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KNOWLEDGE AND AWARENESS OF ROLE OF DIFFERENT LIGHT SOURCES IN CERAMIC SHADE MATCHING FOR VENEERS AMONG UNDERGRADUATES

Amina Mehrin Bano[1], Dhanraj Ganapathy[2], Kiran Kumar Pandurangan[3]

ABSTRACT*:Aesthetic dentistry is a blend of science and art. Its success is determined on the basis of functional and esthetic results. To achieve esthetics, four basic determinants are required in sequence; viz., position, contour, texture and color. Because esthetic dentistry imposes several demands on the artistic abilities of the dentist and the technician, knowledge of the underlying scientific principles of color is essential. Thequestionnaire-based study was conducted among the students studying at a private dental college with the aim to assess their knowledge and awareness of role of different light sources in ceramic shade matching for veneers. A questionnaire was created on Google Forms and the subjects were administered with a structured questionnaire encompassing their knowledge and awareness of role of different light sources in ceramic shade matching for veneers. The Multiple-Choice Questionnaire developed, had 15 questions and it was made sure that individuals gave their first natural response and attempted all the questions spontaneously. Among the study population higher incidence of interns(blue) 60%, followed by 3rd years(beige) 23% and 4th years (green) 17% was found. Experience was the most commonly chosen answer among interns(blue) 26% and 3rd years(beige) 9%, knowledge and experience were chosen equally among 4th years(green) 6%. A most commonly selected answer was "Yes" and highest response was seen among interns(blue) was 55%, among 4th years (green) it was 16% and among 3rd years(beige) was 13%.A higher incidence of the correct response(beginning of diagnostic appointment) among interns(blue) 26% ,4th years (green) 10% and 3rd years(beige) 15% was seen .A higher incidence of the correct response(85-90) among interns(blue) 23% followed by 4th years (green) 6% and 3rd years(beige) 11% was seen. To achieve the excellent esthetic result the dentist should be able to carry out proper shade selection & communicate it to the lab. From the results of our study we can conclude that the knowledge and awareness of role light source among undergraduates has further room for improvement. Although interns seem to fairly have hold of the concept, more experience and practise in this field is needed for exceptional shade selection skills*

Keywords: *Shade selection; light sources;knowledge;awareness; undergraduate delta students*

[1]*Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Email: 151501085@saveetha.com*

[2]*Professor and H.O.D, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India*

[3]*Senior Lecturer, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India*

Corresponding author: Dhanraj Ganapathy

Professor and H.O.D, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, No. 162, PH Road, Poonamallee, Chennai - 600077, Tamilnadu, India, Contact No: +91 9841504523

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1. INTRODUCTION

Aesthetic dentistry is a blend of science and art. Its success is determined on the basis of functional and esthetic results. To achieve esthetics, four basic determinants are required in sequence; viz., position, contour, texture and color. spectrum and the optical characteristics of the object is to be understood before evaluating and selecting the proper color shade for the restoration. Continued research on the human visual system has given us greater insight into how color discrimination is affected by environment and other features like disease, drugs and aging. [1]The basic fundamentals of color and light, the radiation

Light is electromagnetic radiation that can be detected by the human eye. Natural white light falls between 380 and 770 nm along the electromagnetic spectrum, having a couple of component bands along the spectrum. The component bands produce six different sensations, i.e. red, orange, yellow, green, blue and violet. However, there is an infinite number of gradations among the component bands with ill-defined boundaries. The color of any object is dependent on the illuminant in which it is viewed. If incident light does not contain a particular wavelength segment, the object cannot reflect it. Colorants (pigments or dyes) are responsible for chromatic reflection of light.[2] The chemical composition of a colorant selectively absorbs one part of the visible spectrum more than another. When a particular wavelength segment of light is reflected and enters the eye, the sensation of color is produced

