Age estimation by Drusini’s method and Jeon’s method in Indian population – A comparative assessment

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Abstract

Context: There has been extensive focus on forensic odontology with an increase in the research for age estimation procedures. Teeth are biological markers for human age estimation. In adults, age estimation with a tooth has to be done by the analysis of cementum annulations, root transparency and determination of aspartic acid racemization. Various age estimation methods are known in literature; however, the reliability and relevance of these methods for the Indian population have seldom been studied.

Aim: To assess and compare age estimation by Drusini’s method and Jeon’s method and correlate chronological age and age estimation by both the methods in Indian Adults.

Objective: Comparative assessment of Drusini’s method and Jeon’s method for age estimation within Indian adults.

Subjects and Methods: Two hundred intraoral periapical radiovisuographs of the patients aged 20–69 years with optimum diagnostic quality radiographic images of permanent mandibular first molars were selected from the digital archive of the Department of Oral Medicine Diagnosis and Radiology from the dental college. Measurements were done using Drusini’s and Jeon’s methods and compared with the chronological age. A P < 0.05 was considered statistically significant.

Statistical Analysis Used: Analysis of variance followed by Tukey’s Post hoc test, t-test.

Results: Mean chronological age, estimated using Jeon’s method and estimated by Drusini’s method, was 30.77 ± 9.32, 29.790 ± 7.729 and 27.885 ± 8.190, respectively. This difference was statistically highly significant, whereas Jeon’s method showed a strong positive correlation between chronological age and age.

Conclusions: The study concludes that Jeon’s method is more accurate than Drusini’s in the Indian population.

Keywords: Age estimation, chronological age, Drusini’s method, Indian adults, intraoral periapical radiouisographs, Jeon’s method
INTRODUCTION

With the advent of digital radiography, forensic odontology has shown increasing interest in the search for optimal age estimation procedures. Assessment of chronological age is an essential part of forensic sciences. Teeth form a unique and suitable parameter for estimating dental age since their development is least affected by endocrinal disturbances or nutritional deficiencies. Once formed, they are the most stable for the entire life, with high resistance to many factors, including injuries. Thus, teeth can be used in forensic identification and as biological markers for human age estimation.[1,2]

Age determination is helpful in the identification of unknown individuals, including children of unknown birth records, in scenes of crime and accidents.[3,4] Due to the developmental variations, chronological age and biological age may not correlate in all cases. Hence, various parameters, including dental age, bone age, mental age and other factors such as menarche, voice change, height and weight, are considered indicators for biological age.[3,4]

In adults, age estimation with a tooth has to be done by the analysis of cementum annulations, root transparency and determination of aspartic acid racemization. In living individuals, invasive techniques like extractions are not possible. With advancing age, there is secondary dentin deposition leading to a reduction in the size of the pulp cavity. The age estimation methods that can overcome this problem and yield satisfactory results are lesser-known.[7‑10]

A noninvasive, reproducible and straightforward method of age estimation is more suitable in living individuals. Radiographic evaluation of teeth is thus broadly used for this purpose.[11,12] Secondary dentin deposition occurs on the pulpal surface of the primary dentin throughout life after root formation is completed.[11,13] A significant correlation has been observed between the height of the coronal pulp cavity and chronological age.[7] Thus, pulp to tooth ratio can be considered as a reliable parameter in age estimation.

Various methods of age estimation are known in the literature. The technique developed by Ikeda et al.[8] was applied by Drusini et al.[8] Jeon et al. derived an equation based on pulp chamber floor height ratio (F/L), pulp chamber ceiling height ratio, roof height ratio (R/L) and pulp chamber depth ratio (D/L).[11] Anterior teeth used for recent age estimation methods are absent in the elderly Indian population.[14]

Inclusion criterion

Radiovisuographs of individuals aged between 20 and 69 clearly showing the sound permanent mandibular first molar. Whereas grossly destructed tooth; tooth with caries, periapical lesions, developmental anomalies; malaligned, rotated, overlapped teeth; tooth with endodontic filling and treatment, prosthesis was excluded from the study. Thus, two hundred IOPRs of the patients aged 20–69 years with optimum diagnostic quality radiographic images of permanent mandibular first molars were selected from the digital archive of the Department of Oral Medicine Diagnosis and Radiology from the dental college using a simple random sampling technique. The software used in this study is Kodak Dental Imaging Software.

