

The Perfect Match: Recent Advances in Shade Matching

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ABSTRACT:- Shade matching involves a delicate balance between managing realistic goals against personally held expectations. Consistent and correct shade selection is fundamental to the placement of aesthetic restorations which are an essential part of everyday practice.

This article reviews various recent technologic advances to provide excellent shade-matching results and esthetics.

Keywords:-

I. INTRODUCTION

Esthetics is the primary concern for patients seeking prosthetic treatment. According to Young “it is apparent that beauty, harmony, naturalness, and individuality are major qualities of esthetics” [1]. With a beautiful smile, people tend to feel good about the mselves.

The dentist should know the language of color and light characteristics to accurately convey the information to the laboratory [2]. Shade matching is science and art combined.

Various shade selection techniques are summarized and a method for choosing the appropriate shade from the guidelines is given. The scientific principles and evidence-base behind the new technique are elaborated. The advantages and problems of instrumental shade-taking devices are reviewed. This helps consumers to perceive an attractive smile which is a necessary part of a confident presentation of the mselves.

II. HISTORY

Albert Henry Munsell in 1915 created an orderly numeric system of color description that is still the standard today. In this system color is divided into three parameters—hue, chroma, and value (AH.Munsell, 1969).Munsell color system showing a circle of hues, and levels of value and chroma. The term “Hue”is synonymous with the term “color” and is used to describe the color of a tooth or dental restoration. With aging, variations in hue often occur because of intrinsic and extrinsic staining from restorative materials, foods, beverages, smoking and other influences (Aschheim, 2015).

Chroma is the saturation or intensity of hue; therefore it can only be present with hue. Value is the relative lightness or darkness of a color. A light tooth has a low value. Value is the most important factor in shade matching. If the value blends, small variations in hue and chroma will not be noticeable (Preston JD,1980).To compare the color match between a restoration and tooth, value is generally considered the most challenging of the three dimensions of color.

Dental Shade Guides

A shade guide is used for accurately determine the shade of a tooth. The introduction of the three-dimensional Munsell Color Order System would be a boon to dentistry and to the color matching of ceramo-metal restorations.

Clark shade guide (Tooth color indicator): A shade guide was developed in porcelain by Clark 60 years ago.

There was 60 tabs in the Clark guide. In 60 tabs - 3 basic hue, 19 value, 6 chroma. According to him, “Value” is the important dimension to control [4].

Spectatone: used 12 hues, but the shade guide had only every other hue represented. The missing hues could be selected by interpolation. Once the closest hue was selected, the viewer had 36 value and chroma variations of this hue. Since there were 6 hues, a total of 256 selection tabs were available, and an additional 256 tabs could be created by interpolation. The system enabled the viewer to move about in the color space to every hue, value,

and chroma needed to achieve the closest match to the tooth being replicated. Even though the initial consideration of 256 tabs seemed overwhelming, the guide was simpler and more effective than the illogically ordered systems having fewer tabs [5].

VITA Shade guide (VITAPAN CLASS-I): Introduced in 1956, it is a very popular shade guide : Tabs of similar hue are grouped into letter groups like: A (hue of red-yellow) - A1, A2, A3, A3.5, A4 B (hue of yellow) - B1, B2, B3, B4 C (hue of gray) - C1, C2, C3, C4 D (hue of red-yellow-gray) - D2, D3, D4 Chroma is designated with numerical values 1, 2, 3 and 4 (Fig 1).



Fig 1

Vita pan 3D-Master Shade Guide: The manufacturer of this recently introduced shade system which covers the entire color space (Figure 2). It was introduced in 1998 and reflects distribution of tooth shades in nature. There is systematic and equidistant coverage of the natural tooth shade spectrum [6, 7]. The shade sample are grouped in six lightness levels, each of which has chroma variations in evenly spaced steps. The shade is spaced in steps (ΔE) of CIELAB 4 units in the lightness dimension and 2 CIELAB units in the hue and chroma dimensions [8].



