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The influence of varying layer thicknesses on the color predictability of two different composite layering concepts

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ABSTRACT

Objective. Optical properties of teeth are mimicked by composite layering techniques by combining a relatively opaque layer (dentin) with more translucent layers (enamel). However, the replacing material cannot always optically imitate the tooth when applied in the same thickness as that of the natural tissues. The natural layering composite system is available in 2 concepts: (1) dentin (*D*) and enamel (*E*) have the same shade but with different translucencies; (2) *D* and *E* have different shades where *E* is always the same high translucent shade. The objective was to evaluate the influence of varying thicknesses of *E* and *D* composites on the overall color and on the translucency for both concepts.

Methods. For each concept three composite brands were tested; Concept 1: Clearfil Photo Bright (Kuraray), Herculite XRV Ultra (Kerr), Venus Diamond (Heraeus Kulzer); Concept 2: Amaris (VOCO), CeramX Duo (DENTSPLY) and Point4 (Kerr). Two specimens of each shade (A1–A3) per composite were made of standardized thicknesses with a poly-acrylic mold and Teflon cover, making 36 specimens of wedge-like dimension. The $L^*a^*b^*$ values were measured three times against a white and black background ($n = 216$). Student's *t*-tests revealed significant levels between the average ΔE^* values of the 3 areas for each composite.

Results. Statistically significant differences ($p < 0.05$) were found for all thicknesses and for all shades between the concepts. Concept 2 showed greater variations in ΔE^* with increased thicknesses.

Significance. Concept 2 composites are more sensitive to layer thickness changes, which implicates less predictability in a daily clinical routine.

1. Introduction

The increased demand for esthetic restorations motivates the dentist to develop special skills and knowledge of dental restorative materials. Restorations in the anterior region of the mouth especially, should meet high esthetic demands. This can be achieved with resin composites as long the proper materials and techniques are applied. However, when working with resin composites it is important that a

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predictable satisfying result can be achieved within a reasonable time frame. Yet the materials that are available are quite technique-sensitive and may demonstrate more variation in the esthetic performance, especially when experience is lacking or scarce. To gain more of an understanding of the esthetical outcome of such restorative materials one should first study the composition and anatomy of natural teeth.

The optical properties of a natural tooth are quite remarkable due to its internal buildup of organic and inorganic material at a molecular level. The two outermost layers of the crown of a tooth are enamel and dentin, and they play a major role in conveying the tooth its color. One important esthetic property of natural teeth is their degree of translucency. This is related to how the level of hydroxyapatite minerals in the organic matrix of the tooth scatters shorter wavelengths of light. The density of enamel decreases as we move inwards from the surface of the tooth and it is characterized by weak absorption over the visible wavelength [1]. Its crystalline prismatic structure gives rise to the relative amount of light transmitted (translucency) through the enamel. As the thickness of enamel gradually decreases from the incisal one-third of the tooth, toward the cervical one-third, so does its level of translucency [2]. It has also been defined that the natural enamel is anisotropic [3] with respect to the orientation of the enamel rods and hence its optical properties, which becomes less translucent with increased thickness [2,4]. Therefore, the chroma of natural dentin becomes less visible throughout thicker enamel, whereas the total value becomes higher. In contrast to enamel, restorative materials such as dental composites and porcelain are isotropic materials, which exhibit a different optical behavior. Increasing the thickness of these materials will reduce the influence of the background on the shade but is accompanied by a decrease in the value or an increase in grayness [5,6]. Hence, it can be doubted if the comparable thicknesses of the composite layers can mimic the optical properties of the natural enamel and dentin. Ideally, if the anisotropy factor of the restoration material was equal to that of the natural tooth, then there would be no visible difference between them [7]. This is why it is imperative to select restorative materials that can achieve an accurate shade by coinciding with the natural levels of translucency of a tooth.

The color distribution along the tooth surface has been studied repeatedly [8,9] and it is generally agreed that teeth are polychromatic and do not have a single uniform color. According to O'Brien et al. [9], there are both statistically and clinically significant color differences between the three regions of a natural tooth and this information is beneficial when esthetic restorations are required.

In order to attempt to replicate the "tooth-model" situation, contemporary composite systems are available in different layering concepts, and basically distinguish between 2- and 3-layer techniques. It has been frequently reported that the ideal and simpler technique is the 2-layer approach [3,10], which can be subdivided into two basic concepts: (1) dentin and enamel have the same shade for a particular shade-code (corresponding with Vita Classical guide) with variable translucency levels; (2) dentin and enamel have different shades where enamel is universal and always highly translucent (Fig. 1). The shade codes of the latter mostly correspond with the Vita shading system (Vita, Bad Säckingen, Germany) but sometimes employ a uniquely developed shade concept.

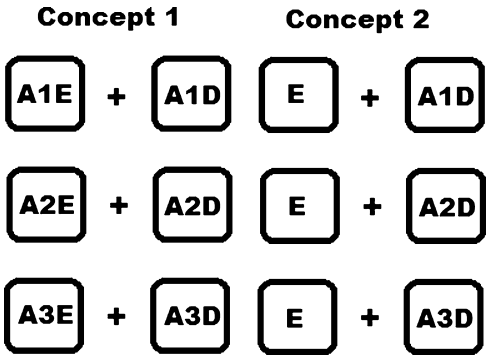

Fig. 1 – Layering concepts 1 and 2.

Even when the correct restorative material and shades are selected, errors in the optical appearance of the restoration may still occur due to the difficulty to control the thickness of each layer. Ideally a material should possess similar optical properties to that of dentin and enamel. To that end manufacturers are introducing different layering concepts, which are aiming to embrace the nature and mimic the tooth tissues in all their optical characteristics. This brings us to the objective of this study, which was to evaluate the influence of variations in the thickness of the Enamel and Dentin layer on the shade distribution and translucency of two different layering concepts.

2. Materials and methods

For this study a comparison was made between the composites of six different commercially available brands, which make use of the layer concept. In order to do so, an evaluation of combinations of different thicknesses of each layer was performed to see the influence it has on the resulting color and translucency for two different concepts.

2.1. *Concept 1*

The Concept 1 is based on the Classic layering concept. The composites tested for Concept 1 were: Clearfil Photo Bright (Kuraray), Herculite XRV Ultra (Kerr) and Venus Diamond (Heraeus Kulzer). For all these brands three combinations of enamel and dentin shades were produced coinciding with the shades A1, A2 and A3 of the VITA® Classical color guide (Vita, Bad Säckingen, Germany).

2.2. *Concept 2*

The Concept 2 which was evaluated for this study is based on the Modern two layered concept. The composites tested for Concept 2 were: Amaris (VOCO), CeramX Duo (DENTSPLY) and Point4 (Kerr). For all these composite brands three different dentin colors coinciding with the A1, A2 en A3 of the VITA® Classical color guide were chosen always in combination with the one same transparent shade provided by the manufacturer.