

Evaluation of Maxillary Central Incisor Tooth Shade and its Correlation with Eye Colour and Hair Colour in an Indian Population

Research Article

Rajalakshmi Rakshanaa TV¹, Raghu Sandhya^{2*}¹ Graduate Student, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.² Reader, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Abstract

Aim: Selecting the tooth shade considering the eye colour and hair colour can bring in more life to the prosthesis. The aim of this study was to evaluate the maxillary central incisor tooth shade and its correlation with eye colour and hair colour in an Indian population

Materials And Methods: The study comprised of 100 individuals in the age group of 18-70 years. Among them 36 were males and 64 were females. The tooth shade of the patient was evaluated among Indian population using Vitapan classic shade guide (Vita Zahnfabrik H Rauter, Germany). Age, gender of the patient was noted. Eye colour and hair colour of the patient were recorded in categories. The recordings were tabulated, and the data was analysed by descriptive statistics using SPSS software.

Results: In the study population, majority of the patients had dark brown eye colour (54%) followed by light brown (27%), black (12%), and grey (7%). A2 was the most common tooth shade. There was no significance correlation between eye colour with the tooth shade. Population with black, dark brown and light brown hair colour had predominantly A2 shade (31.0%, 31.8%, 46.2% respectively) and people with grey hair had predominantly A3 shade (42.9%).

Conclusion: Within the limitations of the study, among the Indian population, A2 was the most common tooth shade in both the young men and women. Darker hair colour patients had dark tooth shade. No conformity between the shade of teeth and eye color was found in this study.

Keywords: Tooth Shade; Indian Population; Central Incisor; Eye Colour; Hair Colour.

Introduction

Esthetics is an important perspective affecting the success of dental restorations [1]. In this regard, selecting a suitable tooth shade is a vital step ensuring natural appearance with dental restorations [2]. Shade selection with the help of shade guides and color matching the restorations to the natural dentition continues to be one of the most perplexing and frustrating problems. A correct color match to the natural tooth is just one of the essentials in creating an aesthetic restoration [3, 4]. Visual response of an individual, quality and quantity of the viewing lights, metamerism, color of the surroundings and past experiences are among those elements that enter into the color matching [5-7]. Shade selection requires knowledge of physics, physiology and psychology of color and therefore it is both an art and science requiring in

depth knowledge, accurate clinical judgment and perception on the part of the dentist [5]. Advances in technology have made shade selection easier, because of the availability of a wide range of commercially available shade guides. Early shade guides were derived from tooth colors that were considered pleasing, rather than from the distribution of shades found in the general population. In 1931, Clark recognising the need for a more systematic approach, introduced a custom shade guide based on visual assessment of human teeth, recorded in Munsell: Hue, Value, and Chroma [8-11].

In dentistry, comparison with remaining teeth is frequently used to select the color of artificial teeth [12]. This method cannot be used when providing an edentulous patient with a new set of complete dentures. There is no shade selection system for edentulous

*Corresponding Author:

Raghu Sandhya,
Reader, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Science, Saveetha University, Chennai 600077, India.
Tel: 9884610410
E-mail: drsandhyaendo@gmail.com

Received: November 05, 2020

Accepted: November 18, 2020

Published: November 27, 2020

Citation: Rajalakshmi Rakshanaa TV, Raghu Sandhya. Evaluation of Maxillary Central Incisor Tooth Shade and its Correlation with Eye Colour and Hair Colour in an Indian Population. *Int J Dentistry Oral Sci.* 2020;S10:02:0014:74-78. <http://dx.doi.org/10.19070/2377-8075-S102-0100014>

Copyright: Raghu Sandhya ©2020. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

patients. Shade selection for artificial teeth becomes a subjective process [13]. Dentists either choose shade for denture teeth with their clinical experience, shade guides or patients choose shade from the tabs of teeth in a shade guide. In these situations, skin, eye, gender or age are taken as guides that could help dentist while choosing shade for denture teeth in edentulous patients [14].

