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Review Article

Determination, implication, and satisfaction of shade selection in aesthetic dentistry

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ABSTRACT

Delivering an aesthetic solution that proportionally complements the patient's neighboring teeth is crucial. In the discipline of cosmetic dentistry, qualities like surface form, translucency, and color are the most important factors for creating esthetic prostheses. The final color of translucent ceramic restorations is determined by many factors such as the thickness of the porcelain veneer, the thickness and color of the luting agents and the color of the underlying tooth structure. In order to the results to be accurate, homogenous, and predictable—all of which are crucial for cosmetic dentistry—color matching must be carried out in a methodical manner. Lighting control at the site, the surrounding environment, state of the teeth, patient positioning, time, and clinician proximity to the tooth, squint test, visual color guidelines, Vita Classical shade guide, Vita Toothguide 3D-Master, Chromascop, customized shade guides, and dentinal and extended shade guides are all considered when mapping shade and translucency. A sensor, a signals conditioner, and technology that allows the conversion of the signals into data usable in the dental laboratory or operatory make up the three components of every color-measuring instrument. Colorimetry, spectrophotometry, digital photography, hybrid equipment, and spectroradiometry comprise a few types of color measurement technology. Both print and electronic shade systems need to be used when choosing the right shade in order to create acceptable aesthetics. The practitioner and patient are both satisfied when the appropriate shade is matched, and the patient also has a more appealing appearance.

Keywords: Shade matching, Color matching, Cosmetic dentistry, Aesthetic dentistry

INTRODUCTION

Across the previous decades, both dental patients and dentists have begun to place a greater emphasis on aesthetics. Delivering an aesthetic solution that proportionally complements the patient's neighboring teeth is crucial.[1] It can be difficult to get an exact shade match between the prosthesis and natural teeth owing to the wide

variety of natural tooth colors. Every dentist ought to be knowledgeable about the shade choosing method to get the best possible results as several prostheses fail owing to inappropriate shade choice. Over a million shades can be distinguished by the humans, and precision technology has been designed that can distinguish about ten times more different shades. The human teeth have a wide range of shades, and while the unassisted human vision can only distinguish 1% of these shades, electronic instruments can recognize almost 100,000 dental shades.[2]

In the discipline of cosmetic dentistry, qualities like surface form, translucency, and color are the most important factors for creating esthetic prostheses.[1] The porcelain hue of restorations made with porcelain laminate veneers must resemble the tint of the natural teeth next to them.[2] The manufacturing companies now offers a variety of resin cement colors to help dentists create restorations that are clinically acceptable and have good color matching to the nearby natural teeth. However, the final color of translucent ceramic restorations is determined by many factors such as the thickness of the porcelain veneer, the thickness and color of the luting agents and the color of the underlying tooth structure.[2]

METHODS

This study is based on a comprehensive literature search conducted on 20 November 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about determination, implication, and satisfaction of shade selection in aesthetic dentistry. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Shade guides are another name for shade-matching tools. Value, chroma, and hue are chosen in that order when choosing a shade. In order to the results to be accurate, homogenous, and predictable—all of which are crucial for cosmetic dentistry—color matching must be carried out in a methodical manner.

Lighting control at the site

In comparison to early and late daytime exposures, that are higher in red and yellowish wavelengths, midday sunlight is thought to include a nearly similar mix of all light wavelengths, making it the best exposure for choosing a shade. Synthetic lighting should be utilized to mimic sunlight in facilities that do not have easy accessibility to it. Despite the fact that no synthetic lighting can exactly replicate sunlight, it is sufficient for therapeutic applications.[1,3-5]

Environment

Practitioners should avoid backgrounds with loud colors since they affect the colors in the reflected light and obstruct appropriate color matching. To cover up unfavorable coloring in the patient's attire and accessories, utilize a drape. Lip color must be taken off to avoid it from affecting how colors are perceived. The optimal backdrop for shade matching is a very pale grey. High-gloss surfaces cause unsettling glares, and the clinician must avoid working around them.[1,3-5]

