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Research Article

The Effect of Veneer Thickness on Color Match of Discolored Teeth

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Abstract

Background: All-ceramic restorations are sometimes used to mask discolored teeth or restorative materials. A dark background may affect the final color of the restoration.

Aim: The aim of this study was to evaluate the required thickness of a glass ceramic restoration in order to mask a dark background and to study the effect of presence of a supporting framework.

Methodology: Lithium disilicate discs were prepared in different thicknesses (0.5, 1 and 1.5 mm) by cutting and milling a CAD-CAM block. 0.5 mm thick white zirconia discs were prepared in the same manner. Nine shades of discolored dentine-like polymer discs mimicking all possible background colors were prepared and used as took like replica. All color of all prepared ceramic discs was measured using a dental spectrophotometer the color was measured again when the discs were placed against the nine discolored dentine like background. Measurements were made with and without the zirconia discs (anatomical versus layered assembly). Delta E values were measured for all combinations.

Results: Discolored backgrounds influenced all combinations of ceramics except for the 1.5 mm thick low opacity glass ceramic discs and the 0.5 mm zirconia veneered with 1 mm glass ceramic discs.

Conclusion: Masking discolored backgrounds requires using thicker veneer sections in order to achieve the required color match.

Keywords: Veneer Thickness; Color Match; Ceramic Restorations; Zirconia

Introduction

In dentistry, color matching of natural teeth has been and is still one of our biggest challenges. That is because, color matching of dental restorations is one of the most critical elements of a successful esthetic outcome. The shift from metal-ceramic restorations to all-ceramic high strength restorations, has been a slow and constant evolution. The first ceramic to be introduced was alumina core, then leucite-reinforced glass ceramic, followed by lithium disilicate glass ceramics and zirconium oxide [1].

Monolithic CAD/CAM designed and milled solid zirconia restorations can be colored in the pre-sintered state for both pink and white esthetics. In addition, developments of monolithic lithium disilicate ceramic restorations, whether CAD/CAM or pressed, have shown impressive *in vitro* strength results with large choice of colored ingots and CAD blocks, with various translucencies. Color and dental ceramics has always established an important marriage to achieve the desired esthetic outcomes. Significant studies in research and development focused on optimizing color and translucency of esthetic restorations [2].

The final color of the restoration is affected by many variables including; thickness of the restoration-whether crown or veneer, the number of firing cycles of the ceramic material, the shade of the resin cement and its type, and finally the underlying structure as post, core or any build-up material [3-7]. For superior esthetic results, translucency of the used restorative ceramic materials must be of high value; in order to allow for vitality and individual characterization of the restorative material used [8]. For this purpose, most ceramic systems are supplied in different translucencies according to the clinical case requirements. It is been shown in literature that ceramics with high strength tend to be more opaque and thus lead to challenges when trying to match natural tooth color, but they can be used to mask discolorations when present. Since there are several variables that can affect translucency, of ceramic systems, it is difficult to compare translucency in terms of absolute values [9-11].

However, translucency is not always desirable. Depending upon the clinical situation, a balance between greater translucency and masking ability will be identified according to the remaining tooth

structure shade or presence of a core build up material. For this reason, the most appropriate porcelain systems can only be determined according nature of the supporting tooth [12]. The opacity of the conventionally available 3Y-TZP restorations is related to its larger grain size and the presence of ordered structure which is evident at micro-structural level of these materials [8]. This lead to the development of newer versions of zirconia with higher translucencies than the conventional one; so that they can be used in esthetically demanding clinical situations. Studies done on this new version of translucent zirconia, showed that they not only have higher translucency than conventional zirconia, but also two-thirds more flexural strength than lithium disilicate- based ceramics [7].

It is been shown that slight changes in ratios between translucent porcelain and opaque porcelain; resembling tooth enamel and dentin respectively, would influence the ability to achieve final color match of the final restorations [13]. However, up till now there is no method to predict the exact outcome based on consideration of luting agent and background color [14]. Controlling the thickness adds another difficulty especially when the supporting tooth is discolored. The aim of this study was to detect the effect of thickness of glass ceramic material on its masking potential of a discolored tooth.

Materials and Methods

Leucite-reinforced glass ceramic A2/LT shade (IPSEmpress CAD, ivoclar vivadent) was used as the restorative ceramic in the study. Empress CAD blocks were sectioned into different thicknesses using a precision cutting device (Isomet 1000, Buehler; Lake Bluff, IL, USA). Thicknesses obtained were 0.5 mm, 1 mm, 1.5 mm of 0.5 mm thick discs were obtained from zirconium oxide blocks (IPSEmpress Zir CAD, ivoclar vivadent).

Preparation of the background

Nine shades of the natural dentine die material (Natural dentine, ivoclar vivadent) were prepared into 5 mm thick disks by incremental packing and light polymerization using a high-intensity (1200 mw/cm^2) LED curing unit (Bluephase, soft start mode, ivoclar vivadent).

