



Color Matching Instruments and Systems in Prosthodontics.

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ABSTRACT

The science of color is the knowledge of physiological and physical conditions of color vision and color generation. In aesthetic dentistry the color and the selection of shade plays a vital role in the success of treatment. Different methods and instruments are used for the proper shade selection. This article reviews about the different color matching instruments and systems and their applications.

KEYWORDS

Subtractive color ; Color rendering index (CRI); Chromascope; Hue.

Introduction

Aesthetics which is one of the main concerns in restorative dentistry depends totally upon the proper shade matching of the prosthesis with the surrounding structures, which can be teeth or soft tissue^{1,2}. Color matching is done for better compliance. Perception of color is a physiological response by human eyes and sensory structures of brain towards the light reflected from an object.

Nature of light

Light is a small portion of electromagnetic waves. Light consists of photons which move in the form of wave. Human eye can see only white light also called as visible light which is from 380nm to 780nm³. Invisible spectrum which cannot be seen by human eye include infrared, ultraviolet, microwave, radio, gamma rays and X-rays. Both visible and invisible spectrum is collectively called as electromagnetic spectrum.

Color

Color is the property of light. It is just a particular wave length which is reflected by an object, rest of the entire wave lengths are absorbed by the object. Munsell⁴color space describes the color in hue, chrome and value.

Hue: It is the dominant color of an object e.g. red, green or blue it describes the wavelengths present in the spectral distribution.

Value: It describes the darkness or lightness of particular color.

Chroma: It represents the degree of saturation of a particular hue.

Color can be additive and subtractive⁵.

Additive color: These colors are obtained by emitted light, additive color are seen in computer displays and television. Red blue and green are primary additive colors, while as cyan, yellow and magenta is secondary additive colors. This is produced by the combination of additive primary colors.

Subtractive color: These colors are seen in reflected light. These color are used in pigments for making prints inks, fabrics etc. Red yellow and blue are primary subtractive colors. While as green violet and orange are secondary subtractive primary color produces. Black is produced by the combination of subtractive primary colors.

SHADE SELECTION

Quality of light:

Color perception is dependent on the energy distribution of the light used. For the shade selection the source of light used should contain full spectrum of rays with the uniform distribution of all the wave lengths. If an object is observed under light source in which same particular wave length is dominant (color bands) that specific color becomes dominant to the observer. Light sources are of three types⁶.

1. Incandescent light: In this light yellow waves are emitted in high concentration. Color rendering index (CRI) is low. Hence this light is not suitable for shade matching.
2. Florescent Light: Here Blue Waves are emitted in high concentration .CRI is 50-80. Hence it is also not suitable for Shade matching.
3. Natural Day Light: Northern Light from blue Sky is considered to be the best for shade selection because this light contains most uniform balance of light wave lengths, it is used as a standard to judge other light sources .CRI is close to 100. Day Light is usually used as a standard to compare other light sources, but it should not be used under direct sun light for shade selection, the light waves from the sun vary in its distribution depending upon humidity pollution and the time of day. The blue and green waves are shorten in the morning and evening incident light, only longer waves penetrate atmosphere therefore dawn and dusk light is rich in yellow and orange and lacks blue and green wave lengths. Northern day light on a bright day around noon hour is considered to be the best for shade selection because this day light is most balanced in the visible light spectrum.

Color Rendering Index

Northern daylight is used as a normal standard for judging the light from other sources. CRI indicates how well a particular light source renders color when compared to specific standard source and is rendered on the scale of 1to 100. Color temperature is another light source reference standard. It is related to the color of a standard black body when heated. The average color temperature for Northern daylight is around 6500° K, with the variations with cloud cover, humidity, pollution and the time of day

Metamerism:

Sometimes two subjects may reflect same color under one

source of light but may appear totally different under another kind of light, this is called metamerism. This property of metamerism can be avoided by selecting the shade under a particular light source followed by confirmation of shade under different light sources e.g. Florescent and natural light.

Optical properties of teeth⁷:

1. Florescence: when a material absorbs a light and emit spontaneously in longer wave length it is called florescence. Teeth are fluorescent because when they are exposed to ultra violet light they emit visible light.
2. Opalescence: when a translucent material appears blue in reflected light and red orange in transmitted light it is called as opalescence. The translucency of natural teeth determines its opalescence effect.
3. Translucency: When the light is transmitted and diffused through a particular object and a definite image beyond that object cannot be seen it is called as translucency.

GUIDELINES FOR SHADE SELECTION^{8, 9}:

1. The tooth or shade selection for the prosthesis should be done at the start of clinical session before the operator's eyes become fatigued. Make the patient to remove all the lipstick especially if it is bright colored. Remove the heavy makeup or large jewelleries and even if the patient is wearing bright clothing it should be covered with grey napkins. If the tooth is observed next to a bright red lipstick the red receptors are fatigued and blue and green receptors remain fully stimulated and fresh hence the tooth appears blue-green shade.
2. All the debris and stains should be removed from the teeth to be matched, pumice the teeth if necessary.
3. The most sensitive part of the retina is used if the patient is viewed at a distance of arm length and at eye level. This is the recommended operator position for the shade selection.
4. Operating light should not be used for shade selection. Color corrected fluorescent light is preferred and orderly method of shade selection should be used to avoid confusion. If the eyes of the operator are fatigued to yellow, look at blue napkin or a blue wall to desensitize your eyes. Metamerism should also be avoided by viewing the restoration under one light and conforming under some other light. Since exact matching is not possible a shade slightly lower in hue (darker) than the tooth being matched should be selected. A slightly darker shade is always less conspicuous than a lighter shade. The basic hue of the tooth should be selected, by matching the shade of the canine which is the most highly chromatic tooth in the mouth. Once the proper hue group is selected the proper match is obtained within the same hue group of shade guide.
5. Shade comparison should be made within 5 seconds with the shade tabs placed adjacent to the tooth to be matched.

