With ever increasing emphasis on esthetics in dentistry, and patient demands to fabricate ceramic restorations that mimic natural teeth that are indistinguishable from adjacent natural teeth, the ability to evaluate tooth shade information correctly, and communicate it to the ceramist effectively is now more critical than ever. Esthetics is the science of beauty and is a branch of philosophy concerned with the perception of beauty and unattractiveness. In 1984, Goldstein and Lancaster [1] conducted a survey to study patient attitudes toward current esthetic dental treatments, reasons for selecting dental procedures and their satisfaction with their smile. General esthetic dissatisfaction was found among patients, indicating the need for improved esthetic dentistry. Color is probably the most important determinant of esthetics in prosthodontics. Color measurement is a very complicated process, as color cannot be literally measured by any device, as it is essentially a subjective sensation. What one can do is describe a color in idealized and standardized terms using numbers that correlate with what is perceived. In 1990, Van der Burget and others [2] reported visual and instrumental methods to evaluate color. Visual color determination by comparing the patient’s tooth with a color standard (shade guides) is the most frequently applied method in clinical dentistry for color communication with dental technicians. Shade taking devices are designed to aid clinicians and technicians in the specification and control of tooth color. [3] The shade taking devices are based on the principles of colorimeters, digital cameras as filter colorimeters, spectrophotometers, and spectroradiometers. [1] Visual shade selection is the most common method of color determination in dentistry, but color duplication via this process is plagued by unreliable and inconsistent result. [1] Clinically, there is difference in the readymade shade guides available and the porcelain fired for metal ceramic crowns after selecting the shade from the guide. Most brands of porcelain are labeled to match shades of the Vita shade guide, but produce slightly different colors from this guide upon firing. There have been a number of recent technologic and material advances that offer potential to improve color matching skills in prosthetic dentistry. [2] Hence, a study was designed to compare the color of a custom-fabricated ceramic sample of C2 and D2 shades of Vita.

**ABSTRACT**

**Introduction:** Smile is one of the most important interactive communication skills of a person. A smile is the key factor for an aesthetic appearance. Hence aesthetics is one of the motivating factors for the patients to seek dental care. Correction of unaesthetic appearance gives a positive effect to the self esteem of the patient. **Aim:** The aim of this study was to compare the difference in the shade between the commercially available shade guides namely Vita Classical And Ivoclar Chromascop and the fired porcelain samples fabricated using Vita Zahnfabrik VMK 95 and Ivoclar Classic Materials respectively. **Objectives:** The objective of this study was to obtain a matching brand of material that has a particular shade tab among the brands used. **Conclusion:** To conclude, Ivoclar material matched the chromascop shade guide better than the vita material matched the vita classic shade guide.

**KEY WORDS:** Shade matching, shade tabs, zirconia
classic and Ivoclar classic ceramic material samples fabricated to manufacture’s specifications to a Vita classic shade guide and Ivoclar Chromascop.

The development of CIELAB helps in the quantification of the shade duplication process. The color difference of two objects can be determined by comparing the difference between respective coordinate values for each object. When color is measured and specific color differences are identified, the CIELAB system is frequently used. In 1931, the Commission Internationale de L’Eclairage (CIE) defined a “standard observer” by a set of three functions \( x(\lambda), y(\lambda), \) and \( z(\lambda) \). These were carefully prescribed spectral sensitivity curves designed to model blue, green, and red sensitive cone receptors of the eye, respectively. These functions are the key to transformation of spectral energy data into meaningful color data.

Visual shade matching is the most used method of selecting shade for crowns from the shade guides available in the market.

The purpose of this study is to evaluate the difference in the shades between the shade tab and fired porcelain. Instrumental color measurement has the advantage of obviating the subjective aspects of color assessment and expediting the determination of color; so, a spectrophotometric evaluation is done.

**Aims and objectives**

**Aim**

The aim of this study was to evaluate the difference in the shade between the readily available shade guide namely vita classical and Ivoclar Chromascop, and the fired and glazed porcelain samples fabricated using VITA VMK 95 and Ivoclar classic materials, respectively.

