CORRELATION BETWEEN NATURAL TOOTH SHADE AND SCLERAL SHADE USING VITA TOOTHGUIDE 3D-MASTER SHADE GUIDE AND DIGITAL PHOTOGRAPHY

A Dissertation submitted to

THE TAMILNADU DR. MGR MEDICAL UNIVERSITY

In partial fulfillment of the requirements for the degree of

MASTER OF DENTAL SURGERY

BRANCH – I

PROSTHODONTICS AND CROWN & BRIDGE

2017 – 2020

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This is to certify that **DR. FRANCILIN F,** Post Graduate student (2017 - 2020) in the Department of Prosthodontics and Crown and Bridge, has done this dissertation titled "**CORRELATION BETWEEN NATURAL TOOTH SHADE AND SCLERAL SHADE USING VITA TOOTHGUIDE 3D-MASTER SHADE GUIDE AND DIGITAL PHOTOGRAPHY**" under the guidance of **Dr. A. MEENAKSHI**, **M.D.S** Professor and Head of The Department, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital, Chennai – 600 003.

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DECLARATION BY THE CANDIDATE

I **Dr. FRANCILIN F** do hereby declare that the dissertation titled **"CORRELATION BETWEEN NATURAL TOOTH SHADE AND SCLERAL SHADE USING VITA TOOTHGUIDE 3D-MASTER SHADE GUIDE AND DIGITAL PHOTOGRAPHY"** was done in the Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital, Chennai-600 003. I have utilized the facilities provided in the Government Dental College and Hospital for the study in partial fulfillment of the requirements for the degree of **Master of Dental Surgery** in the specialty of **Prosthodontics and Crown & Bridge (Branch I)** during the course period 2017-2020 under the conceptualization and guidance of my dissertation guide **Professor Dr. A. MEENAKSHI M.D.S.,**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College and Hospital.

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And

Dr. FRANCILIN F aged 26 years currently studying as Post Graduate student in the Department of Prosthodontics and Crown & Bridge, Tamil Nadu Government Dental College and Hospital, Chennai-3 (herein after referred to as the 'PG/Research student and Co- investigator').

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Witnesses

PG Student

1.

2.

Acknowledgement

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With immense pleasure and honour I take this opportunity to express my humble and heartfelt gratitude to my mentor, a relentless source of inspiration and dissertation guide **Dr. A. MEENAKSHI, M.D.S.,** Professor and Head of the Department, Department of Prosthodontics, Tamil Nadu Government Dental College and Hospital, for her able guidance and support. I am grateful for her help at various stages of the dissertation. Without her help this dissertation would not have come out in a befitting manner. Each word said to describe the experience as her student, which was a boon in disguise, would be an understatement. Her esteemed and able guidance made this dissertation a possibility. Her dedication to work which made us realizes the worth of discovering our own capabilities. Her unprecedented calm and patient personality, an unfailing, caring and understanding demeanour made each endeavour easier.

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CONTENTS

LIST OF ABBREVIATIONS

S.No.	ABBREVIATION	EXPANSION
1	3DM	3D Master
2	L	Yellow hue
3	M	Medium hue
4	R	Red hue
5	Mm	Millimeter
6	VC	Vita classical shade guide
7	%	Percentage

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Introduction

INTRODUCTION:

Aesthetics, form and function are the three main pillars of treatment outcome in prosthodontics. Aesthetics remains the foremost thing especially when it comes to prosthodontic needs. Tooth shade is one of the most important criteria for determining the aesthetic outcome. There are various methods to determine the tooth shade for fully edentulous patients. In order to obtain the shade of teeth Boucher has advocated the use of pre extraction records, previous dentures, or any photographs that shows the patient happy and smiling. But if the patient dislikes his own natural teeth or the existing dentures or if there are no previous dentures, then determining shade of teeth becomes difficult in completely edentulous cases and in patients undergoing full mouth rehabilitation. In order to overcome these difficulties many studies have been conducted to study the correlation of teeth shade with the color of skin, hair etc... Though the results of these studies are applicable to those particular geographic population where study is conducted, there is still not a universal criterion for determining the teeth shade. Restorations will be more aesthetically appealing when the dental aesthetics is in harmony with the facial aesthetics. This provides a greater psychological impact on patients receiving it and it improves their self-confidence.

Maxillofacial prosthodontics deals with the artificial replacement of all lost maxillofacial structures both extraoral and intra oral. Maxillofacial prosthesis is any prosthesis used to replace part or all of any stomatognathic and/or craniofacial structures. Orbital prosthesis is one of those maxillofacial prosthesis which artificially replaces a missing eye as a result of trauma, surgery, or congenital absence. In treating patients with

orbital defects, the most challenging aspect will be selection of scleral shade. In case of unilateral ocular defect, scleral shade selection is done by shade matching with the sclera of the other eye considering it as shade indicator. But in case of bilateral orbital defect, since there is no shade indicator, scleral shade selection becomes a questionable one. In order to overcome these difficulties this study is done to correlate the natural scleral shade with the natural tooth shade using various parameters like visual shade matching and digital shade matching, so that scleral shade can be used for selecting teeth shade and vice versa.

Colour assessment and reproduction remains the most challenging aspect in maxillofacial prosthodontics. The Munsell colour system is based on the steps of visual perception with any colour being defined as a point within the three-dimensional Munsell colour space. This was created by **Prof. Albert H Munsell** in the first decade of twentieth century in 1905. The attributes of Munsell colour system are Munsell hue (H), Munsell chroma (C) and Munsell value (V). They are written in the form H, V, C, which is called the Munsell notation. Hue is the name of the basic color as found in its pure state in the spectrum. It is divided into five principal groups: Red, Yellow, Green, Blue, and Purple, along with five intermediate hues which are halfway between adjacent principal hues. Chroma is the degree of a color's vividness, with the lower chroma showed the less purity of the color. Value is the lightness or darkness of a color varied vertically along the color solid, from black (value 0) at the bottom, to white (value 10) at the top. Neutral gray color lie along the vertical axis between black and white. The Munsell color system was the first color system to separate hue, value, and chroma into perceptually uniform and independent dimensions. It was the first system to systematically illustrate the colors in three-

dimensional space. It has been widely used in many fields of color science as a standard system of color specification.

The **CIELAB** color order system was developed by **the Commission Internationale de l'Eclairage (CIE, International Commission on Illumination)** in **1931**. It is generally used in color research and is based on the color standardization of light sources and of observers. A specific shade is defined by its location within the CIELAB system using three coordinates: L*, a*, and b*. The CIELAB color scale is an approximately uniform color scale. L* runs from top to bottom. The maximum value for L* is 100, which represents black. There are no specific numerical limits for a* and b* axes. Positive a* is red. Negative a* is green. Positive b* is yellow. Negative b* is blue.

Visual colour matching with a commercially available dental shade guide is the most widely used method. In 1931 Clark introduced a custom shade guide based on visual assessment of human teeth, and was recorded in Munsell's system of Hue, value and Chroma. The first shade guide was marketed by Vita Zahn Fabrik in 1956. It is used for the measurement of colour of ceramic system. The Vita Pan classical shade guide consist of 16 tabs arranged into 4 groups based on hue and Chroma was arranged within the groups in increasing order. Ivoclar Vivadent chromoscope was developed following Vita Pan Classical shade guide. It was found similar to Vita Pan Classical shade guide. In 1974, Sproull suggested that a perfect shade tabs should be distributed and logically arranged in color space. This was in accordance with Munsell color system. Since all the shade tabs had few deficiencies, new generation shade guides were developed. In the late 1990s Vita 3D master shade guide with systematic distribution of shade tabs within color space was

developed. It consists of 26 samples ranging from lightest to darkest value and intensity from lowest to highest and hue from yellow to red.

Instrumental assessment is performed using spectrophotometers, colorimeters, spectroradiometers, digital- and spectral imaging. Among all these instrumental methods for shade matching, digital imaging and analysis is gaining its popularity in this new era. Digital imaging has potential for use in dental shade determination. Digitized images can be transmitted electronically, which along with the widespread use of the Internet, makes this option advantageous. Shade matching using the digital images acquired through digital photography has gained its own popularity because of the greatest advantages it possesses.

Shade matching using shade guides and digital photography is more convenient and less expensive than the use of spectrophotometers or colorimeters, and it may also provide the entire spectrum of color space for natural teeth. It is also a recognized objective and efficient tool for communication with a dental technician.

Aim and Objectives

AIM:

The aim of the study is to find the correlation between natural tooth shade and scleral shade using vita 3d-master shade guide and digital photography to use as an aid in shade selection for patients undergoing restoration of entire dentition and anopthalmic patients.

OBJECTIVES:

- To assess the natural tooth shade in youth subjects.
- To assess the shade of the sclera in same subjects.
- To evaluate the correlation in hue between natural tooth and scleral shade using visual shade matching method.
- To evaluate the correlation in chroma between natural tooth and scleral shade using visual shade matching method.
- To evaluate the correlation in value between natural tooth and scleral shade using visual shade matching method.
- To evaluate the correlation between natural tooth and scleral shade using digital shade matching method.

Review of Literature

REVIEW OF LITERATURE

GPT 9 [1] *The* ***Shade*** *is a term used to describe a particular hue, or variation of a primary hue, such as a greenish shade of yellow and to describe a tint that is a mixture with black as opposed to a tint that is a mixture with white. Color is determined visually by measurement of hue, saturation, and luminous reflectance of the reflected light*

GPT 9 [1] *The* ***Shade selection of a tooth*** *is the determination of the color and other attributes of appearance of an artificial tooth or set of teeth for a given individual*

Andrew Joiner et al (2008) [2] *concluded in his study regarding the measurement of tooth color that the color and appearance of teeth is a complex phenomenon, with many influencing factors such as opacity, light scattering, gloss, lighting conditions, translucency, the human eye and the brain influencing the overall perception of tooth color. The measurement of tooth color is possible via a number of methods including visual assessment with shade guides, spectrophotometry, colorimetry and computer analysis of digital images. These methods have been successfully used to measure longitudinal tooth color changes.*

Stephen J. Chu, Richard D. Trushkowsky, Rade D. Paravina, (2010)[3] *studied Dental color matching instruments and systems and their reliability in tooth color analysis and measurement. The result of their study proved that spectrophotometers, colorimeters and imaging systems such as high-resolution digital photography are considered as relevant tools for tooth color measurement and analysis, and can be used as control for color*

reproduction. These devices measure either the complete tooth surface or color of limited area up to 3-5 mm providing a ''color map'' or an ''average'' color on the tooth surface. These tooth color measurement devices are useful tools in analysis communication, reproduction and verification of shade of color for direct or indirect restorations. Whenever possible, both visual and instrumental color matching method should be used so that they complement each other and can lead towards predictable esthetic outcome of the restorations.

Yong-Keun Lee, Bin Yu, Seung-Hun Lee, Moon-Sang Cho, Chi-Youn Lee, Ho-Nam Lim (2010),[4] *studied the variation in instrument-based color coordinates of esthetic restorative materials by measurement method and determined that surface roughness influences the color coordinates differently by their range and the measurement geometry. They studied the influence of specimen conditions, the influence of instrument settings and the influence of the kind of illuminant. Surface roughness and background conditions are taken for analyzing specimen condition, measurement area and measurement geometries for instrument settings and metamerism for kind of illuminant.*

Conclusively, kind of illuminant, surface roughness and the measurement range and geometry of the instrument all influenced the color coordinates significantly.

Eunji Kim, Taeyoon Son, Yoon Lee, Byungjo Jung (2012) *[5] studied development of polarization dental imaging modality and evaluation of its clinical feasibility and concluded that the Polarization dental imaging modality produced repeatable glare-free tooth color images by removing the specular reflection from the imaged tooth surface.*

Since specular reflection caused by roughness or saliva on the tooth surface caused artefacts in image analysis, they used polarization dental imaging modality to obtain cross polarized images. These images were successfully used for shade guide selection, plaque detection, and tooth whitening by minimizing artefacts. The study was performed for selecting shade tab for implant, evaluating teeth whitening procedures and for plaque detection.

M.M. Tin Oo Et Al (2011) [6] *in his study about the factors influencing patient satisfaction with dental appearance and treatments they desire to improve esthetics has stated that color is a psychophysical response of an individual toward the light interaction with the object. He also stated that the physical properties of light and hard tissues affect the color. He has given special mention to the fact that psychological precondition of an individual also influences the perception of color.*

NATURAL TOOTH COLOR:

Bilmeyer and Saltzman (2000) [7] *defined color as the result of the physical modification of light by colorants as observed by the human eye and interpreted by the brain*

J.J. ten Bosch and J.C. Coops (1995)[8] *in their study related to light scattering and enamel hardness found that tooth color is determined mainly by dentin, with enamel playing only a minor role through scattering at wavelengths in the blue range.*

Habab Osman Elamin et al (2015)[9] *did a study to identify tooth shade among group of 227 Sudanese patients, aged 15 to 72 years. He did study with right and left sound*

maxillary central incisor, using Vita easy shade guide and found that A3 was the most common classical tooth shade and women's teeth were lighter than men's in Sudanese population.

