Original Article

The Translucency Effect of Different Colored Resin Cements used with Zirconia Core and Titanium Abutments

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ABSTRACT

Purpose: The purpose of this study was to evaluate the effect of the different color of resin cements and zirconia cores on the translucency parameter (TP) of the restoration that simulates the implant-supported fixed prosthesis using titanium base on the bottom. Materials and Methods: Zirconia core plates (Zr-Zahn) were prepared in A2 shades (n = 11). Resin cement plates (3M ESPE) were prepared in A2, A1, translucent (TR) shades (n = 11). The initial color measurements and were measured on zirconia core plates, and resin cement plates using a spectrophotometer. Then, the resin cement plates were placed below the zirconia core plates, and the second measurements were done. The final measurements were done after placing the titanium discs in the bottom. The data were analyzed with two-way analysis of variance and Tukey honestly significant differences tests (α = 0.05). Results: The highest TP values were recorded for A1-colored resin specimens and the lowest for zirconia core plates in the first measurement (P < 0.05). The addition of zirconia core decreased the TP values in all tested resin cement groups (P < 0.05). The highest TP value was recorded for A1-colored resin cement with zirconia core plates and the lowest for A2 and TR with zirconia core plates after second measurements (P < 0.05). The addition of titanium decreased the TP of the zirconia core plate and resin cement combination (P < 0.05). Conclusions: The addition of a zirconia core under the resin cement dramatically reduced the TP values, and the presence of a titanium layer decreased the TP value and caused a darker appearance.

KEYWORDS: Resin cement, titanium, translucency, zirconia

INTRODUCTION

There are several materials used to make fixed prostheses such as all ceramic, zirconia, and metalceramic mixtures. All these prostheses have different physical, mechanical, and esthetic properties. One of the critical success factors in the rehabilitation of a lost tooth in the anterior region is the color.4 Color is the major consideration from an esthetic point of view since it gives the prosthesis an appearance that matches the adjacent teeth which makes it look very natural. With the correct color match, an outstanding esthetic result can be achieved. Technically, the color of the prosthesis depends on variations in ceramic materials as well as the metallic or zirconia core material. The characteristic colors of the prosthetic materials are affected by their translucency.1,5-9

The translucency parameter (TP) can be explained as the state of a material that allows some light to pass through it and which will result in opacity if no light is passed and transparency if all available light is passed through it.1,10,11 Although allceramics are translucent, metalceramics are opaque. In addition, zirconia ceramics are semi-translucent, which means that the color of the underlying tooth or abutment and/or the thickness and color of the luting agent have an influence on the final color.6 The increase of the TP in zirconia core material will increase its translucency which will, in turn, enhance its esthetic properties. However, this material should...
be used with caution when used in discolored teeth, natural teeth with metallic posts, and implanted metallic abutments. With increased translucency, masking ability will decrease, and the color of the metal abutment will be more visible from the surface of the restoration.[12,4,12]

The color of the luting cement affects the final color of the restoration, as with zirconia ceramic restoration, due to its semi-translucency qualities.[6] Manufacturers suggest that zirconia ceramic restorations can be cemented successfully with either conventional or adhesive cements. Since both types of luting cements have different optical properties, their translucency values may also differ.

The zirconia ceramic material is more translucent, the resin cement under the material becomes more noticeable. The different colors of the luting cement will affect its TP. The effect of the luting cement on the final color of the restorations has not been fully researched as of this date.[13] Several studies have evaluated the masking ability of various luting cement materials used with full ceramic restorations. Still, there is not enough research on their influence on the final color, due to their translucency when used with zirconia ceramic.[1,2,6,22-24]

The TP is most commonly used to measure the translucency of dental materials and is calculated directly from the color difference of specimens when measured on a black and a white background.[15-20] The color of the background substrate influences the final color of the ceramic specimen because of its translucency.[12] A TP value of zero corresponds to a completely opaque material. An increasing TP value indicates an increasing translucency. As a result of the higher TP value, the material is more translucent (TR).[9-11,21]

