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Age Estimation Using Ground Section of Tooth and its Correlation with Clinical, Radiographical Findings

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Abstract

Age estimation is a process of particular interest in cases of forensic interest as well as in anthropological studies. In order to obtain a more reliable and reproducible age estimation, the forensic odontologist should use available methods whenever age estimation in the living or dead is required. Various studies have been conducted in the past involving ground sections of teeth. Thus, a study was carried out to evaluate physiological changes in the teeth with the advancing age along with correlation of clinical, radiological and histological factors.

Keywords: Age estimation; Forensic; Clinical; Radiological; Histological.

Introduction

In the case of living people who have no acceptable documents, verification of chronological age is required in order to be entitled to civil rights and social benefits (Willem *et al*, 2002; Kvaal, 2006; Yang *et al*, 2006; Herchaft *et al*, 2007).[1-3] There are instances in which teeth are the only preserved human remains and present the only means for age determination (Gustafson *et al*, 1950; Bang & Ramm, 1970; Maples, 1978).[1] There are many morphological changes that appear during maturation such as dental wear, cementum apposition, secondary dentin apposition, gingival recession, root resorption, root transparency, acid racemization, color change and reduction in size of the pulpal cavity (Prince & Konigsberg 2008; Sengupta *et al* 1999). Many variables have been used as age determinants and even dental histological techniques can contribute to age determination (Sengupta *et al*, 1999). The choice to use teeth for age determination is well accepted due to their longevity ability of being resilient to change (Prince & Konigsberg, 2008; Brkic *et al*, 2006).[4-8]

It is of high importance to take into account that physiological or biological aging is in many cases not related to calendar (chronological) aging. In this manner, a biological marker independent of any environmental alteration is needed to provide information about the age of an individual (Prince & Konigsberg, 2008; Sengupta *et al*, 1999; Amariti *et al*, 1999). Such a biomarker is root dentin translucency, supported by

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Gustafson (1950). Thus, an older approach for age estimation was suggested by Gustafson (1950) focusing on 6 determinants including attrition, periodontitis, secondary dentine, cementum apposition, apical resorption, root translucency. These studies provide conclusive evidence that the base of each investigation is the choice of the correct age determinant (Prince & Konigsberg, 2008).[2]

Age is one of the essential factors in establishing the identity of the person. Estimation of the human age is a procedure adopted by anthropologists, archaeologists and forensic scientists. Different factors have been used for age estimation but none has withstood the test of time for adults above 25 years. Examination of teeth in many ways form a unique part of human body e.g. they are most durable and resilient part of the skeleton. The science dealing with establishing identity of a person by teeth is popularly known as Forensic Odontology or Forensic Dentistry.[2]

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.[3] By taking in consideration, these secondary changes in teeth with advancing age various studies were done to estimate the age of an individual. Such research has resulted in multi-factorial methods that help in age estimation.

Gustafson[3] in 1950 suggested the use of six retrogressive changes and ranked them on arbitrary scale, allotting 0-3 points according to degree of the change. Due to error in this morphometric method several modification were done in subsequent studies. Johanson[4] in 1971 in his research used same six criterions but different ranking scale and then estimated the age of an individual.

Material and Methods

Study Population

The material consisted of thirty teeth collected from the patients who reported for extraction of teeth from Department of Oral and Maxillofacial Surgery.

Inclusion Criteria

The teeth in the study consisted of were relatively healthy, erupted, permanent maxillary & mandibular premolars and molars extracted for valid clinical reasons like periodontal disease or orthodontic treatment. Only those teeth that revealed neither profound caries nor restorations were included. The teeth were stored in individual bottles with alcohol 94% before use. The teeth samples were in the age range of 2nd to 8th decade of life.

Exclusion Criteria

Deciduous Dentition.

Procedure Involved

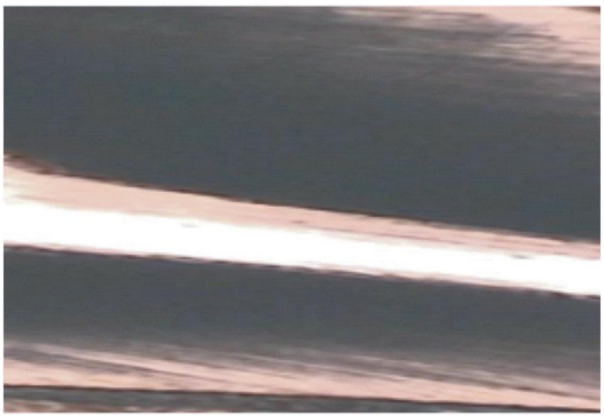
The following dental parameters were studied in each case: Attrition, Periodontal disease, Cementum apposition, Secondary dentine deposition, Root translucency and Root resorption. The apparatus used in the study were Tooth extraction forceps, Probe, Electric lathe (Figure 1), Arkansans stone (rough and smooth), Alcohol and Xylene, Formalin, Microscope and slide, etc.

