Dental age estimation by using cameriere's method in mangalorean children: a pilot study

INTRODUCTION:
The age of an individual as such has a significant role in clinical, medico-legal, forensic and anthropological applications. In instances where the chronological age is unknown, un documented or missing, several other growth parameters based on skeletal indicators such as hand-wrist bone ossification, fusion of cranial sutures, maturation of dentition, changes in pubic symphysis and somatic indicators can be utilized for probable age estimation. However, most of these indicators show considerable variation, which is influenced by environmental and genetic factors. Unlike these, the dental maturation serves to be the reliable and most accurate means, especially because of its unique nature of incrementation formation and periodic mineralization which can be well defined. This pattern of growth and progressive calcification of the developing tooth is independent of the local and environmental influences, as well as from the somatic growth. Hence teeth are counted as the least variable bio-indicator for assessment of age. This is further reassured by the sustainability of dental hard tissues against various environmental insults.

For dental age estimation various methods were proposed by Demirjian, Nolla, Willems and Haavikko for growing individuals. In the above methods, radiographs were used as an evidence to analyse the progressive sequence of teeth development and each stage of development was coded and given a score. These scores were hence manipulated to derive the dental age of an individual, relative with the chronological age, with acceptable error limits. However, all these methods dated back a few decades and the change in the growth trend of the current generation posed a need for formulating a newer method of dental age assessment.

In 2006, Cameriere et al. published a new concept of estimating chronological age in children by measuring the open apices in seven mandibular teeth on radiographs, which gave reliable estimates of age in 455 Italian Caucasian children. However the reliability of Cameriere’s method was evaluated on several sample groups from different nationalities, which revealed that the original regression model formulated by Cameriere is not always suitable for other countries as tooth development differed among populations and exhibited variation among different ethnic groups and regional locations. Although such studies helped in validating Cameriere’s regression model, they also insisted on the need for developing a discrete regression model for the study samples of each country. Thus, in this study we attempted to formulate a regression model for the growing children of South Indian mangalorean population.

Materials and Methods
The study was conducted in the Department of Oral medicine and Radiology at Yenepoya Dental College, Mangalore, Karnataka. Panoramic radiographs of 40 South Indian children aged between...
7-16 years from the archives of the department were analysed. Radiographs that were unclear, with any gross pathology, tooth fractures, hypodontia of permanent teeth or having history of orthodontic treatment were excluded. 40 radiographs with satisfiable criteria were included in the study. Table 1 shows the distribution of panoramic radiographs by gender and age. All the radiographs were digitalized using Agfa CR X digitizer and the images were recorded on computer files and processed by a computer aided drafting program (Agfa nx software).

**Age group * Sex Cross tabulation**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Sex</th>
<th>Count</th>
<th>F</th>
<th>M</th>
<th>Total</th>
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<tbody>
<tr>
<td>7-10</td>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>% within Age grp</td>
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<td>66.7%</td>
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<td></td>
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<td>11</td>
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<td>% within Age grp</td>
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<td>57.9%</td>
<td>100.0%</td>
<td></td>
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<tr>
<td>13-16</td>
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<tr>
<td>% within Age grp</td>
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<td>53.3%</td>
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<td>Total</td>
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<td>% within Age grp</td>
<td>42.5%</td>
<td>57.5%</td>
<td>100.0%</td>
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</tr>
</tbody>
</table>

Table 1 - Distribution of panoramic radiographs in the study samples

All the 40 radiographs were evaluated in accordance with Cameriere’s et al., for dental age estimation. For each individual the chronologic age was calculated by subtracting the birth date from the date on which the radiographs were taken for that particular individual and both were converted to a decimal age by the method of Eveleth and Tanner. Decimal age was taken for simplicity of statistical calculation and age was estimated on a yearly basis, for example, 12 years 9 months as 12.75 years and was considered in the 12 years’ age group.

In brief, the radiographs of 7 left permanent mandibular teeth were assessed. Teeth which were formed completely, with closed apical ends, were designated as N0. The teeth with incomplete root formation and hence with open apex were evaluated in the following order. For teeth with single root, Ai; where i = tooth 1…7, the distance between the inner side of the open apex was measured. For teeth with two roots, A1, A2; where i = tooth 6, 7 and m = mesial root, d = distal root, the sum of the distances between the inner sides of the two open apices were measured as depicted in Figure 1 and both were added. In order to manipulate the accountable differences in magnification and angulations during radiographic imaging, measurements were normalized by dividing by the tooth length (li, where i = tooth 1,…,7). Finally, dental maturity was evaluated using normalized measurements of all the seven permanent left mandibular teeth (xi = Ai/li, i = tooth 1,…,7), the sum of normalized open apices (s) and the number (N) of teeth with complete root development. Tooth length is measured from the point of highest cusp to the root apex and is denoted as (li) (Fig. 1). Dental maturity was thus evaluated using the normalized measurements of the seven right or left mandibular teeth with complete root development (N0). Furthermore, correlation coefficients were evaluated between age and predictive variables. To obtain an estimate of age as a function of the morphological variables and subjects’ gender, a multiple linear regression model was developed with first order interactions by selecting those variables that contributed significantly to age estimations using the stepwise selection method. Statistical analysis was performed with Statistical Package for Social Sciences (SPSS) version 22.0% statistical program. The significance threshold was set at 5%.