**Objectives**

The objectives of this study were to obtain the mean difference in color between the vita classical shade guide and samples fabricated using VITA VMK 95 and to obtain the mean difference in color between the Ivoclar Chromascop shade guide and samples fabricated using Ivoclar classic.

The objective of this study was to obtain a matching brand of material that has a particular shade tab among the brands used.

**Methods**

The samples were made from specific form, size, and were of the suggested dimensions from investing self-cure acrylic strips made using a metal mold [Figures 1 and 2], to casted NiCr specimens\(^\text{[5]}\) using laser technology so as to get exactitude of normal dimensions. The metal substructure was made from nickel Cr alloy [Figure3]. The size of the specimens were 20 mm long, 10mm breadth on one aspect and 3 mm breadth on the opposite aspect, of a preset form and 1.5 mm thick. To work out the thickness of the porcelain layers, 2 templates namely -the dentin template [Figure 4] and also the enamel template [Figure 5] were used. A complete of eighty samples were fabricated. The samples were divided into 2 groups.

Group 1 consisted of 40 samples in which every twenty samples were sub grouped and utilized for VITA ZAHNFABRIK VMK 95 ceramic powder shade C2, D2.

Group 2 consisted of 40 specimens in which every twenty samples were sub grouped and utilized for IVOCLAR - CLASSIC ceramic powder shades of C2, D2.
Procedure for addition of porcelain layers

Two layers of opaque of individual manufacturer recommendations were applied to all the nickel-chromium specimens using brush on technique [Figure 3] and fired which amounts to an approximate thickness of 0.1 mm adequate to mask the metal.[6]

The dentin porcelain powder of shade C2 of Ivoclar classic was mixed with the modeling liquid, and applied onto the nickel chromium metal substructure over the opaque layer in the 20 specimens placed inside the depression in the dentin metal template[7,6] [Figure 6]. The slurry of dentin porcelain was condensed using the custom made covering lid for the metal mold [Figure 7], to a predetermined thickness of 0.7 mm.[8,9] Likewise, 40 specimens were finished with Ivoclar classic porcelain material, and another 40 specimens were finished with vita zahnfabrik VMK95 porcelain material. Thus, a total of 80 samples were fabricated. For standardization 10 samples were fired at one time[Figure 8].

Measurement of color

Color research continued to evolve based on the Munsell color model. In 1976, the CIE, an international color research group founded in 1931, published the CIELAB color system. In this three-dimensional color system, L* refers to brightness (0–100), a* represents red (+a*) versus green (−a*), and b* indicates yellow (+b*) versus blue (−b*). When a* and b* are zero, the L value represents the continuum of black to white. The CIELAB model offers some advantages over other color models. The L*a*b* color space was designed to correlate with perceptions of color. This allows the CIELAB system to measure color differences that are meaningful in industrial applications.

Since the development of the original 1976 CIELAB color system, several refinements have been made to make the color space more visually uniform. These versions are known as the CIELAB 94 and CIEDE 2000 models.[12]

The CIELAB model offers more advantage than the Munsell system. The color coordinates of each of the 80 specimen were measured with a spectrophotometer (MINOLTA CM 3600d, JAPAN) set to the standard illumination source D65 with a 2-degree observation angle according to the CIE recommendation. The data were displayed in L*, a*, and b* values according to the CIELAB system. Shades of the control specimen, i.e., shade tab of C2, D2 shades of VITA CLASSICAL [Figure 9], and IVOCLAR CHROMASCOP [Figure 10] was evaluated spectrophotometrically. Before each measurement session, the spectrophotometer was calibrated according to manufacturer’s recommendations by using the supplied white calibration standard. The spectrophotometer calculated the mean color measurement of all the eighty specimens. The mean and standard deviation estimated from the specimen of each subgroup was statistically analyzed. Mean values were analyzed by one-way analysis of variance. A standardized t-test was done to compare the two brands of ceramic to the shade guide, and the results were statistically analyzed.

Statistical analysis

In this study, there are two main groups to be compared to the standard specimen so the standard t-test was used. Mean color difference for VITA C2 samples ranges from 2.8 to 5.0, with a mean
of 3.4 and IVOCLAR C₂ samples ranges from 2.1 to 3.7 with a mean of 2.6 [Table 1]. Mean color difference for VITA D₂ samples ranges from 2.5 to 3.5, with a mean of 3.2 and IVOCLAR D₂ samples ranges from 1.9 to 2.8 with a mean of 2.9 [Table 2].

