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Case Report Article

Shade selection for natural tooth color replication on porcelain laminate veneers

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Abstract

Introduction: The final color of dental ceramics depends on different factors such as light source, substrate, and selected material (thickness, contour, and texture). **Objective:** To report a clinical case in which a predictable protocol is used to optimize the final color of porcelain laminate veneers. **Case report:** A male patient attended the dental clinic dissatisfied with the composite resin restorations made on his upper anterior teeth. After anamnesis and clinical examination, it was suggested that the resin restorations be replaced by laminated porcelain veneers. A diagnostic wax-up was performed. The mock-up was also used to evaluate the aesthetic length for replicating the details of the incisal edge and the shape and size of the embrasures. The shade was selected before composite resin removal to avoid dehydration of the dental substrate. A photograph was taken to guide the selection of colors in different thirds. After removing the restorations, another photograph was taken to evaluate the color of the substrate. The impression was taken with 000 retractor wire and addition silicone. The laminates were made with pressed ceramic and feldspathic porcelain veneers were subsequently applied by layering the layers of dentin, incisal edge and enamel based on

the waxing diagnosis. After approval by the patient, a conventional cementation technique was performed. The occlusal adjustment was made with rubber polishing cups and the anterior and lateral guides were checked. **Conclusion:** The protocol recommended for successful selection of the color of a porcelain laminate relies on the combination of knowledge of concepts, resources such as shade guides, spectrophotometers, and photographs, and porcelain application and characterization techniques performed by the technician and luting techniques by the dentist.

Introduction

The selection of the color of ceramic restorations is complex and involves an enormous wealth of details. Color can be defined as the interaction of reflected or transmitted light from an object to an observer, i.e., three factors basically influence the final color of teeth to be restored: light, object, and observer [3]. Thus, these three factors should be carefully assessed.

Light intensity is crucial during the selection, manufacture, and color of the resin cement. If light intensity is too low, minute details are overlooked and the eye can barely perceive them. However, not only is the intensity or amount of light important, but also the quality of this light, which should simulate natural lighting conditions [3]. Hence, both dentists and laboratory technicians should work with the most suitable light source during restorations to obtain the best possible outcome.

Regarding the object, in this case, the tooth to be restored, dentists and dental prosthetists often select color based on hue, chroma, and value, but other parameters such as translucency, opalescence, and fluorescence play an essential role as well [2, 5]. All of these parameters are interlinked and should be considered during ceramic restorations. The incisal region, for instance, is more translucent, but enhancing the translucency of a crown lowers its value because less light returns to the observer's eyes. This aspect should be carefully planned during the manufacture of the restoration so that incisal edge details can be replicated. Moreover, fluorescence and opalescence directly influence the selection of the material, and some materials have larger or smaller fluorescence. Therefore, the material must be chosen carefully according to each case.

Regarding the observer, several resources can be used to help select the color of restorations. Shade guides are a traditional and fundamental reference for dentists and technicians for color selection and replication [6]. Currently, photographs have been widely used, since shade selection through digital photographs has facilitated communication between dentists and laboratory technicians, in addition to providing details that might go unnoticed [3]. Furthermore, it is possible to combine these resources with spectrophotometry, improving the outcomes [7, 8].

Thus, the objective of this study is to report a clinical case in which a predictable protocol is used to optimize the final color of porcelain laminate veneers.

Case report

An adult male patient sought our dental clinic because he was not satisfied with the color, staining, and wear of his composite resin restorations made on his maxillary anterior teeth (figure 1). After history-taking and clinical examination, neither anterior disocclusion nor lateral movement was observed. It was suggested that resin restorations be replaced with minimally invasive porcelain laminate veneers.

Figure 1 – Patient's smile at baseline (A) and approximate frontal view of anterior teeth during anterior disclusion (B), showing stained and worn composite resins, thereby compromising posterior disclusion

Prophylaxis, scaling, and diagnostic wax-up were initially performed. Subsequently, a mock-up was obtained to assess the size and shape of the wax-up. This mock-up was also used to assess the esthetic length for replication of incisal edge details and shape and size of embrasures. Both anterior and lateral guidances were evaluated.

Color was selected before removal of composite resins to prevent dehydration of the tooth substrate (figure 2 – A-B). After shade selection by the operator, a photograph was taken with incisal edge of the shade guide towards the incisal third of the teeth to be restored. The image was obtained after previous calibration of the camera with an 18% gray card to prevent color distortions. It is important to frame the teeth to be restored, the shade guide with the description of the corresponding color, and teeth that will be simulated or used for the "color map" at different thirds.

The restorations were removed using Optidisc® (Kerr Corporation, Orange, CA). A small chanfer was made to establish the cervical terminus of indirect restorations (figure 2 – C-D). Then, one more photograph was taken with the shade guide selected initially in a position from which the technician could assess the substrate color (figure 2E). As no stain was found on the tooth substrate, the photograph was not taken using the shade guide that represented the color of the substrate stain.

