask cover was used to cover the active surface of the photocopier. The photocopies (Fig. 4) were scanned using Scanner (Fig. 5).
(HP Deskjet F4488) and a digital image of occlusal surface of each cast was prepared. All the digital images were transferred to AutoCAD environment (AutoCAD 2010 Autodesk Inc.) and the co-ordinates of midincisal edges and buccal cusp tips of all teeth were determined. The original XY co-ordinates on the digitizer was corrected for constant magnification and adjusted to establish a new XY co-ordinates in such a way that the mean inclination of the straight line connecting the right and left second molar cusp tips became parallel to original X-axis thus, obtaining a common reference system for all dental arches independent of the orientation used for arch digitization (Fig. 6). Tracing and digitization of cusps were performed by a single operator.

**Arch Interpolation**

All the co-ordinates of each arch were saved in Microsoft Excel. Then these X and Y co-ordinates of the midincisal edges and cusp tips in each arch were transferred to Table Curve 2D software (version- 5.01 SYSTAT Software Inc). Using this software, maxillary and mandibular arches were interpolated using fourth order polynomial formula:

\[ Y = AX + BX^2 + CX^3 + DX^4 \]

Of note, each of the four weighting coefficient in the equation is interpretable in terms of an arch’s form, namely its left-right asymmetry (terms A and C) and its taperedness (B) and squareness (D).

**Arch Dimension**

Arch widths and depths were computer generated as straight-line distance between the dental landmarks (Fig. 7). The depths and widths were defined as follows:

- Intercanine width (Wc): Distance between the canine cusp tips.
- Inter second molar arch width (Wm2): Distance between the distobuccal cusp tips of second molar.
- Canine depth (Dc): Distance between the contact of central incisors and a line that connects cusp tips.
- Second molar depth (Dm2): Distance between the contact of the central incisors and the line that connects the distobuccal cusp tips of the second molar.
Determination of Shape of Arch

The relative ratios of canine and molar cross-arch widths along with their relatives arch depths were used to determine the shape of the arch by using the formula:

\[ \frac{W_c}{W_{m2}} \times \left( \frac{D_c}{D_{m2}} \right)^{-1} \]

When this ratio of a dental arch is within the range of mean ±1SD, we assume the arch form is ovoid, more than mean +1SD, we consider the arch form as square, less than mean -1SD, we consider the arch form as tapered.

RESULTS

Premolar and Molar Indices

The mean values for all groups are illustrated in the form of bar diagram in Figure 8.

The comparison of the means of interpremolar arch width, intermolar arch width and sum of maxillary incisors shows that males have significantly larger values than females (Table 1). Female lower incisors showed the significant correlation with the interpremolar arch width \( r = 0.405 \) and intermolar arch width \( r = 0.387 \) region (Table 2).

<table>
<thead>
<tr>
<th>Sex</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Unpaired T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>37.59</td>
<td>1.759</td>
<td>4.46</td>
<td>&lt; 0.001 HS</td>
</tr>
<tr>
<td>Female</td>
<td>35.61</td>
<td>1.661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48.1503</td>
<td>2.16018</td>
<td>3.73</td>
<td>&lt; 0.001 HS</td>
</tr>
<tr>
<td>Female</td>
<td>46.1197</td>
<td>2.05880</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30.1233</td>
<td>1.66512</td>
<td>2.097</td>
<td>0.04 S</td>
</tr>
<tr>
<td>Female</td>
<td>29.2903</td>
<td>1.40114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21.7117</td>
<td>1.05548</td>
<td>1.154</td>
<td>0.253 NS</td>
</tr>
<tr>
<td>Female</td>
<td>21.3470</td>
<td>1.37249</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HS: Highly significant; S: Significant; NS: Not significant

Table 2: Pearson correlation of sum of incisors with interpremolar and intermolar arch widths

<table>
<thead>
<tr>
<th></th>
<th>Interpretmolar arch width</th>
<th>Intermolar arch width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male upper incisors</td>
<td>0.107</td>
<td>0.183</td>
</tr>
<tr>
<td>Male lower incisors</td>
<td>0.145</td>
<td>0.199</td>
</tr>
<tr>
<td>Female upper incisors</td>
<td>0.473*</td>
<td>0.29</td>
</tr>
<tr>
<td>Female lower incisors</td>
<td>0.405*</td>
<td>0.387*</td>
</tr>
</tbody>
</table>

* Clinically significant

The premolar and molar indices were determined to establish the norms in Maratha population. The morphometric norm for Maratha population is depicted in Tables 3 and 4.