It can be inferred that from the above statistical analysis, Ivoclar samples matched the standard IVOCLAR CHROMASCOP SHADE TAB better than the VITA group.

Results

All the forty samples fabricated using the VITA material and the corresponding two shade tabs from the VITA classical shade guide were spectrophotometrically analyzed. After statistical analysis, the following inference was obtained.

Mean color difference for VITA C₂ and VITA D₂ is 3.2

All the forty samples fabricated using the Ivoclar material and the corresponding four shade tabs from the Ivoclar Chromascop shade guide were spectrophotometrically analyzed. After statistical analysis, the following inference was obtained.
analyzed. After statistical analysis, the following inference was obtained.

**Mean color difference for Ivoclar C2 and IvoclarD2 is 2.7**

Within the limitations of the study, the obtained results showed that the samples fabricated using Ivoclar material had the least mean color difference [Tables 3 and 4]. Hence, Ivoclar samples matched the chromascop shade guide better than the VITA samples matching the vita classical shade guide.

**Discussion**

Esthetics is the study of beauty. Knowledge of esthetics helps the dentist achieve a pleasing appearance of effect. Esthetics is the primary motivating factor for patients to seek dental care. In fact, corrections of esthetic problems have a positive effect on the self-esteem. A smile has been said to be one of the most important interactive communication skills of a person. The ultimate objective of esthetics in dentistry is to create a beautiful smile, with teeth of pleasing inherent proportions to one another, and a pleasing tooth arrangement in harmony with the gingiva, lips, and face of the patient. In addition, color is complex and encompasses both subjective and objective phenomena. The phenomenon of color is a psychophysical response to the physical interaction of light energy with an object, and the subjective experience of an individual observer. Three factors can influence the perception of color, namely, the light source, the object being viewed, and the observer viewing the object.[13] The light source can emit radiant energy of a range of wavelengths, and this is characterized by the relative amount of energy emitted at each wavelength in the visible spectrum. The light source that illuminates an object affects color perception, since individual sources contain varying quantities of each of the visible wavelengths of light. The spectral reflectance (or transmittance) of an object characterizes the color makeup of that object.

Problems identified were that porcelains do not match the shade guides to which they are compared and shade variations exist between different lots of porcelain from the same manufacturer.[14,15] Hence, it was suggested that a custom shade guide could minimize these problems. The following difficulties were reported with the fabrication of custom shade guide: (1) The problem of matching a thin piece of porcelain to a shade guide several millimeters thick, (2) the variations of ceramic powder batches that do not match the shade guide consistently, and (3) the difficulty of predicting the final color of the typical layered veneer of opaque, dentin, and enamel.[16] The study results and outcome also come close to those of earlier studies by van Der Burgt et al. The significance of the interaction indicates that some shades produced better match with some brands. In this study, Ivoclar showed lowest AE compared to Vita shades. The inadequacies of dental shade guide in terms of range and systematic distribution in the tooth color phase have been described. Significant advances in the shade guide organization and coverage of natural tooth color space arrangement of “virtually all existing natural tooth shades”[15] need to be researched and developed for the future of prosthodontics outcome. On comparing the intragroup P values of the various shades evaluated from the Table 1, the shade of C in the samples fabricated using IVOCLEAR material was found to be more close to the IVOCLEAR CHROMASCOPE shade guide comparing to the other shades of IVOCLEAR B2, C2, D2 with the Ivoclar Chromascop shade guide.

**Conclusion**

On spectrophotometric color analysis the mean color difference between the Ivoclar samples were lower than that of the vita samples. Therefore the samples fabricated using Ivoclar classic matched the Ivoclar Chromascop shade guide closely than the samples fabricated using the vita zahnfabrikVMK95 material matched the vita classical shade guide.

To conclude, Ivoclar material matched the chromascop shade guide better than the vita material matched the vita classic shade guide.

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**Conflicts of interest**

There are no conflicts of interest.

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