Our team has numerous highly cited publications on well-designed clinical trials and lab studies on various topics in endodontics in the past couple of years [15-30]. This provided us with the right platform to pursue the current study. There is no literature evidence investigating the relationships between tooth color and eye color or hair colour in Indian population. The purpose of this study was to evaluate the tooth shade of maxillary central incisor and its correlation with hair color, eye color in an Indian population.

Materials and Methods

A cross-sectional, analytical study with a non-probability convenient sampling technique, conducted. 100 patients, who visited for a routine dental check-up were chosen for the evaluation. Patient were informed about the evaluation and consent received.

The cross sectional study consisted of a sample size of 100 individuals belonging to both genders. Individuals in the age range of 18 years to 80 years with at least one completely erupted permanent maxillary right central incisor were considered for this study. Permanent maxillary central incisors with carious lesions, restorations, endodontically treated teeth, intrinsic staining, extrinsic staining due to diet, smoking and tobacco/pan chewing, tooth wear or any tooth abnormality, xerostomia and history of tooth bleaching or radiation therapy were excluded from the study. The shade of middle third of the labial surface of permanent maxillary right central incisor was recorded using the Vitapan classic shade guide (Vita Zahnfabrik H Rauter, Germany) and to avoid error the recording was done after placing cheek retractor and drying the teeth with cotton. The shade was assessed by the visual observation using natural light.

Following tooth shade the eye colour and hair colour of the individual was assessed. Eye color was assessed as 1=black; 2=dark brown; 3=light brown; or 4=Grey, grey/blue. The eye colour was assessed in the day light. Any patient with lens was excluded and

assessed. The patient original hair color was assessed as 1=black, 2=dark brown, 3=light brown, and 4= Grey/ red. Any hair extensions or patient with hair colouring done were excluded.

The data obtained were entered into the computer and descriptive statistical analysis was done using an statistical package of social sciences (SPSS) software. A p-value of ≤ 0.05 was considered significant.

Result and Discussions

Among the study population, majority of the patients had dark brown eye colour (54%) followed by light brown (27%), black (12%), and grey (7%). Among these patients A2 was the most common tooth shade. The results shows that, people with black eye had most commonly A2, A3, A1 shades followed by A3.5, A4, B3. People with dark brown eye had most commonly A2, A3, B2, A3.5 shades followed by B1, A1, C1, C2, B3, B4. People with grey eye had commonly A2 followed by A3, A3.5, B2, B3 shades. Light brown eye individuals had more of A2, A1, B2, A3.5 followed by B1, C1, A3, C2 tooth shades. But statistically it showed no significance between the eye colour and tooth shade (Table 1).

Among the study population, majority of the patients had black hair colour (58%), followed by dark brown (22%), light brown (13%), and grey (7%). According to our results, black hair individuals mostly had A2, A3, A1, B2 tooth shade followed by other shades. Individuals with dark brown hair commonly had A2, A3.5 tooth shade followed by B1, B2, C1, C2, A3. Individuals with grey hair were less and had A3, A3.5 shades. People with light brown hair had A2, B2 tooth shade followed by A1, B1, B3, C1 tooth shades. Results showed statistical significance ($p = 0.015$) and thus the tooth shades had correlation with the hair colour of an individual (Table 2).

Color is one of the most important determinants of dental esthetics. The trend toward a heightened awareness of esthetics has challenged dentistry to look at dental esthetics in a more organized and systematic manner, so that the health of patients and their teeth is still the most important underlying objective. But some existing dentitions simply cannot be restored to a more pleasing appearance without the assistance of several different dental disciplines. Today, every dental practitioner must have a thorough understanding of the roles of these various disciplines

Table 1. Cross tabulation of eye colour and tooth shade of central incisor among Indian population.