Color measurement procedure

The light black scale (L value), the yellow green scale (a value), and the blue red scale (b value) were used to analyze color measurements of each specimen. Color parameters (L*a*b) of the target shade (A2 shade Empress CAD) and each of the nine colored dentine discs were measured three times with a spectrophotometer (vita Easy shade) to establish the median value. Next, each ceramic disk had its color parameters measured after being placed over the disks of natural dentin dies as a background. The same procedure was repeated for each thickness successively and finally after addition of 0.5mm zirconia discs. Color difference between target color shade and the shade obtained from each test group was determined using the ΔE equation: $[(L1-L2)^2+(A1-A2)^2+(B1-B2)^2)]^{1/2}$.

Color differences leading to ΔE values less than 2.6 were considered clinically as indistinguishable (perfect match), those between 2.6 and 3.3 as clinically acceptable, and values more than 3.3 as clinically distinguishable (mismatch). In this study, ΔE values between target color and color of the ceramic placed over different background were used to interpret the findings.

Results

The thickness of veneer ceramic had a significant effect on the color of glass ceramic materials. 0.5 mm thick glass ceramics were affected by the color of the used underground (Figure 1 and Table 1). Increasing the thickness of glass ceramic to 1 mm improved color match compared to 0.5 mm thick discs but decreased the influence of the underlying background (Figure 2 and Table 2). Starting from a thickness of 1.5 mm, the effect of background was started to decrease as indicated by lower delta E values (Figure 3 and Table 3). Presence of zirconia framework under 1 mm thick glass ceramic discs was the only group which produced perfect color match (Figure 4 and Table 4).

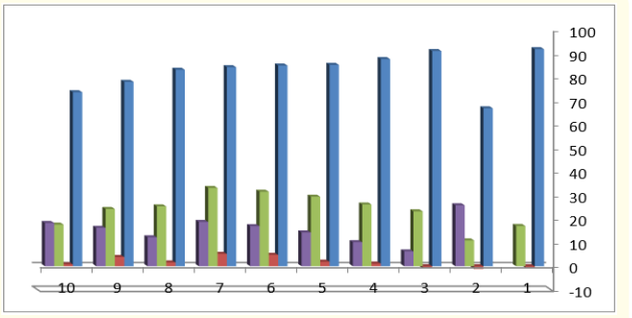

Figure 1: Lab values of 0.5 mm thick glass ceramic disks against nine shades of discolored dentine dies.

Background	Thickness	L	A	b	ΔE
White background	0.5	91.8	-0.6	17	
Dark background	0.5	66.8	-1.2	10.9	25.7
ND1	0.5	91	-0.9	23.2	6.3
ND2	0.5	87.6	1.1	26.1	10.2
ND3	0.5	85.2	1.9	29.4	14.3
ND4	0.5	84.9	4.8	31.5	16.9
ND6	0.5	84.2	5.2	33.1	18.7
ND7	0.5	83.1	1.6	25.3	12.2
ND8	0.5	78	3.9	24.2	16.2
ND9	0.5	73.6	0.8	17.6	18.3

Table 1: Lab and ΔE values for 0.5 mm ceramic disks against nine discolored shades of dentine.

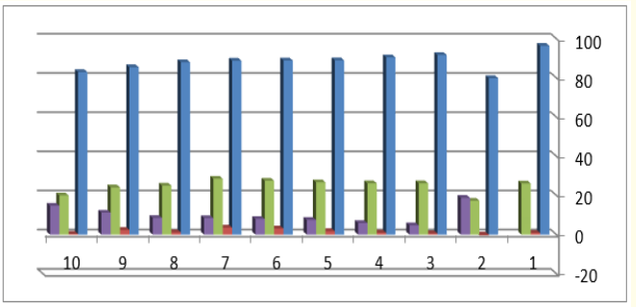

Figure 2: Lab values of 1 mm thick glass ceramic disks against nine shades of discolored dentine dies.

Background	Thickness	L	A	b	delta E
White background	1	96.4	0.9	26.1	
Dark background	1	79.9	-0.4	17.3	18.7
ND1	1	91.7	0.6	26.2	4.7
ND2	1	90.5	1	26.2	5.9
ND3	1	89	1.8	26.7	7.5
ND4	1	88.9	3.1	27.5	7.9
ND6	1	88.8	3.6	28.5	8.4
ND7	1	88	1.2	25	8.5
ND8	1	85.5	2.4	24.1	11.2
ND9	1	83	0.4	20	14.7

Table 2: Lab and ΔE values for 1 mm ceramic disks against nine discolored shades of dentine.

