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Original Research Article

Color variation between composite and vita classical shade guide

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Abstract

Introduction: The correct replication of color and translucency of the tooth structure is one of the biggest challenges in esthetic and restorative dentistry and mistakes in tooth shade selection may lead to failures in treatment. **Objective:** This study aim to evaluate, through CIEL * C * h * and CIEL * a * b * color systems, the difference between color of composite and Vita Classical shade guide, using the Vita EasyShade spectrophotometer. **Material and methods:** Four composite (Forma, Opallis, Oppus and Vittra) shade A2 were used. The specimens (n=6) were obtained using a steel matrix (4x2mm), then hydrated for 7 days and submitted to the finishing and polishing procedures; for subsequent color measurement with spectrophotometer. The color variation was calculated by measuring both color systems values of each material and comparing them with the Vita A2 shade guide results. The statistical analysis used was one-way ANOVA / Tukey test, considering a significance level of 5% ($p \leq 0.05$). **Results:** All materials showed color variation when compared to the shade guide. By the analysis of L*C* h*, all materials demonstrated a color variation greater than what is considered clinically unacceptable, whereas in the analysis of L*a*b* only Vittra APS resin composite showed a clinically acceptable color variation. **Conclusion:** The analyzed materials showed a great variation of color and the Vita Classical shade guide might not be in accordance to composite shade.

Introduction

Dental hard tissues are crystalline, heterogeneous, fluorescent and polychromatic structures that present different levels of translucency and opacity, requiring the examiner's visual acuity, in addition to adequate lighting conditions for color selection [5]. To reestablish the lost tooth structure, there are different materials, with composite and ceramics being the most used due to their physical, optical, mechanical and biological properties, which enables the reproduction of color, shape and texture, emulating the characteristics of the tooth [9, 20].

The correct replication of color and translucency of the tooth structure is one of the biggest challenges in esthetic and restorative dentistry [16]. However, human vision has some limitations to establish the correct shade of the tooth structure. Studies show that several factors can influence the subjective perception of color, such as age, experience, gender and visual problems [6, 7, 13, 14].

Mistakes in tooth shade selection may lead to failures in restorative esthetic treatment due to patient dissatisfaction. The use of complementary tools select shade can be used, such as standardized photographs and spectrophotometer [7, 13]. However, studies show that composite and ceramic do not match their shades to the Vita Classical shade guide [3, 5, 6, 9-11, 14].

Nevertheless, new deep cure low-shrinkage stress bulk fill composite has emerged, changing its opacity; along with new polymerization initiator molecules, different from yellowish camphorquinone, leading to variation in color behavior of current available composites [8, 18].

Thus, the aim of this study was to evaluate, through the CIE L*a*b* and CIE L*C*h* systems, the color difference (ΔE) of composite resins and Vita Classical shade guide, using the Vita EasyShade spectrophotometer.

Material and methods

Sample preparation

Samples (n=6) of four different commercial brands of A2 shade composite were made, resulting in 24 samples (table I). For the preparation of each specimen, a steel matrix with 4 mm in diameter and 2 mm in thickness was used. The composite resin was inserted into the metallic matrix and light-cured (Optilight LD Max, 600mW/cm^2; Gnatus, Ribeirão Preto, SP, Brazil) according to the manufacturer's recommendations. The samples remained submerged in distilled water for 7 days at room temperature. Subsequently, the finishing and polishing procedures were performed with Diamond Pro sandpaper discs (FGM, Joinville, SC, Brazil), from coarse (G), medium (M), fine (F) to extra fine (XF), applied for 10 seconds each.

Table I – Composite used, composition, batch and light curing time

Composite resin / Manufacter	Composition	Batch	Light curing time
Forma / Ultradent, Indaiatuba, SP, Brazil	Bis-GMA; Bis-EMA; TEGDMA; BHT; PEGDMA; UDMA; ytterbium trifluoride; fillers based on silane-treated ceramic, silane-treated silica, silane-treated silica-zirconium oxide, and barium glass	D05MV	20 s
Opallis / FGM, Joinville, SC, Brazil	Bis-GMA, Bis-EMA, TEGDMA and UDMA, CQ, coinitiator, silane, silanized barium-aluminum silicate fillers, pigments and silica	270617	20 s
Opus Bulk Fill / FGM, Joinville, SC, Brazil	UDMA monomers, coinitiator, photoinitiator, stabilizers, pigments, silanized silica and stabilizers	110918	40 s
Vittra APS / FGM, Joinville, SC, Brazil	Mixture of methacrylate monomers, photoinitiating composition (APS), coinitiators, stabilizers, silane, zirconia filler, silica and pigments	081217	20 s

Bis-GMA: bisphenol A-glycidyl methacrylate; Bis-EMA: bisphenol A diglycidyl methacrylate ethoxylated; TEGDMA: tryethilene glycol dimethacrylate; BHT: butylhydroxytoluene; PEGDMA: polyethylene glycol dimethacrylate; UDMA: urethane dimethacrylate; CQ: camphoroquinone

Color measurement

The color of the samples was measured with Vita EasyShade Advance 4.0 spectrophotometer (VITA Zahnfabrik, Bad Sackingen, Germany), using the systems defined by the CIE (Commission Internationale de l'Eclairage), CIE L*a*b* and CIE L*C*h.

In order to measure Vita Classical shade guide (VITA Zahnfabrik, Bad Sackingen, Germany), the A2 shade was submitted to spectrophotometer analysis using a customized acrylic matrix with a perforation located in the central region of the sample. Then, the composite resin samples were placed one by one onto a dental ceramic block (IPS e.max Press, Ivoclar Vivadent, A2 color, Low Translucency) to standardize the background of each sample. In all analysis, three color measurements were performed for each specimen and values for the L * a * b * and L * C * h systems were obtained.