State of the teeth

Plaque, various depositions, and superficial staining should not be present on the tooth of focus or its neighboring teeth. Saliva should be applied to keep the teeth wet because drying makes teeth seem lighter. Before placing the rubber dam, shade matching needs to be done since the rubber dam causes increases the dryness of the tooth.[1,3-5]

Time, patient positioning, and clinician proximity to the tooth

The optimal range for shade matching is thought to be between 61 cm (2 feet) and 183 cm (6 feet) away from the mouth.[1,3-5] The patient must be seated so that their teeth are in line with the dentist's vision. Lighting should be directed toward the patient's dentition as the clinician stands squarely across from them.[1,3-5]

The clinician should choose and match shades especially early in the daytime, when the eyes are less fatigued.[1,3-5]

Squint test

The squint test allows to select shades by limiting the amount of light that reaches the eyes. Firstly, the eyelids are brought closer, and then the shade guide and the original tooth are observed. When compared to tooth color, the color that fades from vision first is the one that is least noticeable.[6]

The traditional way and the usage of color measurement tools are the different approaches to choosing shades.[1]

Visual color guidelines

The most well-known and practical technique to choose dental hues is by using a visual shade guide, which is the traditional method. They are affordable, easily accessible, and successfully mimic the shade of the teeth using a uniform reference shade guide. By using the tab technique, choosing teeth shades is entirely dependent on visual perception.[7]

Vita classical shade guide

Sixteen tabs are divided into four groups according to the hue, with the chroma of each group's members. The Vita 3D-Master shade guide is the most often utilized amongst some of the shade tabs available on the market because Vita's basic shade guide has certain drawbacks. It offers superior and consistent color contrasts.[8,9]

Vita toothguide 3D-master

It has 26 tabs, which are divided into five categories based on how light the color is. The category number and degree of lightness are indicated by the numerals (1, 2, 3, 4, and 5), where a lower number denotes a higher level of lightness. The amount of chroma is represented by the digits (1, 1.5, 2, 2.5, and 3) underneath the category number; bigger numbers denote more higher chroma. Three bleaching shades (0M1, 0M2, and 0M3) represent higher level of lightening, three chroma grades, and a medium hue. The primary difference between the Vita classical shade guide and the Vita 3D-Master is that the former is based on hue, while the latter describes value. Comparable to the Vita original shade guide, the Vita 3D-Master shade guide is thought to be superior. Additional chromatic tabs and an improved brightness spectrum are included. When compared to the reddish spectra, the hue range is enlarged. Additionally, category classification is enhanced, and the distribution of the shade tabs is uniform.[10-12]

Chromascop

Chromascop classifies shades using a numerical system. According to hue, it is split into categories, and within the categories, chroma rises from 10 to 40.[3]

Customized shade guides

The full spectrum of hue and chroma values found in a human dentition cannot be represented by the conventional shading guides. It is helpful for choosing 85% of the shades, while the other 15% require its modification or the creation of unique color tabs. Custom shade guides are produced from substances including composite resin, ceramics, or acrylics. Surface colorings or aluminum oxide contact abrasion can both be used to modify shade guides. To imitate the subtle differences in tints, comparable translucency, and identifying colors, use fine markers and coloring pencils.[13]

Dentinal and extended shade guides

Crowns and veneers made entirely of ceramics with translucency can be created using the dentin method. The dental laboratory can better communicate a certain hue owing to this shade guide. The technician can evaluate the restoration's aesthetics by using carefully colored die materials that match the dentin shade.[14] The tabs for all the substances needed to create the restoration are included in the extended shade chart. It can be used to increase the palette of available colors as well.[15]

Disadvantages of shade guides

The shades in a shade guide do not have logical organization and do not encompass the amount of shade diversity that occurs in human dentition naturally, which is one of the shade guides' drawbacks. Another is that the colors in a shade guide vary for each manufacturer; the porcelain utilized as restorative material may not be equivalent to that present in a guide; guides are not able to lead the fabrication of porcelain restorations; conventional shade tabs are constructed of synthetic resins and are thicker than that employed in fabricating crowns; shade guide tabs allow for both reflection and light transmittance creating the impression of translucency and life.[16,17] A restoration, on the other hand, reflects light mostly and is less likely to transmit it, giving the restoration the appearance of being dense and impenetrable.