As light enters the eye through the cornea and lens, an image is focused on the retina. The amount of light entering the eye is controlled by the iris, which dilates or constricts depending on the level of illumination. The retinal rods and cons can adjust the variation of light intensity. The area around the fovea centralis has a mixture of sensors responsible for differences in color discrimination among observers with normal color vision.[3] The accuracy of color perception depends on the area of the retinal field stimulated by light. In high illumination, the pupil narrows and when light is dim, the pupil widens, stimulating sensors that are less accurate. As a regulator of pupil diameter, light intensity is a critical factor in color perception and shade matching. The three important features that reflect color matching are successive contrast, simultaneous contrast and color constancy.[4] Successive contrast is the projection-negative effect that occurs after staring at a colored object. Simultaneous contrast is an instantaneous change in chromatic sensitivity, characterized by a change in appearance due to the surrounding colors. Color constancy occurs because we perceive certain objects as being of different color and the object seems to be of the same color even if the light received by the eye varies.[5] A neural response is involved in color vision and constant stimulation by a single color may result in color fatigue and decrease in the eye's response. Our ability to perceive color and visual acuity is also affected by aging, chronic illnesses, glaucoma and medications like oral contraceptives, ibuprofen, antiepileptic drugs, aspirin and antibiotics and lidocaine, etc.

Color perception is affected by the reflection or interference from the surrounding colors. The effects of clothing and make-up, especially lipstick, should be neutralized. One should stare at a tooth for less than 5 s because our eyes become accommodated to the red and yellow colors.[2] The after-image that occurs when looking continuously at an object of one color can be minimized by looking at a blue object between assessing different shade tabs. Blue backgrounds, however, are not appropriate because they also cause after-images and may bias your perception to its complementary color "orange." The eyes should be given a break with a neutral grey background such as a Pensler Shield (Kulzer), which is designed to screen out the background color glare.[6])

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Previously our department has published extensive research on prosthetic dentistry [7–15], on effect of various drugs [16,17], oral hygiene status of women [18], on the effect of impregnated gingival retraction cords [19], on the medical management of cellulitis [20], this vast research experience has inspired us to research this topic. Thequestionnaire-based study was conducted among the students studying at a private dental college with the aim to assess their knowledge and awareness of role of different light sources in ceramic shade matching for veneers.

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2. MATERIALS AND METHODS

Background:

The questionnaire-based study was conducted among the students studying at a private dental college to assess their knowledge and awareness of role of different light sources in ceramic shade matching for veneers. It was conducted in the city of chennai, tamilnadu, india during january 2020.

Study design:

A questionnaire was created on Google Forms and the subjects were administered with a structured questionnaire encompassing their knowledge and awareness of role of different light sources in ceramic shade matching for veneers. The Multiple-Choice Questionnaire developed, had 15 questions and it was made sure that individuals gave their first natural response and attempted all the questions spontaneously. Anonymity was maintained and their responses were noted and tabulated. Ethical approval to conduct the study was obtained from the ethical review board of Saveetha Institute of Medical and Technical Sciences.

Inclusion criteria:

3rd, 4th students and interns studying at a private dental college were included in the study

Exclusion criteria:

Post graduate students, professors were excluded from the study. Incomplete responses were excluded due to the risk of bias.

Statistical analysis:

The responses were tabulated and Chi square tests were performed using SPSS software by IBM

Limitations of study:

The study was conducted only in one private dental hospital and thus confined to one metropolitan area.

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3. RESULTS & DISCUSSION

Among the study population higher incidence of interns(blue) 60%, followed by 3rd years(beige) 23% and 4th years (green) 17% was found. (figure 1) Experience was the most commonly chosen answer among interns(blue) 26% and 3rd years(beige) 9%, knowledge and experience were chosen equally among 4th years(green) 6% (figure 2). A most commonly selected answer was “Yes” and highest response was seen among interns(blue) was 55%, among 4th years (green) it was 16% and among 3rd years(beige) was 13%(figure 3).A higher incidence of the correct response(beginning of diagnostic appointment) among interns(blue) 26% ,4th years (green) 10% and 3rd years(beige) 15% was seen(figure 4) .

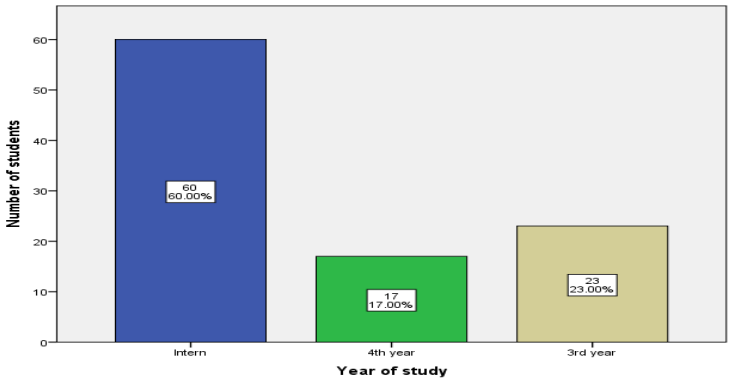

Figure1: Graph depicts the number of students in each year .X-axis represents the year of study of subjects and Y Axis represents number of students. Among the study population higher incidence of interns(blue) 60%, followed by 3rd years(beige) 23% and 4th years (green) 17% was found.