Color difference and TP are measured with a spectrophotometer which provides light. That light penetrates into the material that is measured, travels through the material, and is reemitted or absorbed. Some of the photons that are reemitted follow pathways leading outside of the window area, and this results in a mathematical measurement that corresponds to a visual perception as color.[2,6,22-24]

The purpose of this study was to measure the TP of the resin cement that is used to lute the zirconia core onto the gray-colored metallic abutment using spectrophotometer. The first research hypothesis tested was that there are no differences in the TP values of different colored resin cements. The second hypothesis tested was that the addition of a zirconia core does not affect the TP values. The third hypothesis tested was that there are no differences in the final color of the restoration when a zirconia core was cemented with different colored resin cements on gray-colored titanium abutments.

**Materials and Methods**

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

Eleven zirconia (Zr) core plates (10 mm in width, 5 mm in length and 0.5 mm in thickness) were fabricated, and each sample was colored with A2 shades of coloring liquid (Color Liquid for ICE Zirkon, Zirkonzahn GmbH, Gais BZ, Italy, Lots: CB0382B, CB00025B, CA9257A, CB0242B, CB0254B) according to the Vita Classic Shade Guide: A2, (VitaZahnfabrik, H Rauter GmbH and Co., BadSackingen, Germany). Each sample was immersed in the coloring liquid using plastic tweezers, held for 3 s, as recommended by the manufacturer, and then, dried under a heating lamp (Zirkonlampe 250, Zirkonzahn GmbH, Gais BZ, Italy) for 30 min. After coloring, all samples were sintered at 1,500°C in a sintering furnace (Zirkonofen 600 V/2, Zirkonzahn GmbH, Gais BZ, Italy) following the protocol. The temperature was raised to 1,500°C for 3 h and maintained for 2 h before cooling.

Resin cement plates; (RelyX-U200 or RelyX-Ultimate; 3M-ESPE, St. Paul, MN, USA) 10 mm in width, 5 mm in length, and 0.4 mm ± 10 μm in thickness were prepared in A1, A2, or shades (n = 11). Silicone molds were used for the production of the resin cement plates to maintain the same plate size. After calibrating the desired thickness, the two resin cements were mixed according to the manufacturers’ instructions, applied in the silicone molds, and covered with a Mylar matrix (no. 687, Hawe Neos, Bioggio, Switzerland). Each sample was colored with A2 shades of coloring liquid (Color Liquid for ICE Zirkon, Zirkonzahn GmbH, Gais BZ, Italy, Lot: ZB0061D) was sliced by a precise cutting machine (Mecatome T1800, Presi, Grenoble, France) using a diamond wafering blade (Isomet, Buehler Co., Lake Bluff, IL, USA) into rectangular plate slices 0.5 mm thick, and all slices were carefully measured using a digital caliper (500-784, Mitutoyo Co., Kawasaki, Japan). The accuracy of the micrometer was ±10 μm. Each finished plate was measured 3 times, and the mean thickness was calculated and standardized.

The initial TP measurements were done individually on the zirconia core plates and the resin cement plates using a spectrophotometer (CM 2600d, Konica Minolta Inc., Tokyo, Japan). Then, the resin cement plates were placed under the zirconia core plates, and second
measurements were taken. Before the measurements, the airspace between the zirconia and resin cement plates was minimized by smoothing the interacting surfaces. Four resin cement plate groups made of two resin cements (RelyX-U200 or RelyX-Ultimate) were created, and each group consisted of two colors (RelyX-U200, Shades: A2, TR; RelyX-Ultimate, Shades: A1, TR).

Each resin cement plate was used as a background for the zirconia plates without additional adhesive during the TP measurements. These measurements were performed by positioning the flat surface of the spectrophotometer against the center of the flat zirconia surface of each cement plate’s assembly. The final measurements were done after placing the titanium disks (5 mm in diameter, 3 mm in height) at the bottom of the plates to simulate implant abutments. This three-layered assembly mimics the final restorations.