EYE COLOUR	TOOTH SHADE (No. of teeth and %)											Total
	A1	A2	A3	A3.5	A4	B1	B2	B3	B4	C1	C2	
BLACK	2 16.70%	4 33.30%	3 25.00%	1 8.30%	1 8.30%	0 0.00%	0 0.00%	1 8.30%	0 0.00%	0 0.00%	0 0.00%	12 100.00%
DARK BROWN	4 7.40%	14 25.90%	9 16.70%	6 11.10%	0 0.00%	5 9.30%	8 14.80%	1 1.90%	1 1.90%	3 5.60%	3 5.60%	54 100.00%
GREY	0 0.00%	3 42.90%	1 14.30%	1 14.30%	0 0.00%	0 0.00%	1 14.30%	1 14.30%	0 0.00%	0 0.00%	0 0.00%	7 100.00%
LIGHT BROWN	4 14.80%	10 37.00%	1 3.70%	3 11.10%	0 0.00%	2 7.40%	4 14.80%	0 0.00%	0 0.00%	2 7.40%	1 3.70%	27 100.00%
Total	10 10.00%	31 31.00%	14 14.00%	11 11.00%	1 1.00%	7 7.00%	13 13.00%	3 3.00%	1 1.00%	5 5.00%	4 4.00%	100 100.00%

Table 2. Cross tabulation of hair colour and tooth shade of central incisor among Indian population.

HAIR COLOUR	TOOTH SHADE (No. of teeth and %)											Total
	A1	A2	A3	A3.5	A4	B1	B2	B3	B4	C1	C2	
BLACK	9 15.50%	18 31.00%	10 17.20%	3 5.20%	0 0.00%	3 5.20%	7 12.10%	2 3.40%	1 1.70%	3 5.20%	2 3.40%	58 100.00%
DARK BROWN	0 0.00%	7 31.80%	1 4.50%	6 27.30%	0 0.00%	3 13.60%	3 13.60%	0 0.00%	0 0.00%	1 4.50%	1 4.50%	22 100.00%
GREY	0 0.00%	0 0.00%	3 42.90%	2 28.60%	1 14.30%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 14.30%	7 100.00%
LIGHT BROWN	1 7.70%	6 46.20%	0 0.00%	0 0.00%	0 0.00%	1 7.70%	3 23.10%	1 7.70%	0 0.00%	1 7.70%	0 0.00%	13 100.00%
TOTAL	10 10.00%	31 31.00%	14 14.00%	11 11.00%	1 1.00%	7 7.00%	13 13.00%	3 3.00%	1 1.00%	5 5.00%	4 4.00%	100 100.00%

in producing an esthetic makeover, with the most conservative and biologically sound interdisciplinary treatment plan possible.

Ceramics are replacing metals as materials of choice in dental crowns, as well as in other biomechanical prostheses. Tooth color is determined by a combination of extrinsic and intrinsic factors [31, 32]. Extrinsic factors are related to the deposition of either food or beverage stains over the enamel and the acquired pellicle [33, 34]. Intrinsic factors are related to the enamel and dentin properties of reflection and light dispersion. The choice of the correct tooth shade for the fabrication of a restoration poses a challenge, even for experienced clinicians [35]. Various factors, such as type and intensity of the light source, time of day and year, angle of incidence, and patient's clothes and color of the operatory furnishings will influence and complicate the shade-taking procedure [36, 37].

This study tried to establish a relationship between shade values of teeth with eye colour and hair colour of individuals. In this present study, a traditional method of shade matching using a conventional shade guide under daylight was carried out among 100 individuals. In previous studies, shade matching was done using the other dental shade matching systems such as spectrophotometer and spectroscope [38]. As these methods seem to be more expensive and also some host difficulty, it is necessary for the dentist to depend on the method of shade matching systems which is simple, practical and gives reliable results as well. Vitapan classical shade guide (Vita Zahnfabrik H Rauter, Germany) was used for shade matching in this study as it is one of the widely used methods among various dentists [38].

For tooth shade determination, the middle site of the tooth was used. The middle site of the teeth is said to be best representative of its colour because the incisal edge is most often translucent and is affected by its background while the cervical third is modified by scattered light from the gingiva [39].

