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Age estimation by applying cameriere method for lower 2nd premolars using orthopantomograph

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Abstract
Introduction: The aim of this study was to determine age by Cameriere method using mandibular 2nd premolar by Panoramic Radiographs.
Materials and Methods: A total of 225 panoramic radiographs of Kashmiri subjects (108 males and 117 females), aged between 15 and 70 years were analyzed. According to Cameriere *et al*. measurements of the pulp and tooth areas were done. The morphological variables i.e, pulp tooth ratio, age and the subject's gender were entered in a Microsoft Excel spreadsheet for use as predictive variables for age estimation. Chronological age of an individual was calculated by subtracting the birth date from the date on which the radiographs were exposed for that particular individual.
Results: It was found that the 2nd premolar was the closely correlated with age (r=-0.951) and SEE 3.32 years.
Conclusion: As the development of teeth varies among populations and is genetically determined, it becomes imperative to derive population specific data bases. From the results of this study, it may be concluded that the use of Cameriere's age-related variables in lower premolars and canine and the application of the new regression formulae on data obtained from orthopantomograph lead to accurate age estimates, if at least the selection criteria are respected and good quality orthopantomograph with clear radiological images are used.

Keywords: age estimation, pulp tooth ratio, OPG, regression equation

Introduction
Skulls and teeth can provide a lot of information about age at death and that is the reason why there are many age determination methods based on cranial and dental features.1 Although estimation of adult skeletal age at death is one of the most important identifying features in unknown individuals, it is also one of the most difficult to achieve. However in the present global socio-political scenario, an increasing demand also exists for age estimation in living persons, such as immigrants, refugees, asylum Seekers (who seldom have any valid identification documents), to clarify criminal and civil liability and social issue. Teeth are the hardest part of the body and are least affected by the taphonomic process. They are considered as one of the reliable methods of identification of a person in forensic sciences. A variety of methods are used for dental age estimation, for example, morphological, biochemical and histological methods. However these methods are invasive and require tooth extraction, which is not possible in living individuals. Non-invasive radiographic techniques have been developed for measurements of the reduction in the dental pulp cavity associated with advancing age due to secondary dentin formation. This reduction in pulp chamber was correlated with chronological age and regression equations were derived to estimate the age[2]. In children, age determination from teeth is a relatively simple, accurate procedure and is based on the stages of development and eruption of teeth. However, in adults it is a challenge to medico-legal science. Up to now, a multiplicity of methods have been applied to this problem, including methods which analyze the various forms of tooth modification such as wear, dentin transparency, tooth cementum annulations, racemization of aspartic acid and apposition of secondary dentin. Some of the methods are very complex and destructive and are therefore not normally used; wear and the apposition of secondary dentin are the currently available nondestructive methods.

Tooth wear is influenced by various external factors (masticatory function, type of food, timing and sequence of tooth eruption), tooth form, position of teeth, thickness and hardness of enamel and predisposition to enamel hypoplasia. However, apposition of secondary dentin is a continuing, regular process which is only modified by caries or particular abrasion. After tooth eruption, it is well known that the size of the pulp cavity decreases gradually with age, because of the deposition of secondary dentine in the pulp cavity wall. This process is caused by the continual secretion of dentinal matrix by odontoblasts (physiological secondary dentinogenesis). Dentine is a living tissue containing odontoblasts which form the tooth. During a person's lifetime, for both physiological and pathological reasons (attrition, abrasion, erosion, caries), the odontoblasts deposit layers of secondary dentine, which gradually obliterates the pulp chamber. Since 2004, Cameriere *et al*. have published several papers on a method of age estimation using the pulp/tooth area ratio to quantify the apposition of secondary dentine.3 The purpose of present study was to compare the chronological age and estimated age calculated from pulp/tooth area ratio using Cameriere method and to derive a population specific formula based on this method.

Aim of the study

The aim of this study was to test the reliability and applicability of pulp/tooth area ratio (PTR) in 2nd mandibular premolar as an indicator of age by Panoramic Radiographs.

Objectives of the study

To assess pulp/tooth area ratio using digital panoramic radiographs in different age groups.

