



Original Research Article

Objective dimension of tooth color in forensic age estimation: An observational study

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ABSTRACT

Background: Teeth are an integral part of facial aesthetics involved in complex social, cultural & psychological interaction. Of all, in latest, tooth color measurement has attracted attention in the field of dentistry for assessing age.

Aims: To assess the correlation between the enamel color and chronological age and to evaluate the age of an individual from enamel color.

Settings and Design: This was a cross sectional study that included a total of 200 individuals attending the outpatient Department of Oral Medicine & Radiology.

Materials and Methods: The individuals were divided into five groups based on age with 40 in each group. Inclusion criteria comprised of healthy maxillary central, lateral incisor, canine, premolar and molar teeth that were free from cavities, fracture, endodontically treated teeth and those free from stain were selected. The tooth shade was recorded using Vitapan classical shade guide. Firstly, value of the color was assessed followed by hue and then chroma.

Statistical Analysis Used: Numerical scrutiny was conducted using Statistical Package for Social Sciences. Comparison and correlation of the definite variables between the groups was done by Pearson Chi-square test.

Results: For central and lateral incisor common shade was B2 and for canine teeth all the groups had A3 shade and results obtained was statistically significant except for the premolars with B2 was the most common shade for groups I, II and IV, but the B1 (yellowish hue) shade was common in group 2 and C2 shade was common in group V with statistically significant results. For molars B2 was the most common shade for groups I – IV with C2 shade was common in group V with statistically significant results.

Conclusions: Natural tooth color can be used as an effective means of age estimation.

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1. Introduction

Forensically, age estimation is a central step for biological identification. Dental age estimation methods have been widely described and reported.¹ Currently, there are several methods with mutable precision to foresee the age of dead or existing personnel such as a carnal check, hand

wrist radiographs and dental valuations for example, radiological parameter & morphological, but these are time consuming methods.² Of all the existing methods, tooth colour evaluation is of great concern in forensic odontology.³

Wide-ranging structural deviances in teeth during the life form the basis for age estimation in forensics.⁴ Dental hard tissues are highly impervious to deprivation and rotting and

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so teeth are the utmost useful pointer for age calculation.⁵ Natural tooth color is alleged being gaged well than most former degenerating dental changes. Many compiled works disclose that precise colour variation of teeth is relative with the growing age and it is unwavering by inner and outer tooth structure.⁶ Limited studies are reported in the literature using natural tooth color for age estimation, hence the present study was conducted with an aim to consider and correlate between the tooth color and sequential age.

2. Subjects and Methods

In total of about 200 individuals appearing to the outpatient sector of Oral Medicine & Radiology, Institute of Dental Sciences, Bareilly, UP, were enrolled for the study. The sample included was calculated using the G Power software 3.0. The present study was agreed & permitted by the Institutional ethical committee and with the Helsinki Declaration of 1975, as revised in 2000. An inscribed informed consent was taken from all the persons contributing in the study. Further, centred on age, the individuals were alienated into five groups with 40 each in every group as, Group I: 15-25 years, Group II: 26-36 years, Group III: 37-47 years, Group IV: 48-58 years, Group V: 59-69 years followed by a detailed case history taken from all patients. Inclusion criteria comprised of hale and hearty maxillary central, lateral incisor, canine, premolar and molar teeth that were free from cavities, cracked, endodontically preserved teeth and stain free teeth were selected. Initially, scaling was completed and shade was chronicled under satisfactory natural light and noticed at eye level. Shades were verified swiftly so to evade eye fatigue (5-10 seconds). Exclusion criteria included patient with medically and physically compromised state, habit of tobacco smoking or chewing, additional professional habits or if birth trauma existing.

The tooth enamel color was assessed using a Vitapan classical shade guide (Figure 1). The organisation of shade in Vitapan classical shade guide is: A1-A4, B1-B4, C1-C4, D2-D4. This shade guide is set on the source of hue variance from A to D.

3. Technique

The personnel were firstly seated on the dental chair. Added, the shade guide was set aside parallel to the specific tooth with the central third of the facial surface of the specific tooth was harmonised as per the shade guide. Primarily, the value (lightness) of the color was measured trailed by hue and later chroma. All the interpretations were made in natural light keeping the surroundings free from bright colors. The precision of results to the supplementary were gaged by two observers. (Figure 2) By observing the tooth shade found in an individual in an exact age group a linear regression equation was derived for calculating



Fig. 1: Vitapan classical shade guide.



Fig. 2: Photograph gauging the toothcolor in comparison with the patient using Vitapan shade guide under natural light.

age. All the recorded shade grades were tabulated and subjected to the statistical assessment. Numerical scrutiny was conducted using Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 (Armonk, NY: IBM Corp). Comparison and correlation of the definite variables between the groups was carried out by means of a Pearson Chi-square test. A p-value of <0.05 was considered as statistically significant.