Fig 2

Two types of shade guides are available for shade selection in Vitapan 3D master shade guide –

- Vitapan 3D master tooth guide (blue chips) – vita 3D master tooth guide features fired porcelain shade samples built up with cervical, dentine, incisal powders as known to you from most conventional shade guide.
- Vitapan 3D master color guide (red chips) – in contrast to Vitapan 3D master tooth guide porcelain sample contain dentin color without cervical, incisal distinction used to determine basic body color help to see value, chroma, hue in each third that do not match gradations of color in blue chips.

The 3D master is based on the value system rather than grouping the shade by hue as in vita classical and Chromascoplvoclar, Vivodent. The tabs arranged in 5 value level. Within each level tabs present different chroma, hue. Five levels cover that area of the CIELAB color solid occupied by natural teeth, with 50% of

natural tooth shades occupying middle value level. The highest value level has 2 chroma steps of single hue [9,10].

Visually optimal shade guide: Analoui., et al. (2004) designed an optimal shade guide with the use of a hierarchical technique [11]. The hierarchical clustering is a mathematical procedure for creating a sequence of partitions within a data set. In this method the similarity between all tooth samples in the population is computed. With the use of this hierarchical clustering method a series of shade guide was designed with varying number of tabs. From each shade guide the average error (Δe) between colors measured and the extracted teeth was computed. It was demonstrated that a hierarchical clustering can be used to design an optimal shade guide. without cervical, incisal distinction used to determine basic body color help to see value, chroma, hue in each third that do not match gradations of color in blue chips. Figure 4: VITA Lumin Shade guide

a. Dentin shade guides - When using a translucent all-ceramic system for a crown or veneer communicating the shade of the prepared dentin to the dental laboratory is helpful [12]. The system provides specially colored die materials that match the dentin shade guide and enable the technician to judge restoration esthetics.

b. Custom shade guide - Sometimes, certain teeth may be impossible to match to commercial shade samples. In addition difficulties may be encountered in reproducing the shade guides in the final restorations. The extensive use of surface staining has severe drawbacks, because the stains increase surface reflection and vent light from being transmitted through porcelain. One approach to this problem is to extend concept of a commercial shade guide by making custom shade guide [13]. An almost infinity number of samples can be made by using different Combinations of porcelain powders in varying distributions. However, the procedure is time consuming and is generally confined to specialty practice.

The fabrication of a custom shade guide, especially one having an expanded shade range can be very helpful. Although fabrication of such a guide is time consuming it provides a more realistic representation of what is achievable. Unlike most shade guides, a custom guide is made of the same material as the final restoration, thus reducing metamerism. Miller has recommended the addition of red (pink) modifiers to supplement the conventional guide in this area of the color space where such guides are lacking [14]

c. Modified shade guide - When a tooth closely approximates a specific shade selection tab, but has characterizations or deviations, those variations may be defined and communicated using a shade guide with the glaze removed and a set of dental surface colorants ("stains"). Airborne particle abrading using aluminum oxide is recommended to remove the glaze although this may also be done using emery discs. The colorant may be applied, and removed or modified until the proper effect is achieved [15,16].

Recent Advances

Advances in electronic technology have provided solutions for many of the current problems in shade selection and color matching in dentistry:

Advantage of Digital shade analysis

- a) Eliminates the subjectivity of color analysis and provides exact information for laboratory fabrication of the prosthesis.
- b) Influence is more objective, can be repeatedly verified.
- c) Not influenced by external factors like surrounding environment
- d) Involves less chair-side time.
- e) The quality control aspect is a real advantage. The technician can verify that the color replication process was accurate for the shade requested, and, with the more sophisticated systems, a "virtual try-in" can be accomplished.
- f) The reading can be translated to materials that can reproduce those characteristics in the fabricated restorations.