Hasegawa et al (2000)[10] *investigated the color of the natural maxillary incisor tooth from Japanese people of all age groups. They concluded that the natural tooth shade in the middle third of a tooth has a tendency to decrease in lightness and also to increase in yellowness with advance in age. Also, the shade of the natural teeth shows an increase in redness at the incisal site because of long term occlusal wears /loss in the incisor region*

Gozalo et al (2008) [11] *did a study to investigate the relationship of tooth shade and age. He found that the age of the participants was found to be directly proportional to the natural shade of the central incisor- the central incisor became darker (more reddish and more yellow) with increasing age.*

In a study by ***Hassel et al (2008)*** [12] *Determining tooth color using gender as a parameter was only partially helpful in a sample of white elderly patients.*

However, other gender studies done by ***Esan et al and Azad et al (2006)[13]****concluded that men have darker teeth than women and women have lighter and less yellow central incisors than men.*

Goodkind et al (1987)[14], *found a statistically significant difference in hue, value and chroma between males and females for all sites of the teeth studied. Female subjects' teeth were less saturated, lighter and slightly yellower.*

Helene J. Haddad Et Al (2009)[15] *did a study to evaluate the influence of gender and level of experience on shade matching quality. They performed this study at 15 universities located in 9 countries. This study tested a large group of dental professionals and students from different countries under the same colour matching conditions and showed discrepancy in gender related shade matching results. However, this study agreed with the findings that the level of experience is not a factor to be considered in shade matching.*

NATURAL SCLERAL COLOR:

Richard Russell and Jennifer R Sweda (2014)[16]: *In their study to assess the scleral colour change with age and in their assessment for scleral colour as a cue for perceiving age, health and beauty found that sclera coloration is a cue for the perception of age , health and attractiveness that is rooted in the physical changes that occur with age. Redness or yellowness of sclera are known signs of illness. Older faces have sclera that are more dark, red and yellow that younger faces. Faces with decreased sclera darkness, yellowness, redness was perceived to be younger than faces with increased sclera darkness, yellowness, redness.*

SHADE MATCHING METHOD:

Selecting shade for dentulous patients is somewhat easy because the color requirements of matching to adjacent teeth are well known. The selection of color for an edentulous patient is difficult because the natural teeth are no longer present to act as a guide

A.V. Pensler (1998)[17] *stated that shade matching should be done in the mornings at the beginning of appointment*

RELIABILITY OF VITAPAN 3D MASTER SHADE GUIDE:

Ghahramanloo et al (2008)[18] *carried out a study to evaluate the repeatability of color selection using various shade guides. He used Vitapan Classical and 3DMaster shade guides with 20 sample size involving 10 male and 10 female 6th-year dental students. He reported no significant differences in the repeatability between these two systems. He also stated that sometimes two objects exhibit the same shade under one light source such as natural light, but they exhibit differences under a different light source, e.g. artificial light. This phenomenon is referred to as metamerism and should always be taken into account*

Jin- So Ahn DDS and Yong- Keun Lee DDS, PhD (2008)[19] *conducted a study to determine the colour distribution of tabs from Vita 3D master shade guide in the value (CIEL*), chroma (C*ab) and hue scale. They found that Vita 3D master shade guide was more reliable than many other traditional shade guides since the colour distribution in vita 3D*

master shade guide was more ordered than others. They also found that the interval between adjacent tabs was not uniform by value and chroma.

Hammad IA et al (2003)[20] *conducted a study among 10 prosthodontist and 10 general dental practitioners to find the intra rater repeatability of shade selections with 2 shade guides in canine tooth. He found that use of Vita 3D master Shade guide notably improved the intra rater repeatability especially among the general practitioners.*

Paravina RD et al (2002)[21] *did a study to analyze the colour compatibility and colour parameters of two randomly chosen Vita shade guides. In this study the data were recorded using a colorimeter set to standard illuminant source C and the CIE Lab system. A custom adapter system was produced for measuring only the middle third area of the shade tabs. All these 42 tabs were recorded one time in each. It was done on three different days. Color distribution was examined in diagrams whose coordinates were L a b and L C H color coordinate pairs. Color difference ranges of Vitapan Classical was 14.3 and for Vitapan 3D Master it was 19.2. They found that shade tabs in Vita Pan 3D master shade guide were uniformly placed than Vitapan Classical shade guide. They also found that chromacity ranges of Vitapan 3D master were extended in the desired directions; hue was extended towards yellow toned and saturation was extended towards more saturated tabs. The shade guides that were examined were found to be color compatible.*

Sônia Saeger Meireles, DDS, MS et al (2008)[22] *did a study to evaluate the validity and reliability of the visual assessment of tooth color using a commercial shade guide (Vitapan classical shade guide). They used digital spectrophotometer (Vita Easy shade) as the gold standard to calculate sensitivity and specificity of the visual assessment. Shade selection was done for six maxillary anterior teeth. The results of this study proved that using Vitapan Classical shade guide is a valid method for distinguishing between light and dark tooth colors when determining shade by visual assessment method.*

DIGITAL CAMERAS FOR SHADE SELECTION:

Stephen Phelan (2002)[23] *found that technician was able to create an esthetic, accurate and successful restoration by using color slides as a part of the dentist–technician communication process . He presented a single onlay case that was significantly enhanced by using color slides as a part of communication process between the clinician and the laboratory technician.*

J.D. Brewer et al (2004)[24] *has reported that digital cameras can be used as filter colorimeter for digital shade matching. The newest digital shade matching devices are based on digital camera technology. Instead of focusing light upon film to create a chemical reaction, digital cameras capture images using charged coupled devices (CCD) which may contain millions of small light sensitive elements.*

Vela Desai et al (2013)[25] *reported process of digital dental photography as a kind of macrophotography. With the advent of digital cameras, photography has become an easy way of educating and documenting the patients details for shade selection whenever needed. Digital images can be stored easily and kept for future use for legal or academic purposes*

F.D. Jarad et al (2005)[26] *conducted a study to develop a shade matching method based on digital imaging and to compare observers' ability using this method with the conventional one set against a spectrophotometric 'gold standard'. Two Vita Lumin shade guides were used in this study, nine shades being selected from the first Vi ta Lumin shade guide, and the second shade*

guide was used to match the selected shades. A Nikon Coolpix 990 digital camera with Nikon SB21B ring flash was used to record the digital images of the shade tabs of the two shade guides and the images were processed using Adobe Photoshop software. A total of 27 samples were matched with a digital shade guide prepared from the digital images of the second shade

guide by 10 observers on a computer screen. The observers shade matching performance was significantly better with the digital photography method compared with the conventional visual shade matching method. There was a large variation in the observer ''s matching ability. Thus, digital camera can be used as a very good means of shade matching in the dental clinic.

Alvin G Wee et al (2006)[27] *studied the accuracy of commercial digital camera for dental applications. They used three types of camera Nikon D100, Canon D60 and Sigma SD9 camera. Pictures were in raw format and they converted it into "TIF F" via the converting software which evaluated the CIELAB values obtained and compared with the calibration models.*

concluded that these cameras when combined with the appropriate calibration protocols shows potential for use in the color replication process of clinical dentistry.

Won-Suk Oh et al (2010)[28] *did a study to evaluate the validity of the digital photo colorimetric (PCM) method in shade matching of human teeth. Vitapan classical shade guide was used in this study. Vitapan classical shade guide contains 16 shade tabs. Two Vitapan classical shade guides were used in this study. First visual shade matching was done and then digital photographs of three pairs of each shade guide teeth were taken in a color matching booth. Visual shade matching was performed on 48 subjects on upper central incisors by two prosthodontists independently using Vitapan classical shade guide. Three shade guide tabs which matches closely to that of the natural teeth were selected and ranked in order of preference. Digital photography was taken for those shade tabs under ceiling daylight. Digital images acquired were analyzed using software. The color difference between the reference shade tab and natural teeth were calculated. The percent color matching for the shade guide teeth was 88% and that of human teeth was 75%. The result of this study showed that shade matching of natural tooth using digital photocolorimetry method is very much valid and it enhances the communication with the laboratory personal in shade matching.*

Oi Hong Tung et al (2011)[29] *conducted a study and hypothesized that different illuminants and camera's white balance setups shall influence color rendering of digital images and affect the effectiveness of color matching using digital images. Fifteen ceramic disks were custom made and they were photographed with DSLR camera using custom white balance (WB) and automatic white balance (AWB) under either light -emitting diode (LED) or electronic ring flash.*

The L a b parameters of The Commission Internationale d '' Éclairage system images was derived from Photoshop software and it served as digital shade guides. They found a significantly high correlation coefficient (r 2 > 0.96) between the respective spectrophotometer standards and those shade guides generated in CWB setups. It was concluded that the shade matching with digital images is much influenced by the illuminants and cameras white balance setups. Digital shade guides that were derived under LED illuminants with CWB setups can be used as a valid tool in color assessment.

Fabiana Takatsui et al (2012)[30] *did a study to analyze the color alterations performed by the CIE L a b system in the digital imaging of shade guide tabs. These shade guide tabs were obtained using digital photography according to the automatic and manual modes. Four Vita Lumin Vacuum shade guide tabs were used: A3.5, B1, B3 and C4. An EOS Canon DSLR camera was used to obtain the digital images of the shade guide tabs, and the images were analyzed using Adobe Photoshop software. A total of 80 observations were obtained, leading to color values of L, a and b. The color difference (Δ E) between the modes were calculated and classified as either clinically acceptable or unacceptable. It was concluded*

that the B1, B3 and C4 shade tabs can be used at any of the modes in digital camera (manual or automatic), which was a different finding from that observed for the A3.5 shade tab which demonstrated a clinically unacceptable shade.

W K Tam et al (2012)[31] *conducted a study to compare the color of shade tabs taken by a digital camera using appropriate color features. They used Vi ta 3D master shadeguide and Canon EOS 1100D DSLR camera for this study. Shade tab images were compared in two reference strategies. The color of tooth sur face was presented by a content manually cropped out of the image. The content was divided into 10*2 blocks to encode the color distribution. Color features from commonly used color spaces were evaluated. The top n matches were selected when the least n shade distances between the shade tabs were attained. Using Sa*b* features, the top one accuracy was 0.87, where the feature S is defined in HSV color space, a* and b* features are defined in L a b color space. Sa*b* were suitable features for shade matching using a digital camera s in this study. Both the color and texture of the tooth surface could be presented by the proposed content -based descriptor. Clinical use of digital cameras in shade matching became possible.*

Lars Schropp, DDS, PhD (2008)[32] *evaluated the efficacy of photographs and graphic computer software for colour matching with the conventional visual shade matching. He used Vita 3D shade guide for conventional visual shade matching and a graphic software program was used for colour analysis in digital shade matching method. He found that 8 out of 12 tabs (67%) were matched correctly by computer software method. He concluded that shade matching done by digital photographs and computer software was more reliable than conventional visual methods.*

Terence S. Leung et al (2015)[33] *has done a study to screen neonatal jaundice based on scleral color of the eye using digital photography. It involves taking digital photographs of newborn infants' eyes (n = 110) and processing the pixel colour values of the sclera to predict the total serum bilirubin (TSB) levels. the results of this study have shown that digital photography in screening neonatal jaundice has shown its potential as a screening device.*

RELATION OF TOOTH SHADE AND SCLERAL SHADE:

Panagiotis E. Lagouvardos et al (2013)[34] *did a study to investigate the possible interrelationships of teeth, skin eye and hair colour in Greek young adults using portable colorimeter (SHADE EYE NCC /Shofu). They recorded the color in the CIELAB system of the right central incisors and found that there is no relation between eye color and teeth color and that teeth colour is related more to the reflection and absorption mechanisms. Teeth and eye colour coordinated were not corelated. Teeth colour was not related to eye colour but lighter teeth were found to be associated to lighter skins. An explanation for the result of no association of teeth colour to eye colour is probably that teeth colour is related more to absorption and reflection mechanism than inclusion of pigments in its structure.*

Alexander J Hassel et al (2008)[35] *in their study to assess the possibility of predicting tooth colour in elderly from hair and eye colour concluded that determination of tooth colour with hair and eye colour was only partially possible.*

Kobayashi and Koshima (2001)[36] *in their study have mentioned that the sclera, the eyes, outer layer is white only in humans.*

Watson et al (2003)[37] *provides the base for the display of its own colors and those variations in response to emotion and disease is expressed in the overlying transparent conjunctiva.*

Provine et al (2011)[38] *has stated that bright, white human sclera is ideal for chromatic information because of its contrast with surrounding darker skin and its disproportionately large size.*

Papavramidon et al (2007) *in his study has mentioned that scleral colour has considered as very important criteria in diagnosis of medical conditions from at least early as Hippocratic era.*

Watson et al (2003)[37] *has stated that the relationship between scleral color and the perceived traits of age, health and attractiveness are supported by medical and biological evidence.*

Murphy et al (2013)[39] *has stated that redness is a symptom of numerous pathologies of eye and body.*

Provine et al (2013)[38] *in his study evaluated the scleral color as a cue of socially significant information about health, attractiveness and age by contrasting the perception of eyes with normal whites with copies of those eyes whose whites were reddened, yellowed, or further whitened by digital editing has stated that healthy eyes with white sclera deserves a place in the universal list of traits signaling reproductive fitness and beauty.*

Sclera coloration is also related to age. A recent study by ***Gründl, Knoll, Eisenmann-Klein, and Prantl (2012)[40]*** *using photographs of 60 Caucasian women aged 15 to 65 found*

that the saturation of the sclera has positive correlation with age, whereas the brightness of the sclera has negative correlation with age. This means that the overall "whiteness" of the sclera decreases with age. The decrease in whiteness of the sclera with age is a result of multiple factors, including increased lipid deposits (Fraunfelder, Garner, & Barras, 1976; Watson & Young, 2004) and yellowing caused by changes of the elastic fibers in the conjunctiva due to cumulative sun exposure (Gründl et al., 2012).

Reddening of the eyes is a result of a wide variety of causes that result in dilation of the blood vessels of the conjunctiva (Provine et al., 2011). It seems plausible that cumulative lifetime experience of these pathologies could result in an increased baseline level of redness in older eyes.

In the ***Gründl et al., 2012*** *study, participants rated the perceived age and attractiveness of the faces whose scleral color had been measured. Significant negative correlations were found between saturation of the sclera and attractiveness and perceived age, and between brightness of the sclera and perceived age.*

Materials and Methods

MATERIALS AND METHODOLOGY

STUDY DESIGN:

The present clinical study was conducted to compare the correlation between natural tooth shade and natural scleral shade using vita 3D master shade guide and digital photography. This study was carried out in the Department of Prosthodontics at Tamilnadu Government Dental College and Hospital, Chennai.

ETHICAL COMMITTEE APPROVAL:

The study was performed after obtaining approval from the Institutional Ethical Committee.

