

The effect of coloring liquids on the translucency of zirconia framework

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PURPOSE. Translucency of all-ceramic restorations is an important factor which affects the final appearance and esthetic outcome of the restoration. The aim of this study was to evaluate the effect of the shade of coloring liquid on the translucency of zirconia framework. **MATERIALS AND METHODS.** Thirty zirconium oxide core plate (15 × 12 × 0.5 mm) were divided into 6 groups of 5 plates each. Each group was classified according to the shade of coloring liquid based on Vita Classic Scale (A2, A3, B1, C2, and D2), and each sample was immersed in coloring liquid for 3 seconds as recommended by the manufacturer, except for the control group. Contrast ratio, as a translucency parameter, was calculated using a spectrophotometer and the data were analyzed with one-way analysis of variance (ANOVA) and Tukey's honestly significant differences (HSD) tests ($\alpha=.05$). **RESULTS.** Significant differences in translucency among the control and test groups, and the B1 shaded group and other shades was observed. There were no significant differences among A2, A3, C2, and D2 shaded groups. **CONCLUSION.** The translucency of the zirconium oxide cores was affected by the coloring procedure and significant differences in the translucency measurements were identified between specific shades. [*J Adv Prosthodont 2013;5:448-51*]

KEY WORDS: Coloring; Shaded zirconia; Translucency

INTRODUCTION

Although metal ceramic restorations have favorable characteristics, the opaque structure of the metal framework, metal reflection in the gums, metal allergies, and corrosion problems related to non-precious metals lead clinicians to use all-ceramic restorations for their patients. Coinciding with the increasing demands for esthetically pleasing and natural-looking restorations, all-ceramic restorations have gained popularity.^{1,2}

When compared to metal-ceramic restorations, all-ceramic restorations are more acceptable in terms of translucency. The metallic framework and overlying opaque porcelain of metal ceramic restorations can decrease the translucency significantly. Compared to natural teeth which have high translucency, metal ceramic restorations can only absorb or reflect the incoming light.³ Due to their high flexural strength, some all-ceramic systems can be used for posterior restorations. However, strengthening these materials by increasing the crystalline content could decrease the translucency.⁴⁻⁷

Considering dental ceramics, the amount of absorbed, reflected, and transmitted light are dependent on the crystalline structure of the core material. It has been observed that the particle size similar to the wavelength of light would be the most important reason of scattering event, while larger particles reduce the overall number of particles in a given volume and decrease the scattering effect (decreasing opacity).⁸ Zirconia particles have a slightly bigger size than the wavelength of visible light and also have different refractive indexes than zirconia matrix. These dispersed particles throughout the matrix give rise to maximal scattering effect and opacity, thus zirconium oxide has an

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opaque appearance.⁸

Although zirconia frameworks are esthetically more favorable than metal frameworks, the opaque and whitish appearance are still undesirable. For this reason, zirconia framework can be colored to achieve more natural and favorable color match. The main advantage of zirconia ceramics is their ability to reflect the intended color, beginning with the inner layer, as seen in the dentin and enamel structure of natural teeth.

Optical properties such as light transmittance and reflectance have important roles in the aesthetics of restorations,⁴ and the translucency of the material can ensure a lifelike and natural appearance of the restorations.⁹ Materials with higher translucency can be used to imitate lightly shaded natural teeth while materials with lower translucency should be used in order to imitate or mask more darkly shaded teeth.^{10,11} The translucency of the porcelain is generally dependent on light scattering characteristics.¹² As the scattering and reflectance of the light increases, the material will look more opaque. Lower reflectance and higher transmission of light increase the translucent characteristics of the material.¹³

The aim of this study was to evaluate the effect of the shade of coloring liquid on the translucency of zirconia framework. The null hypothesis to be tested was that there are not any significant differences in translucency among zirconia core ceramics colored with different shades of coloring liquid.

MATERIALS AND METHODS

A yttrium partially stabilized green-stage zirconium dioxide block (ICE Zirkon, Zirkozahn GmbH, Gais, Italy, Lot: ZB0061D) was sliced using a slow-speed diamond saw (Isomet wafering blades, Buehler, IL, USA) and a precise cutting machine (Mecatome T1800, Presi, Grenoble, France) into rectangular plate slices of 0.5 mm thick, and all slices were carefully measured using a digital caliper (500-784, Mitutoyo Co., Kawasaki, Japan) to ensure similar thicknesses.

The samples were divided into 6 groups of 5 samples each, and each test group was colored with different shades of coloring liquid (Color Liquid for ICE Zirkon, Zirkozahn GmbH, Gais, Italy, Lot: CB0382B, CB00025B, CA9257A, CB0242B, CB0254B) according to the Vita Classic Scale: A2, A3, B1, C2, and D2 (Vita Zahnfabrik, H Rauter GmbH & Co., Bad Sackingen, Germany). Each test group (except the control group) was immersed into the coloring liquid using plastic tweezers and held for 3 seconds as recommended by the manufacturer, and then dried under a heating lamp (Zirkonlampe 250, Zirkozahn GmbH, Gais, Italy) for 30 minutes. After coloring, all of the samples were sintered at 1500°C in a sintering furnace (Zirkonofen 600 V/2, Zirkozahn GmbH, Gais, Italy) following the protocol. The temperature was raised up to 1500°C for 3 hours and maintained for 2 hours before cooling (Fig. 1).

