

Customized shade guide vs Traditional shade guide: A step towards explicit shade matching

Dhanya Gangadharan^{1*}, Anshida V P², Ashwini Santosh³, Adarsha MS⁴, Shivekshith A K⁵

^{1,2}Post Graduate Student, ³Associate Professor, ⁴Professor, ⁵Assistant Professor, Dept. of Conservative Dentistry and Endodontics, Vokkalighara Sangha Dental College and Hospital, Bangalore, Karnataka, India

***Corresponding Author: Dhanya Gangadharan**

Email: dhanyadent@gmail.com

Abstract

The demand for aesthetic restoration is a key factor in the placement and popularity of direct composites. New technologies have been implemented over a period of time in the shade matching of composites, which is more reliable than the conventional approach to date. Difficulty with rapidly evolving technologies and inflationary pressure due to increased costs can be the reason why most practitioners use the Vita classic shade guide as traditional method. These traditional shade guides are often manufactured according to the properties of porcelain materials rather than composite resin options.

Aim: This article compares the color difference (ΔE) between Vita classic shade tab and customized composite shade tab using spectrophotometric analysis for predictable shade matching in direct composite restorations.

Materials and Methods: In order to compare the customized composite shade tab (A1 and A2) with the regular Vita classic shade tab (A1 and A2), five A1 and A2 shade tabs were fabricated from two separate composite brands (AmelogenTM Plus-ULTRADENT, Coltene Brilliant) in order to obtain a total of twenty samples (n=5 each). The fabrication of the customized shade tabs was done using Smile line Style Italiano mini guide kit. All the twenty samples, (customized composite A1, A2 shade tabs) and the Vita classic A1 and A2 shade tab were subjected to spectrophotometric analysis using Data color 650 spectrophotometer to measure the CIE-Lab values. Based on CIE-Lab parameters obtained from computerized spectrophotometry digital reading of A1, A2 customized composite shade tab and A1, A2 Vita classic shade tabs, the Euclidean distance (ΔE) between two color points (composite-Vita classic) was calculated for the determination of color differences.

Conclusion: There was a perceptible color difference between the most commonly used Vita classic shade tab and the customized shade tab. Therefore, shade matching in direct composite restoration requires customized composite shade tabs to achieve predictable results.

Keywords: Shade guide, Spectrophotometer, Shade matching, Customized composite shade tab.

Introduction

Placing tooth-colored direct composite restorations is a clinical challenge even for the most experienced clinician. Apart from the flexibility of the process used in adhesive bonding, it can be extremely difficult to find a shade – whether single or layered – that reliably fits the natural tooth predictably and accurately.¹ Because of the great variety of natural color of the tooth, achieving a close match of shade with natural dentition is a complex process.²

Shade matching for most composite materials relies upon 1950s technology, ie, visual color determination using shade guides.¹ Here a patient's tooth is compared with a color standard shade guide.

But these color “standard” could vary due to the difficult-to-control parameters during fabrication (layering). In addition, no commercially available dental shade guides are made of commercially available dental composites and as such have different light absorption and reflective properties.³ For eg: A1 Vita Classic shade tab does not precisely match the A1 shade composites available in the market. Despite this lack, such shade guides still are the only “standard” upon which determination of color is based in dentistry.³

Some of the conventional shade guides designed to facilitate shade selection for various restorative procedures are often produced based on the properties

of porcelain materials rather than composite resins that can compromise the final result of restoration.⁴ Thus, custom composite shade tabs could be used as a method for consistent shade matching.

Among the different instruments to detect color, Spectrophotometers measure the full spectrum of reflected or transmitted light, converted afterwards into tristimulus data.⁵ In several studies, spectrophotometers have been used as a reference^{6,7,8} due to their sensitivity, accuracy and reproducibility.^{5,9} They provide readings from Commission Internationale de l'Eclairage (CIE) L*, a*, b* color space, where L* represents lightness (the amount of white and black within a color), a* is a measure of redness (positive a*) or greenness (negative a*) and b* represents the position on the blue (negative b*)-yellow (positive b*) axis.^{10,11} This color notation system is widely used in dental research for both in vivo and in vitro color measurements.¹²

In color research, the Euclidean distance between two color points (ΔE) remains one of the most important parameter needed in the determination of color differences.¹³ Delta E* was used in dentistry to establish clinical perceptibility thresholds¹⁴⁻¹⁶ and clinically acceptability thresholds¹⁶⁻¹⁸ after visual determination or instrumental measurement of tooth color coordinates.

There are no studies conducted to compare the color difference between traditional Vita classic shade guides and the customized composite shade guide. Hence the aim of the study is to compare the color difference (ΔE) between Vita classic shade tab and customized composite shade tab using spectrophotometric analysis.

