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Spectrophotometric comparison of translucent composites and natural enamel

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ABSTRACT

Objectives: To compare the optical characters of four translucent composites and natural enamel.

Methods: Thirty natural enamel slabs and 120 composite replicas ($n = 30$) using four brands of translucent composites (Polofil Supra, Brilliant Esthetic, Gradia Direct, and Vit-l-escence) were evaluated at the thicknesses of 1.0 mm and 0.8 mm. The colors of the enamel slabs or corresponding composite specimens placed on an A3 shade, white and black backgrounds were measured using a spectrophotometer. Color differences (ΔE^*) of the enamel–composite pairs and translucency parameter (TP) of each specimen were calculated. Reflection spectrums were recorded in the wavelength from 380 nm to 780 nm. Paired-*t* tests were performed to evaluate the differences of color coordinates (L^*, a^*, and b^*) and TP values between the translucent composites and natural enamel.

Results: There were significant differences of color coordinates (L^*, a^*, and b^*) between the enamel and translucent composites ($P < 0.05$). Although no statistical difference of TP values were found in the enamel–composite pairs with Polofil Supra and Brilliant Esthetic composites. The main peaks of the reflectance spectrums of the enamel are different from the four brands of the translucent composites. A reddish shifting of the main reflection peaks was observed, while the thickness of the composite specimens decreasing from 1.0 mm to 0.8 mm. Whereas, the main reflection peak was not changed in the teeth enamel.

Conclusions: The color and the translucency of translucent composites are different from the teeth enamel.

1. Introduction

The increase in patient awareness and demand for esthetic restorations is challenging for the dental team.[1] Among the esthetic attributes, color has been considered as one of the most important factors on the appearance of natural tooth because it is mostly ready to be observed.[2] However, more and more studies confirmed that some other optical characters, such as translucency,[3] fluorescence and opalescence also played important roles in the cosmetic dentistry, especially giving the teeth or restorations vital-looking. The apparent color of natural teeth is the result of the reflectance from the dentin modified by the absorption, scattering, and thickness of the enamel.[4] Therefore, the esthetic outcome is not only determined by the ''basic color'', but also depends on the sophisticated blending of colors and the placement of layers of diverse optical quality.[5,6] One of the major tasks for esthetic dentistry is

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to achieve perfect optical properties duplication to natural teeth with artificial materials.[7,8]

As a general rule, dentin is very rich in hue and chroma; it is covered by enamel layer which is highly transparent. Thus, layering techniques are required and commonly used in prosthodontics to mimic the complex anatomy and optical appearance of natural teeth to achieve the multiple-layering effects.[6] In order to obtain optimal ''natural looks'', diverse shades and opacities of composites have to be employed for one single restoration. Nevertheless, creating a natural-looking esthetic restoration, which blends harmoniously with the surrounding teeth, is not easily achieved.

Initially, manufactures paid most attention to the composite products delivered in a wide scale of colors, while only recently, composites in varying degrees of translucency are available to achieve color matching. Now it is possible to imitate aspects of the natural tooth such as high translucent margins, specific shade and reflectance of the bulk. Thus translucent dental resin composites could contribute to shade match by allowing the shade of the adjacent and underlying tooth structure to shine through.[9]

However, there is very limited scientific literature available regarding the effects of translucent composites upon the resultant color. And no quantitative analysis has been conducted to investigate the differences of the color and translucency between natural enamel and translucent composites. Therefore, the purpose of this study was to compare the color and translucency of four translucent composites and natural enamel slabs. The null hypothesis was that the color and translucency of the translucent composites were consisted with those of the natural enamel.

2. Materials and methods

The study protocol was reviewed and approved by the Ethics Committee of the School and Hospital of Stomatology, Wuhan University. Patients (ranging in age from 14 to 21 years), who donated their teeth for orthodontic reason, were asked to read and sign a consent form prior to teeth extraction.

2.1. *Preparation of specimens*

Thirty enamel slabs from freshly extracted premolars and four brands of translucent/incisal composites were investigated (Table 1). The extracted teeth were free from enamel defect, bleaching treatment, and restorative replacement. Discolored teeth, such as tetracycline teeth and fluoride teeth were excluded. The teeth were scaled and polished with rubber cup and pumice. After storage in 0.01% sodium azide (Sigma, St. Louis, MO, USA) solution in a humid environment at 37 °C, buccal enamel portion of the teeth was longitudinally separated using a diamond rotary cutting instrument (SP1600, Leica Microsystems GmbH, Wetzlar, Germany). The section plane of the enamel slabs was polished using wet silicone carbide paper (320-, 600-, 800-, 1000-, and 1200-grit). The buccal surface of the enamel slabs was kept intact during the specimen preparation. The maximum thickness from the buccal surface to the section plane of the enamel slabs was measured using a digital micrometer (Mitutoyo Manufacturing Company Ltd., Kawasaki, Japan) and achieved 1.0 ± 0.01 mm in thickness. In order to avoid the flake of the enamel specimens, the preparation procedure was performed in a humid environment with distilled water flushing. All of the enamel slabs were investigated using a stereomicroscope (Stemi SV11 Apo, Carl Zeiss Microlmaging Inc., Thornwood, NY, USA) to exclude the cracked or dentin involved specimens. Impression of each enamel slab was taken using silicon impression material and served as a mold for the fabrication of composite specimens. Composite resins were packed into the silicon molds with a cover glass pressing on the top, and light cured for 40 s using a light-polymerizing unit (Spectrum, Dentsply Inc., PA, USA) in the both surfaces. Then, 120 tooth-shaped composite replicas ($n = 30$) were fabricated with the thickness of 1.0 ± 0.01 mm and stored in distilled water for 24 h at 37 °C to ensure complete polymerization. The composite specimens were divided into four groups, according to the composite brands (Fig. 1).

2.2. *Color measurements*

In the present study, layering technique was simplified by assembling the composite or enamel specimens on an A3 shade composite backing (4.0 mm in thickness, Filtek Z350, 3 M ESPE, St. Paul, MN, USA). A refractive liquid ($n = 1.50$, Suzhou Chemical Inc., Suzhou, China) was applied between the two layers to achieve optical connection.[10] The enamel slabs and the corresponding composite replicas composed the enamel–composite pairs.

A spectrophotometer (PR-650 Spectra Scan, Photo Research Inc., Chatsworth, CA, USA.) with a Macro-Spectra MS-75 and SL-0.5X lens, based on the standard illumination source D65, 2° standard observer and 0°/45° optical configuration, was used for the color measurements. Spectral reflectance of each composite or enamel specimens was obtained from 380 nm to 780 nm, with 2 nm intervals, and subsequently converted to CIE $L^*a^*b^*$ values.[11] The aperture diameter of the measuring aperture size was 1.5 mm. Further more, color parameters of

Table 1 – Translucent composites' information.

Code	Material (shade)	Batch number	Composition	Manufacturer
VO	Polofil Supra (incisal)	751247	60 vol.% microhybrid filler of 0.05 μm; Bis-GMA, UDMA	VOCO GmbH, Cuxhaven, Germany
CO	Brilliant Esthetic (incisal)	0156974	58.5 vol.% inorganic filler of 0.5 μm; Bis-GMA, UDMA	Coltène/Whaledent AG, Altstätten, Switzerland
GC	Gradia Direct (clear translucent)	0802141	64 65 vol.% microhybrid filler of 0.85 μm; UDMA	GC Corporation, Tokyo, Japan
UL	Vit-l-escence (trans ice)	Y1103	58 vol.% hybrid filler of 0.7 μm; Bis-GMA	Ultradent, South Jordan, UT, USA