ORIGINAL ARTICLE

Age estimation using pulp/tooth area ratio and hand wrist radiographs: A comparative study

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Abstract

Background: Radiological images are utilized in the process of age estimation, which is one of the essential tools in the identification in forensic science. Age estimation of bodies that are severely mutilated or decomposed either in single cases or mass graves can be done with previous dental records of the victims.

Objectives: To estimate the age using pulp tooth area ratio of right mandibular canine in digital orthopantamographs (OPGs) in 30 patients. To estimate the age using hand wrist radiographs in the same patients. To compare the age estimated using OPGs and hand wrist radiographs with the chronological age of the patients.

Materials and methods: 30 patients visiting the out patient department of our Dental Hospital were selected and after obtaining informed consent, hand wrist radiographs and digital OPGs were taken. Skeletal age was determined with hand wrist radiographs applying Bjork Grave and Brown method and dental age by using the pulp tooth area ratio of right mandibular canine in digital OPGs.

Key words: Age estimation, Hand-wrist radiographs, Pulp/tooth area ratio.

Results: The results showed that age estimated using pulp/tooth area ratio in digital OPGs was more accurate when compared to age estimated using hand-wrist radiographs.
Introduction

Identification of deceased persons by dental means is one of the most rapid and useful methods utilized by investigating authorities following mass disasters. Age estimation may pose a real difficulty in the forensic practice. Dental age estimation methods are of particular value because they are highly resistant to mechanical, chemical or physical impacts and time. Moreover, dental age predictors are minimally influenced by the nutritional, medical, environmental and living conditions the individual was submitted to.

Age estimation based on digitization of panoramic radiographs and their computerized storage have recently become available. These procedures exploit image analysis to obtain non-destructive metric measurements of both pulp chambers and teeth. Forensic odontologists may now utilize these techniques that are relatively precise and accurate. The most frequently used statistical technique for age estimation in forensic dentistry has been multiple linear regression, although partial least-square linear regression, polynomial regression and other robust regression methods have also been applied.

Skeletal maturation staging from radiographic analysis is a widely used approach to predict timing of pubertal growth, to estimate growth velocity, and to estimate the proportion of growth remaining. Although use of the cervical spine and frontal sinus has been reported, skeletal maturation is generally determined by using stages in the ossification of bones of the hand and wrist, because of the quantity of different types of bones available in the area or by evaluating the ossification onset of the ulnar sesamoid.

In addition to evaluation of the hand radiograph using standard tables and the atlas of Greulich and Pyle (1959), the analysis of Bjork (1972) has been useful in orthodontics which divides the maturation process of the hand between the 9th and 17th year into eight developmental stages. The delineation of single developmental stages is facilitated by the inclusion of six further ossification centers (Grave and Brown 1976) whereby the skeletal age can be determined more accurately.

The purpose of the present investigation is to compare the chronological age estimated using pulp/tooth area ratio of right mandibular canine and skeletal age using hand-wrist radiographs applying Bjork Grave and Brown method.

Canines are the favoured teeth as they are single rooted with largest pulp area for ease of analysis. In addition they have less chance for wear when compared to other anterior teeth.

Materials and methods

30 patients visiting the Outpatient department of our college for the purpose of orthodontic treatment were selected for this study. Digital Orthopantamographs (OPGs) and Hand wrist radiographs were taken from the patients.

Image analysis of the OPGs revealed the clearest digital images of canines and incisors. For our study, the right mandibular canine was selected.

Radiographic images of canines (RIC) were processed using a computer aided drafting program (AutoCAD 2008, Autodesk Inc...
San Rafael, CA, USA). Points were marked on tooth outline and pulp outline to evaluate tooth and pulp areas (Figure 1).

![Figure 1. Orthopantamographs introduced into AutoCAD 2007 software](image)

Left hand-wrist radiographs of the selected patients were traced. Based on Bjork Grave and Brown method, skeletal maturity was observed and the age was estimated (Figure 2).