The premolar and molar indices derived from sum of maxillary incisors \( S_{\text{Imax}} \) are 80.29 ± 5.39 and 62.66 ± 4.0 for males and 82.33 ± 4.02 and 63.6 ± 3.62 for females respectively. However, these indices are not showing significant difference between males and female.

The significant difference \( p < 0.05 \) is observed in males and females for premolar indices but no significant difference is found for molar indices. Mean maxillary and mandibular intercanine widths, inter second molar arch widths, canine depths and second molar depths are reported in Tables 5 and 6 respectively along with the male and female comparison of arch dimensions.
DIMENSIONS OF THE MAXILLARY AND MANDIBULAR DENTAL-ARCH FORMS

The maxillary and mandibular arches were divided into tapered, ovoid and square arch forms on the basis of relative ratios of the canine and the second molar cross arch width along with their relative arch depths on the basis of the following formula.

\[ \frac{Wc}{Wm_2} \times \left( \frac{Dc}{Dm_2} \right)^{-1} \]

Tables 7 and 8 show the distribution of arch forms in males and females respectively. Based on the obtained data, separate maxillary and mandibular arch forms (tapered, ovoid and square) were constructed for male and female Maratha population and the same is depicted in the Figure 9.

In the maxillary arch, 60% of arches were ovoid form (2.74-3.23), 20% of arches were tapered (<2.74) and 20% of arches were of square form (>3.23), while in the mandibular arch 73.33% of arches were ovoid form (2.93-4.48), 10% of arches were tapered form (<2.93) and 16.67% of arches were of square form (>4.48).

In maxillary arch 76.67% of arches were of ovoid form (2.74-3.50), 6.67% of arches were of tapered form (<2.74) and the 16.67% of the arches were square form (>3.50), while in the mandibular arch 70% of the arches were ovoid form (3.25-4.40), 10% of the arches were of tapered form (<3.25) and the 20% of the arches were square form (>4.40).

DISCUSSION

The results of the present study indicate that the arch width’s (both interpremolar and intermolar) are greater in males than in females. This is in agreement with the result obtained for a British sample,13 and for Saudi population,14 but in disagreement with the findings for Egyptian population.15 In this study statistical analysis showed that the maxillary incisor widths are significantly larger for males than females. These findings are in agreement with the finding of Hattab et al who found that Jordanian males have significantly larger incisors than females and with the findings of Agnihotri et al who found that North Indian males have significantly larger incisors than females. But disagrees with the results of Al-Omari IK et al,17 who found no significant differences in maxillary incisor widths between Jordanian males and females. Dalidjan et al18 and Sarraf HA et al19 concluded that Pont’s index generally underestimated the arch widths.
In this study, the sum of the maxillary ($S_{I_{\text{max}}}$) showed the poor correlation between the interpremolar and intermolar arch width in males (Table 2). These findings are in agreement with those of Lew K for Chinese population, Dalidjan et al for Indonesian, Australian aborigines and White subjects. On the contrary, in female samples, the sum of the maxillary incisors ($S_{I_{\text{max}}}$) showed the significant correlation between the interpremolar width but poor correlation with the intermolar width. The sum of mandibular incisors ($S_{I_{\text{mand}}}$) in male showed the poor correlation with the interpremolar and intermolar width while in female samples, the sum of mandibular incisors ($S_{I_{\text{mand}}}$) showed the significant correlation with the interpremolar and intermolar width. In this study Premolar index was found to be 80.29 for males and 82.33 for females. The Molar index was found to be 62.65 for males and 63.6 for females. These indices were derived from the sum of maxillary incisors. Pont’s values were 80 and 64 for premolar and molar indices. These premolar and molar index showed no significant difference between the genders, so the mean is calculated for the premolar and molar indices and the following formula is proposed for the Maratha population to determine the arch width in the premolar and molar region.