Currently Available Devices

- a. Shofu's Shade Chroma Meter
- b. The Vita Easyshade
- c. The ShadeScan
- d. ShadeRite Dental Vision System
- e. The Spectro Shade
- f. Clear Match System

Shofu's Shade Chroma Meter

This consists of a freestanding, hand-held contact probe which is about 3 mm in diameter. The probe is placed against the tooth, and an activation button is pushed. This sends a Hash of light to the tooth from the periphery of the probe, and the reflected light is transported through the center of the probe to the detector where

the collected light is evenly distributed through color filters that closely match the three standard observer functions [16]. Data are transmitted to the docking unit via an infrared signal. There is a database of porcelain samples stored in memory, and the closest match of the target with the stored data is presented. Readout is generated that includes the tooth number; the closest Vita Lumin shade guide designation; and specific opaque, body, and enamel powders.



Fig 3

The Vita Easyshade

It is a hand-held spectrophotometer that consists of a hand piece connected to a base unit by a monocoil fiber optic cable assembly. The contact probe tip is approximately 5 mm in diameter. It contains 19 1-mm-diameter fiber optic bundles. During the measurement process, the tooth is illuminated by the periphery of the tip, directing the light from a halogen bulb in the base unit into the tooth surface. Through this arrangement, spectral reflectance of the scattered light is essentially measured in 25 nm bandwidths.



Fig 4

The Shade Scan

It is a hand-held device with a color LCD screen to aid in image location and focus. Through a fiber optic cable, a halogen light source illuminates the tooth surface at a 45° angle and collects the reflected light at 0°. Light intensity and calibration to gray and color standards are continuously monitored and adjusted to provide consistent color reproduction. The image is recorded on a flashcard, obviating the need for a computer in the operatory.



Fig 5

The transmitted data can be downloaded to a computer with the Shade Scan software. Shade and translucency mapping can therefore be transmitted to the dental laboratory by e-mail or by including a printout or flashcard with the clinical items required for ShadeScan is in basic Vita Lumin shade designations. Higher-resolution shade mapping, additional shade guide designation conversions, and Hue/Value Chroma values are possible with additional software for dental laboratories

Shade Rite Dental Vision System

It is another instrument that combines digital color analysis with colorimetric analysis.



Fig 6

It consists of a hand-held device with its own light source, and an LCD screen facilitates positioning on the tooth. To focus and align the camera, a “glare spot” must be located at the junction of the gingival and middle thirds of the tooth. Measurements are taken through a series of rotating filters that simulate the CIE standard observer functions.

The Spectro Shade

It is the dental shade-taking device most complex in design and is the most cumbersome in terms of hardware. It is the only one that combines digital color imaging with spectrophotometric analysis.



Fig 7

It offers the most flexibility in terms of color analysis and colorimetric data and is by far the most expensive. The hand piece is relatively large compared with the contact probe designs.

Clear Match System

This is a software system that requires a Window platform PC and a digital camera. To properly calibrate the digital color signal, a black and white standard and a shade tab must be included in each photograph. The incisal edge is always pointed upward even if you are shooting the lower teeth. If the tooth is too posterior, choose a tooth that is more anterior that appears to be the same shade. Slant the Black and White standard toward the patient so the flash's reflection is on the gingival third of the shade tab. There should be no flash reflection in the middle of the shade tab. Use your digital camera to take the pictures. Take three pictures as one picture will usually be better than the other two. Also, take pictures prior to prep so the teeth are hydrated. Email the pictures to your lab or import the pictures into the software.