Table 1: Percentage of closest shades matched to the examined central and lateral incisor teeth in different age group indicated by Vitapan classical guide.

Age group	Common shade	Percentage (%)
15-25 Yrs	B1	69.2%
26-36 Yrs	B2	46.2%
37-47 Yrs	B2	69.2%
48-58 Yrs	B2	71.8%
59-69 Yrs	C2	64.1%
Pearson Chi-square	19.11	p < 0.001*

Table 2: Percentage of closest shades matched to the examined canine teeth in different age group indicated by Vitapan classical guide.

Age group	Common shade	Percentage (%)
15-25 Yrs	A3	74.4%
26-36 Yrs	A3	71.8%
37-47 Yrs	A3	66.7%
48-58 Yrs	A3	74.4%
59-69 Yrs	A3	69.2%
Pearson Chi-square	1.89	p = 0.756 #

Table 3: Percentage of closest shades matched to the examined premolar teeth in different age group indicated by Vitapan classical guide.

Age group	Common shade	Percentage (%)
15-25 Yrs	B2	79.5%
26-36 Yrs	B1	59.0%
37-47 Yrs	B2	69.2%
48-58 Yrs	B2	66.7%
59-69 Yrs	C2	66.7%
Pearson Chi-square	10.51	p = 0.0327*

Table 4: Percentage of closest shades matched to the examined molar teeth in different age group indicated by Vitapan classical guide.

Age group	Common shade	Percentage (%)
15-25 Yrs	B2	71.8%
26-36 Yrs	B2	76.9%
37-47 Yrs	B2	84.6%
48-58 Yrs	B2	87.2%
59-69 Yrs	C2	64.1%
Pearson Chi-square	20.21	P < 0.001*

Table 5: Percentage of the closest shades match to the examined subject's teeth in different age group as indicated by the Vitapan classical shade guide.

Group	Age (in yrs)	Enamel shade
I	15-25 Yrs	B1,A3,B2
II	26-36 Yrs	B1,A3,B2
III	37-47 Yrs	A3,B2
IV	48-58 Yrs	A3,B2
V	59-69 Yrs	A3,C2

Table 6: Gender association with different shades with respect to Central & Lateral incisors

		Male		Female		
Group		No	%		No	%
Group1	B1	17	77.3	B1	10	58.8
Group2	B2	10	52.6	B2	9	45.0
Group3	B2	16	72.7	B2	11	64.7
Group4	B2	16	76.2	B2	12	66.7
Group5	C2	18	78.3	C3	9	56.3
Pearson Chi-square		1.18		p=0.881 (not significant)		

Table 7: Gender association with different shades with respect to canine

		Male		Female		
Group		No	%	No	%	
Group1	A3	15	68.2	A3	14	82.4
Group2	A3	13	68.4	A3	15	75.0
Group3	A3	14	63.6	A3	12	70.6
Group4	A3	17	81.0	A3	12	66.7
Group5	A3	16	69.6	A3	11	68.8
Pearson Chi-square		3.11		p=0.540 (not significant)		

Table 8: Gender association with different shades with respect to premolars

		Male		Female		
Group		No	%		No	%
Group1	B2	19	86.4	B2	12	70.6
Group2	B1	10	52.6	B1	13	65.0
Group3	B2	20	90.9	B2	7	41.2
Group4	B2	15	71.4	B2	11	61.1
Group5	C2	12	52.2	C2	14	87.5
Pearson Chi-square		30.6		p < 0.001*		

Table 9: Gender association with different shades with respect to molar

		Male		Female		
Group		No	%	No	%	
Group1	B2	15	68.2	B2	13	76.5
Group2	B2	12	63.2	B2	18	90.0
Group3	B2	19	86.4	B2	14	82.4
Group4	B2	18	85.7	B2	16	88.9
Group5	C2	15	65.2	C2	10	62.5
Pearson Chi-square		4.06		p=0.318 (not significant)		

4. Results

The present study included total 200 individuals selected randomly from the outpatient department with grit to assess the relationship between the natural tooth color and chronological age. Fallouts exhibited that for the central and lateral incisors in the group 1 and 2 i.e. from 15-36 years the mutual shade was B1 (yellowish hue), for group 3 and 4 frequent shades was B2 (yellowish hue) and for group 5 i.e. in patient above 59 years C2 (grayish hue) was the common shade.

Overall, the most predominant shade for central and lateral incisor was B2 (Table 1) and effect got was statistically significant. The examination of the canine teeth revealed that all the groups had A3 (Reddish hue) shade in common and the results obtained were not statistically significant (Table 2). For the premolars B2 (yellowish hue) was the most shared color for groups I, II and IV, but the B1 (yellowish hue) shade was common in group 2 and C2 (greyish hue) shade was common in group V (Table 3) with statistically significant results. For molars B2 (yellowish hue) was the utmost communal shade for groups I – IV with C2 (greyish hue) shade was common in group V (Table 4) with statistically significant results.

