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Estimation of Age by Modified Gustafson's Method from Incisor and Canine Teeth

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Background: Estimating age from teeth is generally reliable as they are naturally preserved long after all the tissues and even bones have disintegrated. **Aim of the study:** The present study was an attempt to estimate the age of an individual by using modified Gustafson's method from age related alteration in incisors and canines in Karad. **Materials and methods:** A cross sectional study was conducted in Karad for a period of 4 months from Nov 2018 to Feb 2019. **Results:** 95 teeth were observed, out of which 59 were incisors and 36 canines. The coefficient of variations among parameters ranged from 22.61 to 29.92%. **Conclusion**: - The estimated age error was minimized to 1.15 years. The age calculated by this method was found to be more accurate, reliable and reproducible.

Keywords: *Age, tooth, incisor, canine, attrition, secondary dentin, cementum apposition.*

Introduction

Identification of the person is of paramount importance in forensic practice. Age estimation is one of the important factors employed to establish identity. Estimating age from teeth is generally reliable as they are naturally preserved long after all the tissues and even bones have disintegrated[1-5].Recent natural disasters like earth quakes in different states of India, world trade center attack etc. has brought in to focus the importance of teeth in determination of age of an individual and thus helping in their identification. Age estimation from the teeth may be the only useful method especially when the skull is only available as skeletal remains[6].

In children age estimation from the teeth is relatively simple and accurate**.** For adults, the methods are often based on degenerative modifications, such as attrition, periodontosis, transparency of the root, secondary dentin, cementum apposition and root resorption[7-10].

With the lack of quantification in the Gustafson's system, modified method which is based on the quantitative evaluation of four parameters: the attrition, the secondary dentine, cementum apposition and the transparency of root was used to estimate age where standard error of ± 1.50 years was claimed[6, 7].In this study incisors and canines were used as these are less affected by pathological conditions such as caries as compared to the molars and premolars.

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Aims and objective:

To estimate the age of an individual by using modified Gustafson's method from age related alteration in incisors and canines in Karad.

Material and Method

A cross sectional study was conducted in department of Forensic medicine and Toxicology, Krishna institute of medical sciences, Karad for a period of 4 months from Nov 2018 to Feb 2019. Criteria for selection of specimen (Incisors and canines) were the tooth should be caries free and should not have either root or crown fracture.

The incisors and canine were collected from known cadavers between the age group of 20 to 70 years dissected by medical students in the department of Anatomy, Krishna institute of medical sciences, Karad. They were cleaned under tap water and then kept in 10% formalin for 24 to 48 hours. The sample bottles were labeled with actual age of the person from whom the specimen was collected and also labeled to the type of

tooth.

Prior to grinding, incisors and canines were kept in water. Then 1- 2 mm sections were prepared to the central axis of each tooth symmetrically from both sides using the rough carborundum stone grinder with supplementation of continuous water flow from an IV set to reduce the heat produced during grinding. Precautions to avoid cracks and cleavages were taken during grinding of tooth.

After grinding the tooth up to 2 mm, the section of 0.1 mm thickness was prepared on the Arkansas stone. The Arkansas stone was kept in enamel tray containing water. The grinding action was only in one direction to avoid irregularities in sections.

Following dehydration, tooth sections were mounted on glass slides with DPX mountant for microscopic observations. The microscopic parameters were observed at the magnification of 0.25 using light microscope.

Principles:

The formulae of the various index values for each parameter are as follows.

Each index value of the various parameters undergoing regressive changes were calculated by relating the measured change to a fixed measurement on the tooth. The changes in the various tooth parameters were due to functional changes along with age.

1. Attrition (A):

$$[A] = \frac{a}{A} \times 100$$

'a' is width of the tooth in mm at tip showing attrition.

'A' is the width of the tooth in mm at cervical margin.

2. Secondary Dentin (D):

The index value of secondary dentin was measured as percentile value of secondary dentin deposited and the total length of pulp cavity.

$$[D] = \frac{d}{D} \times 100$$

'd' is length in mm of secondary dentin deposition in the pulp cavity.

'D' is the length of entire pulp cavity of the tooth.

3. Translucency of the root (T):

$$[T] = \frac{t}{T} \times 100$$

't' is the length in mm of the translucent region of the root.

