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Chronological Age Estimation by Physiological Changes in the Teeth Among Deceased Human Adults

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ABSTRACT

Background: Age can be estimated from the teeth by various methods like eruption of teeth which is known to be a good indicator of the age of the person.

Aims & Objectives: The current study aimed to estimate the chronological age by physiological changes (Modified Gustafson's method) occurring in teeth and also to find out the effect of the diet, other habits and socio demographic factors on physiological changes in the teeth.

Materials and Method: Present study was done by using the teeth extracted from the deceased bodies sent for post mortem examination to the Department of Forensic Medicine, Sri Venkateswara Medical College, Tirupati, during the period of January 2016 to December 2016. A total of 70 cases were studied in the age group between 25 to 60 years. Six physiological changes were studied in each case that were Attrition, Periodontosis, Secondary dentin deposition, Root resorption, Transparency of the root and Cementum opposition using modified Gustafson's formula.

Results: The mean score of these physiological changes was directly proportional to age. Male to female ratio and non-vegetarian to vegetarian ratio was 3:1. The mean total score was high among males, urban residents, belonged to upper middle-class socio-economic status and alcoholics. However, means total score was low among smokers

Conclusion: Thus, in our study we found that when all the six physiological age factors were scored and used together collectively, we will get better results, rather than using a single physiological factor for estimation of age. Socio demographic factors, diet and habits have no effect on age estimation.

Keywords: Modified Gustafson's criteria, teeth, Physiological changes, Age estimation,

INTRODUCTION

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.[1]

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Age estimation can prove critical part in victim identification process. It can be done in precious archaeological skeletal material dating back to hundreds of years.[2]

Age can be determined from a variety of general physical factors like from height and weight which is applicable in early periods of life, dental development and changes occurring at puberty.[3]

Teeth are strongest parts in human body and are therefore highly durable and very resistant to external influences like putrefaction, fire etc, from teeth age can also be estimated from microscopic examination of a section of central part of teeth by counting the cross striations which appear daily as devised by Boyde and Gustafson's method is used for age estimation from teeth specially for the age above 25 years.[4] Newer modifications like killian's method uses subjective evaluatuion of six markers: The degree of attrition, the periodontosis, the secondary dentine deposition, cementum opposition, transparency of the root and root resorption. Whereas some like koteswarrao and Kashyap attempted the quantitative evaluation of four markers: the attrition, the secondary dentine deposition, cementum opposition and transparency of the root.[5]

In 1950 Gosta Gustafson was the first to devise the microscopic method for age estimation based on the histological examination of ground sections of the teeth.[6] This study is done to estimate the age of person, to note the various physiological changes occurring in teeth which help in age estimation and to find the effect of chewing tobacco, pan effects, sex, socio economic status, diet on these physiological changes of teeth, that are helpful in age estimation.

AIMS AND OBJECTIVES

The current study aimed to estimate the chronological age by physiological changes (Modified Gustafson's method) occurring in teeth and also to find out the effect of the diet, other habits and socio demographic factors on physiological changes in the teeth.

MATERIALS AND METHODS

Present study was done by using the teeth extracted from the deceased bodies sent for post mortem examination to the Department of Forensic Medicine, Sri Venkateswara Medical College, Tirupati, during the period of January 2016 to December 2016. A total of 70 cases were studied in the age group between 25 to 60 years. Six physiological changes were studied in each case that were Attrition, Periodontosis, Secondary dentin deposition, Root resorption, Transparency of the root and Cementum opposition using modified Gustafson's formula.

The teeth were extracted from the dead bodies with informed consent and information regarding age, sex, occupation, monthly income, diet, place of living, education, personal habits like alcohol and smoking were taken from the family members/ relatives / friends and from police officials. The socio-economic status of the diseased persons studied according to Modified Kuppuswamy scale of classification which was updated in the year 2016.

The following apparatus used for teeth extraction and preparation of ground section :Periosteal elevator, Tooth extracting forceps, Extracted teeth, 10% Formalin, Micro motor, Diamond shaped disc, Carborundum stone, Absolute alcohol, Xylene, DPX, glass slides and cover slips.

Method of preparation of ground section of a extractad teeth

For preparation of ground section, the extracted teeth are thoroughly washed with soap and water and then treated with 10% formalin solution, for about 17 days allowing fixation. The degree of attrition and degree of periodontosis are studied at the time of extraction of teeth from the jaw and noted in the proforma. The teeth after removal from the formalin are washed thoroughly with water and in a wet condition their both edges are sliced with a micro motor having a straight handle fixed to a diamond tipped disc. The mid

portion of each tooth thus obtained, is rubbed manually against rough carborondum stone till to the thickness of 1mm and observed for the degree of translucency at this level. The teeth are further rubbed against rough and smooth surfaces of the carborondum stone up to the thickness of 0.25 mm. At this level they are dried in absolute alcohol for 15 minutes and in xylene for clearing dust for further 15 minutes, and allowed to dry. After drying, the teeth are mounted on to a glass slide with DPX (mixture of distyrene, a plasticizer and xylene) These slides are seen under light microscope with 10x power and the degree of cementum opposition, root resorption and secondary dentin deposition are observed and noted. The various physiological changes thus observed in the teeth are recorded using 4 Point allotment system.