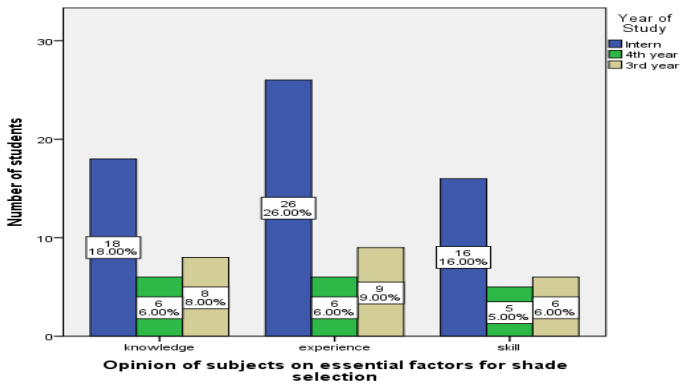

Figure2 : Graph depicts the opinion of subjects on tributes necessary for shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students . Experience was the most commonly chosen answer among interns(blue) 26% and 3rd years(beige) 9%, knowledge and experience were chosen equally among 4th years(green) 6%. Chi square test was conducted,pearson chi square value =0.467, df=4, p=0.976, hence is it statistically not significant (p>0.005).

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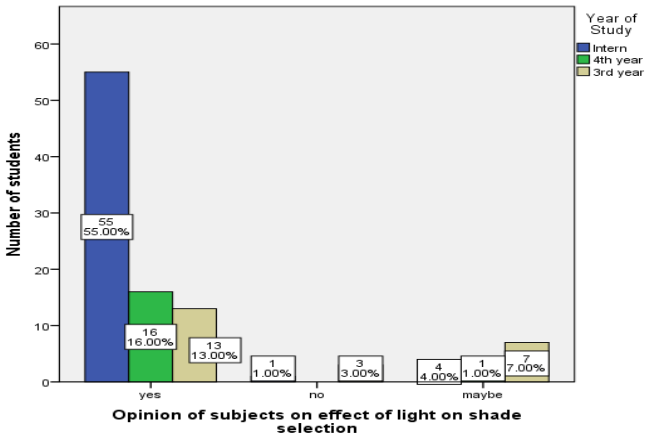

Figure3: Graph depicts the opinion of subjects on the possibility of effect of light source on shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. A most commonly selected answer was Yes and highest response was seen among interns(blue) was 55%, among 4th years (green) it was 16% and among 3rd years(beige) was 13%. Chi square test was conducted,pearson chi square value =, df=, p=, hence is it statistically significant (p0.005)

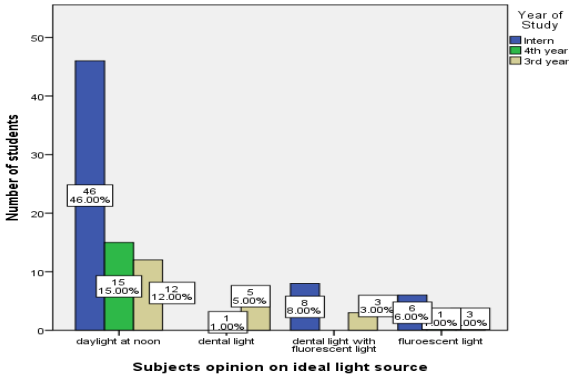

Figure4: Graph depicts the opinion of subjects on ideal light source for shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. A higher incidence of the correct response(daylight at noon) among interns(blue) 46% ,4th years (green) 15% and 3rd years(beige) 12% was seen .Chi square test was conducted among opinion of students and year of study, pearson chi square value =17.869, df=6,p=0.007, hence is it statistically significant (p<0.005) proving a correlation among the favorable variables exists .