'T' is the length in mm of the entire tooth.

4. Cementum Apposition (CE):

$$[CE] = \frac{ce1 + ce2}{CE} \times 100$$

Where ce1 and ce2 were the thickenings of cementum in mm of the thickest point on either side of the tooth and CE is the width in mm of teeth with cementum at thickest point.

The average age was calculated from different index values and it was estimated as

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

Measurement of parameters:

This is known as modified Gustafson's formula for age determination from tooth which was used in the present study[6].

The data was collected and analysed with SPSS 20 Statistical Software and presented as descriptive statistics. The efficacy of proposed modified Gustafson's method in relation with actual age was assessed by computing mean, coefficient of correlation and student t test.

Results

Table No. 1: Showing total number of samples of incisors and canines.

Teeth	Frequency
Incisors	59
Canines	36
Total	95

Table No. 2: Information of attrition, secondary dentin, root translucency, cementum apposition, actual age and estimated age of 95 cases.

Sr. No.	Variable	Range	Mean	SD	CV%
1	Attrition	13.99– 57.62	39.28	11.12	28.30%
2	Secondary dentine	24.13-63.52	47.47	11.19	23.57%
3	Root translucency	19.05-104.27	75.76	17.47	22.75%
4	Cementum apposition	10.06-64.13	35.39	10.59	29.92%
5	Actual age	20.00-70.00	48.94	11.34	23.17
6	Estimated age	21.53-67.96	49.74	11.25	22.61

Table No. 2 revealed that coefficient of variations among parameters ranged from 22.61 to 29.92%.

Table No. 3: Showing correlation coefficient (r) among actual age (AA), attrition (ATT), secondary dentine (SD), root translucency (T), cementum apposition (CE) and estimated age (EA).

	AA	ATT	SD	T	CE	EA
AA	--	--	--	--	--	--
ATT	0.9276***	--	--	--	--	--
SD	0.7777***	0.1407*	--	--	--	--
T	0.6470**	0.2258*	0.6379***	--	--	--
CE	0.2089*	0.8812***	0.5210***	0.6321***	--	--
EA	0.9884***	0.7852***	0.7852***	0.941***	0.820***	--

Correlation is significant at the*** = 0.001 level, ** = 0.01 level and * =0.05 level

Table No. 3 gives the information regarding the relationship between the different parameters under investigations. The relationship between these parameters was expressed in the form of correlation of coefficient (r).

Table No. 4: t-test for actual age of sample and estimated age.

Variables	No. of samples	Mean	SD	SE of mean
Actual age	95	48.94	11.37	1.167
Estimated age	95	49.74	11.25	1.155

Mean difference = 0.091

T test for equality of means:

Variances	t values	df	p values
Equal	0.001	188	> 0.05

Table No.5: Showing index value of attrition, secondary dentine, root translucency and cementum apposition by different workers:

Sr. No.	Attrition	Secondary dentine	Root translucency	Cementum apposition
1	0.93 (Kambe T) [11]	0.83 (Tore Solheim) [18]	0.67 (Wegener R) [22]	0.38 (Solheim T) [24]
2	0.607 (Tomaru Y) [12]	0.72 (Kwak KW) [13]	0.60 (Solheim T) [23]	0.251 (Monzavi) [15]
3	0.630 (Kwak KW) [13]	0.522 (Monzavi) [15]	0.344 (Monzavi) [15]	
4	0.925 (Seth S) [14]	0.609 (Sangeetha P) [16]	0.872 (Sangeetha P) [16]	0.4937 (Sangeetha P) [16]
5	0.394 (Monzavi) [15]	0.764 (Shrigiriwar M) [19]	0.838 (Shrigiriwar M) [19]	
6	0.622 (Sangeetha P) [16]	0.664 (Arora J) [20]	0.97 (Narayan VK) [17]	0.58 (Vystreilova) [21]
7	0.90 (Narayan VK) [17]	0.83 (Vystreilova)[21]	0.75 (Vystreilova)[21]	
8	0.927 (Present study)	0.777 (Present study)	0.647 (Present study)	0.208 (Present study)

Discussion

In the present study, total of 95 teeth were observed, out of which 59 were incisors and 36 canines. Attrition, secondary dentin, root translucency and cementum apposition were four parameters used in calculating the age of an individual. The coefficient of variations among parameters ranged from 22.61 to 29.92%. The variations are biologically induced variations. They are interrelated with each other. The extent of variation among the observation for actual age and estimated age was almost same.