Complete Case-History along with clinical examination of the Patients were recorded in the Case-history Proforma. After collecting the details, teeth to be studied were selected and

Figure 1: Electric Lathe

Fig 2 : Attrition

Fig 3: Ground Section of Tooth for Attrition



this selection is made based on the study of extracted tooth for Orthodontic Purpose, Decayed tooth and tooth selected were in the priority order of First Premolars, Second Premolars, Molars, Canines and Lastly Incisors. Degree of attrition and extent of periodontal disease were recorded before the extraction of the tooth. Then the tooth was extracted by extraction forceps and preserved in formalin until the ground section was prepared. Ground section was prepared by hand grinding which was done first with lathe and then with rough Arkansans stone until a section of 1 mm was obtained and at this thickness, the root translucency was noted. Grinding was further done using fine stone until the section of 0.25-mm thickness is left. Finally, cleaned and dried section was mounted on slide and viewed under microscope for secondary dentine, cementum apposition and root resorption.

Fig 4: Radiographic Interpretation of Periodontal Disease

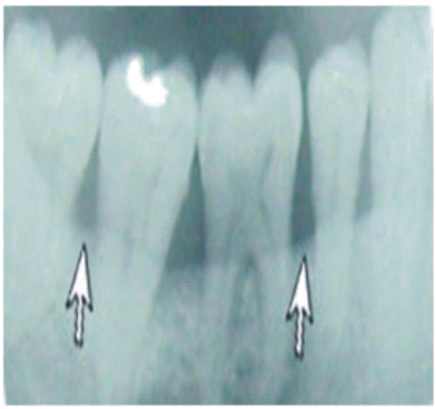


Fig 5: Clinical Root Resorption

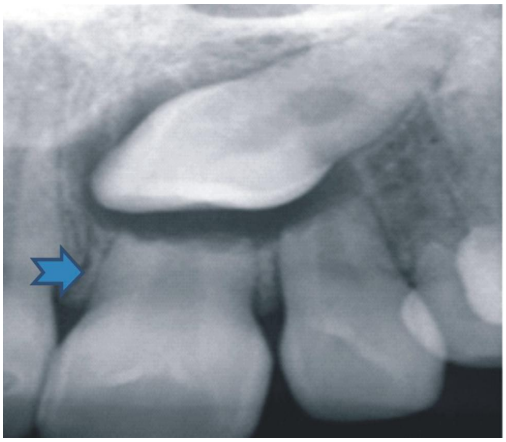
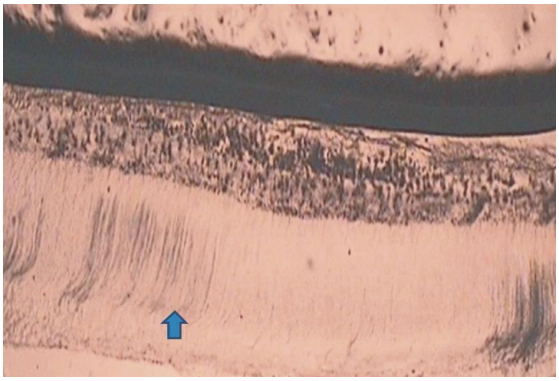


Fig 6: Root Translucency



The factors seen in the tooth before and after sectioning were recorded using 4 points allotment system.[5] [Table 1]