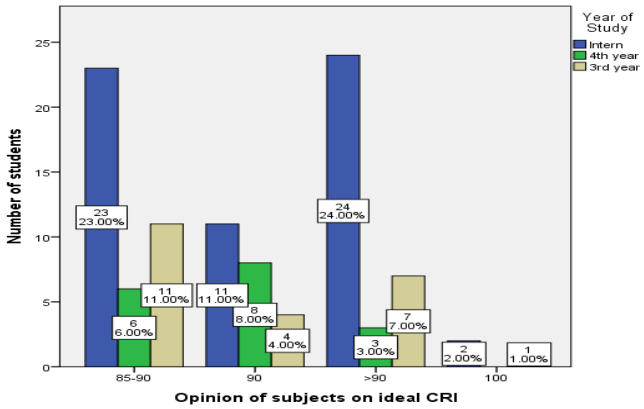

Figure5: Graph depicts the opinion of subjects on ideal CRI of light source for shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. A higher incidence of the correct response(85-90) among interns(blue) 23% followed by 4th years (green) 6% and 3rd years(beige) 11% was seen .Chi square test was conducted among opinion of students and year of study, pearson chi square value =8.379, df=6,p=0.212, hence is it statistically not significant (p>0.005) proving a correlation among the favorable variables does not exist.

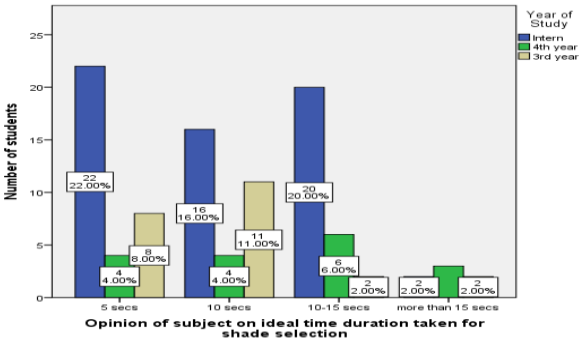

Figure6: Graph depicts the opinion of subjects on ideal time taken to perform shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. A higher incidence of the correct response(5 secs) among interns(blue) 22% ,4th years (green) 4% and 3rd years(beige) 8% was seen .Chi square test was conducted among opinion of students and year of study , pearson chi square value =11.441, df=6,p=0.076, hence is it statistically not significant (p>0.005) proving a correlation among the favorable variables does not exist.

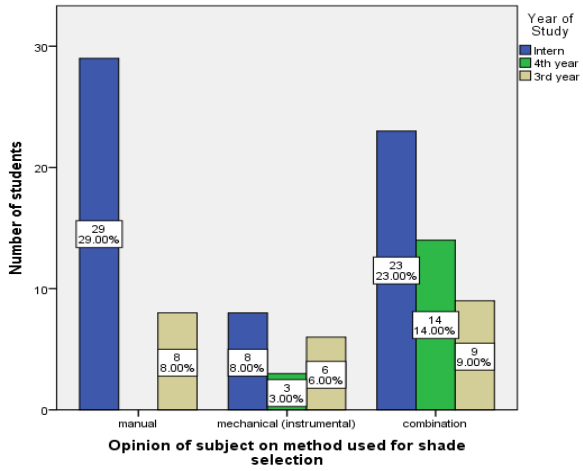

Figure7: Graph depicts the method used by the subjects for shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. A higher incidence of the manual method was seen among interns(blue) 29%.The 4th years (green) responded with a combination of both methods 14% along with 9% of the 3rd years(beige) .Chi square test was conducted among opinion of students and year of study ,

pearson chi square value =15.886, df=4,p=0.003, hence is it statistically significant (p<0.005) proving a correlation among the favorable variables exists

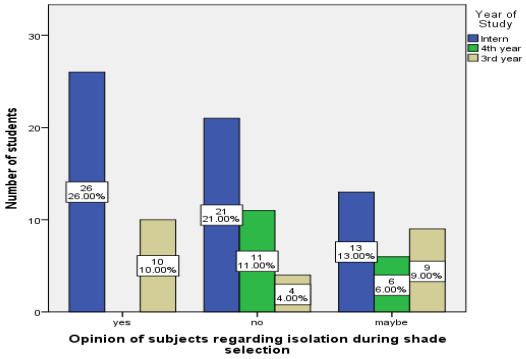

Figure8: Graph depicts the opinion of subjects on isolation during shade selection and the number of students in each year .X-axis represents the opinion of subjects and Y Axis represents number of students. About 26% of the subjects among interns(blue) reposed with "Yes", surprisingly 11% of the 4th years reposed with "No" as the answer and 9% of the 3rd years responded with "Maybe" .Chi square test was conducted among opinion of students and year of study , pearson chi square value =15.694, df=4,p=0.003, hence is it statistically significant (p<0.005) proving a correlation among the favorable variables exists