The relationship between actual age (AA), attrition (ATT), secondary dentin (SD), root translucency (T), cementum apposition (CE) and estimated age (EA) was expressed in the form of correlation of coefficient (r). All the values of (r) obtained were positive indicating the positive correlation between various parameters. There is significant positive correlation between age of the individual and index value of all four parameters as shown in table no 3. Both the values of actual age and estimated age showed a similar trend regarding its relationship with attrition, secondary dentin, root translucency, cementum apposition.

The difference between the actual age and estimated age was insignificant from statistical t test ($p > 0.05$). So on the basis of values obtained from correlation of coefficient and t test it is confirmed that the age of the subject can be safely calculated by the modified Gustafson's method.

Index value of attrition was ranging from13.99 to 57.62, with a mean 39.28 and standard deviation ± 11.12. The value of r= 0.927 between actual age and attrition represented a significant correlation coefficient at 0.001 level. Though attrition varies according to functional variation, it can be used as a reliable index in age estimation, but it is more reliable when used in combination with other variables.

In the present study, index values for secondary dentin showed range from 24.13 to 63.52 with the mean of 47.47 and standard deviation ± 11.19. The value of correlation coefficient among the actual age and secondary dentin formation demonstrated a positive relationship with value (r= 0.777). The correlation between age and single measurement of secondary dentin formation is generally almost as strong as between age and attrition or age and apical translucency, but stronger than between age and cementum apposition. Also the rate of secondary dentin formation may vary in different types of teeth, as canine has shown less of secondary dentin than incisors. But the secondary dentin formation may be so closely related to age to play an important role in multiple regressive formulas for age estimation.

Analysis of 95 teeth in the present study showed, the index value range, which ranged from 19.05 to 104.27 for the patients between 20-70 years, with a mean of 75.76, the values of correlation coefficient among actual age, attrition, secondary dentin, cementum apposition with that of root translucency showed a significantly positive correlation at 0.01 level. The r value between actual age and root translucency was 0.647 which showed significant positive relationship.

Non vital teeth exhibit no signs of translucency in root dentin. But the non vital teeth, location of teeth in the jaws, gender are of little value in age estimation. From the present study, it can be concluded that root translucency above the age of thirty can be a valuable criterion in age estimation. Root translucency can be use as a sole criterion only when the remains consist of root portion. But more accuracy can be obtained when root translucency is used with other three criteria.

In this study, index value for cementum apposition ranged from 10.06 to 64.13 with mean of 35.39. Value for correlation coefficient among actual age and cementum apposition is (r=0.2089) which shows positive correlation.

Though a number of modifications have been suggested by investigators, the modified Gustafson's method still remains the most reliable method in determination of age from tooth. The findings of the present study are in accordance with this.

After complete evaluation of this method, it can be stated that the root translucency and secondary dentin can only be used in estimation of agse of an individual, because these two criteria show a simultaneous increase as the age advances. Most commonly affected criterion by pathology is the attrition and cementum apposition. So it is stated that, though no one of the four criteria can be used alone, all four are useful if used in combination. The estimation of changes should be evaluated. For example: in the cases of attrition, occlusion and articulation must be taken into consideration. Their variations are in the old age individual depending upon factors, such as periodontal conditions and habits.

5. Estimated age:

Table No. 6: showing comparative data of estimated age by different workers.

Sr. No.	Name of the workers	SE of estimated age
1	Bang and Ramm[25] (1970)	7 to 13 years
2	Johnson[26] (1971)	± 5.16
3	Kashyap VK[6] (1990)	± 1.59
4	Amandeep Singh[27](2003)	± 2.16
5	Present study	± 1.15

In the present study, the estimated age error was minimized to 1.15 years. Thus the age calculated by this method was found to be more accurate, reliable and reproducible.

Conclusion

The present study showed that the correlation coefficient between actual age and various parameters was found to be significant. The estimated age error was minimized to 1.15 years. Thus the age calculated by this method was found to be more accurate, reliable and reproducible.

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