Color measuring instruments

A sensor, a signals conditioner, and technology that allows the conversion of the signals into data usable in the dental laboratory or operatory make up the three components of every color-measuring instrument. Colorimetry, spectrophotometry, digital photography, hybrid equipment, and spectroradiometry comprise a few types of color measurement technology.

Colorimeter

A colorimeter assesses color as is seen by the observer (hue, chroma, and value). It is restricted to determining tristimulus readings in specified lighting and spectator circumstances to determine color. The main optical components are the lighting source, integrating sphere, and sensor.[6,16]

Spectrophotometer

They are frequently employed to assess the shades of surfaces. They gauge the body's spectrum output to reflect. It is a photometer that has the ability to gauge strength using wavelength or, more precisely, color. The monochromator, sensor, and lighting source make up the optical components. Light sources are typically exhibit diffraction. The test piece and entry aperture are exposed to a variety of wavelengths.[18] The sample preferentially absorbs various light wavelengths. The exit slit is the next aperture across which the light travels before striking the sensor. An electrical signal that is magnified and shown on a monitor or plotted on a graph is created by the sensor from the lighting intensity at a particular wavelength. To evaluate color properly, spectrophotometry should be used. Spectrophotometry analyzes the light absorption at different wavelengths,

while a colorimeter offers a comprehensive measurement of the light received. Briefly, colorimeter measure the amount of light absorbed overall, while spectrophotometers measure the amount of light absorbed by a specific wavelength. Spectrophotometers are reliable and accurate over time.[19]

Digital cameras

The most basic type of modern shade-matching technology is a digital photography. Unlike film-based traditional photography, this technology uses charge-coupled devices (CCDs), which are made up of tens of thousands of miniatures, light-sensitive components called photosites, to take photographs. In addition to giving a complete and accurate view of the dental surface, it is helpful to map color. The verbal response can be recorded on a flashcard that captures all data and can be delivered immediately to the laboratory without using a computer. To map basic color and translucency, the information can be saved on software.[20,21]

Hybrid devices

Combining modern photography with spectrophotometry analyses is what SpectroShade offers. It does not rely on any equipment and is designed for usage with practically any digital camera and the ClearMatch application software on all Windows using computing devices.[20]

Spectrophotometry and spectroradiometry

The most accurate color evaluations are made possible by these tools. In contrast to spectroradiometry, spectrophotometry primarily has a constant lighting source. For these devices, two separate primary layouts have been used. A solitary photodiode detector is used in the traditional scanning device to record the amount of light at each frequency.[22]

The most recent structure allows use of an array of diodes with a particular component for each frequency. All frequencies may be simultaneously integrated according to this design. Although both models function much more slowly than filter colorimeters, they are nonetheless crucial for studies on the creation of accurate color-measurement tools.[23]

Limitations of digital shade guide

Some of the drawbacks of using an electronic shade guide are: edge loss impacts the precision of colorimetry; translucent identification is unsatisfactory for all systems; placing of the probe or mouthpiece appears to be crucial for the reproducibility of the measurement; no digital shade guide is complex enough to continue operating in a formulation configuration; and (e) the laboratory should have modern equipment for the effective implementation of this method.[20,24]

Factors influencing the final shade of ceramic restorations

Numerous criteria that affect the evaluation of restoration color are known according to the research that is currently in circulation. The shade and visual features of tooth structure, ceramics qualities, the color and density of resin cement, how resin cement and ceramic bonds interact, the impact of polymerizing, and dental shade-matching tools are all taken into account.