ARMAMENTARIUM:

I. For Clinical Examination:

1. Mouth mirror
2. Probe
3. Explorer
4. Kidney tray
5. Surgical Mask
6. Surgical Disposable Gloves

II. For visual shade matching:

1. Vita 3d master shade guide
2. Cheek retractor

III. For digital shade matching:

1. Nikon DSLR D5600 camera
2. 15- 55 mm Lens

IV. For interpretation of shade analysis data:

1. Adobe Photoshop CC Software in the computer system.

SUBJECT SELECTION:

The study population for this study was selected from the outpatient section of Department of Prosthodontics of Tamilnadu Government Dental College and Hospital. Subjects between the age group of 18-30 years of both male and female gender were included in the study. Samples were selected based on the following inclusion and exclusion criteria.

Inclusion criteria:

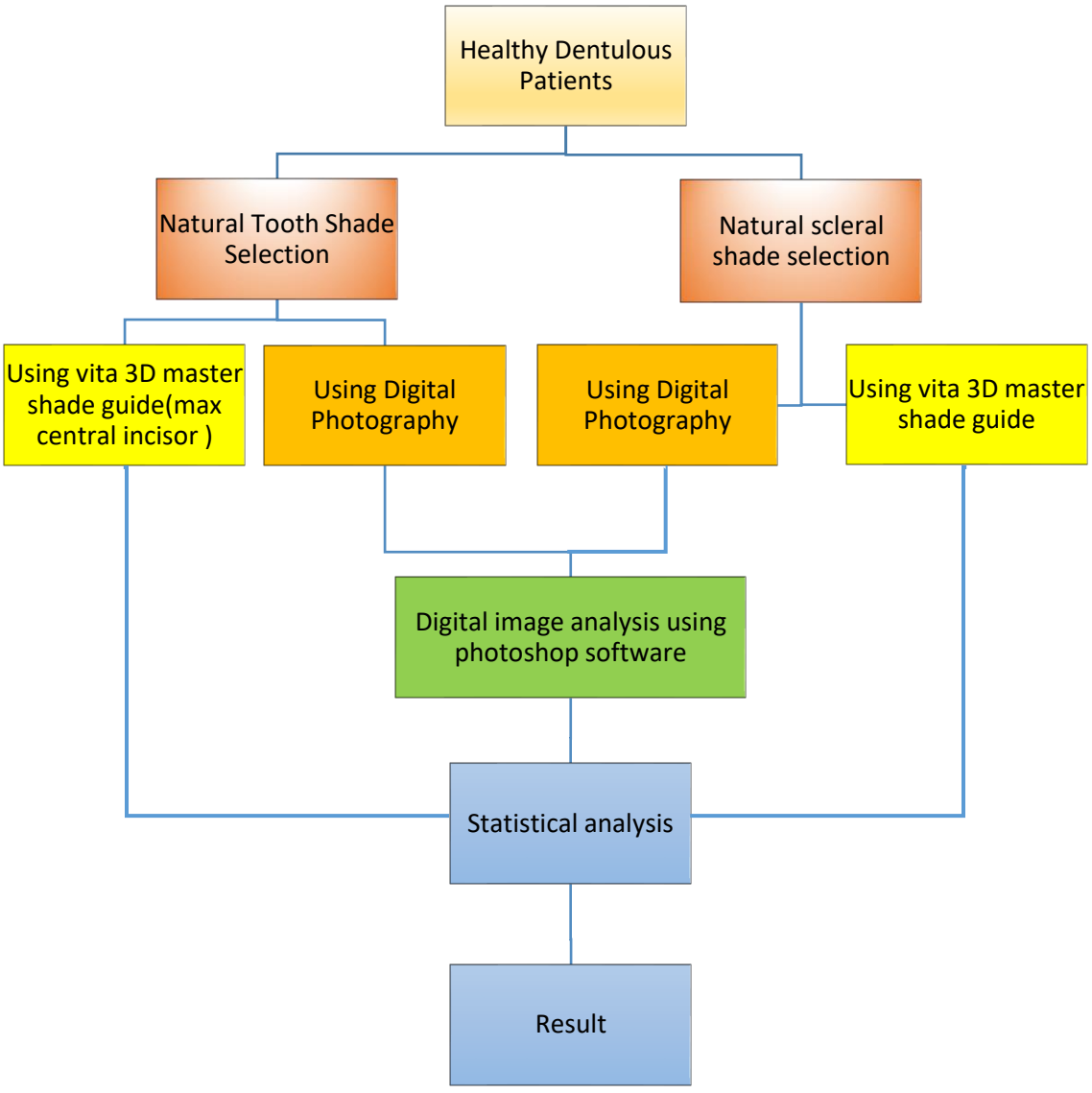
1. Healthy individual
2. Age: 18 to 30 years of age
3. Dentulous patients with intact maxillary central incisors
4. Patients with fully erupted, non-carious maxillary central incisors
5. No evidence of tooth discolorations
6. Right and left eyes without any deformities

Exclusion criteria:

1. Patients with scleral diseases
2. Presence of any tooth discoloration (both intrinsic and extrinsic)
3. Patients with psychological disorders
4. Patients with smoking or tobacco chewing habits.
5. Systemic illness
6. Presence of congenital diseases causing tooth and scleral changes
7. Presence of colored contact lenses

METHODOLOGY:

STUDY DESIGN



A total of 100 dentate subjects out of which 50 males and 50 females within age group 18 and 30 years were selected for the study. The subjects were the students (post graduates, undergraduates, interns, and technicians), patients, and their attendants who reported at the Tamil Nadu Govt dental college and hospital, Chennai. Informed consent was obtained from each patient and this study was carried out on patients who were willing to participate in the study. The confidentiality of the data was assured at all times and no personal information obtained in connection with this study will be disclosed to third parties. Only accumulative and aggregated information will be included in the resultant report.

NATURAL TOOTH SHADE SELECTION WITH VITA 3D MASTER SHADE GUIDE:

Patient was made to sit comfortably on dental chair. Dental prophylaxis was performed on the target teeth prior to the shade selection. Tooth shade was measured on right maxillary central incisor at the middle third of the labial portion. Middle third of the tooth is selected because the range of color changes from the incisal to gingival areas as described by Mayekar. Study was conducted in a series of sessions always between 9.00 am and 11.00 am and on days with bright sky utilizing natural daylight. The shade guide was held at a distance of 30 cm to the patients mouth. Patients were draped with a grey cloth. The arm of the dentist is bent while holding the shade guide. Vitapan (Vita Zahnfabrik H. Rauter GmbH, Bad Sackingen, Germany), 3D master shade guide was used for the purpose of this study. It consisted of 26 shade tabs. It is divided into 5 groups according to lightness

that is Value. Vertically they were arranged according to chroma and horizontally they were arranged in increasing order of hue. The letter M denotes the medium hue and L denotes the yellow hue and R denotes the red hue. Shade matching was done according to the shade matching protocol given for Vitapan 3d master shade guide. The steps were:

Step -1: value selection

Step -2: chroma selection

Step -3: hue selection

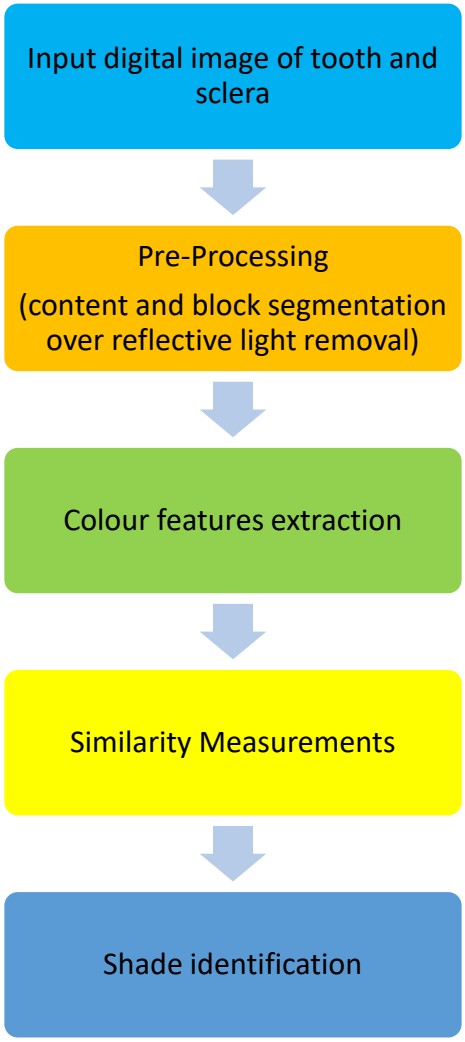
Using Vitapan 3D master shade guide, first the value of the tooth was selected from levels 0,1,2,3,4 or 5. Value was selected from darkest to lightest level. This is done with squinted eyes to reduce the amount of light entering the eye so that rods get activated to allow accurate discrimination of lightness and darkness. Now from the selected value tab, the shade sample with the middle hue was removed and was folded up at the side. From the three shade samples for middle hue, one which matches the natural tooth was selected to determine the chroma. Finally, hue is determined by checking whether the natural tooth is more yellow (L) or red (R) than the middle hue which was already selected. The natural tooth shade was determined as 1M1,1M2,2M1,3M3,4M1,5M1 etc...

NATURAL SCLERAL SHADE SELECTION USING VITA 3D MASTER SHADE GUIDE:

Similar to the natural tooth shade selection, scleral shade was performed on days with bright sky utilizing natural daylight. Study was conducted in a series of sessions always between 9.00 am and 11.00 am. Patients were draped with a grey cloth. The arm of the dentist is bent while holding the shade guide. Vitapan (Vita Zahnfabrik H. Rauter GmbH,

Bad Sackingen, Germany), 3D master shade guide was used for the purpose of this study. Patients were asked to keep eyes wide open and move their eye to the right side so that larger portion of sclera will be visible and shade guide was held at a distance of 30 cm from the patient and natural scleral shade was determined based on the criteria mentioned above.

NATURAL TOOTH SHADE AND SCLERAL SHADE SELECTION USING DIGITAL PHOTOGRAPGHY:



For selecting natural tooth shade and scleral shade using digital photography, Nikon DSLR D5600 camera with 15- 55 mm Lens was used. The following settings were maintained all

through the digital photographic procedure in order to maintain the consistency of acquired images.

DSLR Settings

- Image was taken without flash
- Fixed shutter speed 1/125s
- Automated white balance
- Aperture F/22
- Type of metering - matrix
- ISO 100
- Flash mode - Off
- File type – RAW image

Full -face images of 100 youth population of both gender (50 males and 50 females) with healthy profile were acquired using a closed photographic system that allows accurate and reproducible positioning of the subjects. The height of the camera was adjusted to the height of the face. Flash light was not used. The subjects wore no bright colored makeup or adornments and their eyes and mouth were open. Subjects were asked to give a neutral expression and gaze directly into the camera.

Digital photography was taken by adhering to the above-mentioned criteria and then the digital images were transferred to the computer.

W M Bengel (2003) has given certain protocols for analyzing the digital images. This protocol was followed in this study. The procedure to be followed include:

1. Photoshop program in the computer is started and open the windows@ (Microsoft) information menu; color information of each single pixel will be given in this information menu.
2. Ctrl + 0 is used to open the image to be analyzed
3. Open the Levels dialogue by pressing CTRL + L (or Image, then Adjust, then Levels) to eliminate the overall color cast. Three eyedropper tools will appear. Middle eyedropper tool is selected and it is moved over the piece of gray card in the picture.
4. The image should be clicked again to eliminate the global color cast of the image. This is controlled by checking the information panel.
5. All these steps are done to have the R, G, and B values to the same level which was slightly different initially. Now the L a b values would have also changed. A and b values are set to 0; the L values won't have any change.
6. Now the color space is changed from RGB to Lab. This is done to record Lab values accurately using histogram in photoshop.
7. The brightness of the image is expressed by L value. To obtain images with comparable brightness, image brightness is compared with medium value.
8. The selected tooth will be surrounded by a broken line. This broken line denotes that all the measurements made are of the image within the line.

9. L, a, and b values are measured in the selected area of the tooth by clicking the area of interest.

The average value of L, a, and b values (ΔE) is calculated using the formula

$\Delta E = \sqrt{(\Delta L) * + (\Delta a *)^2 + (\Delta b *)}^2$.

