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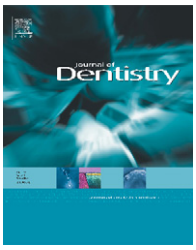

Shade distribution of indirect resin composites compared with a shade guide

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ARTICLE INFO

Article history:
Received 18 August 2008
Received in revised form
2 September 2008
Accepted 2 September 2008

Keywords:
Color
Color distribution
Indirect resin composite
Vitapan classical shade guide
Color difference

ABSTRACT

Objectives: To determine the distributions in color parameters of two brands of indirect resin composite (belleGlass NG: 16 shades; Sinfony: 26 shades), and to compare the color of these materials with the key shade guide (Vitapan classical shade guide).

Methods: Resin composites were packed into a mold and light cured with a light-curing unit, and then were post-cured in each proprietary curing chamber. Color was measured according to the CIELAB color scale on a reflection spectrophotometer. Color distributions were evaluated based on the value–chroma scale and the CIE a^*–b^* scale. Color differences between each shade material and the corresponding shade tab, and between each material and the nearest shade tab, which showed the smallest color difference, in the Vitapan classical shade guide were calculated.

Results: For both materials, the value–chroma distribution was mainly correlated with the shade groups in each material, not with the shade designations themselves. The CIE a^*–b^* distribution showed trends in each shade group for both materials. Compared with the Vitapan classical shade guide tabs, the range of color differences with the corresponding shade tab was 14.7–23.0 ΔE^*_{ab} units, all of which were perceptible ($\Delta E^*_{ab} > 3.7$).

Conclusions: In clinical shade matching, color distribution of each material should be considered and color discrepancy with the corresponding key shade guide tab should be also considered.

1. Introduction

Resin-based indirect restorative systems have been designed to overcome the negative attributes of their porcelain counterparts, and to simplify fabrication, insertion and post-delivery adjustments of esthetic restorations.[1] Indirect resin composite restoratives were introduced as possible alternatives to traditional metallic or ceramic-based indirect restoratives. However, earlier products did not provide evidence of improvement in mechanical and physical properties over direct resin composites, and they required more tooth structure reduction than direct restorations.[2] Although several new generation indirect resin composite systems are being advocated for full contour restoration of teeth, early stage systems have failed in this application, due in part to color instability.[3] Therefore, color stability of these materials has been investigated in previous studies.[3–5]

Fiber-reinforced indirect resin composites were devised to create a translucent framework for fabrication of restorations, which have translucency similar to that of castable

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0300-5712/$ – see front matter
doi:10.1016/j.jdent.2008.09.003

glass-ceramics.[6] The bulk of these restorations are formed using a filled resin, which is similar in structure to those of direct resin composites. Therefore, concerns as to wear resistance, color stability, expansion/contraction and sensitivity remain until these materials are proven in long-term clinical trials.[6]

An indirect resin composite system exhibited the highest values for both hardness and degree of polymerization than packable resin composites.[7] Although stress cracking after thermal cycling and mechanical loading affected veneering indirect resin composites, all veneered 3-unit alloy fixed partial dentures investigated showed a fracture resistance sufficient for posterior application.[8] Based on a study of the clinical performance of ceramic and indirect resin composite onlays, both materials were considered to be successful.[9]

Although color matching in dentistry is routinely performed with a visual method, instrumental color measurement can improve the accuracy of color matching.[10] For the instrumental color measurements, the Commission Internationale de l'Eclairage (CIE) LAB system is usually used. CIE L^* is a measure of the lightness, CIE a^* is a measure of redness (positive direction) or greenness (negative direction) and CIE b^* is a measure of yellowness (positive direction) or blueness (negative direction) of an object.[11]

Most manufacturers cross-refer or key their shades of esthetic materials with those of the Vitapan classical shade guide (VITA Zahnfabrik, Bad Sackingen, Germany).[12] Color of varied shade groups of direct resin composites was compared with commercial shade guides.[13] Color difference between each shade of direct resin composites and the nearest shade tab, which showed the smallest color difference with each shade of material, in the Vitapan classical shade guide was measured.[14] It should be noted, however, that color measurements of shade guide tabs are predictably variable for several reasons: the tabs are not a uniform color, so measurements are sensitive to the measurement location within the tab; the shade guides vary between batches; the standard illuminating light varies; and there are inherent difficulties with spectrophotometer-based measurements of tooth-shaped subjects.[15]

