

Objective measurement of shade color in age estimation

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Abstract

Introduction: Age estimation is an important subspecialty of forensic medicine. Dental hard tissues are highly resistant to degradation and putrefaction. Enamel is translucent and varies in color from light yellow to grey white. The color of the teeth has been reported to be affected by chronological age. Enamel color may also depend on environmental factors viz. diet, occupational habits, vitamin deficiencies, fluoride level in drinking water etc., It has been found that color changes in dentin vary from white to yellow. Studies have been done to measure the dentin color for age estimation. **Aim:** To find a correlation between the enamel color and chronological age and secondly to estimate the age of an individual from enamel color. **Material and Methods:** A total of 300 patients visiting the outpatient department of oral medicine and radiology were selected. Out of those, 150 were men and 150 women. The patients were divided into V groups based on the age. A thorough case history was taken for all the patients. Maxillary Central and Lateral incisor was used for the estimation of shade. The enamel color was evaluated using a VITA classical shade guide. **Statistical Analysis:** Data were exported to an Excel spreadsheet and statistical analysis was performed using the SPSS. Linear regression analysis was used to find correlations between age and enamel shade. **Results:** In the group 1 and 2 i.e. from 15 to 36 years, the shades A 2 and B 2 (reddish hue) was found to be most common. While in the group 3 and 4, shades ranged from A 3 to B 3 (brownish to yellowish hue). In the patients above 59 years i.e. group 5 the enamel shade with greyish hue was found to be most common. **Conclusion:** Age determination using enamel color can be tried in forensic cases in the identification of individuals with no birth records.

Key words: Age estimation, color, enamel, shade guide

Introduction

Human identification is a mainstay of civilization and identification of unknown individuals. It has always been of paramount importance to our

society.^[1] Identification in the medico-legal sense refers to the determination of the individuality of a person which may be complete or partial.^[2]

Age estimation is a sub-discipline of the forensic science and should be an important part of every identification process, especially when information related to the deceased is unavailable.^[3]

An accurate method of age estimation is important for forensic investigators dealing with unknown bodies, parts of bodies or skeletons. The best method for estimating age at death from human skeletal tissue is currently unknown.^[4] General structural changes in teeth throughout the life are the basis for age estimation. The enamel, dentin, and

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cementum that comprise teeth have been used to estimate the chronological age of unidentified individuals.^[5]

Dental hard tissues are highly resistant to degradation and putrefaction. This makes teeth as useful indicators for the calculation of age.^[6] Due to less variability, morphological characteristics of teeth form the basis of most commonly used methods of dental age estimation. Because of this, teeth can be useful indicator of some past variation in diet or of metabolic diseases and can also be of use for calculation of age at time of death.^[7]

Colour of dentin is one such morphological character which can be of great significance in estimating age of an individual; living or dead. Enamel is translucent and varies in colour from light yellow to grey white.^[8,9] The colour of the teeth has been reported to be affected by chronological age.^[10,11] Enamel colour may also depend on environmental factors diet, occupational habits, vitamin deficiencies, fluoride level in drinking water etc.^[12] It has also been found that colour changes in dentin vary from white to yellow.^[9] Studies have been done to measure the dentin colour for age estimation.^[3,13] As discussed by Tencate and Orbans^[9,14] the dentin layer thickens with age. The volume of the pulp chamber also reduces with age due to continuous dentin deposition. So colour of the tooth may also depend on the dentin thickness and the volume of pulp chamber.^[13,14] So far in our knowledge the enamel colour has not been evaluated for forensic age estimation. Keeping in mind above factors a study was conducted with two aims: Firstly to find a correlation between the enamel colour and chronological age and secondly to estimate the age of an individual from enamel colour.

Materials and Methods

A total of 300 patients were selected randomly from the OPD. Out of these 150 were men and 150 women. The patients were divided in to V groups based on the age as follows.

Group 1: 15-25 years, group 2: 26-36 years, group 3: 37-47 years, group 4: 48-58 years, and group 5: 59 – 69 years.

A detailed case history was taken for all patients. Maxillary Central and Lateral incisor was used for shade matching. The following criteria's were used for selection of patients.

Exclusion criteria

A thorough case history was taken and following exclusion criteria were set:

- Medically and physically compromised problem
- History of tobacco smoking or chewing, other occupational habits or birth trauma present.

Inclusion criteria

- Healthy maxillary central and lateral incisor teeth i.e. free from cavities, fracture, endodontically treated teeth or abnormal stains were selected.

Methodology

The enamel color was evaluated using a VITA classical shade guide [Figure 1]. The arrangement of the shades in the VITA classical family of shades is as follows:

A1 – A4, B1-B4, C1-C4, D1-D4

The shade guide is arranged on the basis of hue difference from A to D.