For male:

\[
\text{Interpemoral arch width} = \frac{\text{Sum of mandibular incisors (} S_{I_{\text{mand}}} \text{)} \times 100}{ \text{63.13} }\]  

For female:

\[
\text{Interpemoral arch width} = \frac{\text{Sum of mandibular incisors (} S_{I_{\text{mand}}} \text{)} \times 100}{ \text{60} }\]

The molar index showed no significant difference between the males and females so the mean is taken and formula is given for Maratha population to determine the arch width in the molar region.

\[
\text{Intermolarch width} = \frac{\text{Sum of mandibular incisors (} S_{I_{\text{mand}}} \text{)} \times 100}{ \text{45.75} }\]

Table 8: Female arch form distribution

<table>
<thead>
<tr>
<th>Arch form</th>
<th>Ratio</th>
<th>No. of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean + SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tapered</td>
<td>&lt;2.74</td>
<td>2</td>
<td>6.67</td>
</tr>
<tr>
<td>Ovoid</td>
<td>2.74-3.50</td>
<td>23</td>
<td>76.67</td>
</tr>
<tr>
<td>Square</td>
<td>&gt;3.50</td>
<td>5</td>
<td>16.67</td>
</tr>
<tr>
<td>Mandibular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean + SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tapered</td>
<td>&lt;3.25</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>Ovoid</td>
<td>3.25-4.40</td>
<td>21</td>
<td>70.00</td>
</tr>
<tr>
<td>Square</td>
<td>&gt;4.40</td>
<td>6</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Fig. 9: Templates for tapered, ovoid and square arch forms of the male Maratha population

Uysal et al found that mesiodistal dimension of the maxillary teeth showed greater variability than mandibular teeth. The size of the maxillary lateral incisor also was highly variable. Dalidjan also found that tooth size variation was poorly correlated with arch width variation, with persons often being over or under Pont’s estimation due.

In most studies it was shown that the arch dimensions depend on the sex of the subjects, with smaller values in females. In our study, the mean arch dimensions showed significant differences in maxillary and mandibular arch, with males showing larger intercanine width and inter second molar arch width than females. Engel classified human arches into
nine shapes and Raberin et al.\textsuperscript{22} into five shapes on the basis of ratios transverse and sagittal measurements of the dental arches in an attempt to cope with the great variability in arch form encountered in clinical practice. The square, ovoid and tapered arch forms have not yet been mathematically defined. According to Noroozi et al.\textsuperscript{23} they may be defined on the basis of relative ratios of the canine and the second molar cross-arch widths along with their relative arch depths.

**CONCLUSION**

This study suggests:

- Weak correlation between sum of maxillary and mandibular incisors to the interpremolar and intermolar arch width in male’s respectively. In female, significant correlation was found between the sum of maxillary incisors and interpremolar width but not with the intermolar width while sum of mandibular incisors showed significant correlation with the interpremolar and intermolar arch width.

- The arch dimensions showed that the males had significantly larger intercanine width and intermolar width in maxillary and mandibular arches as compared to that of females while canine depth and molar depth were significantly high in males than females in maxillary arch but difference was not significant in mandibular arch.

- It is clear that there is no single arch form unique to any of the ethnic groups and that it is the frequency of a particular arch form that varies between groups.

- The premolar index showed the significant difference (p < 0.05) between the genders, so the separate formula for male and female is proposed to determine the arch width in the premolar region. The molar index showed no significant difference between the males and females so the mean is taken and formula is given for Maratha population to determine the arch width in the molar region.

**REFERENCES**