The foremost shade in the early age groups was B1, B2 and A3, while A3 and B2 were shared in mid age and A3 and C2 were common in old age (Table 5). Gender association with different shades with respect to centrals, laterals, canines, premolars and molars was assessed which showed non-significant results except for in premolar group, where in female gender showed a statistically significant results. (Tables 6, 7, 8 and 9) To form the connexion between age and enamel color measured by Vitapan classical shade guide correlation coefficient (R) was calculated using age as dependent variable.

5. Discussion

The main attributes of living uniqueness are sex, age, physique, and racial background of the individual, which are also called the 'Big Four' in forensic milieu.⁷ Hominoid credentials are a backbone of civilization and identification of unidentified individuals that has always been of chief significance to our society.⁸

Age estimation is an important stride of the forensic odontology and should be a chief chunk for every proof of identity process, chiefly when evidence related to the departed is inaccessible.⁵ It is unique of the crucial factors

to form the individuality of a human being. It develops a challenging job to estimate age in adults when compared to young age group.⁹ Teeth, being our dental hard tissue, are extremely resistant to fire and are usually the only relics after an extended period of committal.¹⁰

Various methods such as morphological, histological to biochemical based on deteriorating deviations in the teeth have been innovative to find chronological age.^{11,12} Their consistency, morphological deviations in teeth forms the source amongst several common methods to assess age in forensic cases. Assessment of tooth color by association with a dental shade guide has been used broadly by forensic odontologists.¹³ Vitapan Classical shade guide and its derivations such as evidence-based Vitapan 3D-Master shade guide and Linear guide, are the most commonly used shade guides.¹⁴ Chromatic shade matching is a practice, in which a colour classic from commercially offered dental shade guides is equated to and harmonized with the target tooth as it is effortlessly accessible with cost effectiveness.^{5,6,12}

Literature claims, color of teeth in the bulk of young populace is brighter and less yellow, though in elder population teeth are thought to become yellowish and grayish over period.^{12,15} This outcome was consistent with the findings of our study, Singh V et al in 2010,¹⁶ Metgud R et al in 2015¹⁷ whereas study by Vaidya S in 2015¹⁸ exhibited color grades dark & very dark yellow to brown were significantly related with an usual age of more than 55 years. Yellowish color of teeth may be as of the color of dentin shown through thin & translucent enamel. A possible explanation could be that during aging, conformation of the surface layer alterations as ionic interchange with the oral environment befalls.^{18,19} This swing in color might be described based on light scattering and absorption properties within enamel and dentin, which gives upsurge to the inherent color of the teeth, and subsequently enamel, is relatively lustrous, the properties of dentine can play a key part in influencing the ample tooth colour.^{16,19,20} H Eimar et al.¹⁸ had discovered that the tooth shade is controlled by the size of their hydroxyapatite enamel crystals and also discrepancy in the grade of enamel hydroxyapatite carbonization can also upset the tooth shade.

In our study, we used Vitapan classical shade guide for evaluation. Whereas, Rao D et al in 2018²⁰ in her research found that Vitapan 3D values were more frequently organized and more distended in both chroma and lightness as associated to other shade guides like Shofu's Vintage Halo NCC and Vita Lumin vaccum, as they did not appear to shield the chromaticity ranges of the Indian population tooth color. Nevertheless, Ginzburg M et al.²¹ added that amalgamation of optical colour determination with digital cameras and automated devices will rise probabilities for efficacious shade matching.

With concern to the shade values of teeth in relation to gender in the present study, there was no significant variance

detected in tooth colour with regard to males and females in whichever of the age groups excluding for premolars in females which showed the statistically significant results. This disparity may be due to the inequity in the ratio of male to female subjects with that of the study population included in the study. Tooth enamel color was found to be connected with the chronological age ($R=0.61$). Mean age discrepancy of calculated age and real age was found to remain ± 6 year. But, study by Sumanth K et al.²² showed that shade value 2 was the most common value noted amongst males and females. However, Esan et al.²³ directed that gender was significantly associated with tooth shades, in that men were more possible to show darker tooth shades though women of the identical age group were more probable to display lighter tooth shades.

6. Conclusion

Forensic Dentistry is a major attention for dental curricula and tooth color estimation is of prodigious interest in forensic odontology. The definition of shade could bring clinicians closer to reliable shade selection and predictable definitive color match in an objective way. As ours was an observational study in which the natural tooth color aided as a significant system for age estimation. In Dentistry, it is supposed that the solicitation of colour science has empowered the dimension of tooth colour in an unbiased way. Further, longitudinal studies are mandatory to calculate the vagaries in the depth of dentin, enamel and scope of the pulp chamber with progressing age directive to improvise the age estimation using tooth color.

7. Source of Funding

None.

8. Conflict of Interest

None.

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