

Comparative Evaluation of Tooth Colour under Different Light Sources at Different Angulations: An In Vivo Study

Atul Jain¹, Shantwana Singh², Brijesh Kumar Singh³, Remya Ramachandran⁴,
Kamei Neilalung⁵, Piyushi Mishra Tiwari⁶, Michelle Vaz⁷

¹ Professor and HOD, ^{2, 4, 5, 6, 7} PG students, Dept Of Conservative Dentistry And Endodontics,

³Dept of Veterinary Surgery and Radiology

* Corresponding Author: Shantwana Singh

ABSTRACT:- Tooth colour could give different appearance on observation under different light sources and when viewed at different angulations. Awareness of the possible variations in shade selection, resulting from these two factors is paramount. To evaluate the difference in tooth colour under different light sources and due to difference in viewing angulation. 10 patients selected on the basis of predetermined criteria were evaluated for tooth colour by 4 different observers under different light sources- Tubelight, Halogen bulb, Dental Chair Light and Midday Sunlight. Tooth colour of the facial surface of the right maxillary central incisor at different angulations i.e. 30°, 90° and 120° horizontal were evaluated. The colour of the evaluated teeth was confirmed with the help of Spectrophotometer. Light source provided most appropriate shade selection followed by midday sunlight, dental chair light and tube-light, respectively and the difference were statistically significant. A viewing angle of 120° provided most appropriate shade selection followed by 90° and 30° which were statistically significant. Use of halogen light source, with a viewing angle of 120°, provides the most appropriate shade selection.

Key Words:- Shade Matching, Light Source, Shade guide, Observers.

I. INTRODUCTION

Of late, esthetic component has predominated the elective restorative dentistry. In esthetic dentistry, other than proper shape and contour of restored teeth, appropriate shade matching is of prime importance.

This step is often not accorded adequate importance by the general dentist. This could be due to ignorance or neglect.

While selecting the shade, apart from the other factors, two factors which are generally not appropriated due importance are the light source, under which shade selection is made¹ and the viewing angulation².

All the restorative materials used in restorative dentistry, possess the property of metamerism, which is appearance of different shade under different light sources³. Selecting the most appropriate light source for proper shade selection is one of the factors, which is way down on the list of importance accorded by the general practitioner. The second factor, which is accorded minimal or no importance, is the viewing angulation. It has been established in numerous studies that the viewing angulation tends to produced alteration of perceived shade, known as goniochromism⁴.

This study was conceived and carried out so as to evaluate the effect of these two factors on shade selection.

II. MATERIAL & METHODS

For this clinical study, prior approval was taken from the RKDF Institutional ethical committee. In this study, 10 volunteers were selected on the basis of following inclusion and exclusion criteria.

1.1 Inclusion Criteria:-

Young adults, in the age group of 21 to 25 years with healthy and free of defect maxillary central incisor were selected. The subjects belonged to either gender and did not have a history of trauma or any pain or discomfort in any of maxillary central incisor.

1.2 Exclusion Criteria-

Maxillary central incisors with any of the following were excluded:-

- Discoloration
- Caries or restoration
- High Plaque and periodontal index
- Crazing or fracture
- Patient on medication
- Malformed or malalignment
- Endodontic treatment.

1.3 Selection of observers:-

Four observers, irrespective of the gender were selected, belonging to the age group of 25 to 30 years. They were examined for colour blindness and visual acuity. Those with normal 6/6 vision, free of any ocular disease or defect and with proper colour vision were selected.

In the 10 subjects, who were selected, right maxillary Central Incisor were examined clinically, tested for pulp sensibility and examined radiographically for ruling out any pulpal or periodontal disease. They were explained in detail about the study and were asked to sign informed consent form. Oral prophylaxis followed by polishing of teeth, was carried out.

All the 10 subjects, were evaluated for shade of their right central incisor separately, by the four selected observers. For shade selection each subject was seated on the dental chair and the shade of the maxillary right central incisor was evaluated with the help of a classic VITA shade guide at 3 different horizontal angulation - 30°, 90° and 120°. Shade selection was made under four different lighting condition Viz - Tube-light, Halogen bulb, Dental chair light and mid day light.

Shade selection was made by keeping the most appropriate tab adjacent to the right central incisor, partially covered by the upper lip. The shade selected at different angulation by each observer was noted and tabulated under the different light sources.