For Drusini’s method,[7] we considered mandibular first molars. Two observers independently recorded the measurements (in mm) of the length of the crown length and length of the coronal pulp cavity on the radiovisuographs, using a digital calliper to the nearest 0.01 mm. Using the mean of the two measurements, the tooth-coralon index (TCI) for each tooth was then calculated. The side where the pulp chamber was more visible was chosen.
In Jeon’s method,[11] four distances were measured using specific reference points and recorded in mm on the radiographs. The reference points were namely:
1. The roof of the pulp chamber
2. The floor of the pulp chamber
3. The highest point on the root furcation
4. The start point of the lingual groove.

The distance between the floor of the pulp chamber and the highest point on the root furcation was recorded as “F.” The distance between the roof of the pulp chamber and the highest point on the root furcation was recorded as “R.” The distance from the start point of lingual groove to the highest point on the root furcation was recorded as “L” and the depth of the pulp chamber was recorded as “D (R minus F)” [Figure 1]. The following ratios were calculated: pulp chamber (F/L), pulp chamber (R/L) and pulp chamber (D/L). A set of hundred individuals were randomly selected, and a second observer recorded their measurements. This was intended to minimize the effect of a possible variation in magnification and angulation of the dental radiographs. The same observer carried out all measurements, and the radiovisuographs were re-examined under blinded conditions after 2 weeks to ensure intra-observer reliability. This helped in evaluating inter-observer agreement.

**Statistical analysis**

Data collected was entered in MS Office excel sheet (v. 2013) and was subject to statistical analysis using SPSS software (v. 22.0, IBM). Jeon’s and Drusini’s method calculated bivariate correlations with actual age estimated. Comparison of mean differences of actual age versus age determined by Jeon’s method and Drusini’s method between the three age groups was done using one-way analysis of variance (ANOVA) followed by Tukey’s post hoc test. Comparison of mean differences of actual age versus age determined by Jeon’s method and Drusini’s method between gender was done using t-test. P < 0.05 was considered to be statistically significant.

**RESULTS**

The study involved 200 radiographs, of which 95 radiographs were of males and 105 were of female patients. According to their age, they were grouped into three subsets, namely <25 years, 25–40 years, >40 years. There were radiographs of 66 individuals, 103 individuals and 31 individuals in the age groups of <25 years, 25–40 years and >40 years, respectively. The interclass correlation coefficient (ICC) was employed to assess intra-observer and inter-observer reliability as well as variation. The lowest acceptable ICC was set at ≥0.7 for reliability. Although intra-observer and inter-observer agreement showed an excellent ICC (>0.7) in the three ratios carried out on both Jeon’s method and Drusini’s Method, the relatively lower ICC was estimated for Drusini’s Method.

The mean chronological age was found to be 30.775 ± 9.329. The mean age estimated using Jeon’s method is 29.790 ± 7.729, and the mean age estimated by Drusini’s method is 27.885 ± 8.190 [Table 1].

Using one-way ANOVA and Inter-group comparison of the difference of age estimation by Jeon’s method and Drusini’s method between the three age groups was statistically highly significant (P < 0.01) [Table 2].