Lightness values were measured relative to the standard illuminant D65 in the reflectance mode over a white and

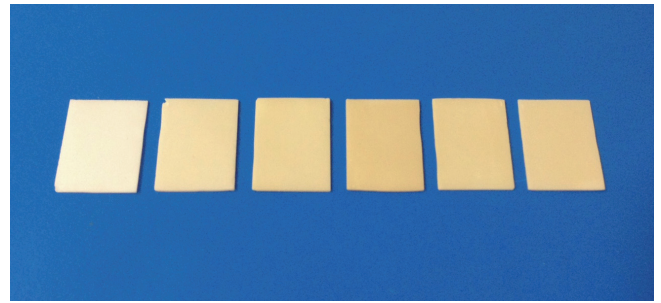


Fig. 1. Shaded zirconia samples before testing.

black background on a spectrophotometer (VITA Easyshade Compact, Bad Sackingen, Germany) with the specular component excluded (SCE) mode. Three measurements were made over a white backing (L^*w) and a black backing (L^*b). Contrast ratio (CR) was calculated as a translucency parameter with the following equation:

$$CR = L^*b/L^*w$$

L^*b : luminance flux of the material on a black surface

L^*w : luminance flux of the material on a white surface

CR value towards unity corresponds to opaque materials and towards zero to transparent materials.¹³

All of the values were calculated as mean \pm standard deviation for all of the evaluated factors using the SPSS software version 10.0 (SPSS Inc., Chicago, IL, USA). The obtained data were analyzed by using the one-way ANOVA and Tukey's HSD tests for pairwise comparisons among the groups ($\alpha=.05$).

RESULTS

The results of the mean translucency values of the differently colored zirconia cores are shown in Table 1. The one-way ANOVA test revealed that the translucencies of the zirconium oxide cores were affected by the coloring procedure. A significant difference in translucency between the control and test groups, and B1 shaded group and other shaded groups was observed. However, there were no significant differences among the A2, A3, C2, and D2 shaded groups.

Table 1. Means and standard deviations (SD) for core contrast ratios

Core material	Mean	SD
Control	0.74 ^a	0.0062
B1	0.76 ^b	0.0074
D2	0.78 ^c	0.0072
A3	0.78 ^c	0.0046
A2	0.78 ^c	0.0048
C2	0.78 ^c	0.0058

Means with the different letter indicate significantly different groups based on Tukey's HSD test. $P>.05$

DISCUSSION

The effect of the different shade of coloring liquid applications on the translucency of zirconia frameworks was evaluated in this study. The null hypothesis that different shades of coloring liquids would not affect the translucency of zirconia frameworks was rejected. The results in this study showed that coloring liquids could affect the translucency of zirconia frameworks.

The translucency of ceramic frameworks affects the overall esthetics of these restorations, and it has been shown that the translucency of dental ceramics can be affected by firing cycles, crystalline structures, and the thickness of the restoration.^{8,13-17} Due to their crystalline structure, zirconia ceramics have a high flexural strength, but this structure increases the opacity of the material.⁴⁻⁷ Heffernan *et al.*¹⁷ evaluated and compared the translucency of structurally different all-ceramic frameworks with clinically recommended thicknesses. The researchers used a spectrophotometer to determine the contrast ratio (CR) in order to evaluate the translucency of these specimens. In their study, In-Ceram Zirconia specimens showed similar opacities to the metal-ceramic specimens, with a value of 1.00 CR. When the results of the present study are compared with that study, it can be seen that those samples reveal a higher degree of translucency than the samples in the present study. While the refractive index and the crystalline content of the matrix affect the scattering of light⁸; the different crystalline structures of the In-Ceram Zirconia frameworks may be the reason for the different degrees of translucency. According to the results of the similar study by Heffernan *et al.*¹⁷, the IPS Empress 2 specimens with clinically recommended thickness (0.8 mm) showed a CR value of 0.74, which is identical to the mean CR value in control group (0.5 mm) from the present study. It could be concluded that the clinically recommended thicknesses of the IPS Empress 2 and zirconia frameworks had the same translucency values when the colorless zirconia framework was used.

Liu *et al.*¹⁸ reported that if the differences in the CR values are equal to or greater than 0.07, they can be clinically perceived by the naked eye. In the present study, the differences in the CR values of the tested groups were lower than 0.07, therefore it can be concluded that the differences among the CR values of the tested groups in the present study cannot be clinically perceived. Spyropoulou *et al.*¹⁹ investigated the CR values of 3 different shades of Procera zirconia samples at 0.6 mm thickness and the reported values ranged from 0.877 to 0.885. When those CR values were compared with the results of the present study, the differences could be considered as clinically perceivable. These differences could be a result of the production procedure of the frameworks, or differences in sample thicknesses.

Heffernan *et al.*¹⁷ compared the CR values of different kinds of ceramic restorations, including metal-ceramic, all-ceramic and zirconia-ceramic, and he recorded CR values

of the metal-ceramic as 1.00. When the results of present study are compared with the findings of that study, the CR value of the zirconia-ceramic is lower than the metal-ceramic, which explains why the zirconia restorations are so similar to natural teeth.

During the preparation of the specimens for the present study, no layering ceramic was applied on the zirconia framework, and furthermore, only a single type of ceramic system and one limited ceramic thickness were tested. These factors can be listed as the limitations of the present study. For more appropriate comparison among ceramic systems, veneered zirconia specimens with different shades should be fabricated with clinically recommended thicknesses.

CONCLUSION

Within the limitations of this study it can be concluded that the coloring procedures can decrease the translucency of zirconia frameworks and this effect of coloring liquids should be taken into consideration during the fabrication of restorations with zirconia framework.

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