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Contents

Determination of Cameriere Regression Equation Accuracy in Haryana Population

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Abstract

Age estimation in children is important in clinical as well as forensic dentistry. The orthopantomograph samples of 50 healthy children (25boys: 25girls) aged between 5-15 years was selected and Cameriere regression equation was applied. We observed underestimation of estimated age in boys and overestimation in girls as compared to their chronological age.

Keywords: Forensic dentistry, Cameriere regression equation, Haryana population OPG, Age estimation.

Introduction

Tooth formation is widely used to assess maturity and predict age. In clinical dentistry, this information aids in diagnosis and treatment planning.1 The continuous patterns of tooth development can be observed on a longitudinal series of radiographs and various mineralization stages. 2-6 Previously number of methods have been proposed to determine dental age,7-15 but, the system developed by Demirijian has gained wide acceptance.9 During developmental stages particularly in root formation, a notable difference between sexes arises with females being advanced when compared with males.9-19 Previously Cameriere et al proposed a regression equation for age determination from Open and closed apices in children 16-17. It has been reported that teeth development depend upon number of factors such as genetic, environmental, nutritional f and geographical factors 4-7 . Since these factors play major role in tooth formation, they may have effect on dental age estimation. Hence the aim of this study was to determine the accuracy of Cameriere equation for age estimation from open and closed apices on Haryana sub

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Population.

Material and Methods

The orthopantomographs sample of 50 healthy children (25 boys: 25 girls) aged between 5-15 years taken during the course of diagnosis and treatment was selected. Panoramic radiographs that were unclear or that showed hypodentia, gross pathology and previous orthodontic treatment were excluded.

The chronological age for each subject was calculated by subtracting the date radiograph was taking from the date of birth.

Orthopantomographs were digitized using a scanner (HP) at 150dpi. Images obtained were imported to Adobe Photoshop 7.

The number of teeth with closed apices (N0) and open apices (S), were calculated. The length of left and right permanent mandibular teeth were measured, measurement was done twice and mean value was taken.

Age estimation was done by applying Cameriere regression equation,

Age?=?8.387?+?0.282 g?-?1.692?x?5?+?0.835 N 0?-?0.116 s?-?0.139 s?×?N 0

The variable g is 1 for male and 0 for female.

.. **Results**

The estimated age obtained was compared with chronological age using student paired t test.

when the whole data is consider (i.e.male and female) there is no significant difference between chronological age and estimated age (P= 0.6954) but when male and female data were considered separately there is a significant difference between chronological age and estimated age. (Male Pr = 0.0001, Female = 0.0001)We observed an underestimation of age in boys and overestimation in girls as compared to their chronological age.

Table a

Sr.No	Chronological age	Estimated age
1	4.5	3.8
2	6.8	5.7
3	8.7	7.6
4	8.9	8.2
5	11.2	10.9
6	6.7	5.6
7	7.8	6.7
8	12.7	11.6
9	15.3	13.2
10	13.2	12.7
11	10.6	9.8
12	7.8	6.9
13	11.8	11.5
14	15.9	14.9
15	16.9	15.9
16	12.5	12.1
17	14.6	13.9
18	15.6	15.4
19	8.9	8.7
20	5.1	4.9
21	5.9	5.1
22	9.1	8.3
23	7.5	6.9
24	6.3	6.1
25	8.5	8.1

Table a showing chronological and estimated age years in boys .

Table b

Sr.No	Chronological age	Estimated age
1	8.3	8.6
2	11.9	12.3
3	10.4	10.7
4	14.5	14.8
5	8.8	9.6
6	7.9	8.1
7	11.9	13.8
8	11.2	. 12.2
9	6.5	8.8
10	9.7	10.2
11	11.9	12.9
12	7.3	8.8
13	11.2	13.9
14	9.6	10.2
15	8.5	9.6
16	5.6	5.7
17	5.9	6.3
18	6.1	6.9
19	11.5	12.9
20	11.8	12.6
21	13.5	14.2
22	14.9	15.6
23	11.3	11.6
24	11.6	12.1
25	13.5	13.9

Table b showing chronological and estimated age(years) in girls

Discussions

The need to estimate the age of living individuals is becoming increasingly important in forensic odontology since there are increasing numbers of illegal immigrants without any documents of birthday. We observed that underestimation of age in boys and overestimation in girls as compared to their chronological age (Table 1,p) .While there is no significant difference data were analysed without taking gender into consideration.This may be due to overestimation in girls same as underestimation for boys .From this finding we concluded that we have to add some correction factor for applying this equation. It may be due to different in geographical ,genetic and environment factors 4-6. So this equation various from population to population, hence it should be required more study on different population. As the results did show statistically significant difference between European countries, one regression equation could not be applied to Indian populations .So new equation will be required for Indian population on this concept or adding some correction factor to apply on Indian populations.

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Forensic Orthodontics – An Innovation

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Abstract

Identifying human remains by dental characteristics is a well-established component of forensic science with a definite scientific basis. A turning point has been reached in the history of forensic dentistry, and this may be due mainly to the greatly intensified international traffic, in the air or at sea. Up to a hundred individuals may now lose their lives at the same time, and, furthermore, these accidents leave behind them bodies that are mutilated to a degree previously unknown. In such cases, the only remains still recognizable may be the teeth or dental restorations, because these are more resistant to fire and water than other parts of the body or personal belongings. From Orthodontic point of view, we can help the forensic team in some respects by putting identification marks on Removable, Functional and Fixed Appliances so that it would be easy for the team to identify the dead bodies. Identification marks can be put in the form of Strip marking, Bar coding etc.

Keywords: Forensic Odontology, Strip marking, Bar coding.

