Effect of Ceramic translucency and luting cement shade on the color masking ability of two recent esthetic veneer materials

Thesis

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Introduction

Throughout the years dentistry has gone through numerous developments in knowledge, techniques and technology. Among many of the more recent challenges for dentists is to achieve the best esthetic restorations, so it is important for restorations to reproduce not only the color but also the translucency of the natural tooth. Color is important because there should be a substantially indistinguishable shade difference between a restoration and its surrounding teeth. The translucency of a restorative material provides an added "lifelike" vitality and a natural appearance to the completed restoration.[(1)]

The patient's need for esthetically successful treatments especially in anterior teeth is always growing. Accordingly many treatment options have been proposed.

Ceramic laminate veneers have been introduced as one of the best treatment choices, they allow adequate reflection and transmission of light, they exhibit good mechanical strength and they are biocompatible.[(2)]

The difficulty in assessing the color of ceramic laminate veneers has been attributed to the numerous variables involved. The supporting tooth structure or esthetic restorative foundation material provides the primary source for restoration color. This color is then influenced by the thickness and translucency of the final veneer restoration and the cement shade.[(3)]

An essential requirement of all ceramic restoration is its masking ability, the absence of which will allow the unacceptable display of a discolored tooth or metal post beneath such a translucent restoration. The masking ability of an all-ceramic restoration can be determined by measuring the color difference (ΔE^*) between a uniform thickness material when it is placed over black and white backgrounds.(4)

Recently new dental ceramic materials were produced with different combinations of microstructures in order to achieve best properties, among them are Vita Enamic and Vita Suprinity.

Review of Literature

1) Color

Color is a complex psychobiophisycal phenomenon resulting from the behavior of light through its wavelengths to the human eye. Color is not a property of the object, but of the light that enters our eyes from it.[5] Therefore, the real factor responsible for visual perception of color is the light. Without this, we can only see dark, or black.[6]

Light is an electromagnetic wave. Electromagnetic waves can be decomposed into multiple wavelengths, giving rise to a broad spectrum from radio waves (with wavelengths in kilometers) to the waves of cosmic rays (wavelengths less than 10 -13m).[7] The region of light that reaches our eyes is called visible light. It includes the range of 400 to 700nm, and all the colors we know are within this range. The color we perceive is a mixture of various wavelengths.[6]

Our eyes have two kinds of light-sensitive cells: rods, which are responsible for defining the shape of objects and night vision, and cones which are located in the central area and are responsible for daytime vision, identification and differentiation of colors.[8]

Perception of color involves the participation of three factors that can effectively exist.[8]

Object to be observed: The object being viewed may have different physical behaviors in relation to the incident light. If an object is transparent, it acts as an absorbing environment by allowing light to pass through it (light transmission) and allowing us to see through it.

If an object is translucent, some light passes through the object and part is reflected, allowing our perceptions regarding the color of that object. If the object is opaque, the reflection of light occurs in a diffuse way, which is responsible for the colorimetric awareness of our eyes.[9]

Likewise, if the object absorbs all incident light, there is no reflection, and then we will see a dark color or black. If the object completely reflects the incident light, our vision will identify a white object. However, if part of the light energy is reflected and part is absorbed, the display is a colored object.[8]

Observer: The observation of an object can be in a visual or an instrumental way. In a visual analysis, the perception of color is a subjective process and the interpretation depends on the observer's visual individuality. If the observer is an individual trained in the analysis of color, they can identify small differences in color. Changes in color perception may occur based on age, duration of exposure of the eye, fatigue or illness related to color, such as color blindness.[10] In instrumental analysis, colorimetric instruments objectively observe and record color.

Light source or illuminant: The illuminant may be a natural or artificial light source, which, according to its origin, can change the perceived color of an object. For example, a white sheet of paper may seem bluer under fluorescent light and more yellowish under a light bulb, in comparison to its original color in the presence of daylight. This phenomenon is known as metamerism.[9]

Color parameters

In 1936, Munsell described the three dimensions of color to opaque objects: hue, chroma and value.[5] This language became known worldwide; therefore, it became important to understand the color three-dimensional concept to perform visual and instrumental analysis. (fig1)

Hue: It corresponds to the wavelength of light reflected by the objects.

Value or light intensity: the property which is distinguished by the lightness or darkness of a color.