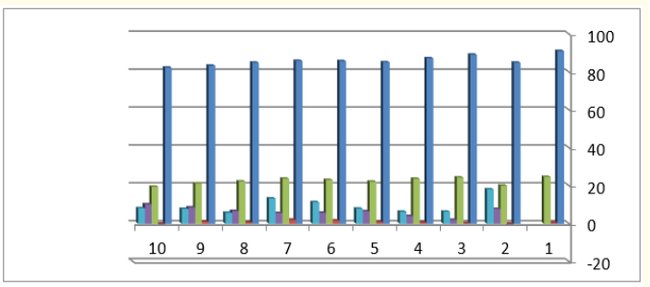

Figure 3: Lab values of 1.5 mm thick glass ceramic disks against nine shades of discolored dentine dies.

Discussion

Several clinical conditions require masking a darkened tooth or core material using glass ceramic restorations. Glass ceramics are characterized by high translucency which compromises the final shade when cemented on such dark backgrounds. Two variables have great effect on final color match, translucency and thickness [10,15]. Color measurement indicated that glass ceramics failed to

Background	Thickness	L	A	b	delta E
White background	1.5	91	0.4	24.6	
Dark background	1.5	84.9	-0.6	20	7.7
ND1	1.5	89.1	0.2	24.3	1.9
ND2	1.5	87.2	0.6	23.6	3.9
ND3	1.5	85.1	0.8	22.1	6.4
ND4	1.5	85.7	1.6	23	5.7
ND6	1.5	85.8	2	23.7	5.5
ND7	1.5	84.9	0.6	22.2	6.6
ND8	1.5	83.3	1	21.1	8.5

Table 3: Lab and ΔE values for 1.5 mm ceramic disks against nine discolored shades of dentine.

Background	Thickness	L	a	b	delta E
White background	1 mm ceramic + 0.5 mm zirconia	99.4	-0.2	26.4	
Dark background	1 mm ceramic + 0.5 mm zirconia	97.7	-0.5	25.2	2.1
ND1	1 mm ceramic + 0.5 mm zirconia	98.5	-0.2	26.8	1.0
ND2	1 mm ceramic + 0.5 mm zirconia	98.5	-0.1	26.3	0.9
ND3	1 mm ceramic + 0.5 mm zirconia	98.4	0	26.5	1.0
ND4	1 mm ceramic + 0.5 mm zirconia	98.2	0	26.1	1.3
ND6	1 mm ceramic + 0.5 mm zirconia	98.1	0.2	26.6	1.4
ND7	1 mm ceramic + 0.5 mm zirconia	98.1	-0.2	25.8	1.4
ND8	1 mm ceramic + 0.5 mm zirconia	97.7	-0.1	25.7	1.8
ND9	1 mm ceramic + 0.5 mm zirconia	98	-0.3	25.7	1.6

Table 4: Lab and ΔE values for 0.5 mm ceramic disks layered on 0.5 mm zirconia against nine discolored shades of dentine.

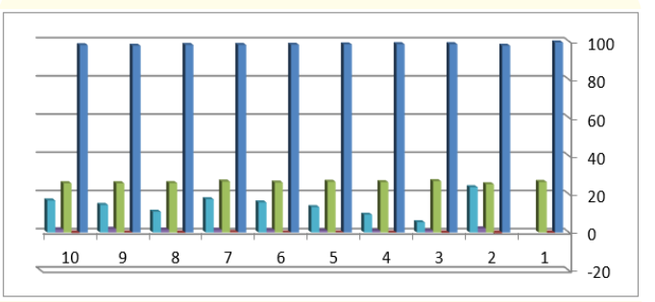

Figure 4: Lab values of 0.5 mm thick glass ceramic disks layered on 0.l5 mm zirconia disc against nine shades of discolored dentine dies.

mask dark backgrounds with a thickness below 1.5 mm [7]. Presence of an opaque zirconia framework layered by 1mm thick glass ceramic successfully produced perfect color match.

Accurate design of multilayered restorations is a crucial factor controlling final shade and translucency, starting from the type of glaze, thickness of enamel layer, type of dentine, and structure of framework material [16]. A thin glass ceramic restoration as veneers or thin crowns provide a great challenge for the dentist who will promise his patient a final color meanwhile the expected color may vary due to penetration of background color through the thin ceramic layer [17]. A simple correlation should be available to allow selection of proper shade and color of veneer ceramic that when placed on the discolored tooth background results in creating the required color [18]. Presence of an opaque zirconia framework simplifies color prediction as it will greatly mask the color of the underlying tooth. When veneered with 1 mm thick veneer ceramic, the target color could be achieved even against dark metallic backgrounds [2].

Further studies are needed to investigate the correlation between translucency and thickness of veneer ceramics and final color of the restoration. Such index could help dentist select the required material type and predict the final color of the restoration.

Conclusions

In clinical situations requiring masking of underlying tooth structure, thin glass ceramics are not the materials of choice to be used. Zirconium oxide opacity aided in optimizing color match.

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