Introduction

Forensic dentistry has, up to recent years, only been more or less a hobby for some people interested in this field. There have been few international congresses dealing exclusively with the pertinent problems concerning identification with the aid of dental data. Assistance has been given to the police in some cases where only the dentist could evaluate the details given. A turning point has been reached in the history of forensic dentistry, and this may be due mainly to the greatly intensified international traffic, in the air or at sea.1 Up to a hundred individuals may now lose their lives at the same time, and, furthermore, these accidents leave behind them bodies that are mutilated to a degree previously unknown. In such cases, the only remains still recognizable may be the teeth or dental restorations, because these are more resistant to fire and water than other parts of the body or personal belongings. It is natural that the specialist, i.e., the dentist, is called when identification turns out to be difficult. As will be seen in the paper presented by Keiser-Nielsen1, the internationalization of air traffic will give rise to many difficulties, which can be cleared up only by people really trained for this purpose.

Some of the ordinary methods for establishing identity can be said to be more or less uncertain. Personal belongings may be sold, borrowed, or stolen, and various articles may be placed on a victim in order to hide a crime. Unfortunately, it can be said that all identifications made on belongings or on something not continuous with the body are not real identifications. This is where forensic science comes in - a true multidisciplinary speciality which amalgamates various sciences including forensic dentistry to derive its objective, which in a nutshell is to establish identity. Forensic odontology may be divided into three major fields of Activity - Civil, Criminal, and Research - and in all three the interests of justice demand the proper handling and examination of dental evidence.2

Civil3: It is concerned with mass disasters like Airline accidents, Earth quakes or train accidents, require identification of the victims in advanced stages of physical destruction, malpractice and different types of fraud.

Criminal3: Identification of the persons from their dental remains alone in cases of suicide or homicide through bite mark analysis, rugoscopy, cheiloscopy.

Research3: Forensic Odontology training for dentists working in criminology or police departments.

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The concept of dental identification is widely known, thanks to the media. But the nuances and complexities of the process are rarely understood. The central dogma of dental identification is that postmortem dental remains can be compared with antemortem dental records, including written notes, study casts, radiographs, etc, to confirm identity.4 (Figure-1)

A range of conclusions can be reached when reporting a dental identification. The American Board of Forensic Odontology recommends conclusions from the above comparison:5

• Positive identification: The antemortem and postmortem data match in sufficient detail, with no unexplainable discrepancies, to establish that they are from the same individual.

• Possible identification: the antemortem and postmortem data have consistent features but,

because of the quality of either the postmortem remains or the antemortem evidence, it is not possible to establish identity positively.

• Insufficient evidence: The available information is insufficient to form the basis for a conclusion

• Exclusion: The antemortem and postmortem data are clearly inconsistent.

Record Maintainance:

Identification depends on the existence of antemortem records to compare with postmortem remains. With up to 32 teeth to characterize a person, there are 160 surfaces that may receive tooth restorations. Furthermore, in patient dental records that also include descriptions of tooth rotations, anomalies, supernumeraries, cavities and radiographic documentation,the number of possibilities becomes very large. Essentially, no two dentitions are literally identical. Unfortunately,dental patient records are not yet standardized. Various fields of dentistry like Prosthodontics, Oral Pathology and Endodontics are contributing their role in forensic odontology. Can we as Orthodontists chip in with this regard? And if so, how and why?

Methods

1. Strip making

2. Bar coding

Strip Making

Any appliance which is having a acrylic portion in it, a strip containing the information such as name of the patient or institute and patient identification number can be placed in it during the curing process (Figure-2).

Step 1. The patient's name, hospital number or any other detail is typed on a paper. If the strip is too long, it can be reduced in size according to the appliance. The strip is then cut and sized.
Step 2. This strip is placed in the appliance during the curing stage.

The details on the strip such as patient identification number are to be written in the patient's case sheet (Figure-3). In case of some mishap, the forensic experts after reading the information from the strip can approach the institute or clinic and hence can identify the patient.

Bar Coding

A bar code is a machine-readable code consisting of a series of bars and spaces printed in defined ratios. Bar code symbologies are essentially alphabets in which different widths of bars and spaces are combined to form characters and, ultimately, a message. Because there are many ways to arrange these bars and spaces, numerous symbologies are possible. Bar code technology has been helping business minimize data entry errors, speed processes, and reduce costs for over thirty years.

Symbology is considered a language in bar code technology. Just as you might speak French while traveling in France, a symbology allows a scanner and a bar code to "speak" to each other. When a bar code is scanned, it is the symbology that enables the information to be read accurately. And then when a bar code is printed, it is the symbology that allows the printer to understand the information that needs to be turned into a label.

All bar codes have start/stop characters that allow the bar code to be read from both left to right and right to left (Figure-4). The stop/start characters are unique characters placed at the beginning and end of each bar code and provide timing references, symbology identification, and the direction that the information is read by the scanner. By convention, the unique character on the left of the bar code is considered the "start" and the character on the right of the bar code is considered the "stop." Immediately preceding the start character and following the stop character is an area of no markings called the quiet zone. Because there is no printing in this area, a scanning signal is not produced, thus the term "quiet." The quiet zone helps the scanner find the leading edge of the bar code so reading can begin. Combining these components, we get a complete bar code such as the one found below. Notice the leading quiet zone followed by a start character, data, a stop character, and a final quiet zone.

We can ask the manufacturer to make a personalised bar code which would designate the name of the institute or dental clinic.

Where to Place Bar Code?

In Fixed Orthodontics, we have a limited space to place bar codes. Molar band can be used for its placement. On the molar band, we have chosen mesial or distal surface as these surfaces are more protected than buccal or palatal surfaces (Figure-5). The number written on the top of bar code is to be written in the patient's case sheet (Figure-6). If some however some mishappening takes place with the patient, the forensic experts after analyzing the bar code can approach the institute and by correlating the number with the patient's case sheet can identify the patient.

