Age estimation using mandibular second molar radiographs: A novel technique

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Introduction:

One of the important parameters in establishing the identity of a person is age. Age determination is an important aspect of forensic dentistry to identify victims in mass disasters [1]. In living individuals also, the determination of the chronological age of adolescents and young adults has received more importance now because of globalization and industrialization, a significant increase in the criminal cases and increased number of immigrants. In these cases, a clear documentation of age is not available [2]. Age estimation is important in both living and dead individuals, for legal procedures, or the identification of victims in mass disasters, and in anthropological studies.

Assessment of age by using teeth is an important aspect of forensic odontology. Teeth are the most durable and resilient parts of the skeleton because they are highly resistant to the influence of various factors and durable. Sometimes, teeth are the only body part which are available and it makes a valuable source from which age can be calculated [3]. Estimation of age from teeth can be done in several ways like in reference to the chronologic age, skeletal age and dental age. Age can be estimated depending on the teeth morphology, or by radiographic investigations, by histologic studies and biochemical methods. Some studies require sectioning while other studies can be done clinically itself with minimally invasive procedures. Morphologic characteristics of teeth when used in age estimation has been considered to yield more reliable results than most other methods [4].

Tooth development is a complex process which takes place from early fetal life till around 20 years of age. In children, age estimation can be done by studying the different stages of tooth development. In older individuals, various parameters depending on the regressive alteration of the tooth structure are used to estimate age. In adults, the factors that can be used to assess age include the analysis of cementum annulations, racemization of aspartic acid, root transparency, synostosis of secondary ossification centers and secondary dentin deposition [5]. Schour and Massler's method, Demirjian's method, Kvaal's method are morphological and radiographic methods of dental age estimtation. The biochemical and histologic methods include Gustafson's index, Bang and Ramm method and Cementum annulation technique and these require sectioning of the tooth and are hence more used in dead individuals. The radiographic methods are more advantageous and are used in living individuals.

Any tooth can be used in age estimation. Several studies of dental age estimation using canine, first premolar and second premolar using intra oral periapical radiographs and panoramic radiographs have been done. Mandibular third molars have been used to estimate dental age by using various radiographic methods. Literature reveals that very few studies have been carried out using mandibular second molar radiographs to determine age.

Examination of the pulp chamber space provides a new opportunity in age estimation from dental aspect. The size of the pulp chamber reduces as the chronologic age increases due to the deposition of secondary dentin and is least influenced by environmental factors and external factors like caries or some abrasion. Secondary dentin can be studied by sectioning and radiography. Mathew et al. put forward a method of age estimation by using mandibular first molar radiographs. It has been stated by Palak Shah and Rashmi Venkatesh that application of the pulp/ tooth ratio to estimate age using molar teeth can be done with good accuracy when compared to anterior teeth [6]. This study aims to develop a non- invasive radiographic technique for estimation of age using radiographs of mandibular second molars by relating the age and the reduction of pulp chamber size by using the procedure stated by Mathew et al [7].

Materials and Methods:

Subject Selection:

Orthopantomograph (OPG) was obtained for 50 subjects and digitalized. The subjects were categorized into two subsets. The first subset was the study subset (n=50) was used to find the regression formula to calculate the age from the pulp chamber height. The second subset, the test subject (n= 50) was used to test the accuracy of the formula developed. The subjects in each subset were grouped into 2nd decade (11-20 years), 3rd decade (21-30 years), 4th decade (31- 40 years). Both the test subject and the study subject had equal number of subjects within a particular decade.

In each OPG, a mandibular second molar was selected randomly. Teeth in which each anatomical landmark can be clearly seen and distinguished were only included in the study. Root canal treated teeth, teeth with visible periapical pathologies, caries, attrition, impacted teeth, teeth with radio opaque fillings and crowns were strictly excluded from the study.

Radiograph measurements:

Adobe Photoshop program was used to mark the points and record the measurements in the digitalized OPGs. The method proposed by Mathew et al. which includes the crown height and pulp chamber height was used in this study. The central fossa and the highest point on the root furcation were marked and a line was drawn connecting these lines and the measurement was recorded as the Crown Root Trunk Height (CRTH). Points were marked on the roof and the floor of the pulp chamber and a line was drawn connecting these points and the measurement was recorded as the Pulp Chamber Height (PCH). A ratio was derived between the ratio of the Crown Root Trunk Height and the Pulp Chamber Height (CRTH/ PCH) in order to avoid projection error. All measurements were recorded by a single observer to prevent any errors in measurement.

Statistical analysis:

All data was entered in Microsoft excel spreadsheet. Statistical analysis was done using SPSS software. Pearson co-relation coefficient was done between the chronologic age and the CRTH/ PCH ratio. the study subset, a correlation was done between the chronologic age and the pulp chamber crown root trunk height ratio. This was then applied to the test subset to determine the accuracy in age estimation. The difference between the chronologic age and the estimated age was recorded as error. P value < 0. 05 was considered as statistically significant.

