Effect of the Outer Composite Layer Thickness in Different Layering Techniques on the Color of Light Shade Composite Resin Restoration

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My Beloved Grandparents,

My Great Parents,

My Adorable Sister,

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Introduction

Along with the increased awareness and demand for esthetic dentistry, there has been an increased emphasis on the importance of obtaining both naturally colored and shaped composite resin restorations that can intermingle imperceptibly with the natural tooth structure surrounding them.[1] The hard tooth structure is composed of enamel and dentin which differ significantly in their optical properties. Therefore, it is preferable to imitate this layered structure using restorative materials of different optical properties in order to obtain optimal shade matching.[2, 3] For this purpose, commercial resin- based composites have been developed in different shades and opacities to enable the dentist to simulate the construction of natural hard tooth structure by layering such materials of different optical behavior.

Enamel shades are used to provide: color depth owing to their translucency, opalescence and sometimes to modify the color on the peripheral surface of a restoration. Dentin Shades are more opaque and with greater chroma compared with the overlying enamel shades.[4] Body shades have an intermediate translucency between enamel and dentin shades and can be used to either make a single shaded restoration but its esthetic outcome is usually inferior to that obtained by the vertical anatomical layering technique that employs enamel and dentin shades or sometimes used to modify the color of dentin shades.

In case of large class IV cavities, there is little or no existing natural tooth structure to provide a color base to the composite resin restoration. Therefore, those through-and-through cavities pose a restorative challenge to dentists as regard to obtaining an acceptable color match.[5]

To manage the complexity associated with layering techniques involving the usage of different dentin, body and enamel shades, VOCO (VOCO GmbH, Germany) introduced the Amaris simplified esthetic composite system. The Amaris system incorporates only 2 steps. The first step is the selection and placement of the appropriate opaque composite layer (From O_1 to O_5) replacing dentin while the second step is the selection and placement of a translucent composite layer replacing enamel that serves to lighten (T_L), darken (T_D), or to complement (T_N) the color of the opaque shade. Therefore, theoretically speaking according to the manufacturer's instructions, each color of the supplied shade guide can be obtained by three different layering techniques: T_N + Proper opaque shade, T_L + Later darker opaque shade, or T_D + Previous lighter opaque shade, and the idea behind the latter two additional layering techniques is to allow the clinician to correct the overall color in case a wrong opaque shade was selected. By this essence, the Amaris system allows what is called active shade management and modification during the composite resin layering procedure.

The manufacturer recommended a thickness of 0.5 mm of the outer translucent layer whether T_N, T_L or T_D. But the question, during active shade modification, does the recommended thickness of 0.5 mm of the T_L and T_D layers gives the desired final color of the composite restoration and what would happen if the thickness of those translucent layers increased or decreased by a fraction of 0.25 mm. Therefore a point worthy of research is to investigate the effect of variation of the outer translucent composite layer thickness in those two additional layering techniques on the final color of the composite restoration.

Review of Literature

Composite resins are widely used in the restoration of deranged esthetics especially in through and through class IV cavities. Proper shade selection and shade reproduction are of paramount importance for the esthetic success of the restoration. Therefore, reviewing the science beyond tooth color assessment and factors affecting the reproduction of color by composites resins is beneficial.

Color perception can be simply explained as the subjective response of the human eye of an individual to the physical interaction of light energy with an object.[6] Three main factors influence the perception of color which are the light source, the object, and the observer viewing that object. The ability of the human eye to distinguish different colors is based primarily upon different sensitivity of different specific cells in the retina to different wavelengths of light. The retina contains three types of color receptor cells known as cones denoted as S, M and L cones. The short-wave sensitive cones (S cones) are most sensitive to blue light and have peak sensitivities at 420 nm. The middle-wave sensitive cones (M cones) are most sensitive to green light and have peak sensitivities at 530 nm. The long-wave sensitive cones (L cones) are most sensitive to red light and have peak sensitivities at 560 nm (Fig. 1).[7] No matter the complexity of composition of wavelengths of light, it is reduced to three color components by the eye and the three previous types of cones generates three signals based on the extent to which each cone is stimulated.

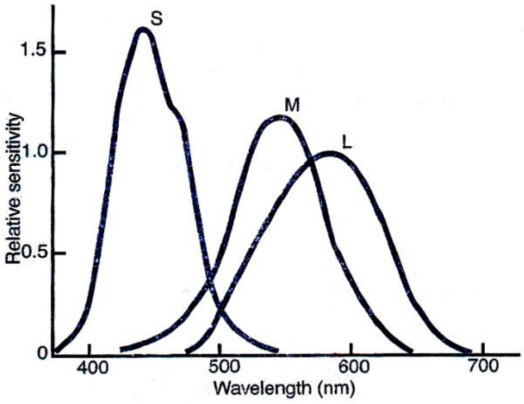

Fig. 1: A diagram showing the spectral sensitivities of the L-, M-, and S-cone classes.[7]

Color processing after stimulation of cones is currently explained by two complementary theories. The trichromatic theory of color vision proposed by Thomas Young and Hermann von Helmholtz in the 19th century postulates that color signals are transmitted out of the eye to the brain by three independent channels based on the fact that the retina has three types of cone cells that have preferential sensitivity to blue, green, and red light. [8] The likelihood of response of any given cone depends not only on the wavelength of the light that hits it but also on its intensity. Therefore, the brain would not be able to differentiate between different colors if it had input from only one type of cone cell and the interaction between at least two types of cone cells is necessary to produce the ability to perceive color. Young and Helmholtz thought they postulated a sound explanation for color vision but there were other phenomena that could not be explained by their theory like the inability of humans to perceive a "yellowish-blue" color or a "reddish-green" color.