To compare the chronological age and estimated age calculated from pulp/tooth area ratio using Cameriere method.

Subjects and Methods

A total of 225 panoramic radiographs of Kashmiri subjects (108 males and 117 females), aged between 15 and 70 years were analyzed. These panoramic radiographs were taken at the nearby Radiology Clinic using Carestream CS 8000C. The patient's identification number, sex, age and date of radiographic taking were recorded. Protocols of the study and for radiographs collection of human subjects were approved by internal Ethical committee of the institute.

Inclusion criteria

Age range: 15 – 70 yrs.

The selected teeth on the panoramic radiograph, mandibular 2nd premolar fully erupted into the oral cavity.

The root of the premolar is fully formed.

Exclusion Criteria

Individuals with the following conditions were excluded from the present study:

Teeth with any pathology, such as, caries or periodontitis or periapical lesions, that would alter the surface area of the tooth.

Teeth with any prosthetic fittings and orthodontic appliances.

Fractured teeth.

Severely attrited teeth secondary to para-funtional habits.

Teeth with any developmental anomalies.

Measurements of the pulp and tooth areas were done according to Cameriere *et al*. [2] Briefly, radiographs were saved as high resolution JPEG files on a computer and imported to AutoCAD 2010 software programme where in the tooth's long axis was aligned vertically using the measure tool. Next, open the image file, enlarge the working area, and zoom in. A minimum of 20 points from each tooth outline and 10 points from each pulp outline has been identified and connected with the line tool on AutoCAD's Draw Toolbox. The pulp and tooth areas were measured using the point and line tools on the Draw toolbox and the pulp/tooth area ratio (PTR) calculated. All measurements were carried out by the same observer. Repeat measurements on 25 randomly selected radiographs were undertaken after an interval of two weeks and the values subjected to a paired t-test to assess potential intra- and inter-observer error. In the present study teeth were chosen either from the left or the right side, whichever were best suited for measurement. As according to Kvaal *et al*. [2] there are no significant differences between permanent teeth from the left and right side of the jaw.

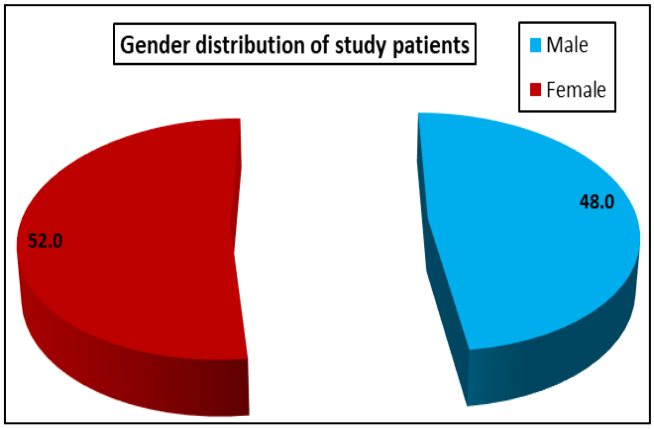
The morphological variables i.e pulp area, tooth area, pulp tooth ratio, age and the subject's gender were entered in a Microsoft EXCEL spreadsheet for use as predictive variables for age estimation.

Chronological age of an individual was calculated by subtracting the birth date from the date on which the radiographs were exposed for that particular individual.