The color variation (ΔE) in the CIE L*a*b* system was calculated by measuring the values of each material and comparing them with the values obtained in the measurement of the Vita A2 shade guide, using the formula:

$$\Delta E = [(L0-L1)^2+(a0-a1)^2+(b0-b1)^2]^{1/2}$$

The color variation (ΔE) in the CIE L*C*h system was calculated by measuring the values of each material and comparing them with the values obtained in the measurement of the Vita A2 shade guide, using the formula:

$$\Delta E = [(L0-L1)^2+(C0-C1)^2+(h0-h1)^2]^{1/2}$$

The values of L0, a0 and b0 relate to the shade guide data, while the values L1, a1 and b1; and L1, C1 and h1 correspond to the values of the composite measurements, respectively to each ΔE system.

Statical analysis

Data were submitted to One-way ANOVA test to identify statistical differences among ΔE means of the materials used in this study. To identify differences between groups, the Tukey test was used, considering a significance level of 5% ($p \leq 0.05$), using SigmaPlot 12.0 software (Systat Software Inc, Germany).

Results

Regarding Vita A2 shade guide data, the following values were obtained for the systems CIE L*a*b* (L = 80,2; a = 0; b = 1) and CIE L*C*h* (L = 80,2; C = 20,8; h = 87,8). As presented in table II, at the analysis of ΔE L*C*h*' values, all materials showed a greater color variation than what is considered clinically acceptable (ΔE L*C*h*≥3.3). Considering the ΔE L*a*b* analysis, only composite Vittra APS presented a ΔE considered clinically acceptable (2.57±0.22), and also the most similar color to its corresponding shade in the Vita Classical shade guide; while the Opus Bulk Fill had the greatest ΔE.

Table II –. Mean and standard deviation of the color variation of composite in the ΔE L*C*h* and ΔE L*a*b* scales, in relation to the Vita Classical shade guide

Material	ΔE L*C*h*	ΔE L*a*b*
Forma	7,43 ± 0,53 B	6,20 ± 0,59 C
Opallis	5,70 ± 1,47 A	5,71 ± 1,46 BC
Opus Bulk Fill	15,11 ± 1,01 C	10,28 ± 0,53 D
Vittra APS	4,30 ± 0,20 A	2,57 ± 0,22 A

Different letters show statistical difference between the composite resins within each analysis system

Discussion

Shade selection is a complex process, influenced by many variables. The International Commission on Illumination (CIE) in 1976 defined color spaces and parameters, in which L* represents value or luminosity, a* is related to the greenish-red content and b* to the bluish-yellow content [5, 15]. The advantage of this system is the fact that its spatial arrangement is three-dimensional and uniform, and also because different colors can be expressed in units related to visual perception and clinical meaning [1, 12, 17].

The graph formed inside a color sphere is based on the theory of opposite colors, which says that two colors cannot be green and red at the same time, nor blue and yellow. As a result, single values can be used to describe the red/green and yellow/blue attributes [2]. The ΔE in both CIE L*a*b* and CIE L*C*h* systems quantify the difference in color between two samples, in this case, the composite shade compared to its corresponding Vita Classical shade. When the ΔE is between 2 and 3, it is visible to the naked eye, but clinically acceptable. However, when exceeding the value of 3.3, this color difference is considered clinically unacceptable [19].

Corroborating the results of the present study, Dantas *et al*. [5] concluded that there is a considerable difference in shade among the brands

of composites and between composite shades and its corresponding Vita shade guide, regardless of the evaluation method used. Similarly, Pessôa *et al*. [15] through visual and photographic analysis, also found incompatibilities between different brands of composite and in relation to its corresponding color in the Vita Classical shade guide. Miranda *et al*. [12] report that composite did not appear the shade informed by the manufacturer when objective analyzed. This study also used spectrophotometer and visual evaluation in order to compare the composites from lighter to darker. It was shown that, for enamel and dentin composites, the result color matching is poor when compared to the reference shade guide [12].

The present study had some limitations, such as having used only a single shade scale, a single batch of each composite and a single material thickness. However, it is of great clinical significance because shade selection is a crucial moment before starting the restorative treatment, as it defines the esthetic result, which is often the parameter most used by patients to assess the quality of treatment, decisively influencing the judgment of the professional's competence [5]. The ceramic background used in the color measurements simulated a tooth preparation shade, standardizing it to allow comparation among groups.

Within this method, it was possible to identify that composite shade does not correspond to the reference shade of Vita Classical Shade Guide, except for Vittra APS composite in the CIE L*a*b* method. The Vita Classical shade guide is a method widely used by dentists and also recommended by composite manufacturers [19]. Therefore, the traditional shade selection should only be used as an approximate color reference, and shade final selection should be clinically confirmed at the time of the restorative procedure, for emulating dental structures. As an alternative to reduce this clinical difficulty, an International Organization for Standardization (ISO) for standardizing the color of composite resin composition could reduce color match errors among restorative materials and the remaining tooth or other teeth during restorative treatment. Another alternative would be the creation of a personalized color guide with the colors of the composite used in the clinical routine.

Conclusion

In the ΔE L*C*h* analysis, all materials showed a color variation greater than what is considered clinically acceptable. In the ΔE L*a*b* analysis, only the composite resin Vittra APS presented a clinically acceptable color variation. All materials studied showed a large color variation in relation to the Vita Classical shade guide.

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