A higher incidence of the correct response(85-90) among interns(blue) 23% followed by 4th years (green) 6% and 3rd years(beige) 11% was seen(figure 5). A higher incidence of the correct response(5 secs) among interns(blue) 22% ,4th years (green) 4% and 3rd years(beige) 8% was seen(figure 6) .A higher incidence of the manual method was seen among interns(blue) 29%(figure 7).The 4th years (green) responded with a combination of both methods 14% along with 9% of the 3rd years(beige)(figure 8).About 26% of the subjects among interns(blue) reposed with "Yes", surprisingly 11% of the 4th years reposed with "No" as the answer and 9% of the 3rd years responded with "Maybe" (figure 9).

Color is one of the most important determinants of esthetic dentistry. Many factors such as type and intensity of the light source, time of day and year, angle of incidence, and patient's clothes, age, and sex gender.[2]Eye color, skin color, and other factors usually influence and make it difficult during shade-selection and matching. The most common of these is the age. Even though light is one of the most important factors,[21] it is the most commonly overlooked one(figure3) .Color is usually described according to the Munsell color space in terms of hue, value, and chroma.

Hue is the attribute of a color that enables the clinician to distinguish between different families of color, whereas value indicates the lightness of a color. Chroma is the degree of color saturation. When color is determined using the Munsell system, value is determined first followed by chroma. Hue is determined last by matching with shade tabs of the value and chroma already determined.[22]Hue is the quality that distinguishes one family of color from another. It is specified as the dominant range of wavelengths in the visible spectrum that yields the perceived color, even though the exact wavelength of the perceived color may not be present. Hue is a physiologic and psychological interpretation of a sum of wavelengths. Hue is represented by A, B, C or D on the commonly used Vita Classic shade guide[21] .Value, or brightness, is the amount of light returned from an object ..Chroma is the saturation, intensity or strength of the Hue If any dye (say red) is

added into a glass of water and the same dye is added again and again, the intensity increases, but the color remains the same (hue). As more dye is added, the mixture appears darker; thus, the increase in chroma has a corresponding change in value.[23] As chroma is increased, the value is decreased; chroma and value are inversely related. Higher numbers on the Vita Classic shade guide represent increased chroma

The quality of light source is the most influential factor when determining tooth shade.[24] The ideal light source is natural light, occurring around midday for accurate color comparison(figure5). The time of the day, month and weather conditions affect the color of sunlight. If the light source changes, then the light reflected from an object changes too; in that case, a different color is perceived. The absence of ideal conditions has led to the use of artificial lighting for color matching. The light source that approximates standard daylight is ideal for shade matching. Color temperature, spectral reflectance curves and Color Rendering Index (CRI) are all used to measure the capacity to reproduce standard daylight. CRI over 90 is recommended for colormatching (figure 6). Dental unit lights are usually incandescent lights that emit light high in the red–yellow spectrum and are low at the blue end. Regular cool white fluorescent lights are high in the green–yellow spectrum. Color-corrected fluorescent lights are also available, which render the color more accurately.[25] Full-spectrum light-emitting diodes (LEDs) are now replacing incandescent bulbs. The shade-matching ability is better with a light-correcting source than under natural light.[23]

A new device that eliminates the variability of different light sources, “The OptilumeTrueshade,” uses full-spectrum LEDs and shows a color spectrum similar to mid-day light. Diffusion lenses over the LEDs mix the three (RGB) colors of light emitted by the individual color diodes to create optimum, diffuse daylight. With the LEDs set at a 45-degree angle to minimize spectral reflectance or glare, the clinician can more accurately assess the true color.[26] A unique feature of OptilumeTrueshade is the ability to reduce the intensity of the light source while maintaining the color temperature. A lower-intensity light allows for better perception of surface details, such as topography, ridges and enamel striations.