Conclusion and Scope

Persons who have been deceased for some time before discovery present unpleasant and difficult visual identifications. Dental identifications have always played a key role in natural and manmade disaster situations and, in particular, the mass casualties normally associated with aviation disasters. Hence, there is a need to address the issue of denture marking for social and legal reasons. Orthodontists can become valuable members of the dental identification process by using these techniques which would be valuable in restoring their patient's identity. The research from this point should be focused on newer, technologically advanced, more viable and foolproof methods which would strengthen the scope of Orthodontics in the field of forensics, ensuring our continual and complete commitment in serving the society in general and humanity in particular, however banal or prosaic the contribution may be.

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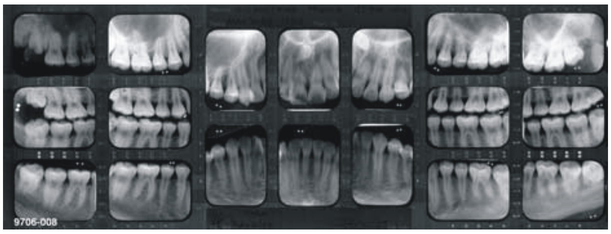

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

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CASE SHEET

Name of Patient: Vivek Chopra Age: 19 Sex: M

Patient Identification Number: PT – 472907090

Date of Commencement: 25-06-07

Name of Operator: Dr. Paramjot Singh Jagdev (MDS 2^{nd} year)

Supervisor: Prof. Praveen Mehrotra

Prof. Sudhir Kapoor

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

SARDAR PATEL INSTITUTE OF DENTAL AND MEDICAL SCIENCES LUCKNOW

CASE SHEET

Name of Patient: Saurabh Bhatia Age: 25 Sex: M

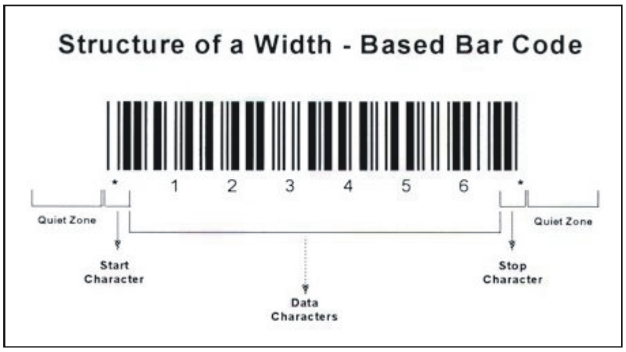
Patient Identification Number: PT – 101

Date of Commencement: 21-08-07

Name of Operator: Dr. Paramjot Singh Jagdev (MDS 2^{nd} year)

Supervisor: Prof. Praveen Mehrotra

Prof. Sudhir Kapoor



Use of Facial Dimensions in Prediction of Stature

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Abstract

In the present study an attempt has been made to explore the correlation between stature, and the two facial measurements, i.e. nasal height and ear length among the male and female Rajputs of Himachal Pradesh. Secondly to observe if these facial measurements could be used to reconstruct stature, under the circumstances when only head of an individual is recovered from a remote area and the complete identity is not possible through visual examination. A total of 165 Rajputs (89males and 76 females) in the range from 20 to 40 years were measured for the nasal height and ear length besides stature in accordance with the standard measurement technique (Martin and Saller, 1959). Analysis of data reveals that males have significantly taller with longer nose and ear than the females Both nasal height and ear length have a relatively low correlation with stature for either sex .Ear length among males exhibit greater correlation than the nasal height while among females nasal height exhibits higher correlation than the nasal height. However the error of estimate is greater for both the measurements with females exhibiting lesser error than the males.

Introduction

Stature or body height is one of the most significant and functional anthropometric parameter which determines the physical distinctiveness of an individual. Most of the studies pertaining to estimation of stature have considered long bone lengths only. However there are certain studies reported from different parts of the world on use of other body dimensions than the long bone lengths, like hand length, foot length, palm length and mid-finger length (Allbrook, 1961; Bhavna and Nath, 2006; Nath, 1997; Sethi and Nath, 2001; Singla et. al., 2005; Majumdar et. al., 2006; Sarajlic et al., 2007)

Some researchers have taken into consideration the head and face dimensions for reconstruction of stature, for example head length, head breadth, morphological facial height, total facial height, nasal height and ear length (Kler, et al. 1992; Miyashita and Takahashi, 1971; Jain and Nath, 1999; Krishnan and Kumar, 2006, Tiwary and Nath, 2005; Devi and Nath, 2001). Keeping this in view an attempt has been made to determine the level of relationship between nasal height and ear length with stature and formulate prediction equations for estimation of stature among male and female Rajputs of Himachal Pradesh.

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Material and Methods

Data for the present study comprises of a total of 165 Rajputs (89 males and 76 females) ranging in age from 20-40 years. All the subjects included in the present study belonged to the middle socio-economic status, inhabiting the nearby villages. Following measurements have been obtained on each subject using the standard measurement techniques recommended (Martin and Saller, 1959).

1. Stature (S): It is obtained as the projective distance between the standing surface and the highest point on the head (vertex), using anthropometre rod.

2. Nasal Height (NH): It measures the straight distance between the nasion and subnasion, using sliding caliper.

3. Ear Length (EL): It measures the straight distance between superaurale to suburale, using sliding caliper.

Data were subjected to statistical treatment for assessing the sex differences in the body measurements as well as for computing Multiplication Factors (MFs) for estimation of stature on the basis of these facial measurements for both the male and the female Rajputs .Subsequently the data on facial dimensions were treated for correlation and regression analysis to formulate sex specific prediction equations for estimation of stature.