A 000 retraction cord (Ultrapack®, Ultradent, South Jordan, UT) was inserted and molding was made with addition silicone (Variotime®, Kulzer, South America). A photograph of the substrate color was taken so that the technician could note the details and color of each area of the teeth. Provisional restorations were made with Structur 3® bis-acrylic resin (Voco, Germany) (figure 2F).

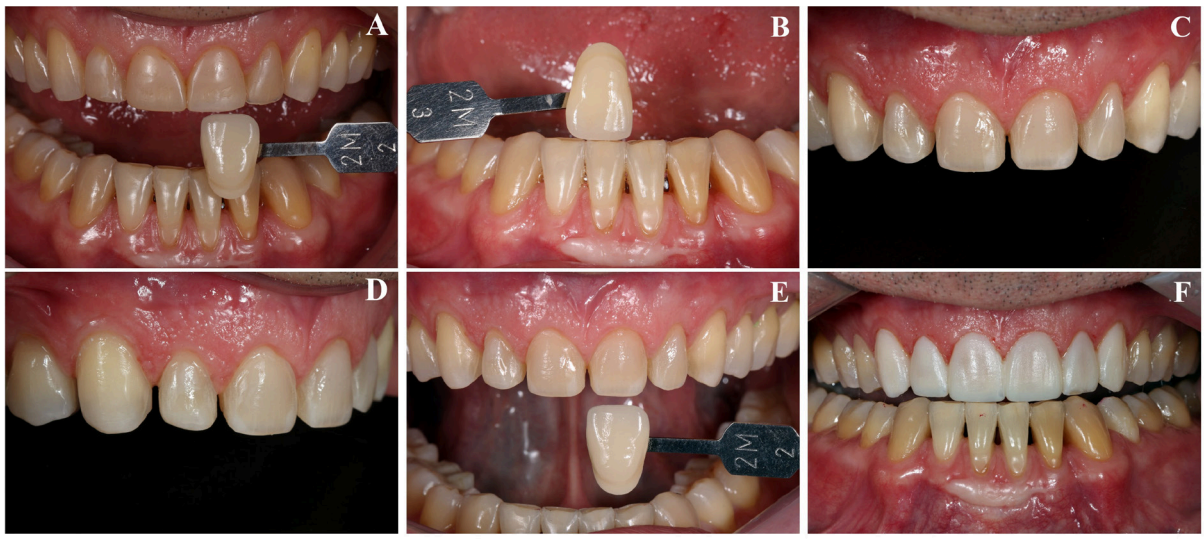

Figure 2 – Photograph with Vita 3D Master shade guide before the procedure to prevent dehydration of the teeth (A-B). Teeth right after preparation (C-D). Enamel in all areas of the prepared teeth. Photograph with shade guide *in situ* indicating the tooth substrate to the laboratory technician (E). In this case, there is no change in the color of substrates; however, it is important to highlight that the teeth are dehydrated and, consequently, more opaque and less translucent. Esthetic assessment of smile and functional assessment of occlusion of the mock-up manufactured with bis-acrylic resin (F). Note that the new tooth length allows posterior disclusion

The dies were fabricated (figure 3 – A-C) and Hera Cera ceramic was used for manufacture of laminates. The laminates were made by stratification of dentin, incisal edge, and enamel layers based on the wax-up diagnosis (figure 3 – D- E). Thereafter, Hera Ceram shade dyes were used to determine the color in the cervical region. Finally, texture was achieved with a diamond bur and glaze was applied (figure 3 – D-E).

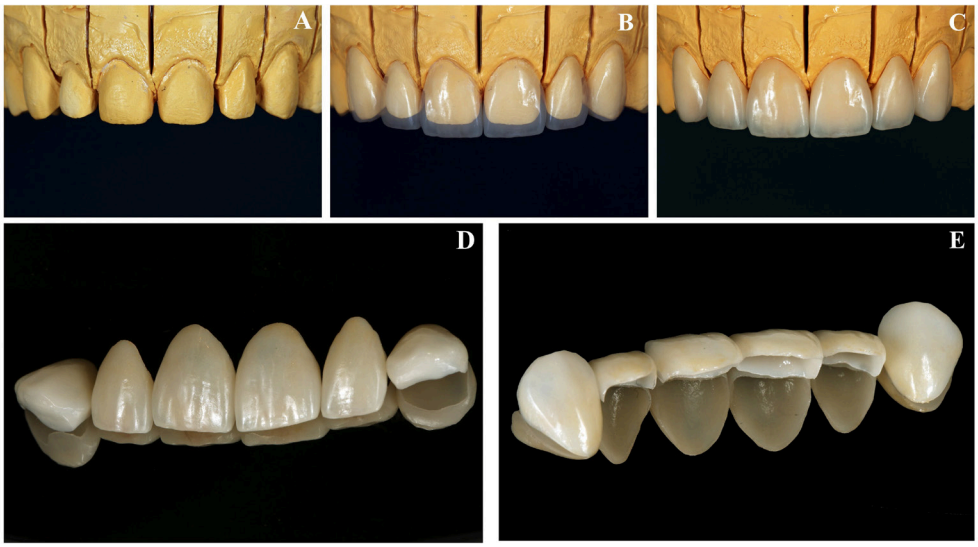

Figure 3 – Model with die *in situ* for manufacture and finish of the ceramic (A), allowing an extremely thin and conservative restoration (B-E)

The porcelain laminates were tried in the mouth using try-in clear paste (Nexus 3® Kerr Corporation, Orange, CA). After approval by the patient, the restorations were etched with hydrofluoric acid for 20 seconds (Condac Porcelain 5% FGM, Santa Catarina, Brazil). Each internal surface was rinsed for 20 seconds and then dried with a 3-way air/water syringe. Silane (Kerr Corporation, Orange, CA) bonding agent was applied and 60 seconds were allowed before the application of Optibond S (Kerr Corporation, Orange, CA).