Hue Sensitivity

Hue sensitivity has a great effect on shade selection. It is the phenomenon by which if a person stares on a tooth or a shade guide for more than 5 seconds; the eyes get accommodated and hence become biased. Just like if a person stares on a color for more than 5 seconds and then closes his eyes or stares on white surface, the image still appears but in the complementary hue i.e. the color opposite to it on the colour wheel.

METHODS OF SHADE SELECTION

The two methods most commonly used to identify the color of natural teeth are visual comparison and instrument measurement system¹⁰. Although the instrument color match-

ing system always provides significant information for better shade selection, still visual method is most commonly used for shade selection. Earlier shade guides were copied from tooth colors but they were not able to represent the color variations of natural teeth, to overcome this problem Clark¹¹ in 1931 introduced a more scientific approach by popularizing custom made shade guides that depends upon the visual judgement of human teeth. The commonly used shade tabs include

1. Vitapan luminvacuum shade tab¹² (vita zahnfabrik ,Bad Sackingen Germany)
2. Vitapan3D master shade system (Vitzahnfabrik, Bad-Sackingen Germany)
3. Chromoscope (ivoclar-vivadent, Amherst,NY)
4. Custom or specific chrome and value guides.
5. The instrument measurement systems include spectrophotometers, colorimeters, digital camera and imaging systems.

Spectrophotometers are the most accurate method of color matching in general as well as in dentistry¹³. The amount of the light reflected from an object is measured by spectrophotometer at an interval of 1-2 nm in the visible spectrum. The components of the spectrophotometers are optical radiation source, a means of dispersing light, a measuring optical system, a detector and finally a means to convert light to a signal that can be analyzed. Spectrophotometers are found to give 33% more accurate results when compared with human eye or conventional technique and more objective match was found in about 93.3% cases. The different spectrophotometers used are crystal eye, vita Easy shade compact, and shade X, spectro shade micro.

Colorimetry¹³ are less accurate when compared to spectrophotometers. This system measures tristimulus values the light is filtered in red, green and blue wave lengths of visible spectrum. Shade vision is the imaging colorimeter.

Procedure of shade matching using vital classical shade guide:

It is the most popular shade guide used since 1960's. Tabs are classified in letter groups based on the hue.

- (Hue of red yellow color) A1,A2,A3,A35,A4
- (Hue of Yellow) B1,B2,B3,B4
- (Hue of Grey) C1,C2,C3,C4
- (hue of red Yellow Grey)D2,D3,D4

The Numerical Values 1, 2,3, and 4 describes the chrome.

Step I Selection of Hue

Hue Closest to the natural tooth should be selected, part of the tooth which is highest in chrome should be used for the selection of hue.

Step 2 selection of Chroma

Next step is the selection of Chroma, Chroma is selected from the graduation of the selected hue e.g. if A is the selected hue, chrome is within A Tab i.e. A1 A2 A3 etc

Step 3 Selection of value for which value oriented shade guide is used

Second shade guide is used to select the final hue .In this shade guide the tabs are arranged with the light shade tabs first followed by a dark shade tabs. For easy determination of value the guide and the teeth to be matched should be observed at a distance and squinting, by squinting the amount of light that reaches the retina is reduced. This reduces the stimulation of cones while as the sensitivity of rods is increased to the increasing achromatic conditions. The clinician has to concentrate on the area which disappears first, the shade tab or the tooth. The one which fades first has lower value.

Step 4 final Check

Once the value is selected the hue tab and the chrome tab may not coincide the selected tab of value. If the value selected from a shade tab is lower than the natural tooth then a new shade tab with higher value should be selected, because the value of the restoration cannot be increased with extensive staining. The excessive staining can only increase the opacity of the restoration. If the value selected is higher than that of natural tooth, then a new shade tab with lower value should be selected or the difference can be compensated by intrinsic or extrinsic staining.

Vitamin 3D-Master

This shade guide was introduced by Vita in early 1990s so as to assess the accurate shade as per three components of color i.e. hue, value and Chroma. 3D master shade has an advantage of analysing the tooth color in 3 dimensions as compared to other shade guides. The arrangement of tabs more systemic and logical compared to classic guides. The tabs are arranged in to 1,2,3,4 and 5 according to the increasing value. Tabs of each value group have similar brightness. In a particular value group, the Chroma increases from top to bottom. L, M and R are subclasses of value 2, 3 and 4. Group 5 has no subgroup e.g. a shade of 2M2 means value is 2, hue is M and Chroma level is 2. Sometimes a combination of 2 shades can be used for the final shade selection in intermediate cases.

Chromascope¹³

In this system the numbers are used to distinguish hue e.g. 100 is for white, 200 for yellow, 300 for orange, 400 for grey and 500 for brown. Another set of numbers is used to indicate Chroma e.g. 10 mean high value with low Chroma while as 40 is low value with high Chroma. Shade selected with Chroma scope can be converted in to vita classic shade a conversion chart.

Custom guides:

Sometimes tooth color fails to match any shade guide tabs, and then a custom shade tab can be fabricated using porcelain. It is used in elderly patients with deep Chroma or in young patients with high value.

CONCLUSION

In aesthetic restorative dentistry the knowledge of color and perception of color is important for the success of treatment. Shade selection may be effected by the limitations in material and techniques. Selection of shade should be done in an organised and proper methodical manner. Using all the precautions the clinician can make best choice and can communicate with the technician accurately.

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