**Results**

There were no statistically significant interobserver and intraobserver differences between the paired sets of measurements carried out on the re-examined panoramic radiographs. Pearson’s correlation coefficients between age and morphological variables showed that all of them were significantly correlated with age. When all the variables were entered in the EXCEL file for statistical analysis, it was found that out of the variables x1, x2, x3, x4, x5, x6, x7, S, N, the variables x3, x4 and x7 contributed significantly to the fit (Table 2). Among these three variables, variable x4 was statistically noteworthy and hence it was used to derive the linear regression formula:

**Age** = 13.868-6.400(x4) - 2.054

**Descriptive Statistics**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
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<td>2.12374</td>
</tr>
<tr>
<td>X3</td>
<td>.1160</td>
<td>.13266</td>
</tr>
<tr>
<td>X4</td>
<td>.1103</td>
<td>.15537</td>
</tr>
<tr>
<td>X5</td>
<td>.1735</td>
<td>.29448</td>
</tr>
<tr>
<td>x7</td>
<td>.2980</td>
<td>.40734</td>
</tr>
</tbody>
</table>

Table 2

The derived variable (x4), calculated from the panoramic radiographs of different children, was applied on the regression equation and the adjusted age/predicted age was calculated. When the adjusted age was compared to the chronological age it was found that the regression equation with selected variables explained 66.1% of total variance (R2 ¼ 0.661). The standard error of estimate is 1.252 (Table 3).

**Model Summary**

The graph (Fig. 2) is an observed versus predicted plot. The values of the observed age are plotted against the predicted values from the regression model. The plot shows that the values are equally distributed; hence, the regression model fits the trend of the data reasonably well.
Our study showed no statistical differences in dental age estimation between male and female samples, which showed that gender did not show significant influence on age estimation and was therefore excluded as a factor in the model equations.

A study was done by Cameriere L et al on Italian population of children aged between 5-15 years. Study based on seven mandibular left healthy permanent teeth for assessing dental age by measurement of open apices in teeth. Statistical analysis showed a significant correlation with chronological age, morphological variables explain 83.6% (R²=0.836). In our study, statistical analysis indicated that gender does not have a significant influence on age estimation. (R²=0.66)

Another study was carried out by Rai B et al on a large sample of Indian children aged between 4-16 years. Results showed correlation coefficient between dental age and chronological ages were highly significant. The present study showed the accuracy of Cameriere method and it’s not influenced by any factors.

A study was conducted by Cameriere, L et al to determine the accuracy of the Cameriere method for assessing chronological age in children based on the relationship between age and measurement of open apices in teeth and to compare with widely used Demirjian and Willems method. Willems method was better than that of Demirjian but was significantly less accurate than that of Cameriere (p < 0.001). However in present sample Cameriere method showed highly significant (p=0.000).

In a study conducted in Haryana sub-population by the same author Kaur J et al Panoramic radiographs of healthy children aged between 5-15 years were selected and Cameriere’s regression equation was applied. Author’s observed underestimation of age in boys and overestimation in girls as compared to their chronological age. But in present study showed, gender does not have a significant influence on age estimation.

In the present study only the variable ‘second premolar’ contributed significantly to the fit and were therefore included in the regression equation. This is in contrast to a study conducted in a sample of South Indian population by Deepa et al where ‘canine’ and ‘second molar’ contributed significantly to the fit.

A similar study was performed in a sample of North Indian and South Indian (Kerala) children by Balwant Rai et al. The results showed that the variables ‘gender’ and ‘second premolar’ contributed significantly to the fit which is similar to our study.

The limitations of the study are that the derived regression equation is same for both the male and female gender and does not differentiate between a fast- or slow-maturing children.

CONCLUSION:
The present research has confirmed that there is significant correlation between age and measurement of open apices. This method can be used for assessing age in forensic as well as legal contexts and based on these variables chronological age can be determined in the South Indian population. Since our study has a small sample size we were not able to give the exact value of variation between each age group that the chronological and dental method assessed. The present Regression equation is derived for age estimation from Indian children. This equation can be applied in various condition of Indian judiciary till Indian Population specific studies are developed.

REFERENCES:
3. Demirjian A, Buschpag PH, Tanguy R, Patterson DK. Interrelationship among...