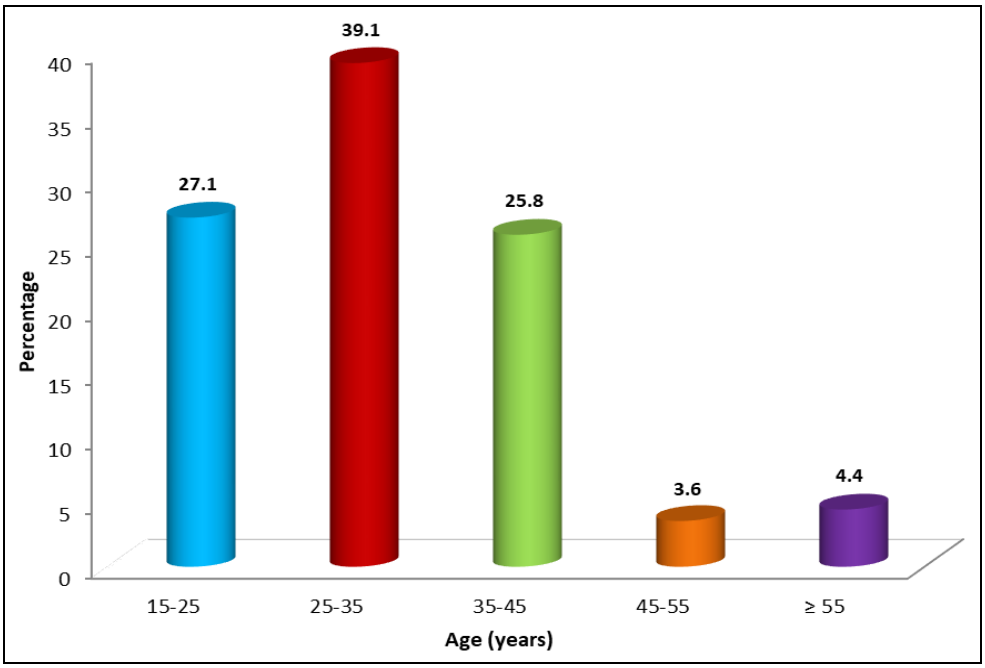
Correlation coefficients were evaluated between chronological age and morphological variables. Estimated age was obtained using morphological variables for each type of tooth. Single linear regression equation was developed by selecting those variables that contributed significantly to age estimation.

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS and Microsoft Excel were used to carry out the statistical analysis of data. Descriptive statistics of data including percentages, means, standard deviations and ranges were reported. Pulp tooth ratios derived was subjected to linear (single tooth) regression analysis. The standard error of estimate (SEE), which reflects the accuracy of prediction, was calculated to predict the deviation of the estimated age from the actual age. Graphically the data was presented by bar diagrams. A P-value of less than 0.05 was considered statistically significant.

Results



Graph 1: Is showing gender distribution of patients



Graph 2: Age distribution of study patients

Table 1: Descriptive statistics of pulp/tooth ratio of the 2nd premolar of study patients

Tooth	Mean	SD	Min	Max
2nd premolar	0.139	0.033	0.0242	0.1926
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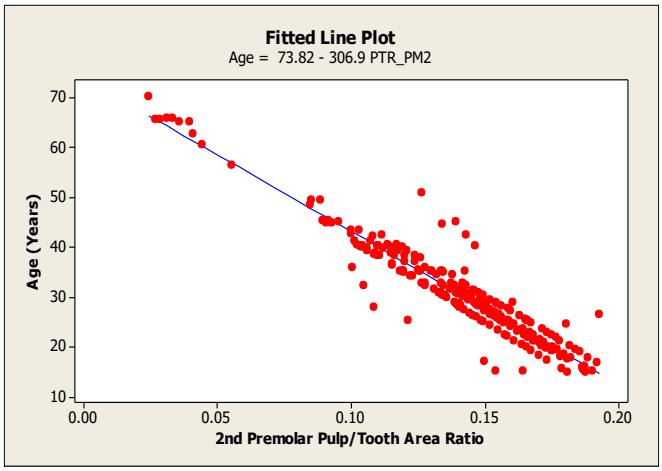

Regression equation for 2nd Premolar
Age = 73.82 – 306.9× PTR_PM2
Where PTR=pulp tooth ratio, PM2=2nd premolar.

