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Original Research

Effect of Age on Tooth Shade, Skin Color and Skin-Tooth Color Interrelationship in Saudi Arabian Subpopulation

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Abstract:

Background: Dental restoration or prosthesis in harmony with adjacent natural teeth color is indispensable part for the successful esthetic outcome. The studies indicate is existence of correlation between teeth and skin color. Teeth and skin color are changed over the aging process. The aim of the study was to explore the role of age on the tooth and skin color parameters, and to investigate the effect of ageing on teeth-skin color correlation.

Materials and Methods: Total of 225 Saudi Arabian ethnic subjects was divided into three groups of 75 each. The groups were divided according to participant's age. The participant's age for Group I, Group II, and Group III was 18-29 years, 30-50 years, and above 50 years, respectively. The tooth color was identified by spectrophotometer in CIE Lab parameters. The skin color was registered with skin surface photography. The data were statistically analyzed with one-way ANOVA and correlation tests with SPSS 18 software.

Results: The Group I had the highest 'L' value of 80.26, Group III recorded the least value of 76.66. The Group III had highest yellow value 'b' at 22.72, while Group I had 19.19. The skin 'L' value was highest in the young population; the elder population had the increased red value 'a' in comparison to younger subjects. The 'L' tooth color parameter had a strong positive linear correlation with skin color in young and adult subjects. While Group III teeth showed the strong positive correlation with 'b' parameter at malar region.

Conclusion: The elder subjects had darker and yellow teeth in comparison with younger subjects. The reddening of the skin was observed as age-related skin color change. The age had a strong influence on the teeth-skin color correlation.

Key Words: Age factors, skin color, tooth color

Introduction

The successful restoration should satisfy function, comfort, speech, and esthetic requirements of the patients.[1] The eventual objective of esthetic rehabilitation is to design a pleasant smile with teeth having a proper inherent proportion and arrangement in harmony with gingiva and face is.[2] Restorative dentistry evolved from its previous dentist driven to patient driven service, the patient opinion plays an important role in selecting a treatment plan and dental services. The determination and communication of optimum tooth color are essential in esthetic dental care. The selection of an artificial tooth or restoration with a proper shade has shown to positively influence the patient's aesthetic perception and improved prosthesis acceptance.[3] It is advisable to select the tooth color in harmony with surrounding environment like facial skin, hair, and eye color.[4] The tooth shade selection is routinely accomplished by considering the adjacent intact teeth as a guide. These natural teeth are absent in completely edentulous patients. Hence, the artificial teeth selection in harmony with facial structure in fully edentulous patient is challenging and subjective.[5] Researchers advocate the utilization of skin, hair, and eye color for selecting artificial teeth in completely edentulous patients.[6-8] Preserved extracted teeth is un-reliable due to the difference in tooth color between vital and extracted natural teeth. The research findings are contradictory in their opinion on the relation between tooth and skin color. Few authors report the positive linear correlation between tooth and skin color,[9] while others describe the inverse relation.[10]

Extrinsic factors like smoking, stains, and intrinsic factors such as tetracycline staining, teeth vitality, age, and congenital defects are known to affect the tooth color.[11,12] The researches have revealed the association of increased age with darker, yellow teeth.[13] The factors attributed this process are increased secondary dentin thickness, decreasing enamel thickness, occlusal wear, and pigment deposition within dentin structure. The studies have shown the statistically significant darkening of the skin with age.[14] The color parameter like L, a, and b change is varied according to the ethnic groups, like parameter 'a' change was more than 'L' in Chinese ethnic groups. The teeth and skin color parameters appear to change non-uniformly over the aging process. There is a limited scientific information on the effect of advancing age on the correlation between tooth shade and skin color. It is important to understand this transitional change over skin-tooth color relation. The knowledge will enable the dentist to select artificial teeth complementing the facial skin color recognizing the age and ethnic parameters. It was hypothesized that, there would be a correlation between tooth-skin colors over ageing process, due to simultaneous age-induced tooth and skin color changes. The objective of this

study was to investigate the effect of age over tooth shade, skin color, and relation between the tooth and skin color.