Photographs

PHOTOS

PHOTO :1(A) ARMAMENTARIUM FOR CLINICAL EXAMINATION

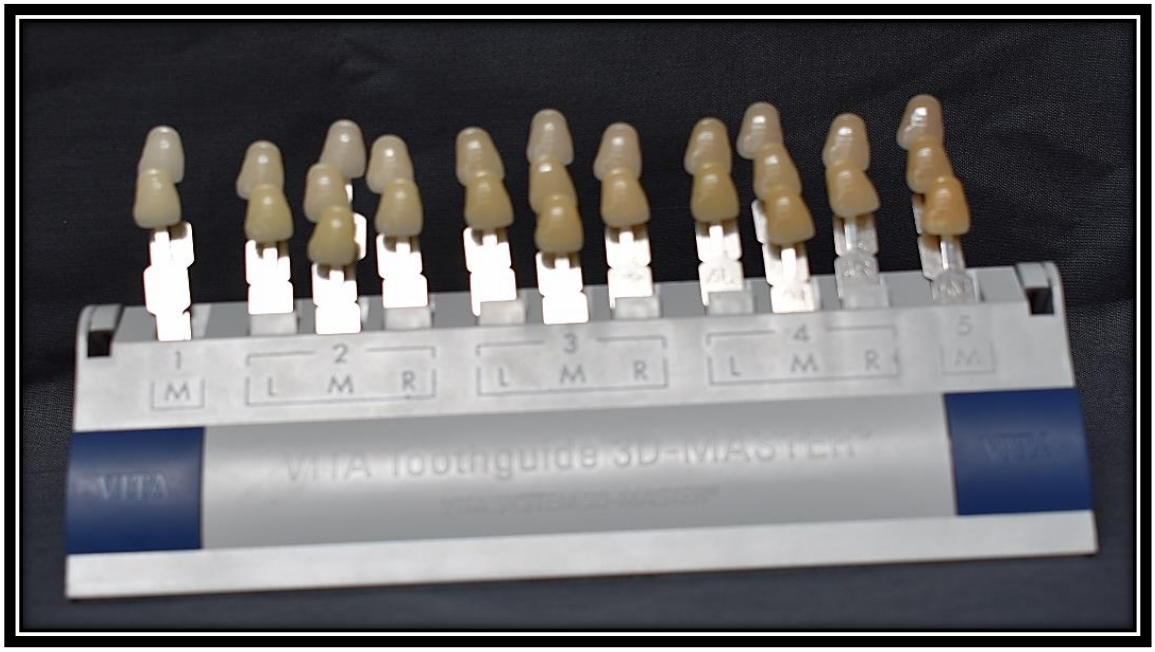


PHOTO :1(B) ARMAMENTARIUM FOR VISUAL SHADE SELECTION

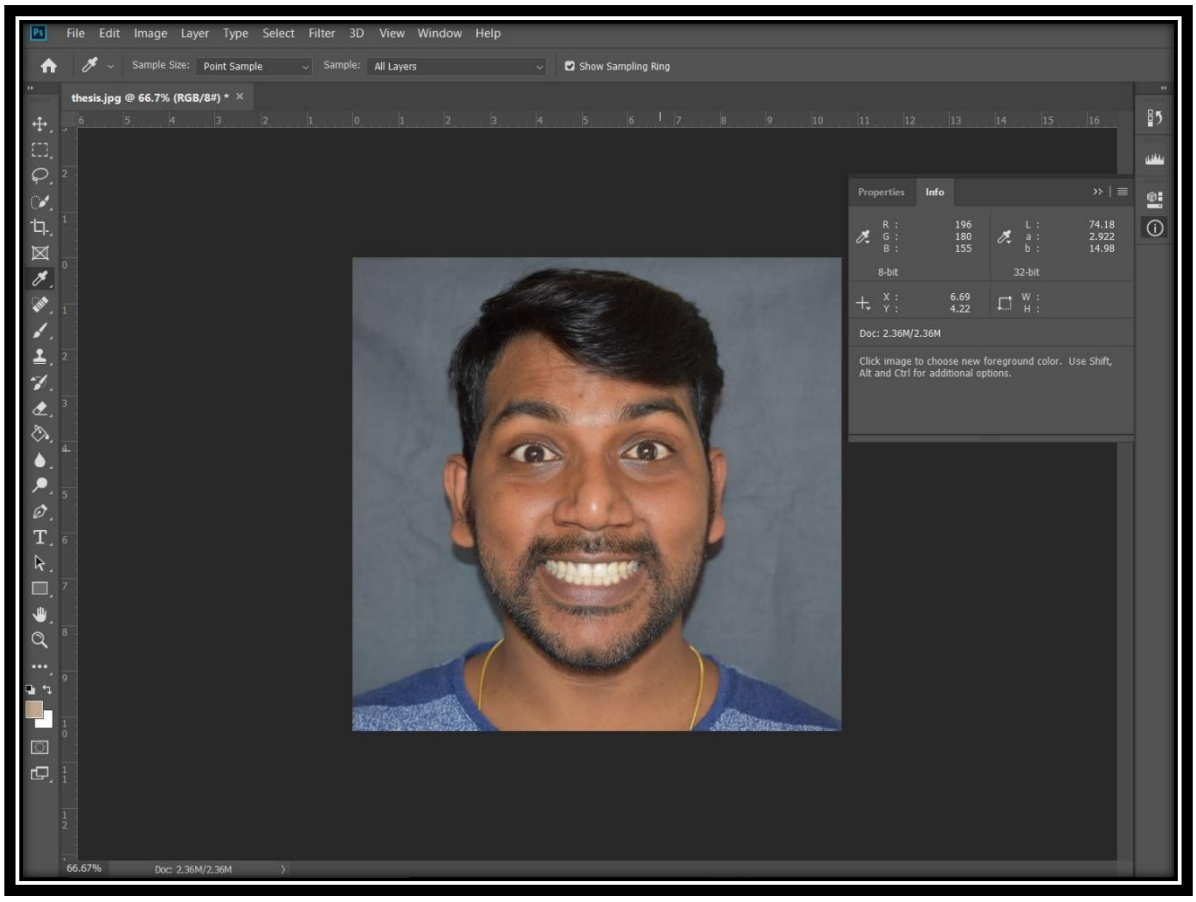
PHOTO :1(C) ARMAMENTARIUM FOR DIGITAL SHADE SELECTION

PHOTO :2 NATURAL TOOTH SHADE SELECTION USING VITA 3D MASTER SHADE GUIDE

PHOTO :3 NATURAL SCLERAL SHADE SELECTION USING VITA 3D MASTER SHADE GUIDE

PHOTO :4 NATURAL TOOTH AND SCLERAL SHADE SELECTION USING DIGITAL PHOTOGRAPHY

PHOTO :5 ANALYSIS OF DIGITAL IMAGES USING PHOTOSHOP SOFTWARE



Results

RESULTS:

The following results were obtained from this study that compared the natural tooth shade that is the shade of maxillary central incisor and scleral shade to evaluate if there is a correlation between the both using vita 3d-master shade guide and digital photography. This study was conducted on 100 samples.

The following methods of statistical analysis have been used in this study. Data was entered in Microsoft excel and analyzed using IBM SPSS (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). Mean and SD were used to summarize the continuous data. Initially the data was checked for normality using Shapiro Wilk test. The data was found to be normal, and thereby it was decided to use parametric test for further comparisons. For intergroup comparison (Tooth vs Sclera CIELAB parameters) independent samples t test was used. Since the data was continuous in nature, a Pearson's correlation coefficient was used to find the correlation between the shade and CIELAB between tooth and sclera, except hue parameter, were Spearman's correlation coefficient was used since it is a nominal type of data. For describing distribution of shades in tooth and sclera, frequency and percentages were used.

Formulation of the Hypothesis:

Null Hypothesis: H0 = There is no correlation between the natural tooth shade and scleral shade using visual and digital shade matching methods.

Alternate Hypothesis Ha = There is correlation between the natural tooth shade and scleral shade using visual and digital shade matching methods.

If P value < 0.05 it is considered statistically significant.

Table 1: FREQUENCY DISTRIBUTION OF TOOTH SHADE

SHADE	NUMBER (N)	PERCENTAGE%
1M1	3	3
1M2	4	4
2M1	17	17
2M2	50	50
2M3	12	12
2L1.5	4	4
2L2.5	2	2
2R1.5	-	-
2R2.5	6	6
3M1	-	-
3M2	1	1
4M1	-	-
5M1	1	1
TOTAL	100	100

Table 2: FREQUENCY DISTRIBUTION OF SCLERAL SHADE

SHADE	NUMBER (N)	PERCENTAGE%
1M1	24	24
1M2	1	1
2M1	43	43
2M2	18	18
2M3	1	1
2L1.5	5	5
2L2.5	-	-
2R1.5	4	4
2R2.5	2	2
3M1	1	1
3M2	-	-
4M1	1	1
5M1	-	-
TOTAL	100	100

Table 3: PEARSON'S CORRELATION WAS PERFORMED FOR VALUE OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING VITA 3D MASTER SHADEGUIDE

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth Value	0.607	Moderately strong	<0.001*
Sclera Value			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

Table 4: PEARSON'S CORRELATION WAS PERFORMED FOR CHROMA OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING VITA 3D MASTER SHADE GUIDE

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth Chroma	0.263	Weak	0.009*
Sclera Chroma			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

Table 5: SPEARMAN'S CORRELATION WAS PERFORMED FOR HUE OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING VITA 3D MASTER SHADEGUIDE

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth Hue	0.958*	Very strong	<0.001*
Sclera Hue			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

Table 6: PEARSON'S CORRELATION WAS PERFORMED FOR LIGHTNESS (L) OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth L	0.866	Very strong	<0.001*
Sclera L			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

Table 7: PEARSON'S CORRELATION WAS PERFORMED FOR REDNESS-GREENNESS (a) OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth a	0.509	Moderately strong	<0.001*
Sclera a			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

0

TABLE 8: PEARSON'S CORRELATION WAS PERFORMED FOR YELLOWNESS-BLUENESS (b) OF TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY

Variable	Correlation coefficient (r)	Correlation strength	P value
Tooth b	0.542	Moderately strong	<0.001
Sclera b			

*THE CORRELATION IS STATISTICALLY SIGNIFICANT

ALL THE CORRELATIONS ARE POSITIVE AND STATISTICALLY SIGNIFICANT

TABLE 10: DESCRIPTIVE STATICTICS – CIELAB VALUES OF NATURAL TOOTH AND SCLERA

Group	CIELAB values	N	Minimum	Maximum	Mean	SD
Tooth	L1	100	55.40	84.60	77.3727	5.00766
	A1	100	.20	4.50	1.6444	.79914
	B1	100	6.50	32.00	19.4848	4.75481
Sclera	L2	100	51.60	84.60	77.6919	6.02428
	A2	100	.20	3.90	1.8677	.89521
	B2	100	10.00	35.00	16.6222	4.20230

TABLE 11: INDEPENDENT SAMPLES T TEST TO COMPARE THE CIELAB VALUES BETWEEN THE GROUPS

Variable	Group	N	Mean	SD	SEM
L	Tooth	100	77.3810	4.98300	.49830
	Sclera	100	77.7050	5.99521	.59952
A	Tooth	100	1.6440	.79510	.07951
	Sclera	100	1.8670	.89070	.08907
B	Tooth	100	19.5580	4.78696	.47870
	Sclera	100	16.6910	4.23721	.42372

Variable	Mean value	t	P Value	Mean Difference	95% CI of the Difference	
					Lower	Upper
L	77.3810	-.416	.678	-.32400	-1.86132	1.21332
	77.7050		.678	-.32400	-1.86164	1.21364
A	1.6440	-1.868	.063	-.22300	-.45845	.01245
	1.8670		.063	-.22300	-.45847	.01247
B	19.5580	4.485	.000	2.86700	1.60631	4.12769
	16.6910		.000	2.86700	1.60620	4.12780

The test shows that B (CIELAB variable) was significantly different between tooth and sclera. The other 2 parameters were comparable for tooth and sclera

BAR DIAGRAMS:

