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Age estimation by dental parameters: Search continues

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Abstract---Age estimation is one of the essential factors in forensics. The hardness and resilience of teeth to the external factors such as chemicals, putrefaction, and fire explosions makes it a reliable source in age estimation. Simultaneously they also undergo age-associated regressive changes. Although age can be estimated by various methods but each method has its own pros and cons. The present study was undertaken with the aim of evaluating three histological methods using teeth. The objectives of the study also included assessment and comparison of two methods of age estimation employing multiple histological parameters, assessment of age estimation using single histological parameter, comparison of methods using multiple histological parameters with a single parameter method for age assessment. In our study we have found that method where

multiple parameters were used gave us the better results however a variation in age assessment does exist and the search continues.

Keywords---age estimation, attrition, root translucency, cementum annulations, root resorption, cementum apposition.

Introduction

Accurate determination of the biological age of an individual remains a problem in physical anthropology. In forensic sciences, a precise age assessment is a necessary requirement for individual identification. An entire set of age determination methods has been elaborated – both macroscopic and microscopic. However, both anthropologists and forensic experts judge these methods to be far from perfect. The search for new methods thus continues.

Dentition is the most durable and often a very informative system for vertebrate organisms, and many age determination methods are based on teeth as they are resistant to different external influences as well as mechanical, thermal and chemical irritation and are naturally preserved long after all tissues and even bones have disintegrated. Further, they grow continuously throughout the life and even undergo degradation which leaves behind evidences by which the age of the individual can be calculated.

Till date methods like histological, clinical, radiological and molecular biology have been proposed by different authors that uses teeth as an indicator for age estimation. Pertaining to histological method, Gustafson's in 1950 suggested the use of 6 retrogressive changes and ranked them on an arbitrary scale, allotting 0-3 points according to the degree of change and linear regression equation was made for assessing the age.^[1] Johanson tested this Gustafson's method on a larger scale and added 2 major refinements – intermediate grades for scoring each variable and multiple regression.^[2] (Figure 1)

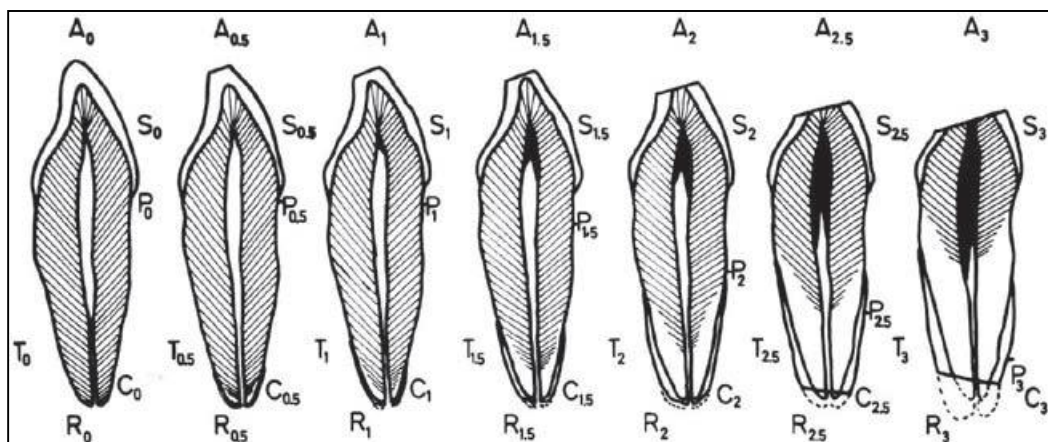


Figure 1: Gustafson's variable and the seven grades suggested by Johanson.

The odontoblasts lining the pulp cavity continuously deposit secondary dentin along the wall of dental pulp chamber leading to a progressive decrease in its volume. Bodecker in 1925 first projected the use of secondary dentin as an age indicator which was included in the method by Gustafson. Applicability of secondary dentin alone as an age indicator has been put forward by various authors using either histological (Solheim et al) or radiological(Kvaal et al, Paewinsky et al, Cameriere et al) approach.^[3,4,5,6]

With advancing age there was gradual increase in the dentinal translucency which could be attributed to the deposition of hydroxyapatite crystals within the dentinal tubules leading to a decrease in light scattering ability of dentin. Metska et al, Lamendin et al, Bang & Ramm proposed formulae dependent on the transparency as the sole morphological predictor for the estimated age.^[7,8,9] Tooth to tooth friction causes the form of wear called attrition. Measurements of attrition have also been advocated as age indicator by Richards et al, Kim et al, Li et al with results statistically significant.^[10,11,12]