A total of 100 individuals were evaluated for the study. Among the 100 patients, 36 were males and 64 were females. According to the results, the most common tooth shades were found to be A2 and A3 shades and the least common were found to be A4 and B4 shades. In previous articles, Hasegawa observed that the natural tooth color showed a significant decrease in lightness at the

center to cervical site and increase in yellowness with advancing age [40, 41]. Similar correlation was reported by Jahangiri where a significant association was found between tooth color and age of the patients, in that with advancing age, teeth tended to become darker in color [42]. In other studies by Esan, he indicated that gender is significantly associated with tooth shades, in that men are more likely to present with darker tooth shades whereas women of the same age group were more likely to show lighter tooth shades [43]. The present study focused on the correlation between the eye colour and hair colour with the tooth shade in an Indian population. The eye colours evaluated were black, dark brown, light brown and grey. Majority of the patients had dark brown eye colour followed by light brown. The most common shade was found to be A2 (31%) followed by A3 (14%), B2 (13%), A1(10%). Patients with black, dark brown eye generally had A2, A3 shades and patients with grey and light brown eye had A2, A1 and B2 shades. No significant association was found between the eye colour and tooth shades of the patients. This is not in agreement with the conclusion of Hassel who found that a significant association exist between eye color and teeth color [44]. However, their conclusion was based on the results of multivariate analysis, while in a univariate analysis no association was found [44]. An explanation for the result of no association of teeth colour to eye colour is probably that teeth colour is related more to the reflection and absorption mechanisms than inclusion of pigments in its structure, which is true also for the light-coloured eyes [45, 46]. Another study examining the relationship between L*, C*, and H* values and eye and hair color reported inconsistent findings [47]. Based on the report of Wang et al. the eye colour should not be used as a sole criterion to determine the tooth shade [45]. Our present also shows no appropriate correlation between the eye colour and tooth shade. The other variable factors such as age, gender, skin colour, hair colour, should be considered for determination of tooth shade. The hair colour of the patients were evaluated as black, dark brown, light brown, grey. Majority of the patients had black hair colour followed by dark brown. Patients with black and dark brown hair had commonly A2 and A3 shades. Patients with light brown hair had commonly A2 and B2 shades. Patient with grey hair had A3 and A3.5 tooth shades. The comparison between hair colour and tooth colour was found to be statistically significant. These results are similar to Hassel, who found an association of hair colour with the hue component of permanent tooth [44].

Conclusion

Within the limitation of the study, among the Indian population, A2 was the most common tooth shade in both the young men and women. No conformity between the shade of teeth and eye color was found in this study. There was a relative correlation found between the hair colour and tooth shades. Darker hair colour patients had dark tooth shade. Use of these characteristics is possible in selection of tooth shade, along with other variable factors. Since the study confines only to a limited population, this study can be extended to other regions for a more precise result.

Acknowledgement and Declarations

The authors thank Saveetha Dental College and Hospital for the approval and support rendered for the study.