FIGURE 1: COMPARISION OF VALUE OF NATURAL TOOTH SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

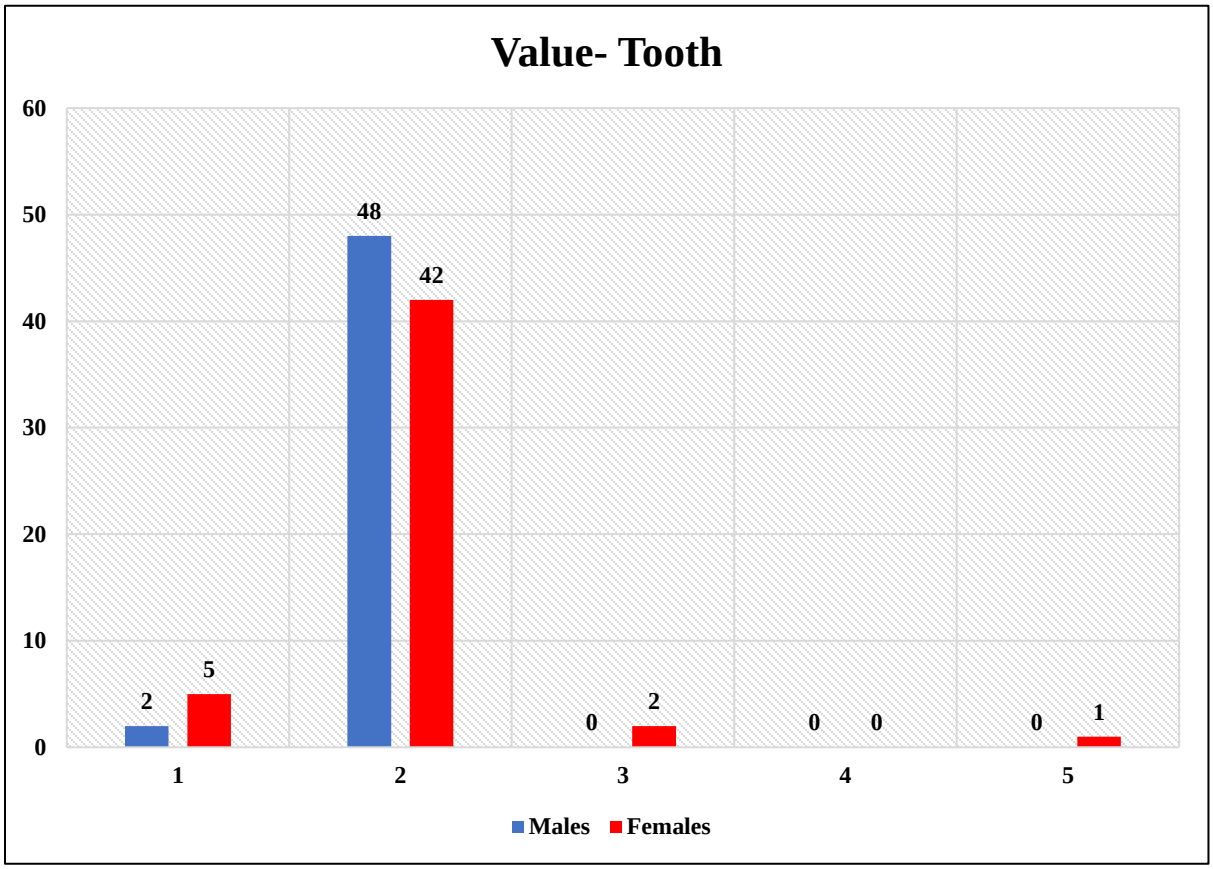


FIGURE 2: COMPARISION OF VALUE OF NATURAL SCLERAL SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

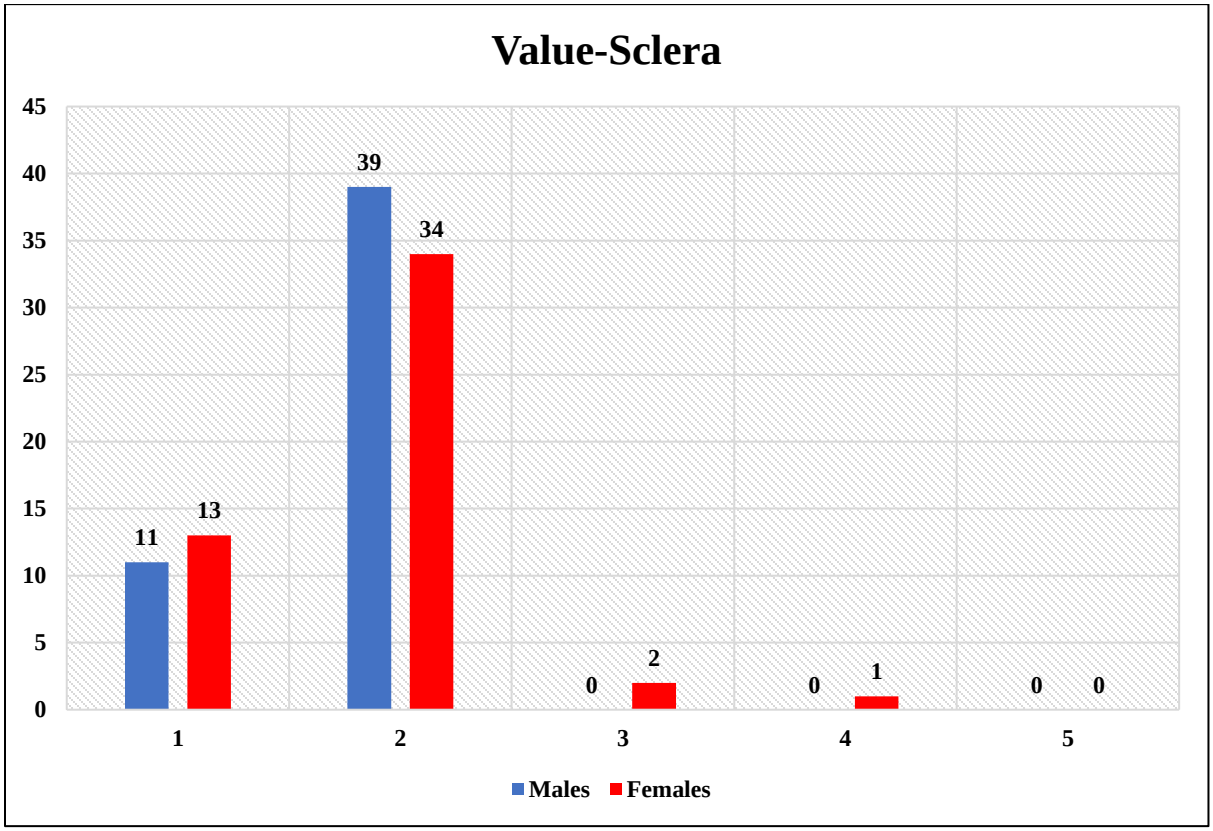


FIGURE 3: COMPARISION OF HUE OF NATURAL TOOTH SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

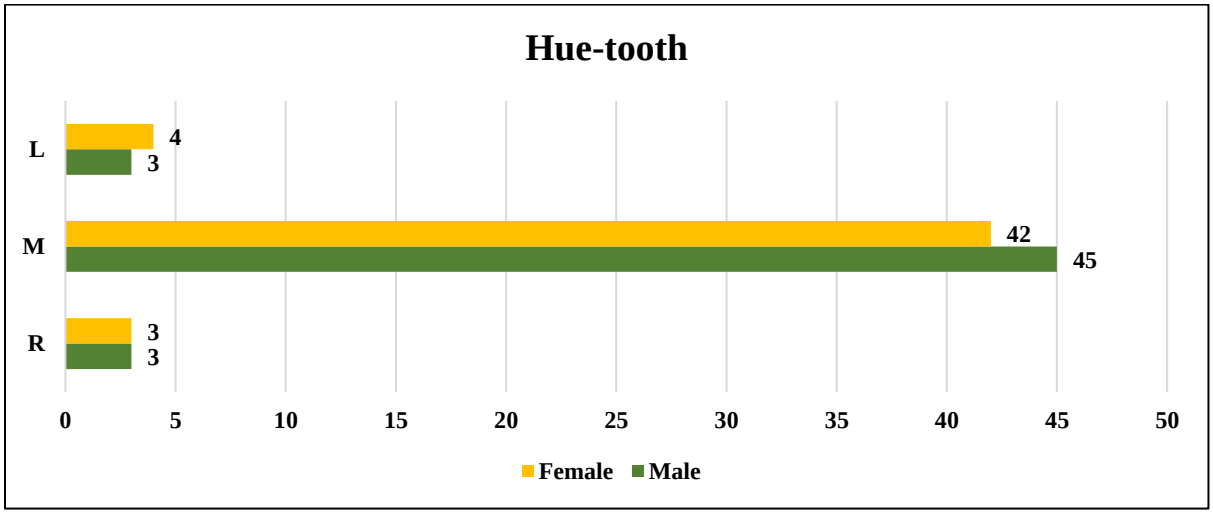


FIGURE 4: COMPARISION OF HUE OF NATURAL SCLERAL SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

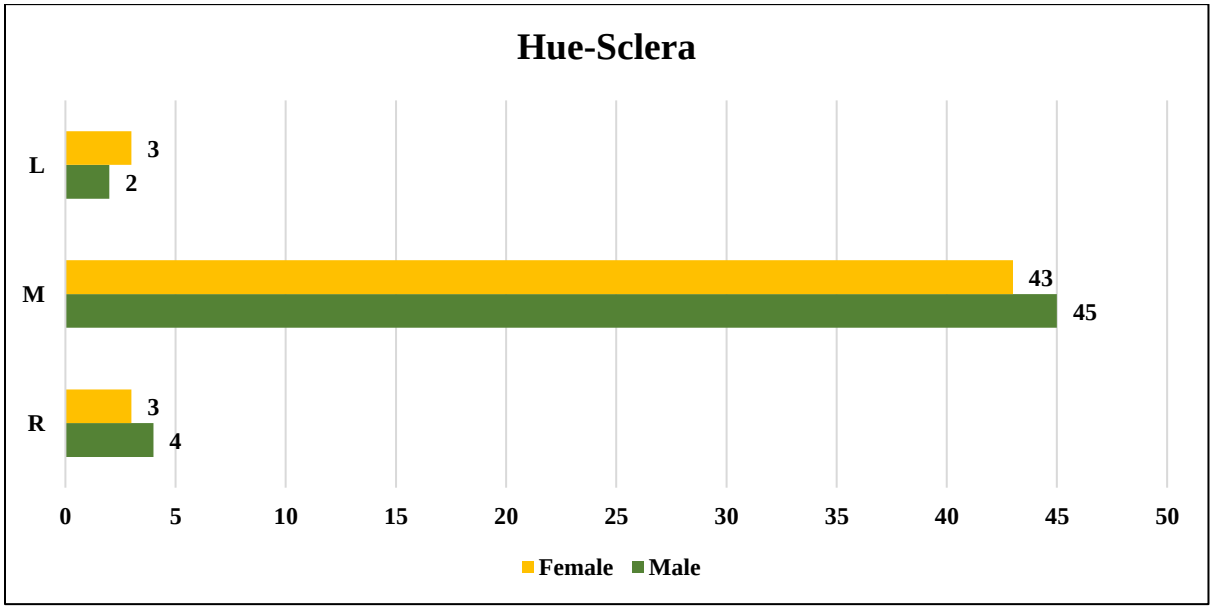


FIGURE 5: COMPARISION OF CHROMA OF NATURAL TOOTH SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

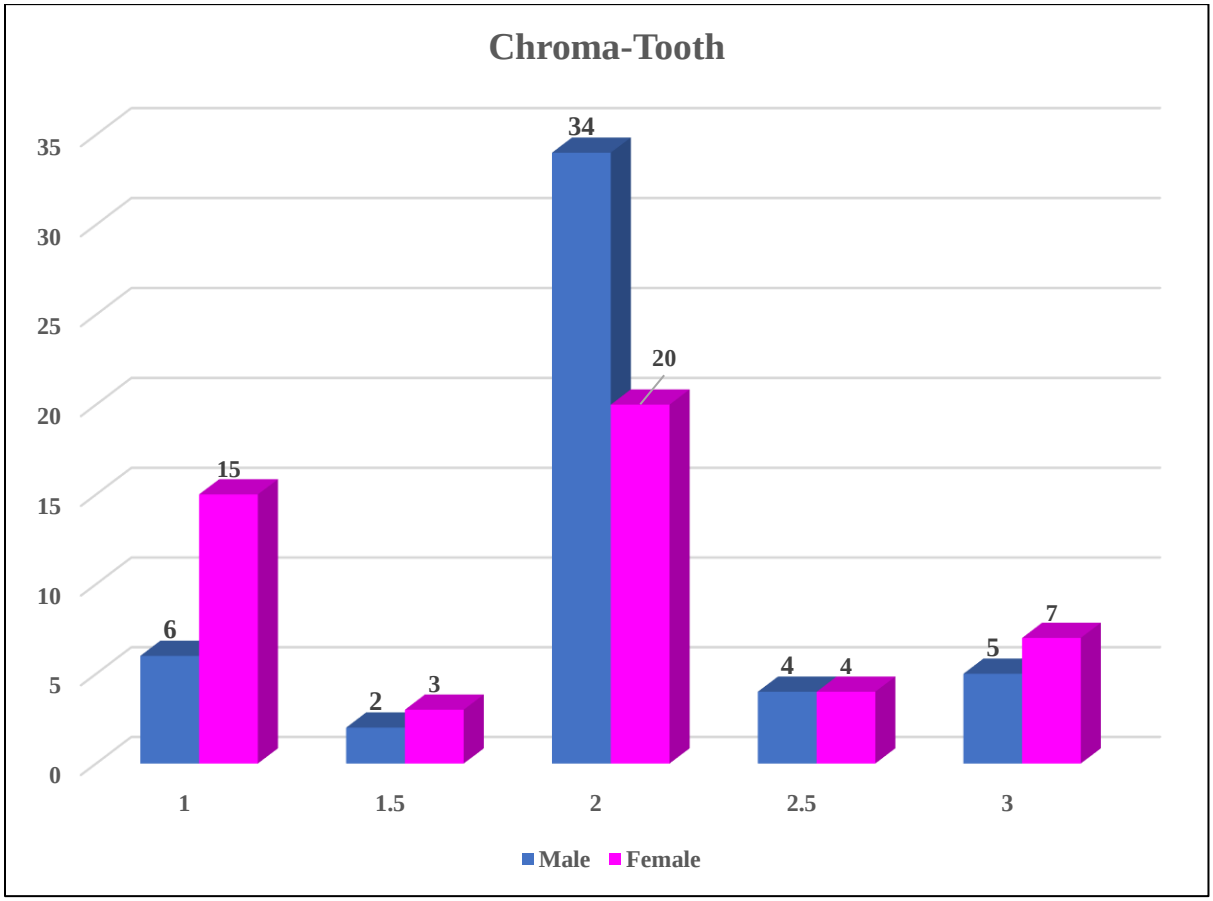


FIGURE 6: COMPARISION OF CHROMA OF NATURAL SCLERAL SHADE BETWEEN MALES AND FEMALES ASSESSED USING VITA 3D MASTER SHADE GUIDE