![Figure 2. A hand-wrist radiograph](image)

Karl Pearson correlation coefficient was calculated between the chronological age of the patient and the respective pulp/tooth area ratio values (Table 1). A multiple linear regression model was then developed to estimate the age of the patient using the formula,

Estimated age = -8.6508(PT ratio) + 14.462.

Student’s t-test was done to compare the dental age and skeletal age with the chronological age of the patient.

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**Table 1.** Karl Pearson’s correlation coefficient between the chronological age of the patient and the respective pulp/tooth area ratio values

**Results**

Chronological age was compared to the
dental age estimated using Student’s t-test and a p-value of 0.6515 was obtained. Since p>0.05, it was concluded that there is no significant difference between dental age estimated and the chronological age (Table 2).
Table 2. Comparison of chronological age with the dental age which indicates that there was no significant difference between dental age and the chronological age of the patient

Similarly, chronological age was compared to skeletal age estimated using student’s t-test and a p-value of 0.049 was obtained. Since P<0.05, it was concluded that there is a significant difference between skeletal age estimated and the chronological age (Table 3).

Table 3. Comparison of chronological age with skeletal age which indicates that there is a significant difference between skeletal age and the chronological age of the patient

Discussion

Secondary dentine apposition is a significant morphological dental age predictor. It is defined as the formation of dentine after the completion of the primary dentine and starts at the moment the related tooth is completed. The formation of secondary dentine reduces the area and the volume of the pulp chamber. Therefore, the area changes of the pulp chamber in intact teeth are considered as dental age predictor.3

In a study conducted by Robert Ccameriere et al age estimation were done using pulp tooth area ratios in 100 individuals aged between 18 to 72 years in right maxillary canines using orthopantamographs.4 They have found significant results with an error of 3.7 years. Similarly in the present study we found significant results with an error of 0.4 years. The spreader plot between chronological age of the patient and pulp/tooth area ratio values showed significant correlation with only a few points lying outside the correlation line (Figure 3).

Figure 3. Spread plot between pulp/tooth area ratio and chronological age of the patient, which indicates that as the age of the patient increases the pulp/tooth area ratio decreases

Similarly Singaraju S et al 8 have done a study on age estimation using pulp/tooth area ratio in right maxillary canines, Star H

Original Article - Age estimation methods

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et al on age estimation using pulp/tooth volume ratios of monoradicular teeth on Cone Beam Computed Tomography (CBCT) images of monoradicualr teeth, Jeevan MB et al 7 on age estimation using pulp/tooth area ratio of canines using Radiography, Zaher JF et al 9 on age estimation using pulp/tooth area ratio in maxillary incisors using Intra Oral Periapical Radiographs. All these studies showed significant results and proved that area or volume changes of pulp chamber can be used in estimation of age.

The radiological study of hand-wrist is the single most useful method of studying bone as stated by Greulich and Pyle.12 There are two general approaches to assess the hand-wrist radiograph. The first method consists of the comparison methods of Greulich and Pyle. They used an atlas as a standard of comparison. The second method by Tanner et al compared an individual with radiographic standards of skeletal maturity of ‘normal’ children of similar age and sex. Individual bones are related using a biological weighted scoring system to assign a ‘skeletal age’. Fishman developed a system for assessment of skeletal maturation on the basis of 11 discrete skeletal maturity indicators covering the entire period of adolescent development.5

In our study, skeletal age was estimated using Bjork Grave and Brown method. Kumar V et al have conducted a study on comparison of dental age and skeletal age with the chronological age of the individual. In their study they used Demirijan method for estimating dental age.10

Vallejo-Bolanos et al 11 and Prabhakar et al 12 have conducted similar studies on the comparison of skeletal age and dental age with the chronological age of the patients where they found significant results.

In the present study we used variation in the pulp area at different ages to estimate the age of the individual and compared it with the age estimated from skeletal maturity of hand-wrist radiograph.

Conclusion

In a mixed population, age estimated using pulp tooth area ratio is a more accurate method of age estimation when compared to hand-wrist radiographs, although the latter can also be used. However, studies with a large sample are required for confirmatory results.

References