Spectrophotometer was used to ascertain the exact shade in each subject. The shade selection made by the four different evaluators was compared in between the evaluators and with the shade determined by the spectrophotometer, statistically using Kruskal - Wallis test.

III. RESULT

The closest shade selection to the actual tooth colour was made under the Halogen light. Sunlight, Dental chair light and Tubelight provided the subsequent higher correct shade selection in decreasing order. Under the Halogen light, Sun light, Dental chair light and Tube light, 27, 20, 18 and 18 correct shade selection were made, respectively. (table 1).

The mean percentage of correct matches for each light source from different observers were calculated and Kruskal-Wallis test revealed significant differences in shade matching under the three light sources ($p \leq 0.05$) (Table 1). The number of correct choices under the Halogen light source was significantly higher than three other light sources ($p < 0.05$) and non significant difference were observed among the other light sources. (Table 2 a & b).

The highest correct shade selection were made when the teeth were observed at 120° angulation, followed by 30° and 90° angulations. 27 correct shade selection were made at 120° viewing angulation, followed by 26 at 90° and 24 at 30°. No statistical significant difference in shade selection was found with different viewing angulations ($p > 0.05$). (Table 3)

IV. DISCUSSION

During shade selection nearly 80% of dentist has been found to have employed improper light sources, with nearly 40% using below the optimal range while 40% used over intensity of light sources.⁵ Thus the importance of light source is paramount during shade selection process. Various light sources have been tested, out of which sunlight has been found to be most suitable.⁶ Shade selection is not made in a number of cases during the day time, moreover majority of the clinics are enclosed and devoid of incoming sunlight. Therefore artificial light source has to be employed, making the shade selection process prone to light variables.

In our study out of the tested light sources, for shade selection, halogen light was found to provide highest number of accurate shade selection. Amongst the numerous variable factors, governing the light sources which tend to influence the shade selection process, some of the important ones are - temperature of the light source, intensity of the light reaching the teeth, CRI index and the position of the light source in respect to the teeth.

Out of these four factors, in our study the position of light source was kept constant in respect to the right maxillary central incisor. For optimal shade selection, temperature of the light source should be near 5500 K, CRI index should be 93 or above and intensity of light should be between 75 to 250 foot - Candle.⁷ Halogen light fulfills these parameters, closest to the optimum, as displayed in Table 4

Although sun light is the most balanced and natural of light sources, is whitest light source and standard by which all other light sources are measured but employing direct sunlight is problematic for shade selection.⁸ Instead indirect sun light is employed but it tends to lessen the qualities compared to the direct sunlight.⁹ Halogen light provides a bright light source and is employed widely, ranging from car headlight to air-rotor hand piece light^{9,10} although they are not energy efficient¹⁰ and waste this high energy through heat¹¹ but this high temperature provides near optimal temperature required for shade selection.¹² Halogen light is also used in dental light but they tends to possess a lower temperature.¹³

On comparing the related properties, tube-light has the most distance values for the light quality required for optimal shade selection.(Table 4) Because of this reason the Halogen light used in our study provided the highest number of correct shade selection followed by indirect sunlight, dental chair light and tube-light respectively.

Jasinevicius et al and Dagg et al , in the studies found that conventional laboratory lighting condition, illuminated by tubelight or bulbs do not provide correct shade match.^{10,14,15} Mohammadreza et al found that natural light provides better shade selection.¹⁶ Francis et al also found that rather than clinical light source sunlight provides more appropriate shade match¹⁷ Similar to our findings Jasinevicius et al, Dagg et al and Mohammadreza et al in separate study found that Halogen light provides appropriate shade selection in comparisons to the dental chair light.^{10,15,16} Contrary to our finding Vaibhav et al and Batu et al did not get appropriate shade match under halogen light.^{18,19} The reason they assigned for not getting proper shade selection was inadequacy was of the temperature and light intensity of the light sources employed.

Goienochromatism is the phenomena of the certain surfaces changing colour with the changed angle of view, has been found to play an important role during the teeth shade selection in our study 120° viewing angulation provided the most appropriate shade selection followed by 90° and 30° respectively. The probable reason for this finding is that when the tooth is viewed at the eye level at 120°, the most colour sensitive part of the retina is used.^{20,21}

V. CONCLUSION

On the basis of results obtained in our study it can be concluded that use of halogen light source, with a viewing angle of 120°, provides the most appropriate shade selection.