Scoring Formula

Age = 11.43 + 4.56 (Total Score). Eg. Age = 11.43+4.56(6)=38.79

Fig 7: Cementum Apposition

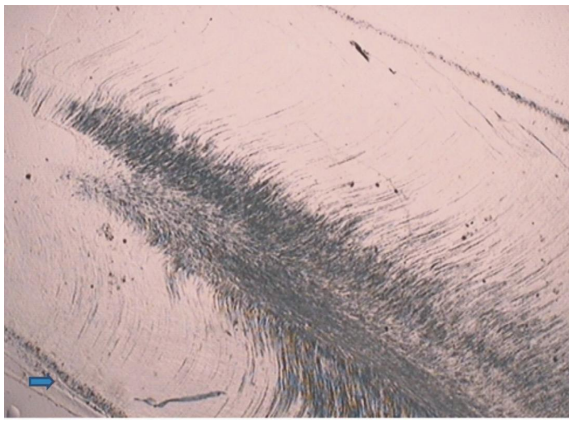


Fig 8: Secondary Dentin

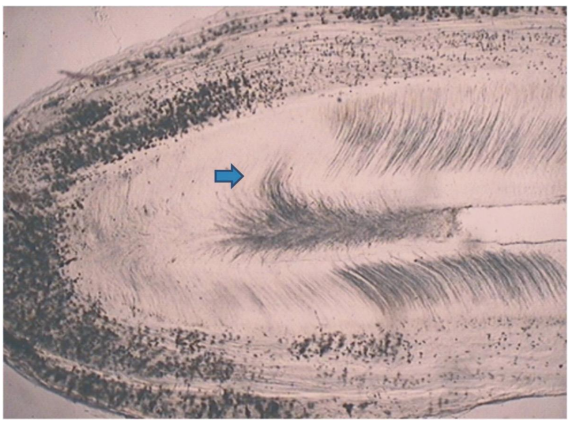


Table 1: Gustafson's Method

Sl. No.	Variable Selected	Gradings Followed
1	Attrition (A) Recorded Clinically	A0: No Attrition. A1: Attrition Limited to Enamel Level. A2: Attrition Limited to Dentin Level. A3: Attrition up to Pulp Cavity.
2	Periodontal Disease (P) Recorded Clinically	P0: No Obvious Periodontal Disease. P1: Beginning of Periodontal Disease but no bone loss. P2: Periodontal Disease more than one third of the root. P3: Periodontal Disease more than two third of the root.
3	Root Resorption (R) Recorded Radiographically	R0: No Resorption. R1: Spotted Resorption. R2: Resorption limited to Cementum. R3: Extensive Resorption of Cementum and Dentin Both.
4	Root Translucency (T) Recorded Microscopically	T0: No Translucency T1: Beginning of Translucency T2: Translucency more than 1/3rd of the apical root. T3: Translucency more than 2/3rd of the apical root.
5	Cementum Apposition (c) Recorded Microscopically	C0: Normal Cementum C1: Thickness of Cementum more Normal. C2: Abnormal Thickness of Cementum near the Apex of the Root. C3: Generalised Abnormal Thickness Of Cementum Through out the Apex of the Root.
6	Secondary Dentin(S) Recorded Microscopically	S0: No Secondary Dentin Formation. S1: Secondary Dentin Upto Upper part of Pulp Cavity. S2: Secondary Dentin Upto 2/3rd of the Pulp Cavity. S3: Diffuse Calcification of the entire Pulp Cavity.

Table 2: Distribution of Study Groups

Groups	Age (In Years)	No. of Cases
Group A	21-25	6
Group B	26-30	5
Group C	31-35	4
Group D	36-40	3
Group E	41-45	1
Group F	46-50	2
Group G	51-55	3
Group H	56-60	2
Group I	61-65	3
Group J	66-70	0
Group K	71-75	1
Total	11 Groups	30

Observations and Results

Out of the total 30 cases taken randomly from 17 males and 13 females.

Statistical Analysis

Intra and inter-examiner reliabilities were tested by checking the concordance of Gustafson's score. Finally, calculating tables for age estimation were designed and the accuracy of age estimation was obtained. Standard deviation was evaluated.

Results

Intra and inter-examiner concordances were 92.9 and 93.9% respectively, which means our scoring system is a very reliable method. Calculation tables were designed for age estimation in total male and female subjects respectively. The estimated age can be calculated by adding an intercept to the sum of numerical values obtained from the table.