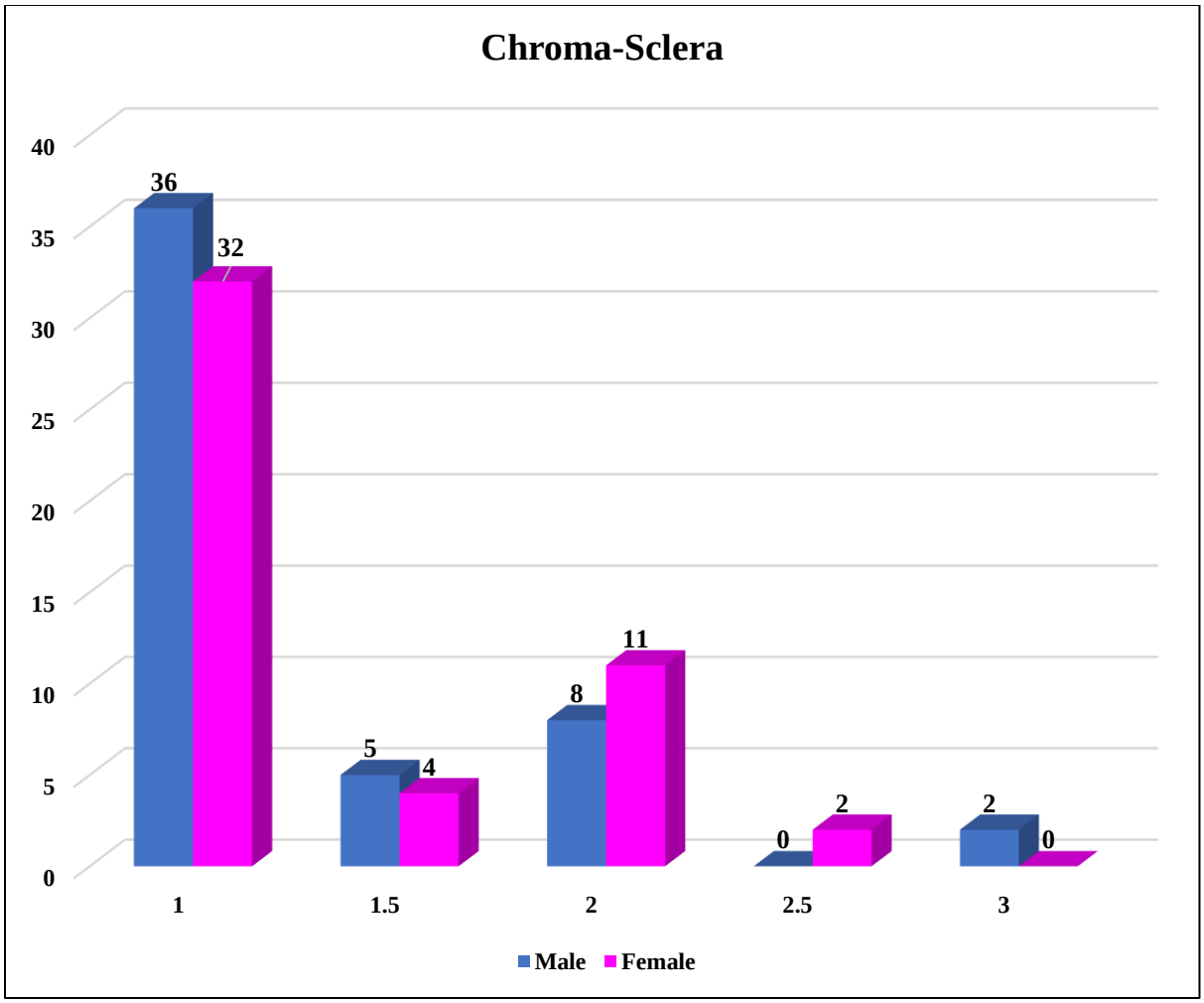
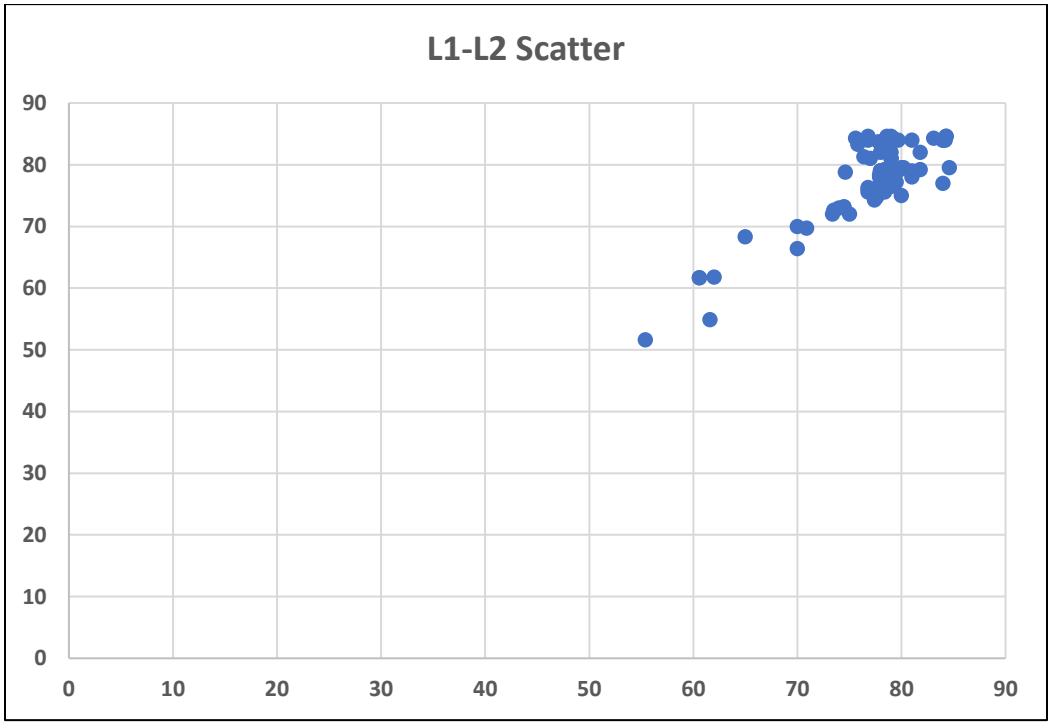
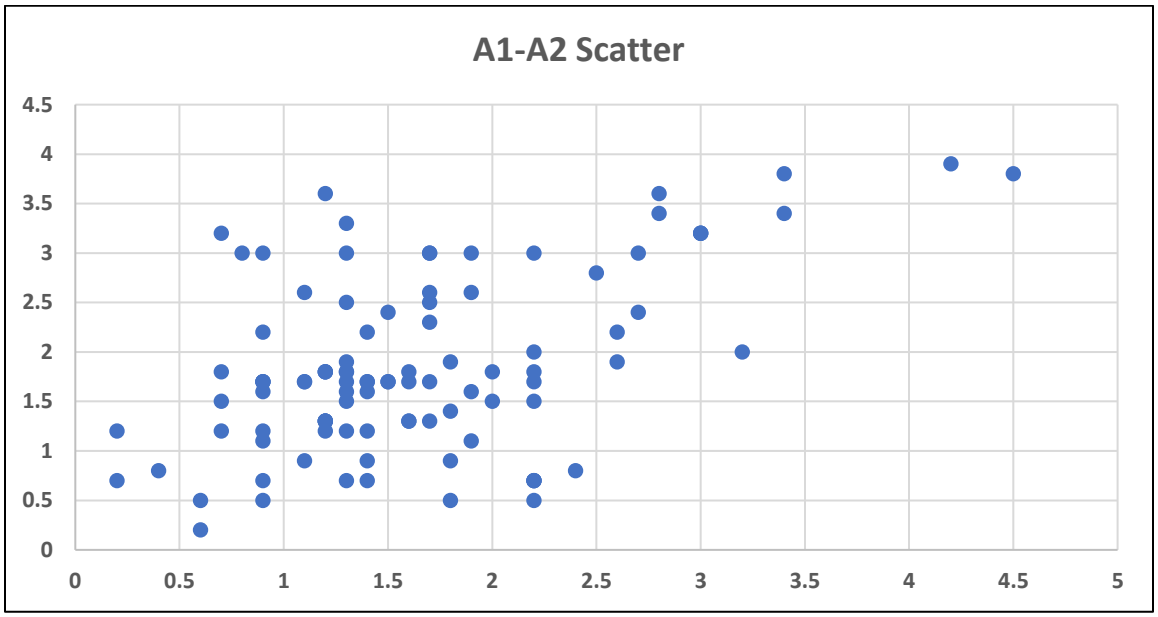


FIGURE 7: SCATTER PLOT SHOWING CORRELATION BETWEEN LIGHTNESS(L) OF NATURAL TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY



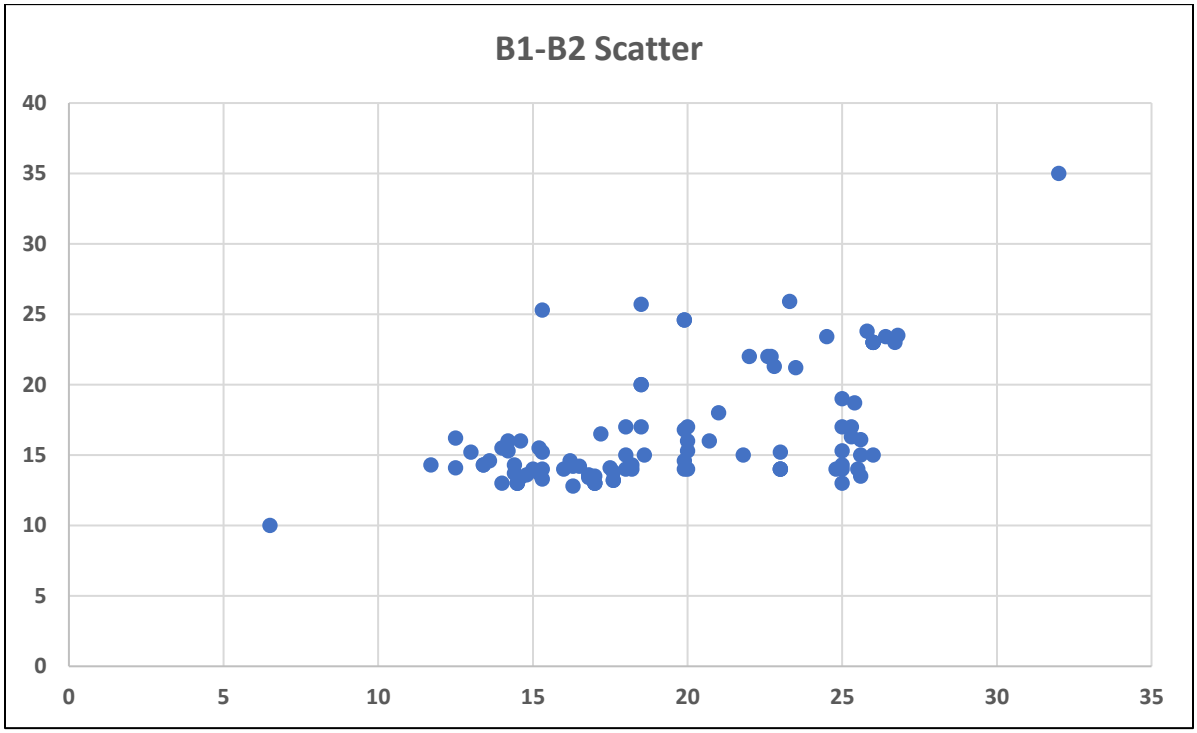
Correlation coefficient = 0.866 (Very strong)

FIGURE 8: SCATTER PLOT SHOWING CORRELATION BETWEEN REDNESS TO GREENESS(a) OF NATURAL TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY



Correlation coefficient = 0.509 (Moderately strong)

FIGURE 9: SCATTER PLOT SHOWING CORRELATION BETWEEN YELLOWNESS TO BLUENESS(b) OF NATURAL TOOTH SHADE AND SCLERAL SHADE ASSESSED USING DIGITAL PHOTOGRAPHY



Correlation coefficient = 0.542 (Moderately strong)

Table no 1 shows the frequency distribution of tooth shade in the study subjects. **2M2** is the most common tooth shade found followed by **2M1**.

Table no 2 shows the frequency of scleral shade in the study subjects. **2M1** is the most common scleral shade found followed by **1M1.**

Table no 3 shows the correlation value (Pearson's test) obtained between the value of tooth shade and scleral shade assessed using vita 3d master shade guide. The correlation coefficient (r) was found to be 0.607 and the **p value is <0.001** which means the correlation strength is moderately strong and the correlation is statistically significant.

Table no 4 shows the correlation value (Pearson's test) obtained between the chroma of tooth shade and scleral shade assessed using vita 3d master shade guide. The correlation coefficient (r) was found to be 0.263 and the **p value is <0.009** which means the correlation strength is weak and the correlation is statistically significant.

Table no 5 shows the correlation value (Spearman's test) obtained between the hue of tooth shade and scleral shade assessed using vita 3d master shade guide. The correlation coefficient (r) was found to be 0.958 and the **p value is <0.001** which means the correlation strength is very strong and the correlation is statistically significant.

Table no 6 shows the correlation value (Pearson's test) obtained between the lightness(L) of tooth shade and scleral shade assessed using digital photography. The correlation coefficient (r) was found to be 0.866 and the **p value is <0.001** which means the correlation strength is very strong and the correlation is statistically significant.

Table no 7 shows the correlation value (Pearson's test) obtained between the redness to greenness(a) of tooth shade and scleral shade assessed using digital photography. The correlation coefficient (r) was found to be 0.509 and the **p value is <0.001** which means the correlation strength is moderately strong and the correlation is statistically significant.

Table no 8 shows the correlation value (Spearman's test) obtained between the yellowness to blueness (b) of tooth shade and scleral shade assessed using digital photography. The correlation coefficient (r) was found to be 0.542 and the **p value is <0.001** which means the correlation strength is moderately strong and the correlation is statistically significant.

Table no 9 shows the descriptive statistics for CIELAB variables.

The lightness **(L)** value of tooth shade for 100 samples is a minimum of 55.40 to a maximum of 84.60 with a mean of 77.3727 and that of scleral shade for 100 samples is a minimum of 51.60 to a maximum of 84.60 with a mean of 77.6919.

The redness-greenness **(a)** value of tooth shade for 100 samples is a minimum of 0.20 to a maximum of 4.50 with a mean of 1.6444 and that of scleral shade for 100 samples is a minimum of 0.20 to a maximum of 3.90 with a mean of 1.8677.

The yellowness-blueness **(b)** value of tooth shade for 100 samples is a minimum of 6.50 to a maximum of 32.00 with a mean of 19.4848 and that of scleral shade for 100 samples is a minimum of 10.00 to a maximum of 35.00 with a mean of 16.6222.

Table 10 shows that the standard deviation of L, a values are more for scleral shade than the tooth shade whereas standard deviation of b value of tooth shade is more than the scleral shade.

Table no 11: The independent samples t test shows that yellowness-blueness value (b) (CIELAB variable) was significantly different between tooth and sclera. The other 2 parameters (L) and (a) were comparable for tooth shade and scleral shade.

Discussion

DISCUSSION:

"Color is light, modified by an object as perceived by an eye". (Saleski, 1972).

Webster[41] defines color as "Color is the sensation occurring due to stimulation of the retina of the eye by light waves of certain wave lengths".

Billmeyer and Saltzman in their book on color science has stated that "Color is the result of the physical modification of light by colorants as observed by the human eye and interpreted by the brain".

The basis of color science is a vast subject applicable to many fields. In Prosthodontics, it is one of the deciding factors for patient's acceptance apart from tooth size, shape, position and texture. The color of human teeth is described in terms of hue, value and chroma. But light influences color such that these three determinants when influencing color to different depths results in perception of same color as different shades. Hence, Shade has gained its importance in the recent era. Prosthodontics is more concerned with tooth shade than other dental branches

Facial appearance of an individual is determined by their skin colour, hair colour, eye colour etc.… Various studies have been performed to find the harmonious association between them.

As per **Dosumu Oluwale O, Dosumu Elizabeth B (2010)**[47] color of the teeth must harmonize with the color of skin, hair, eye color and age in order to enhance the facial appearance. There are various color systems described to differentiate the color space like Greyscale, RGB, CMYK, Lab etc. In **1905 Albert H. Munsell** gave the first color system

based on Hue, value and chroma. Various color systems have emerged in the recent years still MUNSELL's system remains the goal standard for describing color distribution.