A pairwise comparison of the difference in age estimated by Jeon’s Method and Drusini’s Method versus actual age in all the age groups was done using Tukey’s Post hoc Test. When

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**Figure 1:** Measurements performed on radiograph of a mandibular first molar by using Kodak Dental Imaging Software. CEJ, cemento-enamel junction; L, distance from the start point of lingual groove to the highest point on the root furcation; D, depth of the pulp chamber; F, distance between the floor of the pulp chamber and the highest point on the root furcation; R, distance between the roof of the pulp chamber and the highest point on the root furcation

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**Table 1:** Descriptive statistics (mean and standard deviation) of the parameters in the study

| Parameter                        | Minimum | Maximum | Mean±SD       |
|----------------------------------|---------|---------|---------------|
| Chronological age                | 20.00   | 62.00   | 30.77±9.32    |
| Age estimation by Jeon’s method  | 18.79   | 56.07   | 29.79±7.72    |
| Age estimation by Drusini’s method| 7.81    | 57.39   | 27.88±8.19    |

SD: Standard deviation

**Table 2:** Intergroup comparison of the difference of age estimation by Jeon’s method and Drusini’s method between the three age groups

| Age                        | Between groups | Significant |
|----------------------------|----------------|-------------|
| F                          | 6.055          | 0.002*      |

* P < 0.05 statistically significant
estimated age was compared between chronological, Jeon’s method and Drusini’s method, it was found that there was no significant difference in age between chronological age and age estimated by Jeon’s method \((P = 0.474)\). In contrast, there was a considerable difference between chronological age and age estimated using Drusini’s method \((P = 0.002)\). It was also found that there was no significant difference between age calculated using Jeon’s method and Drusini’s method \((P = 0.063)\) [Table 3].

Pearson’s correlation coefficients were estimated to investigate the association between actual age with age estimated by Jeon’s method and Drusini’s method in the total samples. There was a strong positive correlation between chronological age and age estimated by Jeon’s method \((r = 0.969, P = 0.000)\). There was a weak positive correlation between Chronological age and age estimated by Drusini’s method \((r = 0.399, P = 0.000)\) [Table 4].

**DISCUSSION**

The teeth are the most rigid structures in the human body. They are resistant to different external influences, such as mechanical, chemical and thermal stimuli. The most reliable and feasible method to evaluate age estimation using teeth is chronological age estimation.\[7,11,16\] In children and adolescents, age estimation methods involving tooth development and sequence of the eruption have been used.\[11,17\] Reduction in size of the pulp chamber is one of the noninvasive features best known for aging.\[11\] The deposition of secondary dentin was age-related, was pointed out by Bodecker\[18\] in 1925. Secondary dentin deposition is a continuing, regular process, which is least influenced by other environmental factors. One of the best indicators of age could be a reduction in pulp cavity size due to secondary dentin deposition. These changes were best analyzed on radiographs; thus, various methods were proposed.\[11\]

Several radiological age estimation methods were based on orthopantomogram (OPG).\[11,19\] Limitations of OPG are lack of detailing and the projection can be taken at only one angle. This affects the quality of the measurements performed, thus affecting the calculated age’s accuracy. The measurements on intraoral periapical images of mandible first molars yield more reliable data than the measurements on OPGs.\[11\] Thus, the current study is based on IOPRs.\[11\] IOPRs of mandibular first molar (right/left) were considered for this study because:

1. The radiographic resolution of mandibular teeth is better than the maxillary teeth
2. Mandibular third molar varies considerably in morphology in different individuals and presents anomalies of form and in position very frequently
3. Mandibular second molar is smaller than mandibular first molar in all dimensions
4. There may be an early loss of anterior teeth due to periodontal disease or partial loss of crown structure due to trauma in adults.\[20\]

The present study revealed that there is a gender difference in TCI. This study’s result agrees with Agematsu et al.\[21\] in Japan; Igbibibi and Nyirenda\[22\] in Malawi, who mentioned a need for sex-specific formulae in the sampled population since gender has a significant role influence on age estimation using TCI. The gender-based difference was explained by the impact of estrogen on secondary dentin formation. Hietala et al.\[23\] and Silvana et al.\[24\] reported that estrogen receptors existed in the odontoblast of human pulp tissues. In addition, Yokose et al.\[25\] reported that estrogen deficiency promotes the substrate synthesis of odontoblast.