Materials and Methods

The Institutional research Ethical Committee approval was obtained for the study. A total of 225 human subjects in age range of 18-70 were recruited for the study. The participants of the study were selected from the patients attending the Dental Clinic of King Khalid University. The subjects were divided into three equal groups comprising 75 participants each. The Group I included the subjects in the age groups of 18-29 years, Group II had 30-50 years age, and Group III had subject above 50 years age. The study was performed on stratified random sample, consisting of Saudi Arabian nationalities only. The subjects were restricted to one ethnic group to eliminate the heterogeneous facial skin color and to standardize the effect of age on skin color. The study methodology was explained to the subjects, and the informed consent was obtained from all the participants. All the participants were screened for the presence of intact, unrestored, vital maxillary central incisors. The exclusion criteria were the presence of intrinsic staining, severe attrition, heavy smoking, tobacco chewing and bleaching. The exclusion criteria also included skin disease, skin bleaching, excessive skin tanning, post-surgical cicatrices, and radiation therapy. The subjects not willing to participate in the study were also excluded from the study. The mild face wash, soft tooth brush, and tooth paste were provided to every participant. They were requested to wash the face and brush the teeth for 2 min. The maxillary incisors were cleaned by pumice-water mixture prior to shade selection.

Tooth color determination procedure

The selected tooth color from an individual was the average tooth shade from both maxillary central incisors. The middle portion of the tooth selected for the identification of the shade. The Vita Easy shade spectrophotometer (VITA Zahnfabrik GmbH, Bad Sackingen, Germany) was utilized to select the shade; it was helpful to eliminate the clinician subjectivity and influence of the illumination. Since instrument has an embedded fiber optic light, it can record the tooth shade under any light condition. The single tooth option was selected from menu and probe tip was secured perpendicular to tooth surface flushing the whole surface. After the initiation of the measurement procedure, tip was help stable until the long beep. The tooth shade for individual maxillary central incurs was recorded with 'L', 'a', 'b', values. The average shade from both teeth shade was calculated to determine the tooth color for the subject.

Skin color selection procedure

Skin surface photography as described by the previous researchers was followed to identify the skin color. The camera settings and light condition were standardized following the methodology explained in the previous studies to eliminate the effect of illumination on the skin color.[15,16] The Nikon digital single-lens-reflex camera (Nikon Corporation, Chiyoda-ku, Tokyo, Japan) with the resolution of 15 megapixels was used in the study. The focal length at 90-120 mm macro lens, an aperture of f/16, and shutter speed of 1/250 s was selected according the suggestion of the earlier researchers. The photographic detractor such as eyeglasses, jewelry, and hats were removed before radiograph. The patient seated three feet in front of the background, which was covered with non-reflective light blue cloth. The three light sources with color rendering index of 90 were used for the photographic illumination. The two light sources with diffusers were placed at 45 angulation in the front. One light source was placed at perpendicular to the sagittal plane facing downward. The frontal view photograph was made by keeping camera lenses axis at participant's eye level. The head position was standardized by keeping Frankfort horizontal plane parallel to the floor and midsagittal plane in the viewfinder for upright head position. The target facial skin locations were forehead 5 mm above nasal bridge, right ear lobe, and junction between ala tragus line-vertical lines from outer canthus in left malar area. Since skin color was identified in three locations to overcome the variation due to mild skin inflammations and sunburn.

Statistical analysis

The data were interpreted with SPSS 18 (International Business Machines Co., Armonk, New York, USA) program. The one-way ANOVA and correlation tests were performed to identify the difference between means and strength of the relation respectively.

Results

The Table 1 describes the summaries of the mean teeth and skin color in three locations for all the Groups. The teeth lightness value 'L' for Group 1 was 80.26(2.64), followed by 79.67 (2.68) for Group 2, and 76.66 (3.43) for Group III. The results of the study indicate the lightness decreased linearly with advancing age. The redness value 'a' was 0.614 (0.71), 0.680 (0.70), and 1.76 (1.45) for Group I, Group II, and Group III, respectively. On the contrary to lightness value, the redness value 'a' was increased with advancing age. The value of 'b' had similar strong positive linear increase with age in all three groups. The 'b' value

Table 1: Mean L, a, b, values and standard deviation of teeth and skin among all Groups.