A modified rubber dam technique, prophylaxis, etching with phosphoric acid for 30 seconds, and rinsing and drying of the surface were performed. Optibond S (Kerr Corporation, Orange, CA) was applied to the teeth. Clear® cement was applied on the internal surface of restorations and delivered in position. Excess cement was removed with a microbrush and dental floss. Each restoration was polymerized for 120 seconds using Radii Plus (SDI, São Paulo, Brazil). Occlusal adjustment was made with rubber polishing cups (JOTA Brazil, Santa Catarina, Brazil) and the anterior and lateral guides were checked.

The restoration and smile outcomes are shown in figure 4 – A-D.

Figure 4 – Porcelain laminates after luting. Patient's final smile. Note the natural color of restorations on premolar and molar during smile, and anatomy and shape following the mock-up based on the wax-up diagnosis. Central teeth slightly clear, allowing for central dominance

Discussion

Several tools, among which shade guides are the most traditional ones, are available and can help with the selection and description of colors of ceramic restorations. A downside of shade guides is that they are subjective, i.e., they can be influenced by lighting conditions or by the observer. An alternative to minimize errors and optimize the outcomes is the use of photographs combined with shade guides, as done in the present report. Photographs can be efficient and easily available as supplemental tools for clinicians and laboratory technicians [3, 7]. They provide detailed information about spots, hypoplasia, texture, and color map. It is paramount that the equipment be properly calibrated in order to replicate the color correctly [10]. Currently, spectrophotometers and colorimeters have been indicated as devices to make shade selection and communication with technicians more objective, quicker, and more accurate [3, 6, 8]; however, the cost of equipment is high.

In the case described herein, Vita 3D Master shade guide was used. Bayindir *et al.* [1] stated that Vita 3D generates a smaller amount of errors as compared to other traditional guides. This might be because this shade guide uses a selection that starts with value, followed by chroma, and finally by hue, unlike conventional shade guides, which prioritize hue and chroma and do not have a clearly defined value. Thus, this information on value may not have a favorable outcome for the final ceramic restoration.

In the case reported here, Vita 3D Master shade guide was photographed before preparation of the teeth to prevent their dehydration, which would result in a tooth with higher value and lower translucency [2]. The incisal area of the tooth on the shade guide should be positioned against the incisal edge of the tooth in the same plane so that the incident light from the flash can have the same intensity on both without increasing luminosity of one or of the other. In addition, the shade guide will be used as reference by the technician, since color (hue, chroma, and value) more often than not differs from that shown in the shade guide. Therefore, when the dentist is unsure, he/she can send the picture of the shade color he/she believes to be the nearest, as well as of the largest or smallest chroma, for reference. In the case reported herein, the photo with 2M2 and 2M3 shades was used as reference, and the photographed premolars and molars were used as reference for the color map in different tooth regions (cervical, middle, and incisal thirds). The photograph also allows assessing the peculiarities of the incisal third and the surface texture of the other teeth to be recorded. Hence, photography efficiently aids in the communication between dentists and technicians regarding the color of ceramic restorations [7, 10].

In the case of porcelain laminates, the lithium disilicate-reinforced ceramic is often chosen for its optical properties, with opalescence and fluorescence close to those of natural teeth [5]. Because of the relatively low refractive index of leucite and lithium disilicate, despite a relatively high crystal value, these materials are sufficiently translucent for restoration at the incisal third. Therefore, in the case reported here, veneer was applied for characterization of the translucency of incisal areas [4]. In the cervical region, extrinsic characterization was obtained with dyes to simulate the highest chroma, as mapped out at baseline. Extrinsic characterization of the ceramic is preferable at this third for not risking losing it later, as no further adjustment is made in the area. The texture was designed to simulate the reflectance pattern of the photographed adjacent natural teeth [2]. In the case of the adult patient reported herein, the teeth did not have clearly defined striations and lobes. Thus, the combination of application, and intrinsic and extrinsic characterization techniques allowed reproducing the anatomy and color appropriately, satisfactorily, and predictably for the restorations.

Conclusion

The protocol recommended for successful selection of the color of a porcelain laminate relies on the combination of:

- knowledge of concepts;
- resources such as shade guides, spectrophotometers, and photographs;
- and porcelain application and characterization techniques performed by the technician and luting techniques by the dentist.

Conflict of interest

The authors declare that there is no conflict of interest.

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