There are arguments on the threshold color difference levels based on instrumental color measurements that can be visually perceivable or clinically acceptable.[16,17] As a clinical perceptibility threshold, ΔE^*_{ab} value of those ratings judged a perfect match was found to be 3.7 ΔE^*_{ab} units.[18] In addition to the amount of color difference itself, the position of a shade in a uniform color space influences color matching.[19] Also the ratios for the lightness and chroma between pairs of shade tabs influenced the visual perception of color.[20]

Although there have been varied studies on the properties of indirect resin composites,[3–5,7] and many kind of indirect resin composites are widely used, there is limited information on the shade distributions of indirect resin composites compared with that of the key shade guide. The purposes of this study were to determine the distribution of color and color coordinates of two brands of varied shades of indirect resin composite, a total of 16 shades and 26 shades, respectively, and to compare them with those of the Vitapan classical shade guide. The null hypothesis of the present study was that the color difference with the corresponding Vitapan classical shade guide tab would not be perceptible ($\Delta E^*_{ab} < 3.7$).

2. Materials and methods

Two brands of indirect resin composite (belleGlass NG: BG, Kerr, Orange, CA, USA; Sinfony: SF, 3 M ESPE, St. Paul, MN, USA) were investigated (Tables 1 and 2). For BG, shades were divided into three shade groups such as enamel (EN), opaceous dentin (OD) and translucent dentin (TL). For SF, shades were divided into three shade groups such as enamel, dentin (DT) and transparent opal (TO).

Resin composites were packed into a polytetrafluoroethylene mold (12 mm in diameter and 1 mm in thickness) on a polyethylene terephthalate strip. After packing the resin composite, another strip was laid on the top of the specimen. Specimens were light cured for 40 seconds in three overlapping areas with a light-curing unit (Spectrum 800, Dentsply/Caulk, Milford, DE, USA) with an intensity setting of 400 mW/cm^2. The output of the curing light was checked with a radiometer (SDS/Kerr, Orange, CA, USA). After curing, specimens were removed from the mold and both strips were removed. For BG, specimens were post-cured in a proprietary curing chamber (belleGlass HP Curing Unit, Kerr) following the manufacturer's instructions. For SF, specimens were post-cured in a proprietary curing chamber (Visio Beta Vario Light Curing Unit, 3 M ESPE) following the manufacturer's instructions. Five specimens were made for each shade.

The coefficient of variation (CV) for the measured CIE L^* value of all shades of BG was in the range of 0.47–1.80% (mean: $1.12 \pm 0.37\%$) and that of SF was in the range of 0.28–3.00% (mean: $1.40 \pm 0.70\%$); therefore, the number of specimens seemed to make no problem for statistical analysis. In case of the chroma, similar CV values were also obtained.

Color was measured according to the CIELAB color scale relative to the standard illuminant D65 over a white tile (CIE $L^* = 94.3$, $a^* = -0.1$ and $b^* = -0.4$) on a reflection spectrophotometer (Color-Eye 7000A, GretagMacbeth, New Windsor, NY, USA). An untraviolet (UV) filter was positioned to 100% UV included condition with the specular component excluded

Table 1 – Shades of belleGlass NG indirect resin composite.

Group	Group code	Shade	Shade code	Batch number
Enamel	EN	Cuspal	CP	445488
		Gray	GR	440126
		Light	LI	441289
		Neutral	NT	445601
Opaceous dentin	OD	A2	A2	443989
		A3	A3	445091
		A3.5	A3.5	446244
		B0	B0	417283
		C2	C2	451119
		D2	D2	447153
Translucent dentin	TL	A2	A2	452970
		A3	A3	445602
		A3.5	A3.5	445722
		B0	B0	416806
		C2	C2	441024
		D2	D2	443661

Kerr Dental Laboratory Products, Orange, CA, USA.