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A Comprehensive Review of Light Sources and Tooth Shade Assessment

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Abstract

The most delicate processes in the fabrication of any dental restoration is choosing a shade. In dentistry, colour determination can be done visually or with the use of instruments. There have been numerous variances noted in the shades chosen by various observers as well as when the same observer matches the shade for the same tooth on various occasions. In addition to shade guides light source plays a significant role in shade selection. The colour-matching process is affected by various lighting conditions. It has been repeatedly demonstrated that daylight at sunrise is the ideal light source for selecting a shade.

Keywords: Shade matching, Shade Guide, Polarization filter, Corrective light

Introduction

The right shade selection is crucial to the success of aesthetic restorations, and matching the right tooth shade is one of the most important steps in the process. Numerous parameters, such as tooth texture and contour, light source, surroundings, and background, have been cited in the literature as contributing to the quality of shade matching[1]. Three primary elements influence how color is perceived: the type of light, the viewer, and the thing being observed. The way that color is seen will alter if any one of the three conditions changes. As a result, perception can be affected by variations in light or position[2]. The observer's eye is the most sensitive and delicate tool used in the entire shade-matching procedure[3]. Typically, tooth shade is determined by hand using portable shade guide tabs that come from various dental manufacturers[4].The approach is subjective,

though, since the human eye and brain differ from one another and color perception is influenced by a number of factors, including brightness, translucency, opalescence, reflectance, and fluorescence[5].

The light source is one of the most neglected but a decisive aspect of shade matching. In the past it was claimed that shade matching was better under day-light[6] . Later, a polarization filter-equipped light correcting device was unveiled[7] .

Figure 1: Corrective Light for shade selection[7]

Discussion

The determination of the color and other attributes of appearance of an artificial tooth or set of teeth for a given individual[8] .Dental shade guides can be used to visually match tooth tints, or instruments can be used. For dentists, visual shade matching is still the most widely used technique[9].

While subjective and vulnerable to several factors like experience and color deficiency, visual methods for shade selection shouldn't be discounted[10]. The tabs for shade guides in the visual techniques are organized based on whether they are hue-based or value-based shade guides. Nonetheless, value-based shade guides were found to be more accurate in determining shade since the human eye is more sensitive to variations in chroma and brightness or darkness [11].

However, because digital shade-taking devices are thought to be more objective than visual shade selection, they are being used more and more in an effort to achieve standardized, reliable, and accurate color measurements and shade matches[12]. The application of spectrophotometers, colorimeters, or image analysis methods is known as instrumental shade selection. But because they were costly and not always practical to use, dentists were less likely to regularly utilize these specialized devices[13]. When feasible, it has been suggested to combine the use of instrumental and visual methods in order to produce a more certain aesthetic result[14].

Guidelines for shade selection[15]

1. Walls and cabinetry outside should be painted in shades of grey or pastel. Light that has been color corrected is used.
2. The shade needs to match when a procedure or appointment starts. After a procedure, teeth become dehydrated, and the operator's eye becomes tired from focusing on the same. Choosing shade at the diagnostic appointment itself might be a wise decision.
3. Prior to choosing a shade, all distracting items such as heavy jewellery and makeup should be taken off. Vibrant apparel is concealed.
4. The teeth should be kept moist and free of stains and plaque.
5. The patient is positioned between the light source and the upright seat, with the operator's teeth at eye level. A viewing distance of 10 inch is maintained
6. The technician should choose a shade guide that matches the porcelain they will be using.
7. The poorest matches are removed after a speedy scan of the full shade guide is done, placing it next to the teeth.
8. To prevent fatigue, quick 5-second observations are taken while placing matching shade tabs next to the tooth that needs to be matched. The dentist should look at a neutral grey surface to rest his eyes in between. According to the guide, the shade is

matched in terms of hue, chroma, and value. Squinting the eyes improves the selection of value.

9. In case a decision has to be made between two shades, the tabs are held on either side of the tooth. The gingival and incisal portions are matched separately if none of the tabs permit a good match.
10. After selecting in a corrected light source, the procedure is repeated in an additional light source.
11. Lastly, the teeth are checked for any characteristics such as internal stains, craze lines, and hypocalcifications. These are indicated on the shade distribution chart and can be measured with a periodontal probe.
12. The shade guide is then thoroughly cleaned.