Descriptive statistics of pulp/tooth ratio of the 2nd premolar of study patients

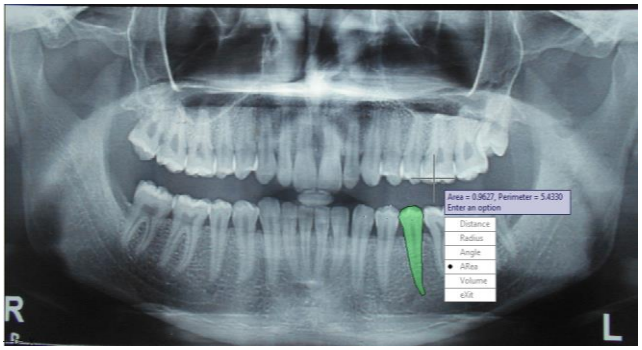

Image showing estimation of area of 2nd premolar using Autocad software

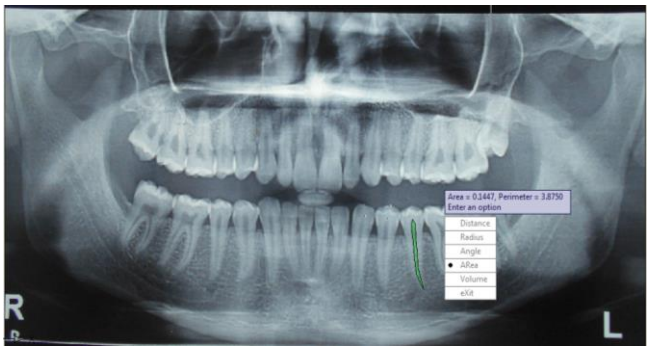

Image showing pulp area estimation using Autocad software

Discussion

Today, dentists are widely respected as a source of valuable data that can be used to answer questions that arise during a death investigation, and forensic dentists can use these data to provide significant conclusions.[4] Age estimation up to puberty can be performed by development process, dental radiographs (intraoral periapical radiographs, bitewing radiographs, orthopantomographs) or by a combined radiographic technique of the third molar tooth staging development and hand wrist and cervical vertebrae radiographs. But, after third molar development, it becomes increasingly difficult to assess age accurately. Only aging process and regressive changes of teeth are helpful at adult age.[5] Changes that are appreciable with increasing age are attrition, periodontal disease, and deposition of secondary dentine, root translucency, cementum apposition, root resorption, color changes and increase in root roughness. By taking in consideration, these secondary changes in teeth with advancing age various studies were done to estimate the age of an individual. In 1925 Bodecker established that the opposition of secondary dentin correlated with age [6]. In 1995, Kvaal *et al.* [7] presented a method for age estimation which was based on investigation of periapical radiographs, while Paewinsky *et al.* in 2004 verified the applicability of this method on orthopantomograms [8]. Rakesh Kumar Dumpala *et al.* 2013 [9] showed that age estimated using pulp/tooth area ratio in digital OPGs was more accurate when compared to age estimated using hand-wrist radiographs. Cameriere *et al.* [10] in 2004 for the first

time conducted a preliminary study to evaluate the variations in pulp/tooth area ratio (AR) as an indicator of age and their method of age estimation seem promising. Similarly, other studies done by Camerier *et al*. (2009) [11] Camerier *et al*. (2012) [12], Paewinsky *et al*. [8], Jeevan *et al*. in 2011 [13], and Jaklin Fekri *et al*. in 2011 [14] also did not reveal any statistically significant intra-observer differences. This may be because of better software used for measurements which might have nullified the variations. Roberto Cameriere *et al*. in 2012 [12] concluded that the use of Cameriere's age-related variables in lower premolars and the application of the new regression formulae on data obtained from orthopantomograph lead to accurate age estimates as seen in our study also. Medha Babshet *et al*. in 2011 [15] states that taking multiple teeth did not markedly improve the PTR age correlation when compared to single teeth Using Cameriere's method, it was found in the present study the 2nd premolar was the closely correlated with age (r=-0.951) and SEE 3.32 years. Similar results were seen by Mostafa M Afify *et al*. in 2014. [2] Thereby, the derived population specific regression equations can be potentially used for estimation of chronological age of individuals.

Limitations of the study

Though the results of the study are promising, it cannot be generalized to other populations.

Rotated teeth, decayed teeth or teeth with any prosthesis were excluded from the study. If the individual has any of the mentioned conditions, then this method cannot be employed to estimate the age, as these conditions alter the tooth surface area.

Need for future studies

The efficacy of this method of age estimation should be further confirmed or validated using a larger sample size in population of different racial and ethnic origin.

Future studies can be taken up to estimate the age using other single rooted teeth and multi rooted teeth to determine the completeness of this method of age estimation so that it may become a method of choice for forensic odontologists on a regular basis

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