Discussion

Forensic identification includes processing long bones and teeth in order to verify a person's age.[9] Based on these age-related changes a variety of methods for dental age estimation were proposed. Most of them require extraction (indirect measurement) with or without preparation of microscopic sections. These methods are time consuming and expensive, and destructive approach may not be acceptable for ethical, religious, cultural or scientific reasons.[10-12]

Since 1982 dental radiography, a non-destructive and simple technique used daily in dental practice, has been employed in methods of age estimation.[13]

Age estimation with ranges of 3-8 years are unsatisfactory from a legal stand-point and of limited use in forensic investigations where accurate age determination is an important factor. When assessing whether or not an individual is over or under the age of 18 years, however more positive conclusions may be drawn.[14]

Forensic Odontology is a relatively new science that utilizes the dentist's knowledge to serve the judicial system.[15] Dental practitioners should be aware of forensic application of dentistry.[16] When performing age estimation, accuracy and precision are of utmost importance. Forensic Scientist must remember the inherent imprecision and variability associated with age estimation measurements. Each age estimation method is based on a linear regression with associated confidence intervals.[17] We observed that estimated age was modeled as a linear function of the chronological age.[18] In this study, the entire sample was distributed into different age groups and found chronological and estimated age were closely related to each other. Similarly, effect of gender on age estimation also showed no significant influence on age. The mean age difference of calculated age from the actual age was ± 2.16 years, which was contrary to the finding of Gustafson who found age difference of ± 3.63 years. A regression formula $y = 4.6696x + 10.381$ was obtained where X is total points and Y is estimated age. These findings were similar to the results of the study done by Pillai and Bhaskar[19] in 1974. The method of Demirjian *et al* is, among other techniques reported, useful in estimating the chronological age of children based on their dental age, i.e., of children with unknown

Table 3: Calculation of Age Parameters in the Study Groups

Case No.	Actual Age	ParametersCalculated	Total Score	Calculated Age	Difference in Age
1	36	A0+P0+R0+S2+T3+C1	6	38.79	-2.79
2	22	A0+P0+R0+S1+T0+C1	2	20.5	1.5
3	22	A0+P0+R0+S2+T1+C0	3	25.1	-3.1
4	55	A1+P1+R2+S2+T1+C2	9	52.47	2.53
5	36	A3+P1+R0+S2+T0+C0	5	34.23	1.77
6	25	A0+P0+R0+S0+T1+C3	4	29.6	-4.6
7	21	A1+P0+R0+S0+T1+C0	2	20.5	0.5
8	59	A2+P2+R0+S2+T3+C1	10	57.03	1.97
9	26	A1+P0+R0+S2+T0+C0	3	25.1	0.9
10	33	A0+P0+R0+S2+T2+C1	5	34.23	-1.23
11	26	A0+P0+R0+S2+T0+C1	3	25.1	0.9
12	40	A1+P3+R0+S1+T0+C1	6	38.79	1.21
13	36	A2+P0+R0+S0+T2+C2	6	38.79	-2.79
14	58	A0+P1+R2+S2+T3+C2	10	57.03	0.97
15	51	A0+P1+R0+S2+T3+C2	8	50.91	0.09
16	48	A0+P1+R1+S2+T2+C2	8	50.91	-2.91
17	24	A0+P1+R0+S2+T0+C0	3	25.1	-1.1
18	48	A0+P3+R1+S2+T0+C2	8	50.91	-2.91
19	42	A0+P1+R0+S2+T3+C1	7	43.35	-1.35
20	53	A1+P0+R0+S2+T3+C3	9	52.47	0.53
21	29	A0+P0+R0+S2+T2+C0	4	29.6	-0.6
22	50	A0+P1+R0+S2+T3+C2	8	50.91	-0.91
23	29	A0+P0+R0+S0+T3+C1	4	29.6	-0.6
24	32	A0+P1+R0+S1+T1+C2	5	34.23	-2.23
25	71	A2+P2+R1+S2+T3+C3	13	70.71	0.29
26	25	A0+P2+R0+S0+T0+C1	3	25.1	0.1
27	35	A0+P0+R0+S2+T2+C1	5	34.23	0.77
28	27	A0+P0+R0+S1+T1+C1	3	25.1	1.9
29	34	A0+P1+R0+S2+T1+C1	5	34.23	-0.23
30	29	A0+P0+R0+S1+T2+C1	4	29.6	-0.6

birth data which is often true for adopted children or of children committing legal offenses. The technique may also be used to estimate the age of unidentified skeletons belonging to children.[20]

Conclusion

In this study, Mean age difference of the calculated age from actual age was found to be ± 2.16 years. Standard deviation was 1.56 for Gustafson's method of age estimation for our study. Each dental age estimation method provides a different combination of the accuracy, precision, procedure and requires different equipment. Forensic Odontologists should evaluate each age estimation case and in addition to their visual age assessment, choose one or more methods that would best serve their particular case, keeping in mind that accuracy and precision are the main requirements. Finally, it is important not only to generate methods for age estimation but also to test their reliability using independent data and examiners.

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