Results:

The digital orthopantomograms of a total of 100 subjects were included in the study out of which 54 were males and 46 were females. There was a statistically significant co- relation between the chronologic age and the Pulp Crown Trunk Height Ration (PCTHR) of the mandibular second molars (r= 0.3813). The regression formula derived for the mandibular second molar was the following:

Estimated age= (2.07801 * PTCHR) + 13.38495

The R^2 value for the regression equation was 0.1454.

The Standard error was found to be around 6.24 years. The mean chronologic age was found to be 20.54+/- 13 yrs and the mean estimated age was found to be 20.314+/- 1.694 years. The scatter plot distribution between the chronologic age and the PTCHR of the mandibular first molar is shown in Figure 1.

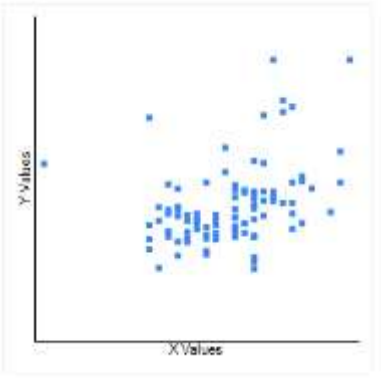

Figure 1

Discussion:

Based on the age- related changes, various methods of dental age estimation can be done. One such method is to use the Tooth Cementum annulations (TCA) to estimate the age of an individual. In a study conducted by Sisira et al., longitudinal ground section 20 extracted teeth with no carious lesions were taken for the study and examined under the microscope. The results of the study suggest that cementum annulations are a characteristic feature which can be related to estimate the age [8]. However, quantification of such experiments will require extraction of the tooth, which is practically not valuable and time consuming and expensive.

The formation of secondary dentin begins after root completion and it continues throughout a person's life and reduces the size of the pulp chamber as the age progresses. Also, the secondary dentin deposition is not uniform in all surfaces of the pulp chamber [9, 10, 11]. It deposits in the roof and floor of the pulp chamber, thus reducing only the height of the pulp chamber and not the width of the pulp chamber [12]. This process is relatively inert as it is least affected by environmental factors. Talreja et. al has stated that the deposition of secondary dentin is influenced even by genetic factors [13]. Non-invasive and easier radiographic methods can be used to assess age based on these changes. A study was done by Srithi Srinath et.al to determine the dimensions of the pulp chamber and the furcal dentin in the mandibular first molar and stated that as age progresses, the vertical dimension of the pulp from the mesial horn to the floor of the pulp chamber significantly decreases when compared with the distal horn [14].

Gustafson introduced the measurement of secondary dentin as a method of age estimation. Bodecker in 1925 established that age is correlated with the apposition of secondary dentin [15]. One such method of radiographic method was proposed by Kvaal in 1995 by using intra oral peri apical radiographs. In a study done by Ridhima Sharma et al., intra oral peri apical radiographs of 6 teeth were included in the study which comprised of the following teeth: maxillary central incisor, lateral incisor, and second premolar and mandibular lateral incisor, canine, and first premolar. 10 measurements were made regarding the pulp length, root length at different aspects and ratios were found and assessed by applying Kvaals's method of age estimation. The results of the study state that the results are more accurate when the lower first premolar is taken for the study [16]. In a study done by Sasidhar Singaraju et al., age estimation using pulp/tooth area ratio was taken to estimate age. The study concluded by saying that the width of the pulp chamber is a better indicator of age and is consistent with previous studies done by Cameriere et al who used canines to obtain a regression equation, Bosmans et al, Kvaal and Solheim [17].

Mandibular third molar radiographs can be used to estimate age based on the various stages it is seen as in an OPG or other radiographic techniques [18].

A study was conducted by N. Jagannathan et. al. to estimate age using the pulp/ tooth volume ratio of mandibular canines based on observations done from cone beam computed tomography (CBCT). The results of this study show that a modification of Yang's formula can be used for a possible method of age estimation in an Indian population. A report on the application of the pulp/ tooth ratio ratio to estimate age concluded that the same formula which had been derived from an Italian population can be applied to Indians as well, but this study disagrees with that and it is stated that the formula devised for one population is not applicable to another population [19, 20]. Respective formulae have to be derived for specific groups of population for accuracy.

Conclusion:

The method of age estimation based on the crown trunk height and the pulp chamber height as propped by Mathew et. al. was done on the mandibular first molar teeth. The present study suggests that this method of age estimation is accurate and hence can be used as a tool to estimate age. However, further research can be performed using various radiographic techniques for a particular age group within a particular geographic location as well to calculate the regression equation, and a larger sample size to obtain accurate results.

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