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Review

Color differences: Polymerized composite and corresponding Vitapan Classical shade tab

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ABSTRACT

Objectives: This study compared newer composite resin restorative materials to the Vitapan Classical tabs they purported to represent.
Methods: Five Vitapan Classical tabs were studied: A3.5, B2, C1, C3, and D2 ($n = 3$). These tabs created a variety of levels of lightness, chroma and hue. Each of these five shade tabs was removed from three different shade guides, and an intraoral spectrophotometer was used to capture CIELAB color coordinates. Three separate readings were made and all nine were averaged. The inter-tab color differences were also calculated. Five specimens approximately 4.0 mm thick were fabricated for each of the shades studied using five different composite resin materials. Composite specimens were of the same size and shape as target shade tabs, and three separate recordings were made for each of them. This average was compared to five Vitapan Classical shade tabs to calculate the color differences using both CIELAB and CIEDE2000 color difference formulas. Color differences were compared to thresholds for perceptibility and acceptability reported in other studies.
Results: CIELAB and CIEDE2000 color differences ranged from 3.9 to 22.8 and from 2.1 to 13.8, respectively. None of the materials proved, an acceptable CIELAB color match to any of the shades tested.
Conclusion: When various shade tabs of Vitapan Classical shade guides were compared with correspondent tabs made of direct restorative composites, no material/shade combination resulted in an acceptable mismatch relative to the used standard of acceptability. Therefore, evaluated resin composites exhibited poor match compared to target Vitapan Classical tabs.

1. Introduction

A composite restorative labeled as a match to a specific Vitapan Classical (Vident; Brea, CA, USA) shade tab tacitly claims to match a definable standard. Stated slightly differently, a restorative labeled as shade A3 ideally should not perceptually differ from the A3 tab on the Vitapan Classical shade guide. Similarly, restorative materials from different manufacturers labeled as A3 should match one another. However, several studies have demonstrated differences between commercially available composite restoratives despite the fact that each was presented as representing the same Vitapan Classical shade.[1–3]

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These studies only compared color characteristics from one brand of restorative to another. Although the studies demonstrated differences between the brands tested, the study design did not allow for comparisons to the standardized color representing that particular tab of the Vitapan Classical shade guide. Accordingly, these studies were not able to determine which, if any, of the brands accurately matched the corresponding tab.

The Vitapan Classical is in wide use and many composite systems base their shade selection on this guide. Having composite shades that match their purported tabs allows clinicians to stick with a system with which they are familiar. There is no need to fabricate custom guides from each composite restorative system used in the office. In addition, consistency from one system to the next allows practitioners to match a new restoration to an existing restoration using the shade recorded in the dental record.

Previous investigations have compared the shade of composite restorations relative to the shade guide included by the manufacturer.[4] One study compared the color match of composite resin restorative to their stated Vitapan Classical tab by having a wide variety of observers compare specimens to the appropriate tab.[5]

The primary purpose of this study was to compare color differences between several newer composite resin restorative materials with corresponding Vitapan Classical tabs. For the five shades tested, a spectrophotometer was used to establish values for each of the three components, and color differences were calculated using a new color difference formula: CIEDE 2000 ($\Delta E'$).[6,7] CIELAB color difference formula (ΔE^*_{ab}) were included for easier comparison with previous studies.

A secondary purpose was to compare the restorative materials to one another and to normal variation in color from one Vitapan Classical shade guide to another. This was done in order to assess which system(s) most accurately reflected the Vitapan Classical standards. The hypothesis that overall $\Delta E'$ values for one or more groups of composite tested were significantly higher or lower than the others was tested against the hypothesis that there were no differences. As an additional observation the correlation between $\Delta E'$ and ΔE^*_{ab} was investigated.

2. Methods and materials

2.1. Color measurements of Vita shade tabs

Five Vitapan Classical tabs were chosen: A3.5, B2, C1, C3, and D2. These tabs were chosen to create an array of specimens representing a variety of levels of lightness, chroma and hue (Table 1). Each of these five shade tabs was removed from three different shade guides. The guides were from 3 to 5 years old, had been used in a clinical research facility on a regular basis and had been gas sterilized after each use. These guides were chosen as opposed to brand new guides to increase the relevance of the project results to general practice.

Table 1 – CIELAB color coordinates of five Vitapan Classical shade tabs.

Vitapan Classical	L^*	a^*	b^*	C^*	h°
A3.5	73.4	1.7	26.5	26.5	86.2
B2	80.9	−1.9	20.6	20.7	95.1
C1	75.9	−0.7	15.9	16.0	92.6
C3	70.5	0.3	21.8	21.8	89.2
D2	73.8	−1.0	14.2	14.2	93.8

An intraoral spectrophotometer (Vita Easyshade; Vident; Brea, CA, USA) was used to establish the color standards. The Easyshade has two spectrometers positioned and activated in such a way as to provide for measurements of shallower or deeper structures. One spectrometer is positioned to confirm the color of porcelain in restorations at depths of 0.7–1.5 mm. The other spectrometer is positioned to measure tooth color at the dentin level. Because the Vita tabs have a thickness of approximately 3.5–4.0 mm in the middle-third, the Easyshade was used in tooth color mode. For both types of measurements specular light was excluded. Previous studies have cited the difficulty of measuring the color of shade tabs because the surfaces are curved and irregular.[1,2] The spectrophotometer used also includes an automated system for assuring proper positioning and angulation of the probe.[8] In addition, the specimens measured in previous studies were 2.0 mm or less in thickness,[2–5] while in the present study the specimens were 3.5–4.0 mm in thickness.

In this study, color was measured using CIELAB color notation system: L^* (lightness, ranging from 0 to 100 with higher numbers being brighter), a^* (green–red coordinate), b^* (blue–yellow coordinate), C^* (chroma, lower number—lower chroma), and h° (hue, e-specific color and is measured from zero to 360°: 0° is red, 90° yellow, 180° green and 270° blue). CIELAB values were subsequently converted into units of CIEDE2000 color notation formula.

Color measurements of the Vitapan Classical shade tabs were performed as follows: with the metal handle extending gingivally rather than incisally, the tab was held by the handle and the probe of the Easyshade was placed in the middle-third of the tab. Three independent measurements were made for

Table 2 – CIEDE2000 color differences and color coordinate differences between target Vitapan Classical tabs and composite tabs, by material.

Material[a]	Designation	Manufacturer	City	State
Esthet X®	EX	DENTSPLY Caulk	Milford	DE, USA
Filtek Supreme™	FS	3M ESPE Dental	St. Paul	MN, USA
Matrixx Anterior	MA	Discus Dental	Culver City	CA, USA
Point 4	PF	Kerr Corp.	Orange	CA, USA
Renamel™	RE	Cosmedent®	Chicago	IL, USA

[a] Where there was a choice of dentin, body or enamel shades the dentin shade was used.