Cementoblasts, during its life time deposit cementum onto the roots of the teeth in a more or less regular pattern which can be seen as a combined set of bright and dark line under a microscope. Because of its rhythmic deposition, it can be proved as a valuable tool for age determination. Lipinsic et al correlated the age with cementum annulations and the results were statistically significant.^[13] Pundir et al assessed the age of the patients based on tooth annulations using three different(light, polarized and phase-contrast) microscopic technique.^[14]

The present study was undertaken with the aim of evaluating three histological method using teeth. The objectives of the study also included assessment and comparison of two methods of age estimation employing multiple histological parameters, assessment of age estimation using single histological parameter, comparison of methods using multiple histological parameters with a single parameter method for age assessment.

Materials and Methods

A total of 47 patients (Table 1) were selected from the Department of Oral Medicine & Radiology of RKDF Dental College and Research Center, Bhopal with age range from 27 to 65 years.

S. No.	Teeth included in the study group	Number
1.	Maxillary Central Incisor	4
2.	Maxillary Lateral Incisor	1
3.	Maxillary Canine	4
4.	Maxillary 2 nd Premolar	1
5.	Maxillary 1 st Molar	1
6.	Maxillary 2 nd Molar	4
7.	Maxillary 3 rd Molar	1
8.	Mandibular Central Incisor	8
9.	Mandibular Lateral Incisor	2
10.	Mandibular Canine	5

11.	Mandibular 1 st Premolar	3
12.	Mandibular 2 nd Premolar	2
13.	Mandibular 1 st Molar	5
14.	Mandibular 2 nd Molar	4
15.	Mandibular 3 rd Molar	1
16.	Deciduous Maxillary Central Incisor	1

Table 1:- Teeth included in the study group

The inclusion criteria for the teeth selected were

- Teeth extracted for orthodontic purpose, mobility and fabrication of dentures.
- Teeth devoid of any pathologies.
Teeth with any clinical and radiological pathology were excluded. Teeth were preserved overnight in formalin and cleaned with hydrogen peroxide followed by which it was washed thoroughly under running water. The tooth was kept along the lateral surface of the lathe and was grinded till it was 3 to 4 mm in thickness. Then it grinded manually on a fine carborandum stone till the section of 0.25 mm thickness was left. The section was then finally cleaned and dried section was mounted on slide using DPX. Sections were then visualized under microscope.
- techniques of dental age estimation were carried out (Table 2):-

4 parameters by Kashyap and Koteswar ¹⁵	5 parameters by Rai ¹⁶	Cementum annulations
1. Attrition	1. Attrition(A)	Counting of incremental lines of cementum
2. Secondary dentine	2. Secondary dentine(D)	
3. Cementum apposition	3. Cementum apposition(CE)	
4. Root translucency	4. Root translucency(T)	
	5. Root resorption(R)	

Table 2:- Dental age estimation methods used in the study.

- The estimated age was obtained using equation (4 parameters)⁽¹⁵⁾ :-

$$A = \{(A)+(D)+(T)+(CE)\} / 4$$

Using statistics, linear as well as multiple regression equation was made for the criteria.

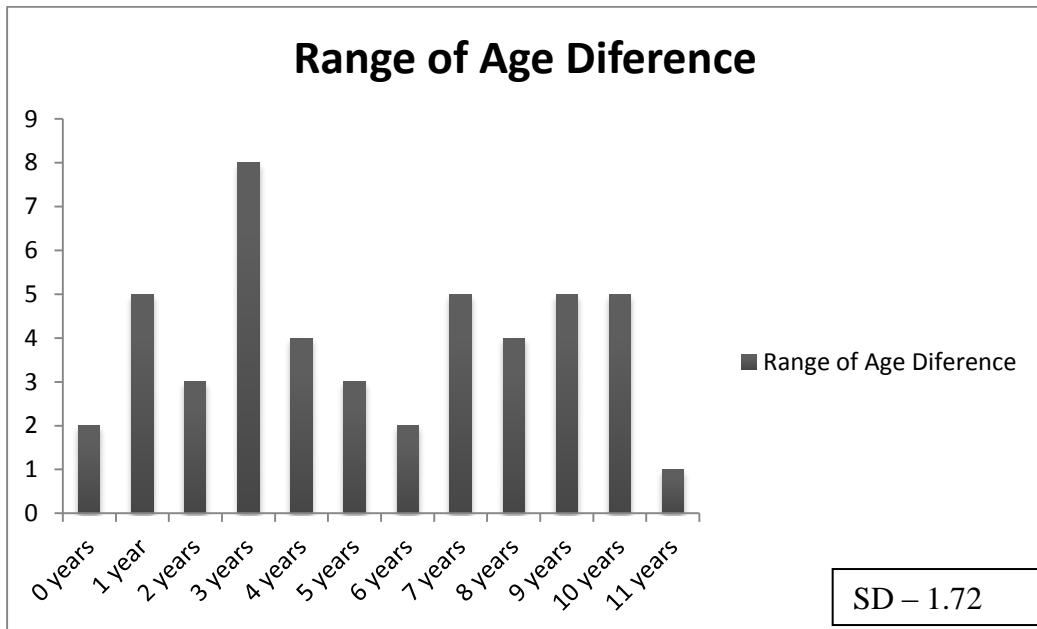
- The estimated age was obtained using equation(5 parameters)⁽¹⁶⁾:-