Group	Location	L value		a value		b value	
		Mean	SD	Mean	SD	Mean	SD
Group 1	Tooth	80.26	2.64	0.614	0.71	19.19	3.92
	Ear lobe	48.49	5.67	29.13	3.98	23.85	3.43
	Forehead	52.32	4.67	29.26	3.59	26.01	2.79
	Malar	52.74	4.97	29.33	3.68	25.08	2.48
Group 2	Tooth	79.67	2.68	0.680	0.706	19.76	3.28
	Ear lobe	47.58	7.86	30.52	5.14	24.42	3.76
	Forehead	51.18	6.72	30.53	4.51	25.42	2.87
	Malar	50.94	6.70	30.72	4.33	24.64	3.17
Group 3	Tooth	76.66	3.43	1.76	1.45	22.72	4.33
	Ear lobe	42.20	6.06	33.52	4.07	24.52	3.65
	Forehead	43.24	5.98	33.40	3.61	24.36	3.42
	Malar	43.56	5.65	35.12	4.00	24.84	5.05

SD: Standard deviation

for Group I was 19.19 (3.92), Group II 19.76 (3.28), and the highest value with Group III 22.72 (4.33). The elder population had the relatively yellower teeth than their younger counterpart. The color parameter L, a, b, values for earlobe were 48.49 (5.67), 29.13 (3.98),and 23.85 (3.43) for Group I, 47.58 (7.86), 30.52 (5.14), and 24.42 (3.6) for Group II, the corresponding values for Group III were 42.20 (6.06), 33.52 (4.07), and 24.52 (3.65). The L 'a' 'b' values at forehead region was Group 1 had 52.32 (4.67) 29.26 (3.59) 26.01 (2.79), Group II had 51.18 (6.72), 30.53 (4.51), 25.42 (2.87), and Group III with 42.24 (5.98), 33.40 (3.61), 24.36 (3.42). The color parameters pattern was similar in Malar skin location. The result shows the gradual reduction in 'L' value with age, but there was a gradual increase in 'a' value with aging process. The study results indicated the skin 'b' value had no significant change with advancing age except at malar region. One-way ANOVA (Table 2) analysis of mean teeth L, a, b values, showed a statistically significant difference ($P = 0.000$) between all three groups.

The correlation analysis (Table 3) indicated the presence of moderate to strong linear between teeth and facial skin 'L' value in Group I and Group II. The strong correlation between teeth and skin 'L' value was recorded at earlobe, forehead locations for Group I with $r = 0.218$, $P \leq 0.05$, and $r = 0.216$, $P \leq 0.05$ respectively. The strong positive linear correlation was also found between teeth and skin 'L' value in Group II across all three skin sites. The Group II earlobe had $r = 0.290$, $P \leq 0.01$, forehead $r = 0.280$, $P \leq 0.01$ and Malar $r = 0.354$, $P \leq 0.01$. The Group III showed no significant relation in 'L' parameter with skin color across all three locations.

Table 2: One way ANOVA analysis for tooth L a b values.

Groups	Sum of squares	df	Mean square	F	Sig
TL					
Between Groups	552.180	2	276.090	31.661	0.000
Within Groups	1935.902	222	8.720		
Total	2488.082	224			
TA					
Between Groups	62.313	2	31.156	30.014	0.000
Within Groups	230.447	222	1.038		
Total	292.759	224			
TB					
Between Groups	532.285	2	226.142	17.744	0.000
Within Groups	3329.811	222	14.999		
Total	3862.096	224			

ANOVA: Analysys of variance, TL: Tooth 'L'value, TA: Tooth 'a'value, TB: Tooth 'b'value

Table 3: Pearson's correlation coefficient matrix of teeth and skin colour at different location.