Color determination in dentistry can be divided into two categories: Visual technique and instrumental technique(figure 8) .A popular system for visual determination of color is the Munsell color system, the parameters of which are represented in three dimensions . Value (lightness) is determined first by the selection of a tab that most nearly corresponds with the lightness or darkness of the color.[9] Value ranges from white (10/) to black (0/). Chroma is determined next with tabs that are close to the measured value but are of increasing saturation of color. Chroma ranges from achromatic or gray (/0) to a highly saturated color (/18). Hue is determined last by matching with color tabs of the “value” and “chroma” already determined. Hue is measured on a scale from 2.5 to 10 in increments of 2.5 for each of the 10 color families. Visualcolor determination of a patient’s tooth is the most frequently applied method in clinical dentistry. [27]However, visual determination of shade selection has been found to be unreliable and inconsistent. Visual color assessment is dependent on the observer’s physiologic and psychologic responses to radiant energy stimulation. Inconsistencies may result from uncontrolled factors such as fatigue, aging, emotions, lighting conditions, previous eye exposure, object and illuminant position and metamerism.

Instrumental color analysis, on the other hand, offers a potential advantage over visual color determination because instrumental readings are objective, can be quantified and are more rapidly obtained. Spectrophotometers and colorimeters have been used with modifications in an attempt to overcome problems with visual shade matching in dentistry. Photoelectric tristimulus colorimeters have the potential to remove some of the shortcomings of the visual method, and have been shown to provide accurate and repeatable measurements; however, they are not error-proof[28]. In dentistry, the

results of a colorimetric device can be altered because the standardized illuminating light emitted from the device may be scattered, absorbed, transmitted, reflected and even displaced in a sideways direction as a result of the translucent optical properties of teeth and dental ceramics. Haywood et al. (1994) found out that colorimeters are designed for flat surfaces rather than the curved translucent surfaces found on teeth.[29].

Ceramic an innovative restorative material has enabled the dentist to meet increased patients demands. Closely matching teeth with an artificial restoration can be one of the most challenging procedures. To achieve the excellent esthetic result the dentist should be able to carry out proper shade selection & communicate it to the lab. Shade selection plays a vital role in the success of the esthetic restorative dentistry. It involves the perception of color, which is influenced by observer variables, object variables and light source variables [30]. Source of light & its intensity is very important factor in shade important. The property of light source to influence the color of the object is called “color rendition”. Different source of light is preferred in day to day practice; color selection can be modified by these primary source & source of ambient light. This is definitely misleading & will affect the shade of the final restoration. There are three main illuminant within any dental operatory: day light, incandescent light & fluorescent light [31]. Day light is variable in nature & has been suggested to be the most appropriate type of lighting for matching shades

4. CONCLUSION

To achieve the excellent esthetic result the dentist should be able to carry out proper shade selection & communicate it to the lab. From the results of our study we can conclude that the knowledge and awareness of role light source among undergraduates has further room for improvement. Although interns seem to fairly have hold of the concept, more experience and practise in this field is needed for exceptional shade selection skills.

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AUTHORS CONTRIBUTION

Author 1 (AminaMehrinBano) carried out the retrospective study by collecting data and drafting the manuscript after performing the necessary statistical analysis. Author 2(Dr. Dhanraj Ganapathy) aided in conception of the topic, has participated in the study design, statistical analysis and has supervised in preparation of the manuscript. Author 3 (Dr.kirankumar)has supervised in preparation of the manuscript All authors discussed the results and contributed to the final manuscript.

CONFLICT OF INTEREST

The researcher claims no conflict of interest.

REFERENCE

1. Fondriest JF. Shade matching a single maxillary central incisor. Quintessence Dent Technol 2005;28:215–25.
2. Sikri VK. Color: Implications in dentistry. J Conserv Dent 2010;13:249.
3. Hofmann L, Palczewski K. Advances in understanding the molecular basis of the first steps in color vision. Prog Retin Eye Res 2015;49:46–66.
4. Bäuml KH. Simultaneous color constancy: how surface color perception varies with the illuminant. Vision Res 1999;39:1531–50.
5. D’Zmura M, Lennie P. Mechanisms of color constancy. J Opt Soc Am A 1986;3:1662–72.