References

- Keyf F, Uzun G, Altunsoy S. Choice of Color in Dentistry. *Pak J Med Sci.* 2009;28(3): 52-58.
- Renner RP. An introduction to Dental Anatomy and Esthetics. Quintessence Books, 3rd Ed. Chicago. 1985; 33: 241-273.
- Culpepper WD. A comparative study of shade-matching procedures. *J Prosthet Dent.* 1970 Aug 1;24(2):166-73.
- Sproull RC. Color matching in dentistry. Part II. Practical applications of the organization of color. *J Prosthet Dent.* 1973 May 1;29(5):556-66.
- Judd DB, Wyszecki G. Color in business, science and industry. *Encyclopedia of Color Science and Technology*, Wiley, New York, 1975; 31: 26-40.
- Shinomori K, Scheffner AM, Werner JS. Age-related changes in wavelength discrimination. *J Opt Soc Am A Opt Image Sci Vis.* 2001 Feb;18(2):310-8. Pubmed PMID: 11205976.
- Sperling HG, Wright AA, Mills SL. Color vision following intense green light exposure: data and a model. *Vision Res.* 1991;31(10):1797-812. Pubmed PMID: 1767498.
- Clark EB. An analysis of tooth color. *J Am Dent Assoc.* 1931 Nov 1;18(11):2093-103.
- Preston JD. Current status of shade selection and color matching. *Quintessence Int.* 1985 Jan;16(1):47-58. Pubmed PMID: 3883392.
- Schwabacher WB, Goodkind RJ. Three-dimensional color coordinates of natural teeth compared with three shade guides. *J Prosthet Dent.* 1990 Oct;64(4):425-31. Pubmed PMID: 2231451.
- Hasegawa A, Ikeda I, Kawaguchi S. Color and translucency of in vivo natural central incisors. *J Prosthet Dent.* 2000 Apr;83(4):418-23. Pubmed PMID: 10756291.
- van der Burgt TP, ten Bosch JJ, Borsboom PC, Kortsmits WJ. A comparison of new and conventional methods for quantification of tooth color. *J Prosthet Dent.* 1990 Feb;63(2):155-62. Pubmed PMID: 2304021.
- Sellen PN, Jagger DC, Harrison A. The selection of anterior teeth appropriate for the age and sex of the individual. How variable are dental staff in their choice? *J Oral Rehabil.* 2002 Sep;29(9):853-7. Pubmed PMID: 12366540.
- Curd FM, Jasinevicius TR, Graves A, Cox V, Sadan A. Comparison of the shade matching ability of dental students using two light sources. *J Prosthet Dent.* 2006 Dec;96(6):391-6. Pubmed PMID: 17174655.
- Ramarao S, Sathyanarayanan U. CRA Grid - A preliminary development and calibration of a paper-based objectivization of caries risk assessment in undergraduate dental education. *J Conserv Dent.* 2019 Mar-Apr;22(2):185-190. Pubmed PMID: 31142991.
- Poorni S, Srinivasan MR, Nivedhitha MS. Probiotic Streptococcus strains in caries prevention: A systematic review. *J Conserv Dent.* 2019 Mar;22(2):123-8.
- Manohar MP, Sharma S. A survey of the knowledge, attitude, and awareness about the principal choice of intracanal medicaments among the general dental practitioners and nonendodontic specialists. *Indian J Dent Res.* 2018 Nov-Dec;29(6):716-720. Pubmed PMID: 30588997.
- Azeem RA, Sureshbabu NM. Clinical performance of direct versus indirect composite restorations in posterior teeth: A systematic review. *J Conserv Dent.* 2018 Jan-Feb;21(1):2-9. Pubmed PMID: 29628639.
- Jenarthanan S, Subbarao C. Comparative evaluation of the efficacy of diclofenac sodium administered using different delivery routes in the management of endodontic pain: A randomized controlled clinical trial. *J Conserv Dent.* 2018 May-Jun;21(3):297-301. Pubmed PMID: 29899633.
- Nandakumar M, Nasim I. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. *J Conserv Dent.* 2018 Sep-Oct;21(5):516-520. Pubmed PMID: 30294113.
- Malli Sureshbabu N, Selvarasu K, V JK, Nandakumar M, Selvam D. Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases. *Case Rep Dent.* 2019 Jan 22;2019:7046203. Pubmed PMID: 30805222.
- Siddique R, Nivedhitha MS, Jacob B. Quantitative analysis for detection of toxic elements in various irrigants, their combination (precipitate), and para-chloroaniline: An inductively coupled plasma mass spectrometry study. *J Conserv Dent.* 2019 Jul-Aug;22(4):344-350. Pubmed PMID: 31802817.
- Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 gene expression in inflammation: A molecular study. *J Conserv Dent.* 2018 Nov;21(6):592-6.