Location	Values	Group 1	Group 2	Group 3
Earlobe	L	0.218*	0.290**	0.110
	a	−0.153	−0.236*	0.103
	b	−0.131	0.057	0.162
Forehead	L	0.216*	0.280**	0.190
	a	−0.067	−0.115	0.027
	b	−0.126	0.078	0.158
Malar	L	0.119	0.354**	0.124
	a	−0.127	−0.037	0.089
	b	−0.110	−0.022	0.552**

Significant at P=0.05, ** Significant at P=0.01

The redness value 'a' except for Group II at earlobe location had no significant correlation with teeth value 'a' among all the subjects across three skin locations. The redness value from Group II at ear lobe had strong negative correlation with teeth r value −0.236 and $P \leq 0.01$. The yellow value 'b, at malar skin location, showed a significant correlation with teeth yellowness ($r = 0.552$, $P \leq 0.01$). The results indicate the elder population had yellower teeth with a strong correlation for 'b' value. The 'L' and 'a' values showed no correlation between teeth and skin in elderly (Group III) population.

Discussion

The artificial teeth or restoration color matching with the adjacent natural teeth and in harmony with surrounding facial skin is crucial for successful esthetic rehabilitation. In the absence of remaining teeth as a guide, teeth selection procedure is subjective in completely edentulous patients. The forensic sciences regard the teeth color as an indicator for the age determination.[17] The tooth-skin color relation is also helpful in determining the skin color for maxillofacial prosthesis. The hypothesis of younger subjects having lighter teeth is proved by the present study results. The results indicated the Group I subjects had highest 'L' value (80.26), and elder population (Group III) had the least value of 76.66. The progressive teeth darkening process is in agreement with the observation Zhao *et al.*,[18] Hassan[19] And Goodkind *et al.*[20] With advancing age, the teeth showed the tendency to become more yellow and reddish in color. A significant change in color was observed only in the elder subjects with age more than 50 years (Group III). The Group III had the highest yellow value 'b' 22.72 among all the subjects evaluated. The influence of age on the tooth color could be due to multiple factors. The gradual reduction of the pulp chamber with compensatory deposition of secondary dentine. The secondary dentin is harder, less permeable, and darker in color. The progressive loss of enamel thickness due to wear and tear lead to darker dentin color dominating the tooth shade.[12] It has also been reported that the amorphous organic and inorganic pigment deposition in dentin and dentin enamel junction, resulting in more saturated dentine chroma.[21] The increased redness in elder subjects is ascribed to occlusal wear and loss of translucency with exposed dentin islands.[22]

The skin color is affected by the balance between melanin and hemoglobin pigments. The type, amount, and location of these pigments determine the skin color of an individual. The age-related skin color changes are studied by researchers to help in improving the skin care treatments and cosmetics therapies. Genetic and environmental factors are known to play a critical role in aging influence on skin color.[23] The researchers have also reported the existence of the difference in skin structural features between various ethnic groups.[24] Hence, in the present study only one ethnic group was involved to investigate the age related

skin color changes. The present study results indicate, statically significant darkening of the skin with advancing age, the younger subjects had 'L' 52.32 value at forehead in comparison with 43.24 for Group III. The studied ethnic group showed the redder skin shade in an elder population than yellowing of the skin. The study result emphasized the previous researcher's observation of differences in age-related skin color changes with respect to ethnicity. The previous studies have reported,[25] with the advancing age Caucasian skin becomes darker and redder while Asian skin turns dark and more yellow. The non-uniform age related skin color change should be taken into consideration while selecting artificial teeth for prosthetic purpose. The study results showed the younger and middle age subjected showed the strong correlation between teeth-skin for lightness 'L' value at all three skin sites. The elder subjects showed the very strong positive correlation only for yellow factor 'b' between skin-teeth color. According to the results of the study elder patient has darker teeth in comparison with their younger counter part, the tooth yellow color parameter has strong positive linear correlation with skin 'b' factor. These results are helpful in understanding the gradual change of tooth-skin interrelation. It will be useful to select the artificial teeth in harmony with surrounding facial skin color for completely edentulous patient. The results of the study need to be evaluated further with larger study groups and different ethnic groups.

Conclusion

Within the limitation of the study, the advancing age lead to darker and more yellow teeth. The significant change in teeth color was observed in the age group above 50 years. The advancing age lead to darkening and reddening of the skin in the investigated ethnic group. A strong correlation was observed for teeth-skin 'L' factor in young and middle-aged subjects. The elder population showed very strong positive correlation for yellow factor 'b' between teeth and skin at malar region. The aging process significantly affects the teeth-skin color correlation.

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