6. Fondriest J. Shade matching in restorative dentistry: the science and strategies. Int J Periodontics Restorative Dent 2003;23:467–79.
7. Venugopalan S, Ariga P, Aggarwal P, Viswanath A. Case Report: Magnetically retained silicone facial prosthesis. Niger J Clin Pract2014;17:260–4.
8. Jyothi S, Robin PK, Ganapathy D, Others. Periodontal health status of three different groups wearing temporary partial denture. Research Journal of Pharmacy and Technology 2017;10:4339–42.
9. Duraisamy R, Krishnan CS, Ramasubramanian H, Sampathkumar J, Mariappan S, NavarasampattiSivaprakasam A. Compatibility of Nonoriginal Abutments With Implants: Evaluation of Microgap at the Implant–Abutment Interface, With Original and Nonoriginal Abutments. Implant Dent 2019;28:289.
10. Kannan A, Others. Effect of Coated Surfaces influencing Screw Loosening in Implants: A Systematic Review and Meta-analysis. WORLD 2017;8:496–502.
11. Ashok V, Suvitha S. Awareness of all ceramic restoration in rural population. Research Journal of Pharmacy and Technology 2016;9:1691–3.
12. Ajay R, Suma K, Ali SA, Kumar Sivakumar JS, Rakshagan V, Devaki V, et al. Effect of Surface Modifications on the Retention of Cement-retained Implant Crowns under Fatigue Loads: An In vitro Study. J Pharm Bioallied Sci 2017;9:S154–60.
13. Jain AR, Nallaswamy D, Ariga P, Ganapathy DM. Determination of correlation of width of maxillary anterior teeth using extraoral and intraoral factors in Indian population: A systematic review. World J Dent 2018;9:68–75.
14. Ganapathy D, Sathyamoorthy A, Ranganathan H, Murthykumar K. Effect of Resin Bonded Luting Agents Influencing Marginal Discrepancy in All Ceramic Complete Veneer Crowns. J Clin Diagn Res 2016;10:ZC67–70.
15. Ranganathan H, Ganapathy DM, Jain AR. Cervical and Incisal Marginal Discrepancy in Ceramic Laminate Veneering Materials: A SEM Analysis. Contemp Clin Dent 2017;8:272–8.
16. Selvan SR, Ganapathy D. Efficacy of fifth generation cephalosporins against methicillin-resistant Staphylococcus aureus-A review. Research Journal of Pharmacy and Technology 2016;9:1815–8.
17. Subasree S, Murthykumar K, Others. Effect of Aloe Vera in Oral Health-A Review. Research Journal of Pharmacy and Technology 2016;9:609–12.
18. Basha FYS, Ganapathy D, Venugopalan S. Oral Hygiene Status among Pregnant Women. Research Journal of Pharmacy and Technology 2018;11:3099–102.
19. Kannan A, Venugopalan S. A systematic review on the effect of use of impregnated retraction cords on gingiva. Research Journal of Pharmacy and Technology 2018;11:2121–6.
20. Vijayalakshmi B, Ganapathy D. Medical management of cellulitis. Research Journal of Pharmacy and Technology 2016;9:2067–70.
21. Borse S, Chaware SH. Tooth shade analysis and selection in prosthodontics: A systematic review and meta-analysis. J Indian Prosthodont Soc 2020;20:131–40.
22. Jaju RA, Nagai S, Karimbux N, Da Silva JD. Evaluating tooth color matching ability of dental students. J Dent Educ 2010;74:1002–10.
23. Joiner A. Tooth colour: a review of the literature. J Dent 2004;32:3–12.
24. 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 Rehabil2004;31:900–4.
25. 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;96:391–6.
26. Sambandam TV, Ramesh S. Knowledge, attitude, and practice of dental students and practitioners on shade matching of anterior teeth. Journal of Advanced Pharmacy Education & Research| Jul-Sep 2017;7.
27. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. J Prosthet Dent 1973;29:358–82.
28. Tam WK, Lee HJ. Dental shade matching using a digital camera. J Dent 2012;40 Suppl 2:e3–10.
29. Buskulic D, Casper D, De Bonis I, Decamp D, Ghez P, Goy C, et al. Performance of the ALEPH detector at LEP. NuclInstrum Methods Phys Res A 1995;360:481–506.
30. Derbabian K, Marzola R, Donovan TE, Arcidiacono A. The science of communicating the art of esthetic dentistry. Part III: precise shade communication. J EsthetRestor Dent 2001;13:154–62.
31. Vichi A, Louca C, Corciolani G, Ferrari M. Color related to ceramic and zirconia restorations: a review. Dent Mater 2011;27:97–108.