Substrate characteristics

Color choice should take into account the substrate's effects or the aesthetic restorative basis, which include the color and optical qualities of the tooth structure.[25] Since translucency allows extra light to penetrate and disperse, it complicates color matching systems. This implies the tooth base beneath the ceramic has an impact on the material's ultimate optical characteristics.[26] The density of the ceramic veneers utilized for the restorations also impact this. Numerous investigations have demonstrated that, regardless of ceramic shade, the substrate underneath significantly affects the ultimate shade of ceramic restorations of nominal thickness.[27-31] Key factors to be considered are the ceramic thickness, ceramic variety, shade of ceramic material, and resin cement in order to prevent these unwanted consequences.[26,32-36] The clinical implication including the supporting foundation may clinically influence the overall selected color of thin, translucent ceramic laminate veneers, hence clinician should consider other factors to achieve a good color match.

Ceramic characteristics

According to literature, ceramic laminates can be anywhere from 0.3 to 1.5 mm thick. Across a period of 5–14 years, the observed survival rate varies from 84–97.[37,38] Ceramics exhibit decreased light transmission strength due to their optical heterogeneity. It has been demonstrated that independent of ceramic colors, light transmittance drastically decreased as the depth of the ceramic veneer increased. According to research, ceramic thicknesses of 1.0mm and higher did not result in visually apparent coloration changes when adjusting the substrate's hue. The admissible color variations for dental practitioners vary from 2.6 to 3.7.[39,40] Nevertheless, when ceramic width decreased under 1 mm and ceramic thickness of 0.6-0.3 mm, i.e., ΔE of 5.5, substantial color changes were seen.[34,41] Clinically, the depth of bonded ceramic veneers has a significant impact on the ultimate color variation, which reduces as ceramic depth rises.

Resin cements

Currently, ceramic veneers are only glued with resin cements that are readily available. However, there is a wealth of information in the literature on choosing the right resin cements. In comparison to chemically and dual-cured

resin cements, the light activated resin cements showed advantages in terms of long working times, simpler removal of excess material, and shorter finishing times. In addition to this, research revealed that light-cured resin cements had exceptional color stability because they lacked the aromatic amine which helps in catalysis by self-curing and that results in color variations through time.[42-46] Dual-cured resin cements offered some of the benefits of chemically and light-cured resin cements. In contrast to light- or chemical-curing, dual cure resins demonstrated superior physical qualities in deeper areas where the light is attenuated, and extent of transformation.[47-49] However, the composition of dual-activated resin cements includes aromatic tertiary amine, that jeopardizes the durability of the color. The bonding, or contact between the underlying ceramic and resin cement, also affects the entire restoration's color. Numerous in vitro tests revealed that the expedited aging caused color changes in all resin cements that were within therapeutically acceptable limits. The majority of the substances become opaquer as they age.[50] The final cosmetic results of trial insertion paste and resin cements, which are used to assess color matching of veneer repair, differed noticeably from one another. As a result, its use seems therapeutically inconsequential.[51,52]

Clinical endurance and color stability of resin cements are anticipated to increase with advancements in novel compositions and polymerization processes. It has been said that choosing the right kind and color of resin cements is essential for achieving the best looks when restoring laminates. The final color of laminate restorations is impacted by resin cements. Nevertheless, as the depth of the ceramic repair rises, the visibly detectable influence of resin cement shade diminishes.

CONCLUSION

The basis for great aesthetic appeal is choosing the right color. It is difficult to determine and accurately reproduce the shape and look of teeth. The practitioner needs to have a solid grasp of color chemistry and perception in order to give the patient with an aesthetically pleasing repair. The practitioner and patient are both satisfied when the appropriate shade is matched, and the patient also has a more appealing appearance. Both print and electronic shade systems need to be used when choosing the right shade in order to create acceptable aesthetics.

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