Results and Discussion

Nasal height and ear length are not commonly used measurements for reconstruction of stature as both these measurements can be obtained on dead bodies that are not old and the facial skin has not degenerated and the morphology of the face is partly recognizable. Nasal height has been used by a couple of researchers earlier for this purpose bur the ear length is being used perhaps for the first time as a parameter to formulate means of stature estimation.

Table 1 presents the basic statistical constants for stature, nasal height and ear length for male and female Rajputs of Himachal Pradesh. It is apparent from the table that males are not only taller than the females but they have longer nose and ear dimensions too.

On subjecting the data to test of significance (t-test) it is exposed that the sex differences in all the three body dimensions are highly significant (at 0.01% level of significance).

On observing highly significant sex differences data on male and female Rajputs have been treated separately for further analysis.

TABLE 1: Sex differences in different facial dimensions and stature among the Rajputs males and females of Himachal Pradesh

S. No	Body Dimensions	Males(89)		Females(76)		t-Value
		Mean ($\overline{X}$) (cm)	Standard Error Of Mean (S.E.)	Mean ($\overline{X}$) (cm)	Standard Error Of Mean (S.E.)	
1.	Stature (S)	169.19	0.75	156.26	0.65	12.70*
2.	Nasal Height (NH)	5.13	0.04	4.78	0.03	5.96*
3.	Ear Length (EL)	6.08	0.04	5.83	0.03	4.46*

significant at 0.01% level

Table 2 presents the mean M.F. values of nasal height and ear length computed for estimation of stature among male and female Rajputs. It is evident from the table that males exhibit greater M.Fs than the females for both the facial dimensions Females show higher value for nasal height while for ear length males exhibit greater value of multiplication factor.

The different values of multiplication factors for males and females Rajputs of Himachal Pradesh clearly reflect variation in their physique

TABLE 2: Multiplication Factors (M.F.) for estimation of stature through different facial measurements of Rajput males and females

S. No	Body Dimensions	Males	Females
1.	Nasal Height (NH)	33.14	32.82
2.	Ear Length (EL)	27.92	26.83

The regression equations formulated for prediction of height from these two facial dimensions for male and female Rajputs are presented in Tables 3 and 4 respectively. it is evident from these tables that the value of correlation between ear length and stature is greater for males as compared to the females, while the error of estimate (SEE) is lower for females than that of the males.

TABLE 3: Regression Equations for estimation of stature from different facial measurements among male Rajputs

S. No	Body Dimensions	Equations	Standard error of Estimate (SEE)	Correlation value (r)
1	EL	S = 148.67 + 3.37(EL)	±7.03	0.18
2	NH	S = 158.93 + 1.99(NH)	±7.10	0.11

In case of nasal height the situation is reversed as the females express a higher value of correlation with stature than the males, thereby suggesting that the nasal height may be a better indicator for prediction of stature among female Rajputs of himachal Pradesh. This fact is further supplemented by the relatively low value of the error of estimate (SEE) for females than the males.

TABLE 4: Linear Regression Equations for estimation of stature from different facial Measurements among female Rajputs

S. No	Body Dimensions	Equations	Standard error of Estimate (SEE)	Correlation value (r)
1	NH	S =141.9 + 3.0(NH)	±5.67	0.18
2	EL	S =138.3 + 3.0 (EL)	±5.69	0.16

It may be inferred from the present study that both the facial dimensions,, i.e., could be used for prediction of stature under the circumstances when only chopped out head of an individual is recovered from a scene of crime and all the facial features are not indistinct but it is beyond recognition .

Under such circumstances one should conduct the relevant measurements on nose height and ear length and enter these values into concerned prediction equations or use multiplications for reconstruction of stature.

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Maxillary Lateral Incisor as Biomarker of Age – An in-Vivo Radiographic Study

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Abstract

Estimation of age is one of the perplexing problems faced by forensic experts and anthropologists. Changes in the size of pulp canal caused by apposition of secondary dentin as a person ages is one of the parameters employed in age estimation by X-rays. Radiographic method scores over the other methods because it is non-invasive, inexpensive and easily accomplished. This study measured the Pulp/tooth ratio mesiodistally of the maxillary lateral incisor radiographically. The model explained 74.1% of total variance.

Key Words: Maxillary Lateral Incisor, Pulp/Tooth Ratio, Radiograph, Mesiodistal Dimension

Introduction

Age refers to a period of human life, measured by years from birth. It is usually marked by a certain degree or stage of mental or physical development and involves legal responsibility and capacity. Estimation of age assumes importance from a forensic, anthropologic and medico-legal point of view. Teeth were first used as barometer of age in the 1800s.1

Fully formed teeth show aging changes that mirror those seen systemically. Hence, teeth can be used to estimate an age range for anthropologic and forensic purpose and act as biomarker of age. Many techniques have evolved over the years using teeth as medium for age estimation. In children and adolescents age estimations are based on developmental stage of permanent and deciduous dentition. Age estimation using teeth in adults is challenging and many methods have been explored. Studies reveal that for correlation with chronological age best results are provided by the analysis of tooth cementum annulations, and by determination of aspartic acid racemization.2 These methods though are invasive and cannot be used in living individuals.2 In comparision the radiographic technique is non-invasive, simple and can be used even in living and dead alike and therefore an easy co-relation is possible.

This study is based on the concept that as a person ages the pulp chamber size decreases due to secondary dentin deposition. This size change can be measured radiographically and analysed. The purpose of this in –vivo study was to find a reliable method for chronological age estimation of adults by examining the pulp/tooth width ratio of maxillary lateral incisors at the radiographic cemento-enamel junction (CEJ).