$$A = -0.654A + 1.32D - 1.978CE + 2.432T + 51.63R$$

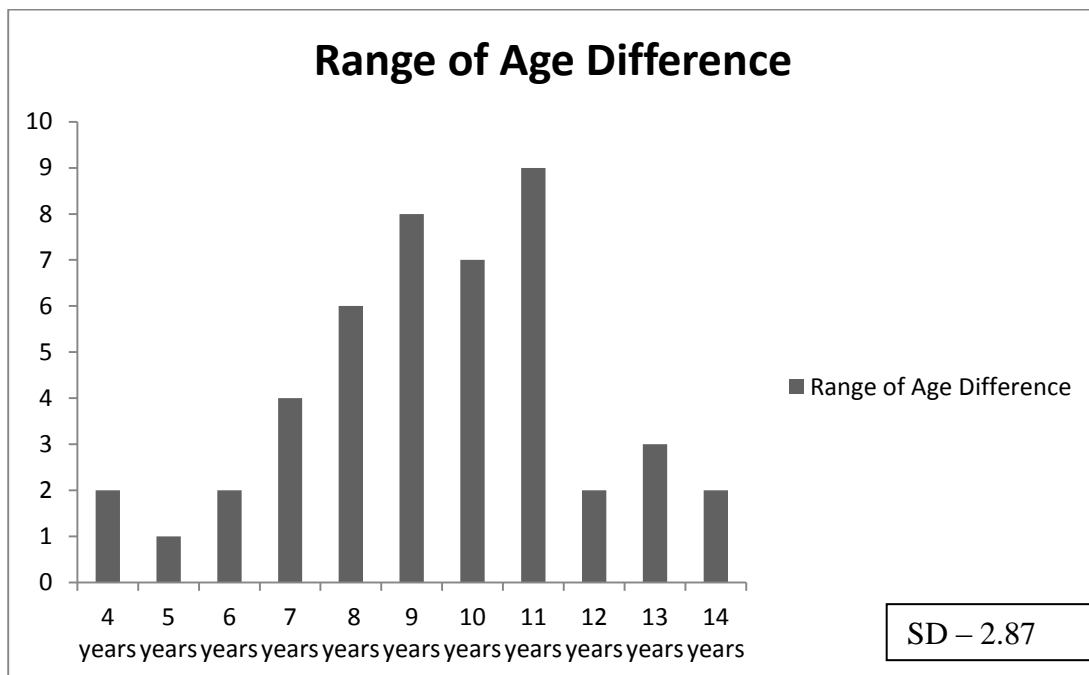
For counting cementum annulations digital images of incremental lines were taken from every section with binocular Olympus microscope. Micrographs were taken in 10X objective with the help of Olympus research microscope with attached MIPS-USP070. The images were magnified on the computer and the cemental lines were counted with the help of pro image 3.0 software.