These reports suggest that estrogen exerts a strong influence on the formation of secondary dentin. On the contrary, the results with studies performed in Italy by Drusini et al.;\[26\] Drusini;\[27\] Zadzinska et al.;\[28\] in India by Shrestha;\[29\] in Egypt by Khattab et al.;\[30\] and in Western Australia by Karkhanis et al.\[31\] stated that sex-specific formulae are not necessary for age estimation in specimens.

| Table 3: Pairwise comparison of the difference in age estimated by Jeon’s method and Drusini’s method versus actual age |
|------------------|------------------|-----------------|-----------------|
| Estimated by (I) | Estimated by (J) | Mean difference (I−J) | Significant |
| Chronological    | Jeon’s method    | 0.98459          | 0.474          |
|                  | Drusini’s method | 2.88970*         | 0.002*         |
| Jeon’s method    | Chronological    | −0.98459         | 0.474          |
|                  | Drusini’s method | 1.90511          | 0.063          |
| Drusini’s method | Chronological    | −2.88970*        | 0.002*         |
|                  | Jeon’s method    | −1.90511         | 0.063          |

*The mean difference and \(P\) value is significant at the 0.05 level

| Table 4: Correlation between chronological age and age estimated by Jeon’s method |
|---------------------------------|-----------------|-----------------|-----------------|
| Chronological age               | Age estimation by Jeon’s method | Age estimation by Drusini’s method |
| Pearson correlation             | 1.000           | 0.000          |
| \(P\)                           | 0.000           | 0.000          |
| Age estimation by Jeon’s method | 0.969**         | 0.399**        |
| Pearson correlation             | 1.000           | 0.000          |
| \(P\)                           | 0.000           | 0.000          |
| Age estimation by Drusini’s method | 0.399**        | 0.392**        |
| Pearson correlation             | 1.000           | 0.000          |
| \(P\)                           | 0.000           | 0.000          |

**Correlation and \(P\) value is significant at the 0.01 level (two-tailed).
of unknown sex as the gender of an individual is found to have no significant influence on the age estimation.

In the present study, we chose the side on which the pulp chamber was more visible. The corresponding tooth of the other side was selected for measurement in cases of tooth malpositioning, tilting or overlapping and/or if insufficient tooth information was available. Our study demonstrated that the side from which the tooth was chosen had negligible impact on radiographic age estimation, which is in accordance with other studies done in Italy by Drusini, Zadzinska et al., in Malawi by Igbibgi and Nyirenda, in India by Saxena, in Egypt by Khattab et al., in Western Australia by Karkhanis et al. In contrast to the studies mentioned above, Morsi et al. found a significant difference between right and left teeth in the case of TCI. This observation by Morsi et al. may be due to developmental or morphological changes or the accuracy of radiographs.

There is a positive correlation between TCI in the current study and age. The correlation is more in females than males, i.e., the index increases with increasing age. This is similar to the Shrestha study in India, which mentioned that TCI was significantly increased with advanced age. While Drusini, Drusini et al., Zadzinska et al. in Italy; Igbibgi and Nyirenda in Malawi and Karkhanis et al. in Western Australia reported that there was a negative correlation between TCI and age.

**CONCLUSIONS**

The present study investigated measurements of mandibular first molars using TCI (Drusini’s method) and Jeon’s method; also compared the two methods. The results demonstrated that Jeon’s approach is more accurate than TCI in the Indian population. As in Jeon’s method, the derived equation was used to estimate the ages, the technique is less time consuming, conducive and newer in the Indian population. However, more regression models can be developed in larger sample groups to enhance the age prediction.

This study underlines the potential value of a lesser-known method of age estimation, which can easily estimate age in both living individuals and individuals of unknown origin in a forensic context.

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**Conflicts of interest**

There are no conflicts of interest.

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