Materials and Methods

70 Individuals within the age group of 19 – 58 years were selected for the study (Table 1). Intraoral Periapical Radiographs (IOPARS) of either of the maxillary lateral incisors of these individuals were exposed using size 2 Kodak E speed films (Eastman Kodak, Rochester, New York). Paralleling method was followed throughout the study to avoid exposure errors. All the peri-apical radiographs were at an exposure of 70 kVp and 8 mA (Evolution X -300 machine, Toshiba Co, Italy). All the radiographs were manually processed in a single batch with newly prepared processing solutions maintaining standard time and temperature.

The inclusion criteria included teeth which were in normal functional occlusion, without

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any clinical or radiographic evidence of caries, trauma or restoration or any periapical pathology. IOPARS with any incidental pathologic findings in relation to area of interest were excluded from study.

Table 1: Age and Sex Cross-tabulation

measurements on the computer for the images stored in JPEG format.

Measurements of all the selected radiographs (Fig. 1 and Fig. 2) were carried out along:

1. Mesiodistal direction of the pulp along the CEJ in cms and recorded (x)

2. Mesiodistal direction of the tooth along the CEJ in cms (y)

Radiographic images of maxillary lateral incisors so obtained were digitized by indirect method (Canon SX 100 camera, 8.0 megapixel) and stored in a computer file in JPEG format (Adobe Photoshop 7.0 ®). Iconico software (ver. 4.0) screen calipers were used to carry out the

Fig 1

Fig 2

Fig. 1 and Fig 2 : Schematic representation of technique of measurement

The values so obtained were entered in Excel worksheet. Pulp-tooth ratio (x/y) of each tooth was calculated from the above measurements and tabulated the descriptive analysis of which is given in Table 2. This ratio method helped to reduce the effect of possible variation in angulations and magnification.

Table 2: Descriptive analysis

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	70	19.00	58.00	37.4429	12.0826
RATIO	70	0.11	0.30	0.2090	4.338E-02

Statistical analysis and results:

All measurements were carried out by same observer. To test intra-observer variability 20 peri-apical radiographs were randomly selected and re-examined after 2 weeks. The pulp-tooth ratio was used as the morphological variable. The values were entered in Excel worksheet with actual age and gender tabulated against the respective ratio.

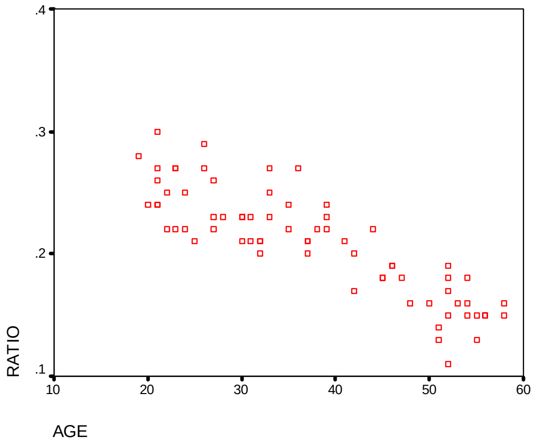
Statistical analysis was performed using SPSS for windows (SPSS statistical software, Ver. 16). In order to assess the difference between actual chronological age and predicted age, a linear regression model with first order interaction was developed. The regression analysis was carried out with age as the dependant variable and ratio and gender as independent variables. As gender did not contribute significantly a step down analysis was done. Following the regression analysis the following regression formula was obtained.

Age = 87.5703 - 239.84 X 2, (X 2 = ratio)

This model could explain 74.1 % of variation (Graph 1). The residual statistics obtained are given in Table 3.

Table 3: Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation
Predicted Value	15.6170	61.1875	37.4429	10.4038
Residual	-12.8046	13.1877	-3.4614E-14	6.1441
Std. Predicted Value	-2.098	2.282	.000	1.000
Std. Residual	-2.069	2.131	.000	.993



Correlation co-efficient were obtained between actual age and predicted variables. The standard error of the estimate was 6.1891 .

Graph 1. Scatter graph showing relation between age and ratio

Discussion

Adulthood heralds many time–related biological changes, many of which can be used to determine age. Current macroscopic methods of age estimation involve teeth, cranial suture, pubis, auricular surface of ilium and sternal rib.3 Teeth are commonly employed for age estimation when skeletal remains are in poor condition as humidity, fire or trauma renders many parts not usable.4 Dental wear is the method commonly used by anthropologists but since attrition is related to diet and culture, this method has little significance except for the population where the data was collected.4 Secondary dentin deposition was introduced by Gustafson for age estimation along with attrition, periodontal recession, cementum apposition, apical translucency and external root resorption as other factors. 2 The apposition of secondary dentine is often preferred because pulp is surrounded by dentin, which changes during an individual's life and leads to reduction in size of pulp cavity. Secondary dentin has been studied using several methods, both by section and radiographic. 4,5 Radiographic study is a non-invasive, simple and reproducible method that can be employed both on living individuals and unknown dead, either in identification cases or archaeological investigations.3,5,6 Many studies using radiographic applicability of pulp-tooth ratio for age estimation have found a positive co-relation. 3,5,6,7 However Meinl et al found that the application of regression formula given by various researchers to their sample either lead to over or under estimation. 2 However, it must be noted that radiographic differentiation between secondary and reparative dentin is not possible.6

This study is unique in the concept that the pulp – tooth width ratio of maxillary lateral incisors at radiographic cemento enamel junction (CEJ) of digitized IOPARs were considered for predicting age. Maxillary lateral incisor was the tooth chosen because the study by Paewinsky, Pfeiffer and Brinkmann showed that this tooth had the strongest correlation coefficient for age amongst the anterior teeth at CEJ level.7 Moreover maxillary anteriors show considerably less crowding and attrition as compared to their mandibular counterpart. The study by Kvaal et al did not find any statistical disparity in teeth between right and left side of jaw for age estimation, hence lateral incisor from either side was randomly selected.6