Chroma or saturation: indicates the purity of the color, quantifying its saturation. The lighter a color is, the lower its saturation. Moreover, saturation increases as the object is darker. For example, red is a saturated hue, while pink is the same hue, but less saturated.[11]

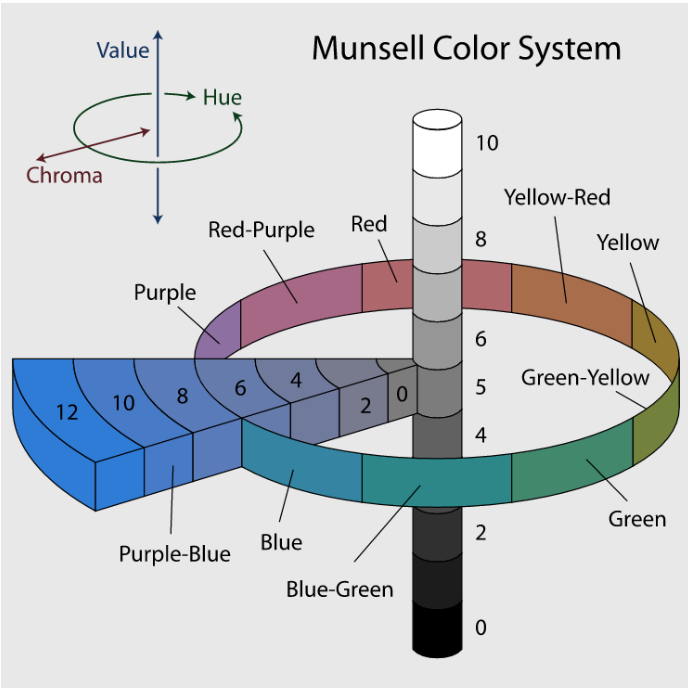

Fig. 1: A diagram showing the Munsell color system. Image by Jacob Rus, 2007.

To improve the precision in color communication of an object, the International Commission of I'Eclairage (CIE) has developed some methods to express the spectral curves in a numerical form. The method used in dentistry is the uniform color space, known as CIEL*a*b*.

Here L* indicates the lightness coordinate of the object, with values from 0 (absolute black) to 100 (absolute white). The values a* and b* indicates the chromaticity coordinates, showing the three-dimensional position of the object in the color space and its direction. When the coordinate a* is positive (+a*), the object color tends to red. When this coordinate is negative (-a*), the trend is green. The coordinate b* indicates the direction to yellow (+b*) or blue (-b*).[12] (fig2)

This System is widely used in dental research and is useful for calculating color differences, but not amenable to easy color communication. For color communication, the HSV (hue, saturation, value) system is most commonly used.[13]

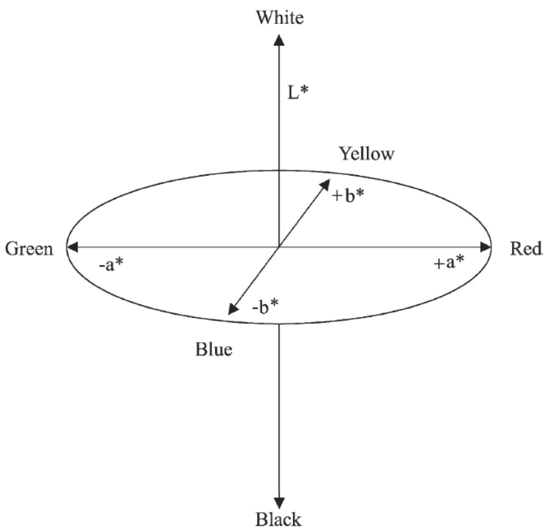

Fig. 2: A diagram showing the CIE Lab color space.[8]

The color difference (ΔE) between 2 objects, or in the same object before and after it is subjected to particular conditions, can be determined by comparing the differences between the respective coordinate values for each object or situation. The color difference value (ΔE) represents the numerical distance between L*a*b* coordinates of 2 colors.[14]

The magnitude of this difference can be obtained by the following equation:[2]

$\Delta E = ((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2)^{1/2}$

Where:

$\Delta L^* = L^*1 - L^*2$

$\Delta a^* = a^*1 - a^*2$

$\Delta b^* = b^*1 - b^*2$

Numerous studies have attempted to determine the degree of color difference between restoration and target shade that is clinically acceptable. According to Ozturk et al[14] the clinically acceptable limit of the color difference value is considered 3.7.

Douglas and Steinhauer in 2009[15]found that mean ΔE values below 3.0 were considered ‘‘clinically imperceptible’’, ΔE values between 3.0 and 5.0 were considered ‘‘clinically acceptable’’ and ΔE values above 5.0 were considered ‘‘clinically unacceptable’’.