After collection of the data, the total score of all these physiological changes is calculated and compared with known age and age calculated by using Gustafson's formula of age estimation. so as to know their reliability and to note the effect of socio demographic factors such as sex, diet, smoking, alcohol, residence, socio-economic status on the outcome of age with physiological changes of teeth. Mean total score and mean difference between known age and age estimated by Gustafson's formula were calculated. The following formula used for age estimation: **Gustafson's Formula (I):**y =4.56 x + 11.43. (y=age, x=Mean total score). This study was approved by Institute ethics committee, S.V. Medical College Tirupati. Informed consent was from taken from the family members/ relatives /friends and from police officials.

Data was entered in Microsoft excel and checked for errors and analysed with IBM SPSS, version 26 software. Qualitative data was presented as frequency and percentage. Quantitative data was presented as Mean(SD). Student t test was used to test the significant difference between two means and one way ANOVA was used to test the significant difference between more than two means. p value <0.05 was considered as statistically significant.

RESULTS

The ages ranged from 25 to 65 years with mean 40.43 (11.23). Gustafson's scores ranged from 25.11 to 61.59 with mean 41.14 (11.51). The differences between actual age and ages calculated by modified Gustafson's formula ranged from -3.77 to 4.23 with mean 0.71 (1.84).

Majority of the study subjects were in the 25-30 years followed by 36-40 years. Lowest were in the 46-50 years. Majority were males from rural areas belonging to lower socioeconomic status, non vegetarians, non-smokers and non alcoholics. (Table 1)

Below table shows grades of various physiological changes in the teeth. In all physiological changes most of the teeth were

Table 1: Socio-demographic characteristics of study subjects

Variable	Categories	Frequency	Percentage
Age group	25-30	20	28.57
	31-35	07	10
	36-40	15	21.43
	41-45	6	8.57
	46-50	5	7.14
	51-55	7	10
	56-60	10	14.29
Sex	Male	53	75.71
	Female	17	24.29
Residence	Urban	16	22.85
	Rural	54	77.15
Socio economic status	Upper	7	10
	Upper middle	9	12.86
	Lower middle	18	25.71
	Upper lower	15	21.43
	Lower	21	30
			100
Diet	Vegetarian	17	24.29
	Non-Vegetarian	53	75.71
Smoking	Smokers	24	34.29
	Non – smokers	46	65.71
Alcoholism	Alcoholics	30	42.86
	Non – Alcoholics	40	57.14

in grade 1 (51.4%, 67.1%, 80%, 71.4%, 51.4% and 52.9% respectively among attrition, periodintosis, Secondary dentin deposition, Root resorption, Transparency of the root and Cementum). Grade 3 was seen in all physiological changes. (Table 2)

The mean age estimation by age groups measured by modified Gustafson's formula is significant. The mean age estimation by gender, Residence, Socio economic status, Diet, Smoking and Alcoholism status measured by modified Gustafson's formula is not significant. The mean age difference by age groups, gender, Residence, Socio economic status, (Table 3) Diet, Smoking and Alcoholism status measured by modified Gustafson's formula is not significant. (Table 3)

Table 2: Distribution according to grades of physiological changes in the tooth

Physiological change	Grade	Frequency	Percentage
Attrition	0	0	0
	1	36	51.4
	2	34	48.6
	3	0	0
Periodontosis	0	7	10
	1	47	67.1
	2	16	22.9
	3	0	0
Secondary dentin deposition	0	2	2.9
	1	56	80
	2	12	17.1
	3	0	0
Root resorption	0	4	5.7
	1	50	71.4
	2	16	22.9
	3	0	0
Transparency of the root	0	15	21.4
	1	36	51.4
	2	19	27.1
	3	0	0
Cementum	0	33	47.1
	1	37	52.9
	2	0	0
	3	0	0

Table 3: The mean age estimation and age difference as measured by modified Gustafson's formula