Materials and Methods

A survey was conducted among a hundred dental practitioners in Bangalore to determine their expertise and the procedure they adopt on shade matching in direct composite restoration. The most common shade used by dental practitioners for direct composite restoration through this survey was A1 and A2.

In order to compare the customized composite shade tab (A1 and A2) with the regular Vita classic shade tab (A1 and A2), five A1 and A2 shade tabs were fabricated from two separate composite brands

(Amelogen TM Plus-ULTRADENT, Coltene Brilliant) in order to obtain a total of twenty samples. The fabrication of the customized shade tabs was done using

Smile line Style Italiano mini guide kit.

A small portion of enamel was placed in the first mould, then pressed with the help of the second mould, which actually presented a positive shape for dentin. It was lightcured to obtain a composite veneer from enamel material and then filled the hollow part of the veneer with the selected shade of dentin composite material. Finishing and polishing were done for all the customized composite shade tabs using Ultradent Jiffy composite finishing and polishing kit. All the twenty samples (customized composite A1, A2 shade tabs) and the Vita classic A1 and A2 shade tab were subjected to spectrophotometric analysis using Data color 650 spectrophotometer to measure the CIE-Lab values.



Fig. 1: Representation of customized shade tab and Vita classic shade tab.

Chi Square test (goodness of fit) was used to compare the distribution of responses to various questions provided by the study participants in the survey conducted among dental practitioners in Bangalore using Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released 2013. Armonk, NY: IBM Corp and the level of significance [P-Value] was set at $P < 0.05$.

Results

The survey showed that general dental practitioners lack awareness about the shade matching of direct restorations. For color matching in direct composite restoration, 80 percent of them used Vita classic shade tab, while only 11 percent used customized composite shade tab. Among practitioners, the most widely used

composite shade was A2 (56 percent) followed by A1 and B2.

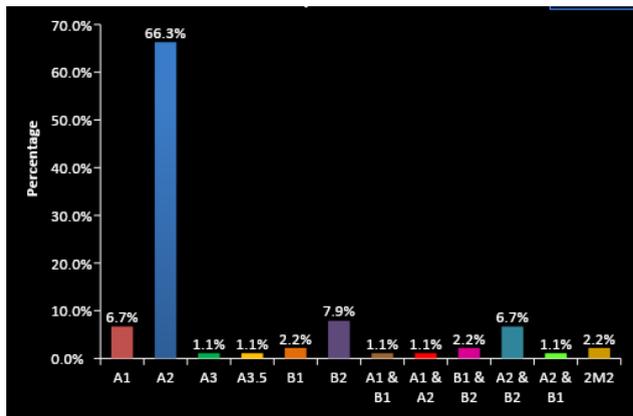


Fig. 2: Survey results showing most commonly used shade tab.

Based on CIE-Lab parameters (Commission Internationale de 'Eclairage, L = lightness, a = chroma along red-green axis, b = chroma along yellow-blue axis) obtained from computerized spectrophotometry digital reading of A1, A2 customized composite shade tab and A1, A2 Vita classic shade tabs, the Euclidean distance (ΔE) between two color points (composite-Vita classic) was calculated for the determination of color differences.

Color difference- ΔE (Ultradent-Vita classic) –A1 (7.64), ΔE (Ultradent-Vita classic) –A2 (8.25), ΔE (Coltene-Vita classic) –A1 (6.66), ΔE (Coltene-Vita classic) –A2 (7.39) value inferred that the color difference between the corresponding shade of the composite and Vita classic was perceptible at a glance.

Table 1: Delta E * values comparing customized shade guide and VITA classic shade tab

L1-Composite	L2-Vita Classic
ΔE Coltene-Vita Classic A1=6.66	ΔE Coltene-Vita Classic A2=7.39
ΔE Ultradent-Vita classic A1=7.64	ΔE Ultradent-Vita classic A2=8.25

Discussion

Shade selection is an important method of providing patients with an esthetic restoration that blends harmoniously with the existing dentition of the patient. Because of the great variety of natural tooth color, it is

a complex process to achieve a close shade match between an artificial restoration and natural dentition.² Innovations in restorative materials, bonding systems, and placement techniques have expanded the opportunities available for restoration over the past decade. Although these choices offered solutions to many of the clinicians ' aesthetic problems, issues associated with aesthetic color matching persisted.¹⁹ In 2014, Chu SJ²⁰ et al recommended a protocol for shade selection:

1. Remove bright color from the field of work. It is best to cover the patient with a neutral color bib (gray) if the patient is wearing bright clothing. Any dark lipstick color should be omitted as it may affect the matching shade
2. Always clean the tooth by using prophylaxis paste prior to shade selection
3. It is important not to look at the shade comparison for more than 7 seconds in order to avoid eye fatigue
4. During shade selection, the clinician should be 28-33 cm away from the patient.
5. Always determine the shade when the teeth are most hydrated, because the dehydration of the enamel reduces its translucency by 82%.
6. Shade comparison should always be made between 10 a.m. and 2 p.m., as the color temperature at this time is around 5500 K and then under color corrected light to ensure the accuracy of the match
7. Always place shade tabs above or below the tooth to match during the shade comparison, never place shade tab adjacent to the tooth to avoid binocular effect
8. The value is always analyzed first, followed by chroma and then hue.
9. Shade selection should not be made immediately after bleaching, patient should be recalled for shade comparison after 2-3 weeks.
10. The teeth should always be divided into 3 regions during shade selection. Always during shade selection teeth should be divided in 3 regions. Gingival area (provides accurate determination of dentinal chroma), Body area and Incisal area (enamel is thickest here and varies from translucent to transparent).

The survey conducted among dental practitioners in Bengaluru in the present study showed that VITA classic shade tabs are the most commonly followed shade guide for porcelain and direct composite restoration.

Although the conventional shade guide has been developed to promote shade selection for various restorative procedures, VITA classic shade tab is manufactured based on the properties of porcelain materials rather than options for composite resin.⁴ Furthermore, the color chosen in the ceramic shade guide shows little resemblance to the corresponding resin color that will be used in the restoration as the various commercial brands portray different shades for the same hue and chroma and can therefore be more or less identical to the color shown by the natural tooth and the ceramic guide.²¹

Using a custom-fabricated layered shade guide of polymerized resin and the accompanying composite system will help the clinician mimic natural color of the tooth. Such custom shade guides are matched with the same polymerized restorative material as the corresponding composite system that allows the clinician to compare the original polymerized composite with the natural color of the tooth for a more precise esthetic color match.⁴

Hence in the present study, customized composite shade tabs were fabricated from two different composite brands and the widely used Vita classic shade tab for evaluating the color difference.

A number of color measuring instruments are commercially available based on the principle of colorimeter and spectrophotometer. Spectrophotometers, generally, provide more systematic and precise measurements than colorimeters because of their ability to measure the amount of light reflected from objects throughout the visible spectra range.²²

Spectrophotometers, can provide readings from Commission Internationale de l'Eclairage (CIE) L*, a*, b* color space, where L* represents lightness (the amount of white and black within a color), a* is a measure of redness (positive a*) or greenness (negative a*) and b* represents the position on the blue (negative b*)-yellow (positive b*) axis.^{10,11} This color notation system is widely used in dental research

for both in vivo and in vitro color measurement.¹² However, color is described by CIE in terms of hue (h*), which is physically associated with the dominant wavelength of a color, value (L*), which indicates the lightness of a color measured on a scale from pure black (L*=0) to pure white (L*=100) and chroma (C*) which represents the amount or the intensity of hue of a given color.²³

In color research, the Euclidean distance between two color points (ΔE) remains one of the most important parameter needed in the determination of color differences. Delta E* is used in dentistry to establish clinical perceptibility thresholds¹⁴⁻¹⁶ and clinically acceptability thresholds¹⁶⁻¹⁸ after visual determination or instrumental measurement of tooth color coordinates.

The CIELAB color difference metric, ΔE, is calculated as follows (Lindbloom, 2017):

$$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Mokrzycki and Tatol, 2011 have given an interpretation for this Euclidean distance (ΔE)^{24,25}

Table 2: Interpretation of Delta E* values (after Mokrzycki and Tatol, 2011).

ΔE	Perceptual Characteristics
0 < ΔE < 1	Observer does not notice the difference
1 < ΔE < 2	Only experienced observer can notice the difference
2 < ΔE < 3.5	Inexperienced observer also notice the difference
3.5 < ΔE < 5	Clear difference in color is noticed
5 < ΔE	Observer notice two different colors

Hence in the present study, the color difference between customized composite shade tab and Vita classic shade tab were evaluated by subjecting through spectrophotometric analysis (Data color 650 spectrophotometric analysis). The Euclidean distance (ΔE) between two color points (composite-Vita classic) was more than 5 implying a perceptible color difference between the two.

Conclusion

Under the limitations of the study, it is concluded that there is a perceptible color difference between the most commonly used Vita classic shade tab and the customized shade tab. Shade matching in direct composite restoration, therefore, requires tailor-made composite shade tabs to achieve predictable results.

Source of Funding

None.

Conflict of Interest

None.

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