Procedure: The patient was seated on the dental chair. The shade guide was held parallel to the selected tooth at an arm's distance and the middle third of the labial surface of the tooth was matched with the shade guide. Firstly value (lightness) of the color was assessed followed by hue and then chroma. Each tooth was observed for 5-10 seconds. All the observations were made in natural light. The surroundings were kept free from bright colors. To ensure the accuracy, these findings were further evaluated by two observers. By observing the enamel shade found in an individual in a particular age group a linear regression equation was derived for the calculation of age. The study was followed by the results and then the statistical analysis.^[1-6]

Statistical analysis

Data were transferred to an Excel spread sheet and statistical analyses were performed using the SPSS. Linear regression analysis was used to find correlations between age and enamel shade.

Results

In present study a total of 300 patients were arbitrarily selected. Out of which 150 were males and 150 females.



Figure 1: Shade guide

In the group 1 and 2 i.e. from 15 to 36 years the shades A 1, A 2 and B 1 (reddish-yellowish –slightly brown hue) was found to be most common. While in the group 3 and 4 shades ranged from A 3 to B 3 (brownish to yellowish hue). In patients above 50 years i.e. group 5 the enamel shade with greyish hue was found to be most common [Table 1] frequency of males and females in different shades of the VITA classical shade guide is illustrated in Table 2. Linear regression equation was used to calculate the age. The difference between the actual and the calculated age was found to be ± 5.2 years

Standard deviation of the equation was ± 7.4 . Table 3 shows the mean of the errors in different age groups. To establish the relationship between age and enamel color measured by VITA classical dental shade guide correlation coefficient (R) was calculated using age as the dependent variable. The value of R was found to be 0.89.

Discussion

Tooth color estimation is of great interest in forensic odontology. Several authors have reported that teeth tend to darken with age.^[13-15] Moreover, estimation of the age of a deceased individual can be of great importance in identification cases. Morphological, histological and biochemical methods based on degenerative changes in the teeth have been developed to establish chronological age. Because of their reliability, morphological changes in

Table 1: Percentage of the closest shade match to the examined subjects' teeth in different age groups as indicated by the VITA classical shade guide

	Age group (years)	Enamel shade
Group 1	15-25	A1 (10%) A 2 (52%) ,B 2 (38%)
Group 2	26-36	A 2, (73%) B 2 (27%)
Group 3	37-47	A 3 (90%) B3 (10%)
Group 4	48-58	B 3 (96%) C (4%)
Group 5	59-69	C 3

Table 2: Percentage(%) and frequency of the males and female in the different shades of VITA classical shade

Enamel shade	Percentage(%) and frequency of males	Percentage(%) and frequency of females
A 2	56	44
A 3	50	50
B 2	80	20
B 3	75	25
B 4	100	0
C 3	81	19
C 4	0	100

Table 3: Dental age estimation

Age groups (years)	15-25	26-26	37-47	48-58	59-69
Mean of the errors (years)	-2.85	0.74	0.5	+3.42	+4.82

teeth form the basis of some of the most common methods to estimate age in forensic cases.^[15-17] The main objective of this study was to develop a new, objective method for estimating dentin color to calculate the age of an individual. Estimation of tooth color by comparison with a dental shade guide has been used extensively by forensic odontologists, since changes in color with aging have been described.^[15,16] Visual shade matching is a method, in which a colour standard from a commercially available dental shade guide is compared to and matched with the target tooth.^[9-11] We preferred visual shade matching over spectrophotometer and digital techniques because of its easy availability and cost effectiveness. The Munsell Color system is recommended for shade matching which is based on the three dimensions of colour: The hue, value and chroma. The results obtained in this study are in agreement with previously published results.^[16] Dentin color when estimated using natural light, a difference in mean age were found from color grades 1 to 3 and 4 to 5 [Figure 1]. Color grades dark or very dark yellow and brown were significantly associated with an average age of more than 55 years. A possible explanation this shift in color could be explained firstly on the basis of light scattering and absorption within enamel and dentin, which gives rise to the intrinsic colour of the teeth, and since enamel is relatively translucent, the properties of dentine can play a major role in determining the overall tooth colour.^[17] Secondly, the darkening may be caused by a continuous deposition of (secondary) dentin and secondly, the surface layer of enamel reflects most prominent changes within this tissue and during ageing, the composition of the surface layer changes as ionic exchange with the oral environment occurs.^[4]

There was no significant difference observed in the colour of enamel in males and females. ($P > 0.05$) in any of the age groups. Visual shade selection varies, depending on the clinician's colour perception and experience, ambient light condition, background of the tooth, and the shade guide used. So this could be one of the limitation of this study. This is a preliminary study in which the color of the enamel served as a significant method for age estimation. Further studies are required to evaluate the changes in the thickness of dentin, enamel and size of the pulp chamber with advancing age in order to improvise the age estimation using tooth color.^[4,5,7,12]

Conclusion

The application of colour science in dentistry has enabled the measurement of tooth colour in an objective way. Considering the limitations of this study, the following conclusions were drawn:

- The use of a visual shade guide for colour matching is an easy, cost effective method which does not require any special equipment and can be used in any setting

- Age determination using enamel colour can be tried in forensic cases in the identification of individuals with no birth records.

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