Results

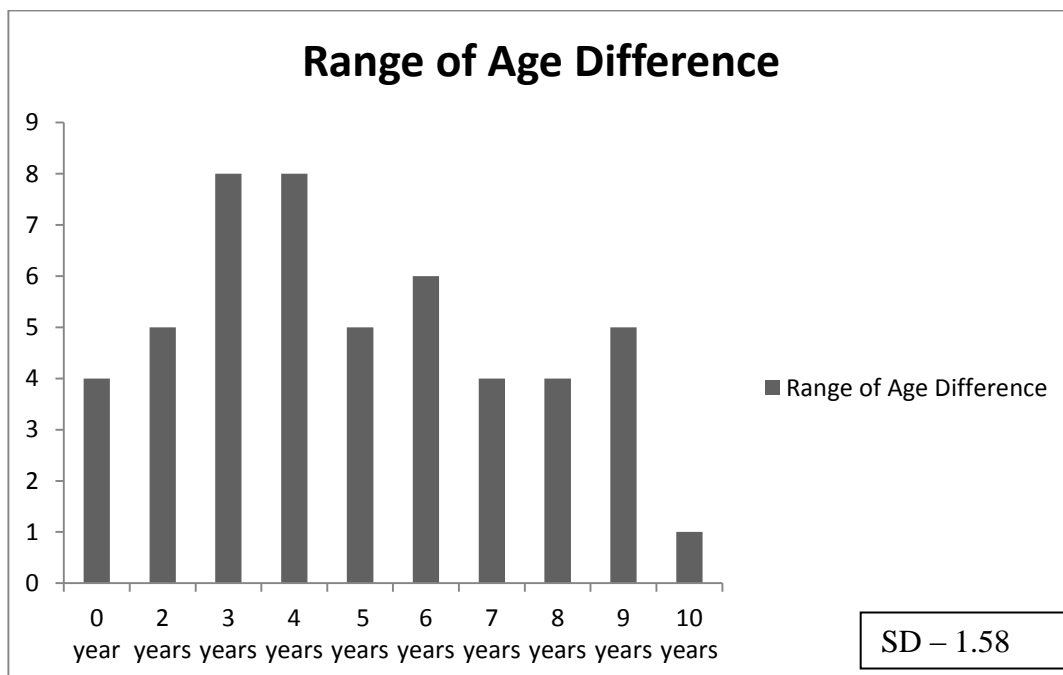
The standard deviation obtained was comparable in all the three techniques, but the method employing multiple parameters scored better than method using single parameter. Even among the multiple parameters, the technique that involved 5 parameters gave better results than Kashyap & Koteshwar with a standard deviation of 1.58 followed by the later with a standard deviation of 1.72.(Graph 1, Graph 2, Graph3)



Graph 1:-Results from Kashyap and Koteshwar Criteria



Graph 2:- Results from cementum annulations



Graph 3: Results from Balwant Rai et al

Discussion

The results demonstrate that tooth cementum annulations show a higher degree of variability as compared to the other 2 methods. Even the technique using higher number of variables was the most reproducible method. Kashyap and Koteshwar modified the Gustafson's technique by omitting the 2 parameters like root resorption and gingival recession. They were omitted because it was difficult to assess these 2 parameters on every sample and even they were lost on preserved samples. A standard deviation of 1.6 years was obtained in the study done by them which is comparable to the results obtained in our study.^[15]

Even when 5 parameters were used, soft tissue parameter i.e. gingival recession was not taken into consideration and root resorption was included. Between these 2 techniques, the method using higher number of parameters scored better. This could be attributed to the individual variations which may be because of the use of regressive alterations in both the methods. If we consider possible changes in all the tissues of the teeth and use multiple regression analysis, it has been shown that more number of parameters resulted in a better correlation with age.^[17]

In case if only single parameter, i.e. cementum annulations was taken into account, variations in cementogenesis induced by biomechanical forces, nutritional status, hormonal fluctuations or ecological factors influenced the number of cementum annulations. Apart from being a tedious method, it is highly technique sensitive. There is no standardized protocol to how to prepare sections and count the lines. To offset this, many methods of counting cementum annulations has been used such as – light, polarized and phase-contrast microscopy. In spite of all these advancements the problem still persists. Moreover, errors in the assessment of line count, selection of an appropriate section reduces the reproducibility and applicability of this method and the same thing is been reflected in our study.

Even on statistical analysis, when age of the sample was calculated using 5 parameters, they showed a variation upto 10 years, when using 4 parameters range was till 11 years while when TCA was used samples showed a variability of 14 years. The number of samples showing variations was also higher in TCA.

Conclusion

Ever since Gustafson has given idea of age estimation we have seen a number of parameter given by various authors but there is no single histological method either employing multiple or single parameter which can accurately predict the age. In our study we have found that method where multiple parameters were used gave us the better results however variations in age assessment does exist and the search continues.

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