

Main Factors Affecting the Final Color of Ceramic Restorations



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Abstract

Nowadays, esthetic demands have been developed among the patients. Color is the crucial part of esthetic dentistry, and it is important to mimic the appearance of the adjacent natural teeth. Therefore, clinicians should know all the aspects related to the color and the factors which affect it. Ceramic restorations are considered as the treatment of choice in esthetic areas because of having no metal substructure. However, there are some difficulties in obtaining the desirable appearance with such restorations. It has been shown that several factors can affect the final color including cement thickness and color, ceramic thickness, abutments shade, and the number of firings. In the following, studies on the effective factors on the final color of ceramic restoration are presented and discussed.

Keywords: Esthetic dentistry; Ceramic restorations; Final color

Introduction

Color is one of the integral parts of esthetic dentistry that affects the satisfaction of patients with their restorations. Because of the complexity of the optical properties of the natural teeth, color reproduction is one of the most challenging issues which the clinicians encounter with [1]. Ceramic restorations are applicable in situations with high esthetic demands. They can mimic the appearance of the adjacent natural teeth. However, suitable shade match is not obtained readily even with these restorations. It has been shown that the ability of ceramic restorations to reproduce the desirable color depends on many factors including abutment shade, cement shade and thickness, ceramic thickness, ceramic brand, and the number of firings. In the present review, these factors are discussed and the studies conducted on them are presented.

Cement thickness

In addition to the esthetic advantages of ceramic restorations because of being free of metal and their translucency, there are some difficulties in situations with underlying discolored teeth and metal foundations [2]. Previous studies showed that the minimum ceramic thickness needed to mask the underlying substructure is

2mm [3,4]. It is not possible to provide such thickness in many cases and it is needed to choose an alternative option to achieve the masking ability. Manipulation of cement thickness and color is the chosen one [5]. There are various studies on cement shade and thickness. In a study done by Turgut et al. [6] the effect of resin cement on the final color of porcelain veneers (IPS Empress Esthetic) was evaluated. They stated that choosing suitable resin cement is the main element for achieving the desirable appearance. Another study by Niu et al. [7] assessed the effect of cement thickness and color on machinable lithium disilicate ceramics. It was shown that white opaque cements provide masking ability when the silver-palladium alloy is used and it results in desirable shade of final restorations of machinable lithium disilicate. In an in vitro study by Montero et al. [8] color stability of e.max ceramic was evaluated after bonding with various shades of cements. They showed that cement color is the main factor predicting the final color. Kurklu et al. [9] stated that changes in cement color causes color differences near or above color acceptability.

Ceramic type

Another factor which affects the final color is ceramic brands. Oh SH et al. [10] studied the effect of zirconia coping type on

the final color of zirconia restorations. They found a significant difference in various ceramic brands which is consistent with previous studies [11] Crispin et al. [12] stated that coping translucency is one of the primary factors influencing the color of all-ceramic restorations which depends on ceramic brands.

Ceramic thickness

Using multiple layers of porcelain with different translucencies and colors is necessary to obtain the desirable appearance [13]. Most of the ceramic restorations include combination of core and veneer thickness. Therefore, it seems that it is important to investigate the effect of the thicknesses on final color. There are several studies on core and veneer thickness. They can be categorized based on restoration type. In studies evaluated the effect of porcelain thickness on all ceramic thickness, it was shown that changes in ceramic thickness results in significant differences in color parameters [10,13-17]. In a study on monolithic zirconia, thickness affects the color significantly as well [18]. Some studies assessed the effect of veneer and core thickness separately, and they showed the similar findings [13].

Abutment shade

Sometimes, all ceramic restorations are indicated for non-vital teeth received root canal therapy and consequently cast post and core. In such condition, both restoration color and underlying tooth color are important factors [19]. Chaiyabutr et al. [3] studied the cumulative effect of the cement shade, ceramic thickness, and tooth abutment color on the final color of CAD/CAM lithium disilicate-reinforced crowns. They demonstrated that restorations with ceramic thickness of 1.5mm bonded with translucent cement and the restorations with a thickness of 1.0mm bonded with either opaque or translucent cement, resulted in color differences above the clinically acceptance threshold. Oh SH et al. [10] showed the significant effect of abutment shade on zirconia restorations.

Number of firings

Several studies have been conducted on the effect of the number of firings. Some of them demonstrated that repeated firings did not significantly influence the color of ceramic restorations [20-22]. Nevertheless, O'Brien et al. [23] found that ceramic restorations fired 3 and 6 times results in perceivable differences ($\Delta E=1$). Uludag et al. [17] reported significant changes in CIELAB parameters with increase in the number of firings. Ozturk et al. [14] assessed the effect of repeated firings on a shade of glass-infiltrated aluminum-oxide (In-Ceram) and Lucite-reinforced (IPS Empress) all-ceramic systems. They found that the number of firings (3, 5, or 7) affects the color parameters. They stated that the number of firings is an important element in obtaining adesirable shade match. It can be explained by the color stability of metal oxides during firing. Several studies have proposed that when particular metal oxides are exposed to firing temperatures, they will not be color stable [12,24,25]. Crispin et al. [12] and Lund and Piotrowski [25] reported that the least color stable at the firing temperatures suggested by manufacturers were yellow and orange hue stains. In Mulla and Weiner S [24], blue was

reported to be the least stable stain where as orange revealed the most stability at elevated firing temperatures.

Conclusion

Due to the importance of achieving the desirable appearance and color reproduction of natural dentition, several studies investigated the factors that can affect the final color of ceramic restorations. Regarding the cement thickness and color, ceramic thickness and abutment shade, studies have reported significant differences. Based on the number of firings, there was no agreement between the investigations. However, recent studies found that it can affect the final color. In general, it can be proposed that in order to achieve a good shade match in ceramic restorations, clinicians should consider all of these factors together.

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