Effect of different light sources on shade selection

The light source is one of the most neglected aspects of shade matching. A full-spectrum light source must be the primary source utilized to illuminate the teeth [6]. A light with a color temperature of between 5,500 K and 6,500 K and a Color Rendering Index (CRI) of at least 90 offers the best conditions for matching tooth shades The accuracy of a "given" light source in rendering color in comparison to a "reference" light source is indicated on a scale ranging from 0 to 100%. CRI scale from 90-100 is considered the best as in natural sunrise light source, whereas scale of below 90 is not suitable for shade matching selection. [16]

The sunrise daylight is regarded as the best, according to the CRI, because it is closest to emitting the entire spectrum of white light, as the light is most balanced during this time. Its color temperature is 5500 K, and it serves as the benchmark for evaluating other light sources. Its CRI is very nearly 100. When matching the shade of artificial teeth in prosthodontics, one should perform the assessment in the presence of only 1 light source, as overlapping illumination from different sources may promote metamerism. [16]

A dental office can have three different types of light: highly variable natural daylight; the operating light of the dental unit, which leans more toward the red end of the visible spectrum than does natural sunlight; and lastly, fluorescent ceiling lights, which, in contrast to incandescent lights, have different color rendering qualities based on the desired color temperature. [16]. It was discovered that only between 10 am and 12 pm is the ideal daytime window for shade recording. It is critical that the main light source being used to illuminate the teeth to be a full-spectrum source. Fluorescent lighting is widely used in dental offices. Although fluorescent light bulbs can be optimized for color matching, they are not the best option for accurately rendering color. Still, they are an energy-efficient source of light. [6] .

A study on the Effect of the Surrounding Light Sources on Shade Selection Accuracy by Ali A. Razooki Al-Shekhli observed how various ambient light sources affected the precision of shade selection.

The study evaluated five distinct ambient light sources: fluorescent, room-halogen, office-halogen, , daylight (sunrise), and daylight (sunset). In order to determine the accuracy of shade selection, VITA classic Shade Guide tabs have been selected for testing in this study using an electronic shade selection device. Ten measurements of each shade tab matching were tested in various lighting conditions. The average percentage of accurate readings and a one-way ANOVA at the 5% level of significance were used to statistically analyze the data. A one-way ANOVA statistical analysis of the data showed that the five light source groups under test differed statistically significantly in their shade matching accuracy readings ($p \leq 0.05$). The highest shade selection accuracy

percentages were shown by sunrise light sources, while the lowest percentages were shown by fluorescent light sources. Among the five light groups under test, only the A2 shade tab showed negligible variations. [17] From the study it was understood surrounding lighting conditions significantly affect clinical shade matching performance of dental professionals. Thus, it was determined that the best light source for accurately matching shades of shadow is natural sunrise light[17].

The amount of daylight, the time of day, and the type of light source—or a mix of these—all have a significant impact on the lighting conditions in the dental office. It has been discovered that these differences have a significant impact on the accuracy of shade determination [18]. In order to control the effects of various light sources, light correcting devices have been developed and are advised. They are thought to be a more cost-effective option than digital shade-taking devices [19]. The fluorescent tube used in the first iteration of the handled light-correcting device had a large size and was not very user-friendly. Newer models of light-correcting equipment have eventually been released, and they have shown improved color matching outcomes [(19,20)]. Polarizing filters have recently been added to light-correcting equipment in order to completely eliminate reflected light and improve the perception of transparency and depth [21]. One of these devices with its polarizing filter was previously studied, and the results showed that while using a light-correcting device improved the ability to match shades, using a filter did not improve shade matching [18]. As of right now, no research has been published to examine the effects of using these light-correcting devices in standard settings against backgrounds other than natural light.[7]

Conclusion

Dental practitioners' ability to match clinical shade is greatly impacted by the lighting source around them. Because it comes closest to emitting the entire spectrum of white light, natural sunrise daylight is regarded as the best ambient light source. It serves as the yardstick for evaluating other light sources. Its CRI is very nearly 100. The sunrise daylight light source is the most accurate for selecting shades, but it is only available for a short period of time during the day.

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