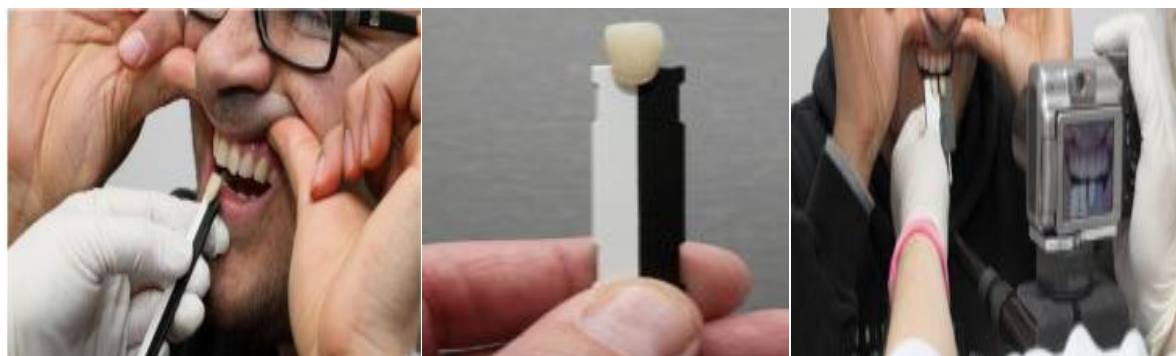


Fig 8

Display or print your original pictures along with shade maps. Also displayed is translucency. Detailed shade mapping is provided in shade guide designations, and standard and custom shade tab information can be entered into the system database. Because this system is software only, it is the most reasonably priced.

III. CONCLUSION

Attractive smile is a necessary part of a confident presentation of the mselves. It is a challenge for every esthetic dentist to determine and replicate the appearance of teeth, as it requires humility, patience and perseverance to mimic nature to its closest sense and form. Dental art does not occur automatically. It must be purposely and carefully incorporated into the treatment plan by the dentist.

REFERENCES

- [1]. M. Vasantha Kumar, S. C. Ahila, and S. Suganya Devi. The Science of Anterior Teeth Selection for a Completely Edentulous Patient: A Literature Review. *J Indian Prosthodont Soc.* 2011 Mar; 11(1): 7–13
- [2]. Fondriest J. Shade matching in restorative dentistry: the science and strategies. *Int J Periodontics Restorative Dent.* 2003; 23: 467-79.
- [3]. Ancovitz, Tony T, Haron R (1998) Texturing and polishing. The final attempt at value control. *DCNA* 42: 607-12.
- [4]. Duane RD, Jane BD (1998) Acceptability of shade differences in metal ceramic crowns. *J Prosthet Dent* 79: 254-60. 5.
- [5]. Philip WS, Nairn HW (1998) Shade selection for single-unit anterior metal ceramic crowns: A 5-year retrospective study of 2,500 cases. *Int J. Prosthodont* 11: 302-06. 6.
- [6]. Yap AU (1998) Color attributes and accuracy of Vita-based manufacturers' shade guides. *Oper Dent* 23:266-71.
- [7]. Duane D, Malgorzata P (1999) Predicting porcelain thickness required for dental shade matches. *J Prosthet Dent* 82: 143-9. 9.
- [8]. Sato R (1999) Using a computer color matching system in color reproduction of porcelain restoration. Color reproduction of porcelain samples. *Int Journal of Prosthodont* 6: 522-7. 10.
- [9]. Sato R (1999) Using a computer color matching system in color reproduction of porcelain restoration. A newly developed spectrophotometer for clinical application. *Int journal of prosthodont* 7: 50-5. 11. Yap AU (1999)
- [10]. Yap AU, Sim CP, Loh WL, Teo JH. Human-eye versus computerized color matching. *Oper Dent* 24: 358-63.
- [11]. Ancovitz, Tony T, Haron R (1998) Texturing and polishing. The final attempt at value control. *DCNA* 42: 607-12. 4.
- [12]. Duane RD, Jane BD (1998) Acceptability of shade differences in metal ceramic crowns. *J Prosthet Dent* 79: 254-60. 5.
- [13]. Philip WS, Nairn HW (1998) Shade selection for single-unit anterior metal ceramic crowns: A 5-year retrospective study of 2,500 cases. *Int J. Prosthodont* 11: 302-06. 6.
- [14]. Scott RO, Ali K, Richards MW, Childress S (1998) Evaluation of visual and instrument shade matching. *J Prosthet Dent* 80: 642-8. 7.
- [15]. Sato R (1999) Using a computer color matching system in color reproduction of porcelain restoration. A newly developed spectrophotometer for clinical application. *Int journal of prosthodont* 7: 50-5. 11.
- [16]. Sood S, Bhat V, Prasad D, Bhat A. Role of colors in prosthodontics: Application of color science in restorative dentistry. *Indian Journal of Dental Research.* 2011;22(6):804.

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