REFERENCE

- [1]. Sikri VK. Colour implications in dentistry. J Cons Dent2010; 13:249-55
- [2]. Lasserre JF, Pop-ciutrita IS, Colosi HA, A comparison between a new visual method of colour matching by intraoral camera and conventional visual and spectrometric methods. J Dent 2011; 39 Suppl 3:e29-36.
- [3]. Curd FM, Jasinevicius TR, Graves A, Cox V, Sadan A. Comparison of the shade matching ability of dental students. J. Dent Educ 2010; 74(9):1002-10.
- [4]. Knezovic Zlataric D, Illes D, Alajbeg I, Zagar M, In Vivo and in Vitro Evaluations of repeatability and accuracy of VITA Easy shade Advance 4.0 Dental shade-matching device. Acta Stomatol Croat. 2015;49(2):112-8.10.15644/asc49/2/4
- [5]. Barna G, Taylor J, King G, Pelleu Jr G. The influence of selected light intensities on colour perception within the colour range of natural teeth. The journal of Prosthetic Dentistry 1981; 46(4):450-3.
- [6]. Brewer JD, Wee A, Seghi R. Advances in colour matching. Dent Clin North Am 2004;48(2):371-58
- [7]. Park JH, Lee YK, Lim BS, Influence of illuminants on the colour distribution of shade guides. J Prosthet Dent 2006;96(6):402-11
- [8]. Brewer JD, Wee A, Seghi R. Advances in color matching, Dent Clin North Am. 2004;48:341-58.
- [9]. Rosentiel F, Land MF, Fujimoto J. Contemporary Fixed Prosthodontics. St. Louis: Mosby 2006;709-39.
- [10]. Dagg H, O'Connell B, Claffey N, Byrne D, Gorman C. The Influence of some different factors on the accuracy of shade selection. J Oral Rehabil 2004;31(9): 900-04.
- [11]. Dunn WJ, Bush AC. A comparison of polymerization by light-emitting diode and halogen based light curing units. J AM Dent Assoc. 2002;133:335-41.
- [12]. Deb S, Sehmi HA, Comparative study of the properties of the dental resin composites polymerized with plasma and halogen light. Dent Mater.2003;19:517-22.
- [13]. Gokce HS, Piskin B, Ceyhan D, Gokee SM, Arisan V. Shade matching performance of normal and colour vision deficient dental professionals with standard daylight and tungsten illuminants. J Prosthet Dent 2010; 103(3):139-47.

- [14]. Clu S, Devigus A, Meeleszko A, Fundamentals of colour; shade matching and communication in esthetic dentistry: Quintessence Pub Co:2004
- [15]. Jasinevicius TR, Curd FM, Schilling L, Sadan A. Shade matching abilities of dental laboratory technicians using a commercial light source. J Prosthodont 2009;18(1):60-63
- [16]. Mohammadreza Nakhaei, Jalil Ghanbarzadeh, Shirin Keyvanloo, Samin Alavi, Hamid Jafarzadeh, Shade matching performance of dental students with three various lighting conditions. JP Journals; 2013; 10(3):10024-1279
- [17]. Francis M. Curd, T. Roma Jasinevicius, Angela Graves, Viktoria Cox, Avishai Sadan. Comparison of the Shade matching ability of dental students using two light sources. J Prosthodont 2006
- [18]. Vaibhav N Awinashe, Effect of Lighting intensity on the shade selection in ceramic restorations. IJDC 2010;2(3):23-26.
- [19]. Batu Can Yaman, Begum Guray Efes, Can Dorter, Yavuz Gomec, Dina Erdilek, Sami Buyukgokcesu. The effects of halogen and light emitting diode light curing on the depth of cure and surface microhardness of composite resin. J. Conser Dent. 2011; 14(2): 136-139.
- [20]. Cook WD, McAree DC, Optical properties of esthetic restorative materials and natural dentition. J Biomed Mater Res. 1985; 19:469-88.
- [21]. Derbabian K, Morzola R, Donovan TE, Areidiacono A. The science of communication the art of esthetic dentistry. Part III: precise shade communication. J Prosthet Dent 2010; 103(3):139-47.