As **Satheesh B. Haralur et al (2014)**[53], has suggested that the tooth shade selection will be more objective if another facial appearance feature is used as a reliable guide, various studies have been conducted by comparing tooth shade with skin shade, hair color and eye color (iris color)[52]. Still, there is no appropriate shade indicator for selection of artificial teeth till date. Among the different facial features utilized for shade selection, the correlation of the scleral shade and the teeth shade is one which is not explored till now. Hence in our study we have taken **SCLERA** as a reliable guide for tooth shade selection as it is a constant factor.

The sclera is the white part of the eye that surrounds the cornea. More than 80 percent of the surface area of the eyeball is formed of sclera, extending from the cornea to the optic nerve, which exits the back of the eye. Only a small portion of the anterior sclera is visible outside[48].

The sclera is the dense connective tissue of the eyeball that forms the "white" of the eye[61]. It is continuous with the stroma_layer of the cornea. The sclera ranges in thickness from about 0.3 millimeter (mm) to 1.0 mm. It is composed of fibrils (small fibers) of collagen that are arranged in irregular and interlacing bundles. The random arrangement and interweaving of these connective tissue fibers are what accounts for the white color of the sclera and for the strength and flexibility of the eyeball[59].

Younger age group (18 to 30 years) were taken for this study as there will be minimal deterioration in the natural appearance of the teeth.

Tooth shade is determined for the subjects chosen by random sampling in this present study. There are two ways of measuring tooth shade – subjective, through the use of shade guides, and objective, mainly through the use of electronic devices such as spectrophotometers, colorimeters, and imaging systems[42].

In 1931, Clark began the era of shade guides based on Munsell 's system of Hue, value and chroma[43,44]. He custom made a shade guide by his visual assessment of human teeth. Then various shade guides were developed Like Vita Lumin Shade Guide, Vita Classical Shade Guide, Chromoscope Shade Guide by Ivoclar[54], Shofu Shade Guide etc.…

Before 1998, the most popular shade guide was Vita Classical Shade Guide[58]. It is based on hue and represents only 16 shades, too few to represent the color variability of natural dentitions.

In 1998, **Vita 3D Master shade guide** was introduced[45]. There are 29 tabs in vita 3D Master shade guide. The shade tabs were identified with Number-letter-number sequence. The first number represents the value, the letter represents the hue, and the second number represents the chroma. The lightness was numbered from **0 to 6** which means from lightest to darkest. The second number chroma ranged from **1 to 3** which means least chromatic to most chromatic, the hue was represented as letters as **L** which means left being yellowish and **M** meaning middle being middle hue and **R** meaning right being reddish.

As **Hassel et al(2005)** has stated that the restorations undergoing shade selection with the 3D Master shade guide could be cemented without the need for any shade modification by conducting a study on Vita Classical shade guide and vita 3D Master shade guides and as similar results were reported on the studies conducted by

Ghahramanloo et al(2008)[53] , Egger B(2003) and Hamad IA(2003) by comparing Vitapan Classical and vita 3D Master shade guides

In this present study Vitapan 3d master shade guide was used to assess the tooth shade and scleral shade by visual shade matching method. It is also stated that 3D Master exhibits the least visual errors compared to Vitapan Classical **Hamad IA (2003**)

The Vitapan 3D-Master shade-matching system is used in this study as it is extensively used in dental clinics and has been shown to enable shade matching. The use of the Vita 3D Master shade guide alone is just as effective as using all 3 shade guides combined (VITA Lumin, Chromascope & vi ta 3D master)[56].

Following all the proper shade selection guidelines[46],

In the present study the most frequently found shade of maxillary central incisors is **2M2 (Table:1)** which is against correspondence to results obtained by **Teuta Pustina-Krasniqi et al (2018)[51]** who reported the most frequent shade of maxillary central incisors as 2M1 assessed by vita 3d master shade guide in Istanbul population.

In this current study it is concluded that the most common hue found in south Indian population is M **(Fig :3)** with lighter value **(Fig:1)** which was in accordance with the study done by **Harinder Kuckreja et al (2017)[50]** in north Indian population where they also concluded that the most common hue was M with lighter value. They also have determined the most common tooth shade in middle third of maxillary central incisors as 1M1, which was not in accordance with the present study which was found to be 2M2. The study done by **Harinder Kuckreja et al (2017)** was done using vita easy shade guide in North Indian

population while the present study was done using vita 3d master shade guide in South Indian population.

There were certain disadvantages in using shade guides like errors in shade selection, communicating with the laboratories etc... It was then, there was a necessity for accurate shade matching methods to overcome those discrepancies. There came out instrumental shade matching methods like spectrophotometer, colorimeter and digital imaging in the 20th century[55]. Since the spectrophotometer and colorimeter were expensive and not readily available for general dentist population, digital imaging modality was opted for this present study.

Digital cameras were introduced in dentistry to perform an objective analysis of tooth shade. The objective methods express the color results in CIE *L* a* b**, color system. According to the CIE *L* a* b** system, all perceived colors have three dimensions, *L* for lightness (*L** = 0 yields black and *L** =100 indicates diffuse white), *a* for green–red (*a**, negative values indicate green, while positive values indicate red), and *b* for the color opposites blue–yellow (*b**, negative values indicate blue and positive values indicate yellow).

According to **Vela Desai et al (2013)** dental digital photography allows accurate measurement of shades of facial images and studies conducted by **Wolfgang M et al in 2003** and **Edward A. Et al** concluded that analyzing shade of tooth by raw images acquired by digital camera is very precise to provide an acceptable aesthetic outcome of the restoration.

Dhruv Anand (2016)[64] reported that images acquired digitally with an SLR camera can be used as an alternative to the VITA easy shade spectrophotometer for obtaining the tooth shade as L and b values obtained by both the methods were highly significant.

In relation to these study results,

In the present study it was decided to use **DSLR camera with Adobe photoshop CC** to acquire the images of the face of the subjects who participated in the study for determining tooth and scleral shade.

In our study conducted in south Indian population, using **Digital Photography** and **Adobe photoshop CC** software with sample size of 100 it is found that mean of **L1** value is **77.3727**, **a1** value is **1.644** and **b1** value is **19.4848** for tooth shade **(Table: 11)** which is in accordance with the studies conducted by **Gozalo-Diaz et al[63]** with Spectroradiometer in US populations, **Cho et al[62]** using Shade vision system in Korean population and **Xiao et al[60]** using Colorimeter in Chinese populations.

In this present study **POSITIVE CORRELATION** is found between the tooth shade and scleral shade measured using both visual and digital shade matching methods.

Pearson's correlation was performed for value and chroma of tooth shade and scleral shade assessed using vita 3d master shade guide and the correlation coefficient was found to be **0.607** meaning moderately strong correlation strength for value **(Table:3)** and **0.263** meaning weak correlation for chroma **(Table:4)** and spearman's correlation was performed for hue and correlation coefficient is found to be **0.958** meaning very strong correlation for hue **(Table:5).**

Pearson's correlation was performed for Lightness (L),Redness-Greenness (a), Yellowness- Blueness (b) of tooth shade and scleral shade assessed using digital

photography and the correlation coefficient was found to be **0.866** meaning very strong for Lightness(L) **(Table:6)** and the correlation coefficient was found to be **0.509** meaning moderately strong for Redness-Greenness (a), **(Table:7)** and the correlation coefficient was found to be **0.542** meaning moderately strong for Yellowness- Blueness (b) **(Table:8).**

Based on **PubMed and Google search** this is the first clinical study conducted to correlate the relation between natural tooth shade and scleral shade to aid in shade matching.

The limitations of this study are listed below:

1. Sample size is limited
2. Tooth shade was determined only from maxillary central incisor.
3. Age related changes can occur in tooth and scleral shade
4. There can be inter observer difference in visual shade selection and scleral shade of natural tooth shade using vita 3d master shade guide. Thus, in order to avoid this difference ideal conditions of shade selection which are mentioned above should be maintained.
5. This study was conducted on individuals in the age group of 18 to 30 years. Further researches can be carried out by including few more age groups

Thus, advanced improvements in scleral shade determination can provide a base for further research associated with this study.

Summary and Conclusion

SUMMARY & CONCLUSION:

The present clinical study was conducted to clinically evaluate the correlation between natural tooth shade and scleral shade using vita 3d-master shade guide and digital photography.

For the purpose of this study a total of 100 dentate subjects in the age group 18 to 30 years, out of which 50 males and 50 females were chosen.

In this study, first visual shade matching of tooth and scleral shade is done using vita 3d master shade guide. The hue, value and chroma were determined. Then a standard frontal view photographic collection was made with the help of a digital camera (NIKON 5600), from subjects with maximum eye opening and anterior teeth exposure. Digital images acquired were analyzed using Adobe Photoshop CC software. The CIELAB values according to Munsell color system was obtained. The measurements of the different variables described in the study were registered and analyzed.

Correlation of natural tooth shade and scleral shade determined by both visual shade matching and digital shade matching was done by using Pearson's test. Correlation of Hue of the tooth shade and scleral shade was done by spearman's correlation test. For intergroup comparison independent t test was used. For describing distribution of shades in tooth and sclera, frequency and percentages were used. P value < 0.05 it is considered statistically significant

The results were obtained and statistical analysis was done. From the analysis following conclusions are drawn.

- The most common tooth shade found in south Indian population is 2M2.
- The most common scleral shade found in south Indian population is 2M1.
- Pearson correlation coefficient(r) 0.607 for value of tooth shade and scleral shade was observed. The value of tooth shade and scleral shade assessed using vita 3d master shade guide shows statistically significant ($P<0.05$) correlation.
- Pearson correlation coefficient(r) 0.263 for chroma of tooth shade and scleral shade was observed. The chroma of tooth shade and scleral shade assessed using vita 3d master shade guide shows statistically significant ($P<0.05$) correlation.
- Spearman's correlation coefficient(r) 0.958 for hue of tooth shade and scleral shade was observed. The hue of tooth shade and scleral shade assessed using vita 3d master shade guide shows statistically significant ($P<0.05$) correlation.
- Pearson correlation coefficient(r) 0.866 for lightness(L) of tooth shade and scleral shade was observed. The Lightness(L) of tooth shade and scleral shade assessed using digital photography shows statistically significant ($P<0.05$) correlation.
- Pearson correlation coefficient(r) 0.509 for redness-greenness(a) of tooth shade and scleral shade was observed. The redness-greenness(a) of tooth shade and scleral shade assessed using digital photography shows statistically significant ($P<0.05$) correlation.
- Pearson correlation coefficient(r) 0.542 for yellowness- blueness(b) of tooth shade and scleral shade was observed. The yellowness- blueness(b) of tooth shade and scleral shade assessed using digital photography shows statistically significant ($P<0.05$) correlation.

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Within the limitations and result of this study it can be concluded that:

1. Positive correlation is seen in hue, chroma and value of tooth shade and scleral shade assessed using vita 3d master shade guide.
2. Positive correlation is seen in L, a, b parameters of tooth shade and scleral shade assessed using digital photography and Adobe Photoshop CC software.

Hence it can be concluded that scleral shade can be used as a valuable shade indicator for tooth shade selection and vice versa. This will be extremely helpful in patients undergoing full mouth restoration and in maxillofacial prosthetics. This can also be helpful in forensic odontological investigations. Thus, this study provides a definitive ground for more future research using scleral shade and tooth shade.

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Annexure

ANNEXURE

MASTER CHART SHOWING PATIENT DETAILS AND DIFFERENT PARAMETRIC VALUES

S. No	AGE	SEX	TOOTH SHADE	SCLERAL SHADE	L1	A1	B1	L2	A2	B2
1.	28	M	2M2	2M1	79	1.7	25	79	3	14
2.	29	M	2M2	2M2	78	1.1	20	79	1.7	15.3
3.	25	F	5M1	4M1	65	4.2	18.5	68.3	3.9	17
4.	19	F	1M2	1M2	84.2	0.6	21	84	0.2	18
5.	19	M	2M2	2M1	78	1.7	25	79	3	13
6.	20	M	2M2	2M2	79	0.9	20	81	2.2	16
7.	19	F	3M2	3M1	74	4.5	20.7	73	3.8	16
8.	20	F	2M3	2M2	79	1.4	25	81	2.2	15.3
9.	20	M	2M2	2M1	81	2.2	16	78	3	14
10.	20	M	1M2	1M1	84	0.6	21.8	84	0.5	15
11.	25	F	2M3	1M1	79	1.4	25.5	84	0.7	14
12.	24	F	2M2	2M2	77	3.2	15	81	2	14
13.	19	M	2M2	1M1	78.7	1.9	20	83	1.6	14
14.	28	F	2M2	2M1	81	2.2	25	79	1.7	19
15.	27	F	2L2.5	2L1.5	79.5	0.2	24.5	77.2	1.2	23.4
16.	20	F	2L1.5	2L1.5	79	1.9	18.5	76.5	2.6	20
17.	24	M	2M2	1M1	81.8	2.2	15.3	82	0.5	15.2
18.	23	M	2M2	2M1	79	2.7	26	79	3	15
19.	29	F	2M3	1M1	79.2	1.4	25.6	84.3	0.9	16.1
20.	28	M	2M2	2M1	80	1.2	18	75	1.2	17
21.	26	F	2M3	1M1	79	1.5	20	82	2.4	17
22.	22	F	2M1	2M2	60.6	0.4	14.2	61.7	0.8	16
23.	21	M	2M2	2M2	62	1.3	11.7	61.8	2.5	14.3
24.	29	M	2M1	2M1	60.6	2.4	6.5	61.7	0.8	10
25.	29	F	2M2	2M2	70	1.4	32	70	1.2	35
26.	25	F	2M3	2M1	61.6	1.1	14.2	54.9	2.6	15.3
27.	19	M	2M3	2M1	55.4	3.4	14.4	51.6	3.8	14.3