Variable	Categories	Age by MGF Mean (SD)	P value	Age difference by MGF Mean (SD)	P value
Age group	25-30	28.07 (2.67)	<0.001	0.37 (1.59)	0.438
	31-35	34.88 (1.72)		1.59 (1.50)	
	36-40	38.48 (2.71)		0.28 (2.11)	
	41-45	45.63 (2.49)		1.46 (1.75)	
	46-50	50.64 (2.49)		1.64 (1.18)	
	51-55	55.07 (2.43)		0.93 (1.93)	
	56-60	58.39 (3.07)		0.29 (2.28)	

cont..table 3

Variable	Categories	Age by MGF Mean (SD)	P value	Age difference by MGF Mean (SD)	P value
Sex	Male	41.72 (10.96)	0.359	0.79 (1.84)	0.695
	Female	39.33 (13.28)		0.44 (1.88)	
Residence	Rural	40.99 (11.30)	0.484	0.86 (1.76)	0.318
	Urban	41.64 (12.56)		0.20 (2.09)	
Socio economic status	Upper	43.35 (11.77)	0.041	0.78 (1.88)	0.858
	Upper middle	50.19 (11.17)		1.07 (1.73)	
	Lower middle	42.39 (10.59)		0.86 (1.49)	
	Upper lower	35.14 (9.32)		0.81 (2.29)	
	Lower	40.09 (12.08)		0.33 (1.94)	
		41.14 (11.51)		0.71 (1.84)	
Diet	Vegetarian	42.01 (12.97)	0.208	0.30 (1.76)	0.765
	Non-Vegetarian	40.85 (11.12)		0.83 (1.86)	
Smoking	Non – smokers	39.88 (12.09)	0.244	0.88 (1.81)	0.820
	Smokers	43.54 (10.11)		0.37 (1.91)	
Alcoholism	Non – Alcoholics	39.02 (11.31)	0.780	0.59 (1.82)	0.728
	Alcoholics	43.96 (11.34)		0.86 (1.89)	

DISCUSSION

In the present study, six physiological changes in the teeth were used for age estimation in deceased adults. These were Attrition, Periodontosis, secondary dentin deposition, Cementum opposition, Translucency of the root, and Root resorption. The association between socio demographic factors such as sex, place of residence, socioeconomic status, habits like diet, smoking and alcoholism with mean total score of Gustafson and mean difference of known age and estimated age were also studied and analysed.

In the present study, a total of 70 cases were studied. The selected teeth in this study are premolars, canines, incisors and first molars and importance was given from left to right.[7] The second and third molar teeth are excluded, as they are greatly affected with diet due to mastication of food and not suitable for preparation of ground section being hard and tough. So only normal teeth which are free from decay, caries are included in the present study. The teeth that are broken during the process of ground sectioning are excluded.

The mean total scores from physiological changes of the teeth calculated from various age groups and it is observed that the total score is constantly increasing with increase in age. This increase was statistically analysed and found to be significant. Maximum mean total score is observed in the age group of 56 to 60 years i.e. 10.3 followed by the age group of 51 to 55 years i.e. 9.57. least score i.e. 3.65 is observed in the age group of 25 to 30 years. These findings were similar to the observations made by studies of P.S.Pillai and G.Bhaskar [1] and Amandeep Singh et.al.[8]

The mean total score of physiological factors calculated in relation to gender of the person is as follows: in males was 6.58 ± 2.42 which is slightly higher than that of females 6.11 ± 2.90. But this difference is statistically not significant. These findings were similar to the observations made by of P.S.Pillai and G.Bhaskar [1] and Amandeep Singh et.al.[8] According to the observations made in the above table1, the mean total score in vegetarians were 6.7 ± 2.8 which is higher than that of non-vegetarians 6.45 ± 2.43. These findings were in contrast to the observations made of P.S.Pillai and G.Bhaskar [1] and Amandeep Singh et.al.[8] The mean total score of people living in urban area was 6.62 ± 2.75, which is higher than that of people living in rural areas is 6.48 ± 2.47. But this difference was statistically insignificant. These findings were similar to the observations made by of P.S.Pillai and G.Bhaskar [1] and Amandeep Singh et.al.[8] Mean total

score among smokers was 7 ± 2.21 and among non – smokers is 6.23 ± 2.65 respectively. The mean total score in smokers is slightly higher than that of non-smokers and it was non significant. Among alcoholics mean total score was 7.13 ± 2.48 and in non-alcoholics is 6.07 ± 2.5. The mean total score in alcoholics is slightly higher than that of non-alcoholics and it was non significant.Mean total score was highest in upper middle class .i.e. 8.17 ± 2.43 and it was found to be lowest in the upper lower class of socio–economic group i.e. 5.2 ± 2.04. The mean total score of various socio-economic groups of the study population is insignificant.

After comparison of the maximum and minimum differences in known age with mean calculated age using Gustafson's method appears to be the best method showing least deviation of the calculated age from the actual age (4.23 to -3.77). The rest of the formulae i.e. Pillai and Bhasker[1], Singh N[9,10], and Multiple regression formulae are showing large range of deviation.

CONCLUSIONS

Thus, in our study we found that when all the six physiological age factors were scored and used together collectively, we will get better results, rather than using a single physiological factor for estimation of age. Socio demographic factors, diet and habits have no effect on age estimation.

Conflict of Interest: None declared.

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Conflict of Interest: None

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