Light Source Viewing Angulation	Halogen Bulb			Tube-light			Sun Light			Dental Chair Light		
	30°	90°	120°	30°	90°	120°	30°	90°	120°	30°	90°	120°
Correct shade selection	24	26	27	17	17	18	15	19	20	16	16	18

Table 1:- Correct shade selection at different viewing angulation and under different light sources

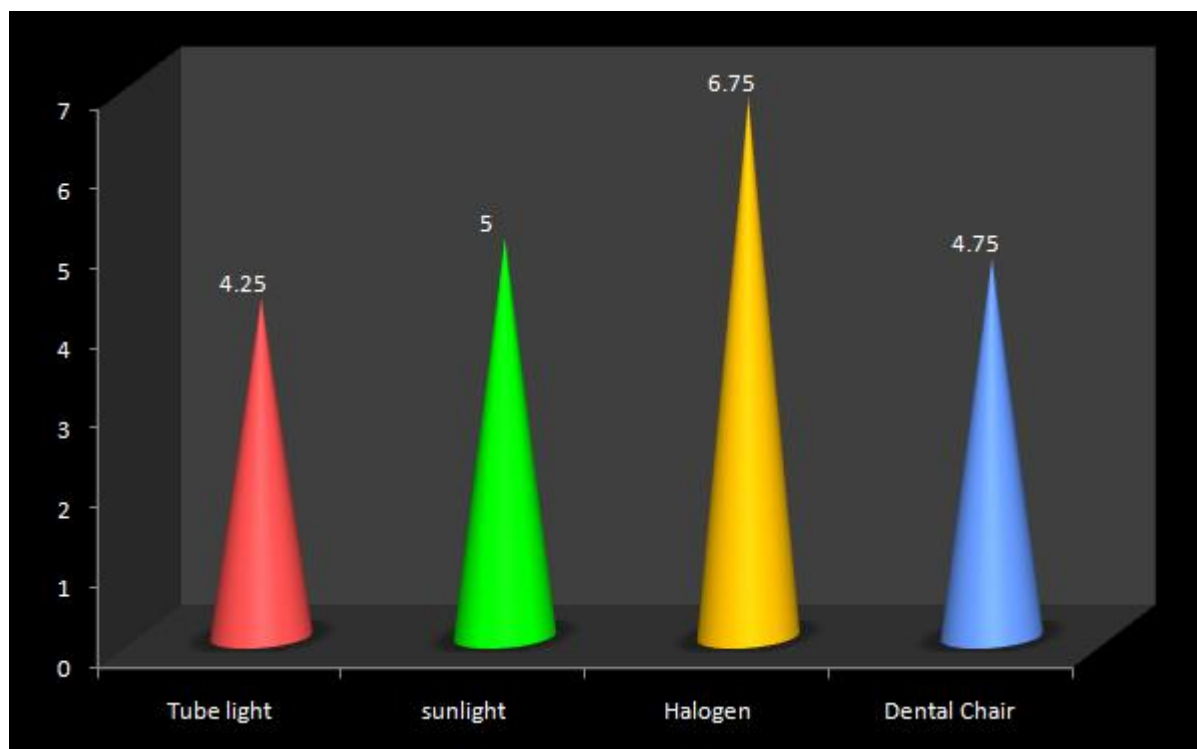
Groups	Mean	Std. Deviation	Chi Square	P Value
Tube light	4.25	0.50	9.23	0.023(s)
Sunlight	5.00	0.81		
Halogen	6.75	0.50		
Dental Chair	4.75	0.95		

Kruskal-Wallis test, $p < 0.05$

Table 2(a): Mean correct shade match scores under four different light sources

Groups	Mean	P Value
Tube light: sunlight	3.37	0.296
Tube light: Halogen	9.50	0.03
Tube light: Dental Chair	2.12	0.51
Sunlight: Halogen	7.37	0.02
Sunlight: Dental Chair	1.25	0.69
Halogen: Dental Chair	6.12	0.04

Table 2(b): Post Hoc Test for comparing the different light sources



Graph1: Mean correct shade match scores of dental students under four different light sources

Groups	30°	90°	120°	Chi square	P value
Tube light	4.00	3.75	4.50	4.46	0.17
sunlight	4.50	5.00	5.00	3.66	0.16
Halogen	6.00	6.50	6.75	3.89	0.14
Dental Chair	4.25	4.25	4.50	4.04	0.19

Kruskal-Wallis test, $p < 0.05$

Table3: Mean correct shade match scores under three different angulations

Light Sources	Temperature	CRI	Light Intensity
Halogen	4500 K	92.2	526 mW
Tube-Light	3200 K	75	260 mW
Dental Chair Light	4000 K	80	300 mW
Indirect Sun Light	5000K	90	1050 mW

Table 4:- Properties of light source.

* Corresponding Author: Shantwana Singh
PG students, Dept of Conservative Dentistry and Endodontics