Various studies on pulpal morphology have shown that width of pulp is a better indicator of age than length.5,6 This study is in tandem with other studies which have highlighted the correlation between pulp-tooth ratio as a good predictor of age.1,5,7,8 In this study minimum predicted age value was 15.6170 and the maximum 61.1875, as in comparison to the actuals which were 19 and 58 years respectively. Other studies using the same concept as ours gave a correlation coefficient value in the range of 71 – 91% as compared to 74 % obtained in this study. 5,1 The result indicates the appropriateness of using maxillary lateral incisor as a viable variable in chronological age prediction. The advantage of this method of study is that it can be safely applied in living individuals also. It should however be noted that maxillary lateral incisors are one of the commonly missing and malformed teeth, although fortunately bilateral incidence of these anomalies is quite rare.

The accuracy of the study depends mainly on the exactitude of measurements and technique of the radiograph exposure. This study gives an analysis of contemporary local population and results could vary in different racial populations. Therefore it would be worthy to note the variations in a larger and more heterogeneous population, with increased variables.

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Efficacy of Pulp/Tooth Area Ratio in Age Estimation by Using Radiographs of Permanent Canine - A Preliminary Study

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Abstract

Objective: To examine the possible application of pulp/tooth area ratio of canine in Intra Oral Periapical X-ray using RVG for estimation of age of an individual.

Material and Method: 25 Individuals aged between 18 to 27years, with apparently normal canine were included in the present study. Radiovisuographic images of canine of upper and lower jaws were obtained. These images will be then transformed to CAD2007 software from which area of pulp/tooth ratio will be calculated with the help of 10 points from each tooth outline and 5 points for each pulp outline. By using regressive formula the age was calculated.

Results: The estimated age using maxillary canine (x1) showed no statistically significant difference between the estimated age and the real age (p=0.1) which means that there is little difference between real age and estimated age. So, it is feasible to estimate age using Pulp to tooth area ratio of maxillary canine.

Key words: Age Estimation, Radiographs, Canine

Introduction

The new millennium has entered with renewed hopes of finding solutions to the existing problems and also with new challenges resurfacing in our day-to-day lives. Although last century has witnessed major breakthroughs in the field of science and technology, crime still persists in all aspects of our lives.

Forensic sciences comprise a vast area of expertise right form conventional forensic medicine to the modern "white collared" cyber forensics, but as progress is being made at the advancing front of this science, its backdrop still suffers from lack of specificity and sensitivity of certain procedures such as "Age Determination."

Age estimation of living or dead individuals is an important aspect of forensic sciences and amongst the various methods involved in the determination of age, those involving teeth have given consistent results. Most of the dental age estimation methods reported are based on the age related changes in the teeth like Root dentine translucency (1-3), tooth cemental annulations(4,5) and apposition of secondary dentine(6,7). But the quantification of these morphological changes nearly always requires extraction and sectioning of teeth which is impossible and unethical in living individuals8. Hence, the techniques which are being developed for age estimation in living individuals mostly on radiological imaging of teeth.

Apposition of secondary dentine is a continuing regular process resulting in the reduction in the pulp area with the advancement of age. This reduction in pulp area can be measured radiographically and has been the basis of many radiological age estimation methods9.

Roberto Cameriere et. al (2007) have developed one such age estimation method, which uses Pulp/ Tooth area (P/T) ratio as an indicator of age. Canines were preferred for present study. The present study was carried out to examine the possible application of P/T area ratio by periapical radiographs for age estimation of an individual using Autocad 2007 software10.

Material and Methods

Source of Data: The present study was carried out in the Department of Oral Pathology and Microbiology, KLES's Institute of Dental Sciences, Belgaum. Students aged between 18 – 25 years with apparently normal canine were included in the

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present study. Of the 25 individuals 13 were males and 12 were females.

Exclusion Criteria

Canines with caries, periapical pathology, abrasion, erosion and any other developmental anomalies.

Method of Collection of Data

All the students aged between 18 to 25 years were given numbers and 25 students among them were selected randomly by using table of random numbers. After obtaining an informed consent, a brief case history was recorded. The real age of the individual was calculated based on the subject's date of birth. Each of the selected individuals was assigned an identification number from 1-25.

IOPA radiographs of both maxillary and mandibular canines were obtained from each individual by a radiologist using Radiovisuography (Kodak 5000 Radiovisuography system). The obtained RVG images were labeled according to their corresponding identification number and were analyzed for estimation of age.

Estimation of Age

The obtained RVG images of canine were processed using a Autocad 2007 software. Pulp and tooth area were obtained by identifying 25 points on the tooth outline and 15 points for pulp outline. From the obtained pulp and tooth areas P/T area ratio was calculated. P/T areas of maxillary canines were designated (X2) and that of mandibular canine (X1). Using X1 and X2 parameters, age of the individual was calculated using the following regression formulae's.

AGE USING X2 & X1: 114:624 - 431:183x1 - 456:692x2 +1798:377x1x2 ………………(1)
AGE USING X1: 89:456 - 461:873x1………………………………………………………… (2)
AGE USING X2: 99:937 - 532:775x2……………………………………………………….. (3)

Results

The real and estimated age of the study groups and their means are shown in Table No 1. The mean difference between the real age and the estimated ages (X2, X1, and X2 X1,) were calculated. In the present study, the estimated age using maxillary canine showed no statistically significant difference between the estimated age and the real age (p=0.1) which means that there is little difference between real age and estimated age (Table no 2). The Karl Pearson's correlation coefficients between Real age and the estimated age using the means are displayed in Table No 3.

Table No. 1: Comparison of real age and estimated age.