28.	19	F	2M1	2M1	70.9	1.7	14.6	69.7	2.3	16
29.	20	F	2L1.5	2M1	84	2.5	25	77	2.8	17
30.	19	M	2M2	2M2	78	1.7	23	77	2.5	14
31.	20	F	1M2	2M1	70	1.7	26.4	66.4	1.3	23.4
32.	20	F	2M2	2M2	78.7	0.9	19.9	79	1.7	24.6
33.	25	M	2M3	2M3	81.8	2.2	15.3	79.2	0.7	25.3
34.	24	M	2M2	2M1	75	1.8	24.8	72	1.4	14
35.	19	M	2M3	2M1	78.5	0.7	25.3	78.3	3.2	16.3
36.	28	F	2M1	2M1	73.4	1.8	14	72	1.9	15.5
37.	27	M	2M2	2M1	74.5	2.2	15.3	73.2	1.8	13.3
38.	24	M	2M2	2M1	73.5	0.9	19.9	72.6	1.7	16.8
39.	23	F	2M2	1M1	75.6	1.3	17.5	84.3	1.7	14.1
40.	29	F	2M1	2M1	78	0.8	14	79	3	13
41.	28	F	1M1	1M1	83.1	1.1	12.5	84.3	1.7	14.1
42.	26	M	2M2	2M1	77.5	1.2	17	75	1.8	13
43.	22	M	2M2	1M1	78.7	0.9	19.9	84.3	0.7	14.6
44.	22	F	2M2	1M1	78.3	1.1	18.6	83.6	0.9	15
45.	21	M	2M1	1M1	78	0.9	15.2	82	0.5	15.5
46.	29	F	2R2.5	2R2.5	79.5	1.7	23.3	79.2	2.6	25.9
47.	20	F	2M1	1M1	77.8	0.7	12.5	83.7	1.5	16.2
48.	24	M	2L1.5	2L1.5	79	2.6	18.5	76.5	1.9	20
49.	23	M	2M1	2M1	78.4	3	14.5	79	3.2	13
50.	29	F	2R2.5	2R2.5	79.7	1.9	23.5	79.2	3	21.2
51.	28	F	2M2	2M1	77.9	0.9	19.9	76.5	1.7	24.6
52.	26	M	2M2	2M2	78.3	1.2	26	78.6	1.3	23
53.	22	F	2M1	1M1	75.8	0.7	13	83.3	1.8	15.2
54.	20	F	2M1	2M1	77.4	0.9	14.8	74.6	1.2	13.6
55.	28	F	2M1	1M1	76.4	1.3	17.2	81.3	1.9	16.5
56.	29	M	2M2	2M2	78	1.6	15.2	77.3	1.3	13.7
57.	25	F	2R2.5	2R1.5	79.7	1.8	22.8	79	0.9	21.3

58.	19	F	1M1	1M1	84.3	1.5	13.4	84.6	1.7	14.3
59.	19	M	2M2	2M2	78.3	1.2	26	78.6	1.3	23
60.	20	M	2R2.5	2R1.5	79.9	1.9	22.6	79.3	1.1	22
61.	19	M	2M2	2M1	77.5	1.2	17	75	1.8	13
62.	29	M	1M1	1M1	84.3	1.5	13.4	84.6	1.7	14.3
63.	20	F	2M3	2M2	78.5	0.7	25.3	77.5	1.2	17
64.	24	F	2M1	2M1	74.6	1.2	13.6	78.8	3.6	14.6
65.	23	M	2M2	2M1	76.8	1.4	18	76	1.6	15
66.	29	F	2M1	2M1	78.3	2.8	16.2	78.8	3.6	14.6
67.	28	M	2M2	1M1	78.6	1.3	23	84	0.7	14
68.	26	M	2M2	2M1	77.9	0.9	19.9	78	3	14
69.	22	F	2M2	2M2	77.9	1.6	25.8	78.4	1.7	23.8
70.	20	F	2M2	1M1	81	2.2	15.3	84	0.7	14
71.	28	M	2M2	2M1	77.6	1.3	16.5	74.7	1.5	14.2
72.	29	F	2M2	2M1	77.4	2	17.6	74.3	1.8	13.8
73.	25	M	2R2.5	2R1.5	80	2	22.7	79.5	1.5	22
74.	19	F	2M2	2M1	76.8	2.2	18.2	76.3	2	14.3
75.	20	M	2M2	2M1	77.5	1.2	17	75	1.8	13
76.	22	F	1M2	1M1	84	0.2	18	84	0.7	14
77.	21	F	2M3	1M1	79.7	1.8	25.6	84	0.5	15
78.	29	M	2M2	2M2	78.4	1.6	26.7	78.6	1.3	23
79.	20	M	2M2	1M1	78.6	1.3	23	84.6	1.2	15.2
80.	24	F	2M2	2M1	77.3	1.3	16.8	75.3	1.8	13.6
81.	23	F	2L1.5	2L1.5	84.6	2.7	25.4	79.5	2.4	18.7
82.	29	M	2L2.5	2L1.5	79	2.6	18.5	84.3	2.2	25.7
83.	28	M	2M2	2M1	78.6	1.3	23	78	3	14
84.	26	M	2M3	1M1	79	1.4	25	84.6	1.7	14.3
85.	22	F	2M1	2M1	78.4	3	14.5	79	3.2	13
86.	20	F	2M2	2M2	78.3	1.2	26	78.6	1.3	23
87.	28	M	2M3	2M1	79.2	1.3	25.6	79.5	3.3	13.5

88.	29	F	2M2	2M1	77.4	1.3	16.8	75.6	1.6	13.4
89.	25	F	2M2	2M2	78.3	1.2	26	78.6	1.3	23
90.	19	M	2M1	2M1	78.4	3	14.5	79	3.2	13
91.	18	M	2M2	1M1	76.8	2.2	18.2	84	0.7	14
92.	22	F	2M1	2M1	78.6	3.4	14.6	79.3	3.4	13.4
93.	28	M	2M2	2M1	78.4	1.4	17.6	75.6	1.7	13.2
94.	29	M	2M2	1M1	76.8	0.9	16.3	84.6	1.1	14.2
95.	25	M	2R2.5	2R1.5	80.2	2.2	22	79.5	1.5	22
96.	19	M	2M1	2M1	78.4	2.8	14.4	79.2	3.4	13.7
97.	19	F	2M2	2M1	77.7	1.3	17	75	1.8	13.5
98.	20	M	2M2	2M1	77.2	1.7	17.6	75.3	1.7	13.2
99.	23	F	2M2	2M2	78.2	1.6	26.8	79	1.8	23.5
100.	26	M	2M2	2M1	76.8	0.9	16.3	75.6	1.6	12.8

PARTICIPANT INFORMATION SHEET

Title of the study: “CORRELATION BETWEEN NATURAL TOOTH SHADE AND SCLERAL SHADE USING VITA 3D-MASTER SHADE GUIDE AND DIGITAL PHOTOGRAPHY”

Name of the research institution:

TAMILNADU GOVERNMENT DENTAL COLLEGE & HOSPITAL, CHENNAI-03

1. Purpose of the study:

The purpose of this study is to correlate the shades of natural tooth and sclera using vita 3d-master shade guide and digital photography

2. Procedures:

1. Patient selection.
2. Obtaining thorough history and informed consent.
3. Assess the natural tooth shade using vita 3d-master shade guide
4. Assess the natural scleral shade using vita 3d-master shade guide
5. Assessing tooth shade and scleral shade using digital photography
5. Compare the correlation between the natural tooth shade and scleral shade

3. Risk of participation and protection:

Protection: Standard guidelines for radiation protection will be followed.

4. Benefits:

Scleral shade can be used as a valuable shade indicator for tooth shade selection and vice versa. This will be extremely helpful in patients undergoing full mouth restoration and in maxillofacial prosthetics. This can also be helpful in forensic odontological investigations.

5. Confidentiality:

The identity of the patients participating in the research will be kept confidential throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

6. Participant's rights:

Taking part in the study is voluntary. You are free to decide whether to participate in the study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

7.Compensation: nil

8.Contacts for queries related to the study:

ஆராய்ச்சிப் பற்றிய தகவல் படிவம்

1. பல் மற்றும் விழி வெண்படல நிழற் சாயலை **வட்டா 3டி மாஸ்டர் நிழற் சாயல் வழிகாட்டி மற்றும்** எண்ணியல் படக்கருவி கொண்டு ஒப்பிடுதல்.
2. நோயாளி பற்றிய குறிப்புகள் பிறர் அறியா வண்ணம் ஆராய்ச்சி முடியும் வரை இரகசியமாக பாதுகாக்கப்படும். அதை வெளியிடும் நேரத்தில் எந்த நோயாளியின் தனி அடையாளங்களும் வெளியிட வாய்ப்பு கிடையாது.
3. இந்த ஆராய்ச்சியில் பங்கு பெறுவது நோயாளியின் தனிப்பட்ட முடிவு மற்றும் நோயாளிகள் இந்த ஆராய்ச்சியில் இருந்து எப்போது வேண்டுமானாலும் விலகிக் கொள்ளலாம். நோயாளியின் இந்த முடிவிற்கு அவருக்கு அல்லது ஆராய்ச்சியாளருக்கு எந்த பாதிப்பும் ஏற்படுத்தாது என்பதை தெரியப்படுத்துகிறோம்.
4. இந்த ஆராய்ச்சி முடிவுகள் நோயாளிகளுக்கு ஆராய்ச்சி முடியும் தருவாயிலோ அல்லது இடையிலோ தெரிவிக்கப்படும். ஆராய்ச்சியின்பொழுது ஏதும் பின் விளைவுகள் ஏற்பட்டால் அதை சரி செய்ய தகுந்த உதவிகள் அல்லது தேவையான சிகிச்சைகள் உடனடியாக மேற்கொள்ளப்படும்.

நோயாளியின் பெயர் கையொப்பம் / கை ரேகை

முதன்மை ஆய்வாளர்
தமிழ்நாடு அரசு பல் மருத்துவக்கல்லூரி,
சென்னை – 600 003.

TAMILNADU GOVT. DENTAL COLLEGE AND HOSPITAL CHENNAI 3

DEPARTMENT OF PROSTHODONTICS & CROWN AND BRIDGE

Investigator: Dr.Francilin F **Guide:**Dr.A.Meenakshi .,M.D.S

INFORMED CONSENT FORM

STUDY TITLE "CORRELATION BETWEEN NATURAL TOOTH SHADE AND SCLERAL SHADE USING VITA TOOTHGUIDE 3D-MASTER SHADE GUIDE AND DIGITAL PHOTOGRAPHY"

Name : Mr/Ms _____

Address: _____ SEX : Male /Female

_____ AGE : Years

_____

I, _____, exercising my free power of choice, hereby give my consent to include myself as participant in the study.

I agree to the following:

1. I have been informed to my satisfaction about the purpose of the study and study procedures. I agree to co-operate fully for complete examination.
2. I hereby give permission to use my medical records for research purpose.
3. I am told that the investigating doctor and the institution will keep my identity confidential.
4. I understand that I have rights to withdraw from the study and also that the investigator has the right to exclude me from the research at any point of time.

Name of Participant: Investigator:

Date: Signature/ Thumb impression of

Parent/Guardian

இணைப்பு -III

வரிசைஎண் :

தமிழ்நாடு அரசு பல் மருத்துவக் கல்லூரி மற்றும் மருத்துவமனை-சென்னை 3

செயற்கை பல்கட்டும் பிரிவு
ஆராய்ச்சி ஒப்புதல் படிவம்

ஆராய்ச்சியாளர்: மரு. பிரான்சிலின். பி வழிகாட்டி: பேராசிரியார். மரு. அ.மினாட்சி, எம்.டி.எஸ்.,

பல் மற்றும் விழி வெண்படல நிழற் சாயலை வீட்டா 3டி மாஸ்டர் நிழற் சாயல் வழிகாட்டி மற்றும் எண்ணியல் படக்கருவி கொண்டு ஒப்பிடுதல்.

பெயர் திரு/திருமதி..... புற நோயாளியின் எண் .....

முகவரி: ..... பாலினம்:ஆண்/ பெண்

..... வயது:

.....

நான் ..... என்னுடைய சுயநினைவுடனும் மற்றும் முழுசுதந்திரத்துடனும் என்னை இம்மருத்துவ ஆராய்ச்சியில் சேர்த்துக் கொள்ள ஒப்புதல் அளிக்கிறேன்.

1. இந்த ஆராய்ச்சியின் நோக்கம் மருத்துவமுறைகள் மற்றும் பரிசோதனைமுறைகள் குறித்த விளக்கங்கள் அனைத்தும் எனக்கு திருப்திதரும் வகையில் அளிக்கப்பட்டன.
2. இந்த ஆய்வுக்காக என் பல் மற்றும் விழி வெண்படலத்தை நிழற் படம் எடுக்க சம்மதிக்கிறேன்.
3. இந்த ஆராய்ச்சிக்கு தேவையான முழுமையான பரிசோதனைக்கு ஒத்துழைக்க சம்மதிக்கிறேன்.
4. நான் ஏற்கனவே உட்கொண்ட மற்றும் உட்கொள்கிற மருந்துகளைப் பற்றிய விவரங்களைஆராய்ச்சியாளரிடம் தெரிவித்துள்ளேன்.
5. மருத்துவரின் ஆராய்ச்சிற்கு தேவைப்படும்பொழுது மீண்டும் மருத்துவ ஆய்விற்கு கண்டிப்பாக ஆராய்ச்சியாளரிடம் வர சம்மதிக்கிறேன்.
6. எந்த ஒரு நிலையிலும் நான் இந்த ஆராய்ச்சியிலிருந்து விலகுவதற்கும் அல்லது மருத்துவ ஆராய்ச்சியாளருக்கு என்னை விலக்குவதற்கும் முழு உரிமை இருப்பதாகவும் அறிகிறேன்
7. என் மருத்துவக் குறிப்பேடுகளை இந்த ஆராய்ச்சியில் பயன்படுத்திக்கொள்ள சம்மதிக்கிறேன். இந்த ஆராய்ச்சி மையமும் ஆராய்ச்சியாளரும் என்னுடைய விவரங்கள் அனைத்தையும் இரகசியமாகவைப்பதாக அறிகிறேன்.
8. எனக்கு படிக்கதெரியாததால், மேலே உள்ளஅனைத்தையும் கூறக்கேட்டேன்.

பெயர் கையொப்பம்/ கைரேகை

தேதி

ஆராய்ச்சியாளர் தேதி