- Rajakeerthi R, Ms N. Natural Product as the Storage medium for an avulsed tooth--A Systematic Review. *Cumhur. Dent. J.* 2019;22(2):249-56.
- Siddique R, Nivedhitha MS. Effectiveness of rotary and reciprocating systems on microbial reduction: A systematic review. *J Conserv Dent.* 2019 Mar;22(2):114-22.
- Janani K, Sandhya R. A survey on skills for cone beam computed tomography interpretation among endodontists for endodontic treatment procedure. *Indian J Dent Res.* 2019 Nov-Dec;30(6):834-838. Pubmed PMID: 31939356.
- Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. *J Conserv Dent.* 2019 Jan-Feb;22(1):40-47. Pubmed PMID: 30820081.
- Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study. *Pesqui Bras Odontopediatria Clin Integr.* 2019;19:1-10.
- Govindaraju L, Neelakantan P, Gutmann JL. Effect of root canal irrigating solutions on the compressive strength of tricalcium silicate cements. *Clin Oral Investig.* 2017 Mar;21(2):567-571. Pubmed PMID: 27469101.
- Khandelwal A, Palanivelu A. Correlation between dental caries and salivary albumin in adult population in Chennai: An in vitro study. *Braz. Dent. Sci.* 2019 Apr 30;22(2):228-33.
- Joiner A. Tooth colour: a review of the literature. *J Dent.* 2004 Jan 1;32:3-12.
- Walsh TF, Rawlinson A, Wildgoose D, Marlow I, Haywood J, Ward JM. Clinical evaluation of the stain removing ability of a whitening dentifrice and stain controlling system. *J Dent.* 2005 May 1;33(5):413-8.
- Watts A, Addy M (2006) Tooth discoloration and staining: A review of the literature. *Br Dent J.* 2006;190:309-16.
- Dahl JE, Pallesen U. Tooth bleaching--a critical review of the biological aspects. *Crit Rev Oral Biol Med.* 2003;14(4):292-304. Pubmed PMID: 12907697.
- Wee AG, Monaghan P, Johnston WM. Variation in color between intended matched shade and fabricated shade of dental porcelain. *J Prosthet Dent.* 2002 Jun;87(6):657-66. Pubmed PMID: 12131889.
- Paul S, Peter A, Pietrobon N, Hämmerle CH. Visual and spectrophotometric shade analysis of human teeth. *Journal of dental research.* 2002 Aug;81(8):578-82.
- Paravina RD. Evaluation of a newly developed visual shade-matching apparatus. *Int J Prosthodont.* 2002 Nov-Dec;15(6):528-34. Pubmed PMID: 12475156.
- Chenchugopal M, Venumbaka NR, Vijayakumar P, Selvaraju G, Rajendran S, Elangovan A. Shade selection of primary maxillary anterior teeth in children using Vitapan classical shade guide. *Indian J Dent Res.* 2016 Nov-Dec;27(6):321-324. Pubmed PMID: 28169266.
- Schwabacher WB, Goodkind RJ, Lua MJ. Interdependence of the hue, value, and chroma in the middle site of anterior human teeth. *J Prosthodont.* 1994 Dec;3(4):188-92. Pubmed PMID: 7866499.
- Young L Jr, Glaros AG, Moore DJ, Collins JE. Assessing shade differences in acrylic resin denture and natural teeth. *J Prosthet Dent.* 1994 Jun;71(6):575-80. Pubmed PMID: 8040819.
- Hasegawa A, Ikeda I, Kawaguchi S. Color and translucency of in vivo natural central incisors. *J Prosthet Dent.* 2000 Apr;83(4):418-23. Pubmed PMID: 10756291.
- Jahangiri L, Reinhardt SB, Mehra RV, Matheson PB. Relationship between tooth shade value and skin color: an observational study. *J Prosthet Dent.* 2002 Feb;87(2):149-52. Pubmed PMID: 11854669.
- Esan TA, Olusile AO, Akeredolu PA. Factors influencing tooth shade selec-

- tion for completely edentulous patients. *J Contemp Dent Pract.* 2006 Nov 1;7(5):80-7. Pubmed PMID: 17091143.
- [44]. Hassel AJ, Nitschke I, Dreyhaupt J, Wegener I, Rammelsberg P, Hassel JC. Predicting tooth color from facial features and gender: results from a white elderly cohort. *J Prosthet Dent.* 2008 Feb;99(2):101-6. Pubmed PMID: 18262010.
- [45]. Wang H, Lin S, Liu X, Kang SB. Separating reflections in human iris images for illumination estimation. In: *Proceedings of IEEE International Conference on Computer Vision.* 2005; 25:215.
- [46]. Over LM, Andres CJ, Moore BK, Goodacre CJ, Muñoz CA. Using a colorimeter to develop an intrinsic silicone shade guide for facial prostheses. *J Prosthodont.* 1998 Dec;7(4):237-49. Pubmed PMID: 10196844.
- [47]. Goodkind RJ, Schwabacher WB. Use of a fiber-optic colorimeter for in vivo color measurements of 2830 anterior teeth. *J Prosthet Dent.* 1987 Nov;58(5):535-42. Pubmed PMID: 3479551.