Sl. No	Real age (Years)	Estimated age using x2 (Years)	Estimated age using x1 (Years)	Estimated age using x1x2 (Years)
1	18	21	25.5	24.31
2	23	25.1	22.4	24.5
3	25	26.1	32	29.04
4	19	15	23	21.3
5	20	22.8	27	25.6
6	21	26.1	31.2	26.1
7	20	23.5	18.7	22.5
8	21	23.4	22.5	26.28
9	22	19.6	24.1	23.13
10	22	26.85	31.89	28.25
11	20	18.2	23.57	22.312
12	20	22.2	30.8	26.16
13	18	16.7	16.9	19.07
14	20	28.1	30.3	28.5
15	18	15.5	26.2	22.1
16	26	18.2	20.2	21.8
17	19	16.8	10.8	17.7
18	19	21.16	16.4	20.9
19	20	20.1	20.3	22
20	18	24.2	26	25.2
21	21	23.2	25.4	25
22	21	29	29	29
23	24	24.9	26	26
24	27	23.1	33.9	28.1
25	22	25.5	23.3	25
Mean ± SD (age in years)	21.0±2.5	22.3 ± 3.9	24.7 ± 5.6	24.4 ± 3.1

Table No. 2: Paired t-tests between real age and estimated age

Variables	Mean difference	t-value	p-value	significance
Real age and X2	1.3 ± 3.9	1.68	0.1	NS
Real age and X1	3.74±5.18	3.60	<0.01	S
Real age and X2X1	3.4 ± 2.9	5.84	<0.01	S

Table No. 3: Karl Pearson's coefficient between real age and estimated age

Variables	r-value	p-value	Standard error	R2
Real age and X2	+0.34	0.09(NS)	2.4	12%
Real age and X1	+0.38	0.06 (NS)	2.3	14%
Real age and X2X1	+0.45	0.02 (S)	2.2	21%

Discussion

The present study utilizes P/T area ratio as a parameter for age estimation. Previous studies have produced reliable results with reduced inter and intra-observer variability. Canines are usually preferred for the following reasons.

*Usually present in old age.

*Undergo less wear when compared to the posterior teeth.

*Are less likely to suffer wear when compared to other anterior teeth.

*Are the single-root teeth with the largest pulp area and thus the easiest to analyze.

In the present study the estimated age using maxillary canine showed no statistically significant difference between the estimated age and the real age (p=0.1) which means that there is little difference between real age and estimated age. This is in accordance with the studies done by Roberto et.al.

Estimated age using mandibular canines alone and combined maxillary and mandibular canines showed statistically significant difference between real age and estimated age with a p value of <0.01, which means that there is more difference between real age and estimated age. These results are in contrast with studies done by Robert et al. In the mandibular canines, the difference between real age and estimated age was more which may be because of difficulty to adopt RVG sensor to the mandible arch due to lack of space to accommodate it.

Nevertheless, the present age estimation method has the following distinctive advantages.

*This method does not require sectioning of tooth.

*Method is tested in subjects aged between 18-79 years.

*Possible to use in both living subjects and skeletal remains.

*This method can be used even though the skeletal remains are in poor conditions.

*Is a fast and chip method (needs approximately just 30 min for age estimation).

Future scope of this study lies in analyzing larger sample sizes in order to reduce the standard errors of the estimates and investigating the effect of race and culture.

Conclusion

Based on the results of the present study, we can conclude that P/T area ratio of the maxillary canine can be used as a reliable method to predict the age of the individual.

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Proposed Recommendation of Dental Age Estimation in Indian Population

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Abstract

The historical development of age estimation and the different techniques are presented. Also it is important to separate individuals below 18 years where tooth development can be used and those above 20 years of age where regressive changes must be used and where the visual assessment may be more important. Suggestions for new recommendations are presented. Finally the Indian dental age estimation project of BR in Northan Indian who claim to be below 18 years of age is described.

Keywords: Age estimation; Quality assurance, Project

Introduction

Dental age estimation can be divided into two periods in life. The first period is when the teeth are developing in the jaws up to 20 years. Comparison of the developmental stages with tables for the different stages may here be used as a scientific statistical method. Later, when all teeth are fully formed regressive age related changes might be used as a scientific method. Such methods are less accurate than methods based on the developmental stages.Dental age estimation may be performed both in living and dead persons. The same methods may be applicable. However for dead persons it is rarely possible to get any information about the living conditions and diseases of the individual. In addition, the teeth may be extracted and ground according to the different techniques for more accurate studies.An examination of the mouth and the dental conditions is an integrated part of age estimation in both living and dead persons. Such an examination should end with a visual assessment of the age of the individual. In many identification cases where we have good dental records the age estimation is of less importance. Thus a visual assessment may be enough. However, in cases where the age estimation may be greater importance, at least two scientific methods should be used.

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Age estimation of individuals below 20 years of age

Most scientific studies have been aimed at the construction of developmental tables for the different stages of tooth formation and how fine these stages can be graded without being imprecise and difficult to determine.Generally, only studies made after 1960 have sufficiently large material and fine grading so they should be used to calculate the age of the individual. These methods, based upon the developmental stages, are more accurate than age estimation based on the stages of eruption of teeth. Therefore, visual age assessment methods have not often been performed in these age periods and the trust in the statistical scientific tables has been strong. However, the dental development may be retarded by severe and long lasting diseases. This may also be the case in many congenital syndromes. Only rare hormonal hyper secretion may accelerate the development. Also nutritional deficiencies may retard the dental development. Severe dental diseases and tooth extraction may also influence the dental development. For a most accurate assessment of the age it is necessary to assess these factors and take them into consideration. In India we are using at one age estimation techniques in cases of age estimation in individuals below 20 years of age. Generally we are using the tables from Balwant rai in Northan Indian population 1 .

Age estimation of individuals above 20 years of age

In dental age estimation of individuals above 20 years scientific methods must rely upon regressive age changes such as attrition, loss of periodontal attachment and secondary dentin formation. Such parameters are partly influenced by function and also by pathologic processes and are thus far less accurate compared to the developmental stages of the teeth. Thus, in these cases the visual assessment may be almost as accurate as the calculated age according to a specific technique. A visual assessment may thus be an important supplement to scientific methods.The first scientific technique for age calculation in adults was presented by Gustafson 2. It was based on longitudinal sections of teeth cut through the central area. It can not be used for living person, only in dead when extraction of a tooth is allowed. The technique consisted in attributing scores from 0 to 3 for the presence and amount of age related changes such as attrition, periodontal ligament retraction, secondary dentin formation, root translucency and root resorption. The scores were added and a regression analysis with age as dependent variable was performed.Later his method has been modified by several researchers 2-6.All these formulae are based upon regression analysis e.g. multiple regression with age as dependent variable and the different age related changes as independent variables. The formulae are generally most accurate around 40–50 years and with increasing inaccuracy in younger and especially in older age groups. Also another difficulty is that there is a pronounced tendency for overestimation of younger persons and underestimation of older persons. These facts must be taken into consideration when making the final conclusion.

In living persons, it is not possible to extract teeth and grind them according to the different techniques. Thus a radiologic technique like the one developed by Jasdeep kaur and Balwant rai is one of the few that can be used. It is based only on the size of the pulp in relation to the whole tooth and gives a measure of the secondary dentin formation. However it is partly dependent on the anatomy of the tooth and pulp. Formulae exist for each of different teeth 7.

An alternative morphologic technique in living persons is the morphologic technique by Balwant rai 4 . This technique is based only upon attrition, and recession of the periodontal attachment, all variables that can be assessed in a living individual.For most methods of age calculation there is only one regression formula that is used for all types of teeth. This is obviously inaccurate as teeth emerge in the oral cavity at different times. Also the contribution of different types of teeth in chewing vary and thus the expected changes. We therefore hold that the best method should have one formula for each type of tooth.

It is difficult to collect extracted teeth to be used as material for methods of age calculations. Therefore, for some methods more than one tooth from the same individual has been used. For others the material is not described accurately enough so that the use of only one tooth from each individual can be verified. It may be obvious that the variation within one individual is less than between different individual. Thus this may result in a too small standard deviation and it may look like the method is more accurate than it really is.

New recommendation for quality assurance in age estimation

In the following the recommendations are proposed by Jasdeep Kaur and Balwant rai .

The purpose of the age examination is to:

1. Estimate the most likely age of the individual;

2. Make reference to the methods used.

All agreed on these steps. These are the more mechanical looking up a stage in a table or apply a formula. There is no assessment by the expert in this and the age estimation could in fact be done by anyone. There is no requirement of stating a standard deviation or confidence interval. It would always be incorrect as it is only valid for the individuals the method is based upon. We should never give any wrong figures in our reports and especially when it comes to statistics. However, the figures for the distribution of the data must only be taken as indicative for the real variation in the actual population.

As optional steps were that the purpose also is to:

3. Express the likelihood of an official age, if it exists;

4. Express the likelihood of an alternative age if it exists.

If the commission is given by the police they will ask explicitly for what they want to know. However others like private persons or schools, etc. do not know what to ask for. In my mind it is self evident that we have to take the official age and the alternative age into consideration, instead of just saying something about the standard deviation. We should express the likelihood of these two ages and if one can be excluded. If we do not do this, it is left to lawyers to argue without proper statistical understanding. The question is, however, whether forensic odontologists have sufficient understanding of statistics.

Optional is also the way of arriving at the final estimate by using:

1. The expert's own assessment;

2. Information from the person on the living conditions and diseases;

3. The results from scientific statistical methods.

As some dentists are not interested in background information the collection of these are also optional. They should be: family economy, food supply, water supply, serious diseases, previous dental problems and treatment, dental hygiene.

There was only agreement on checking the identity of the examined person during the clinical examination. Evaluating the oral mucosa and describing the dentition as far as occlusion, teeth present in the mouth, individual characteristics of the teeth, degree of attrition, colour of the teeth, staining and calculus, periodontal conditions and visual age assessment, solely based upon the teeth, are optional.

It was agreed to carry out a radiographic examination which should include radiographs that may enable the age estimation methods decided upon and which should describe the dentition and individual characteristics of the teeth. It was also agreed to use as many appropriate parameters as possible, to use methods as originally described in the literature and to use as many teeth as possible. Using at least two independent statistical methods was left as an option. Finally the conclusion should end with a complete assessment of the most likely chronological age.

As some of the participants would not make a clinical assessment nor ask for background factors, they had naturally difficulty with taking these factors into consideration in the final assessment of the age.

The optional factors were:

1. Assess if the methods are appropriate in relation to the individual;

2. Assess factors which may have influenced the tooth development or ageing;

3. Assess especially if pathologic factors or other may have influenced the findings.

Final remarks

We believe that this is the way to go for international guidelines on quality assurance in forensic odontology and in age estimation in particular. Steps to be observed should be specified on an international level and the exact technique to be used at each step should be left to the national societies. We have shown that this type of quality assurance is practicable in our age estimation . We have also suggested a improvements in the recommendations with due consideration to those who do not want to make any expert assessment, but confine themselves to reporting the result from a table or a formula.

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Jutta M. Joesch et al. *Does Your Child Have Asthma? Filled Prescriptions and Household Report of Child Asthma*. Elsevier. http://www.jpedhc.org/article/S0891-5245(06)00129-5/abstract (August 21, 2008).

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