The TP values were calculated directly from the color difference of specimens measured on a black background and a white background. All of the values were calculated as mean ± standard deviation. The data were analyzed with the analysis of variance and Tukey honestly significant differences test ($\alpha = 0.05$).

**RESULTS**

In the first measurement, the highest TP values were recorded for A1-colored resin specimens and the lowest for the zirconia core plates ($P < 0.05$). There were no statistically significant differences between the two different TR-colored resin cements ($P > 0.05$) and the A1- and A2-colored resin cements ($P > 0.05$). However, the TP values of A1 colored specimens were higher than the TR ones ($P < 0.05$). The TP values of all groups tested are shown in Table 1.

The addition of the zirconia core decreased the TP values in all tested resin cement groups ($P < 0.05$). In the second measurements, the highest TP value was recorded for the A1-colored resin cement and the lowest for the A2 and Ultimate-TR with the zirconia core plates ($P < 0.05$). There were no statistically significant differences between the A1 and U200-TR colors in zirconia groups ($P > 0.05$); however, there were statistically significant differences between the A1 and Ultimate-TR colors ($P < 0.05$).

The addition of titanium decreased the TP of the zirconia core plate and resin cement combinations ($P < 0.05$). There were no statistically significant differences in TP values among the different colored resin cements when titanium was added as the base material ($P > 0.05$).

**DISCUSSION**

This study evaluated the effect of different colors of resin cements (self-adhesive and adhesive resin cement) and zirconium cores on the final color of the restoration that simulates the implant-supported fixed partial dentures using a titanium base. There were statistically significant differences in TP values among the different colored resin cements. On the basis of these data, the first research hypothesis that there are no differences in TP values of different colored resin cements was rejected. The addition of the zirconia core dramatically reduced the TP values, so the second hypothesis that the addition of a zirconia core does not affect the TP values was also rejected. The final TP value of the restoration was measured with the addition of a gray-colored titanium abutment in the third measurements. The addition of titanium decreased the TP of the zirconia core plate and resin cement combinations. Therefore, the third hypothesis that there are no differences in the final color of the restoration when the zirconia core was luted with different colored resin cements on gray-colored titanium abutments was accepted.

For a single crown, studies have shown that the metal or zirconia core must be at least 0.5 mm or 0.7 mm thick in areas of high stress.$^{[14,24,25]}$ In parallel with those studies, a 0.5 mm zirconia core thickness was used in the present study. The use of disc-shaped specimens allowed for better control of the thickness of the different layers. The flat surface obtained also allowed the spectrophotometer to measure more precisely and that resulted in more reliable color measurements.$^{[4,26,27]}$

Zirconia has been reported to possess the highest mechanical properties among dental ceramics.$^{[25,26,28]}$ Although there is no consensus, it is accepted that the highly dense microstructure of zirconia commonly results in a rapid reduction in translucency. Baldissara et al.$^{[14]}$ recently compared the translucency of several zirconia cores and demonstrated that they all allowed light to pass through the material to some degree.$^{[29]}$

<table>
<thead>
<tr>
<th>Study groups</th>
<th>U200-TR</th>
<th>U200-A2</th>
<th>Ultimate-TR</th>
<th>Ultimate-A1</th>
<th>Zirconia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>28.32±1.98$^a$</td>
<td>30.90±2.82$^{a,b}$</td>
<td>29.31±4.26$^b$</td>
<td>32.97±3.27$^b$</td>
<td>12.54±0.69$^b$</td>
</tr>
<tr>
<td>Cement + zirconia</td>
<td>6.48±0.98$^{a,b}$</td>
<td>6.21±0.38$^b$</td>
<td>6.21±0.44$^b$</td>
<td>7.02±0.76$^a$</td>
<td>0.30±0.20$^d$</td>
</tr>
<tr>
<td>Cement + zirconia + titanium</td>
<td>0.12±0.05$^c$</td>
<td>0.48±0.39$^d$</td>
<td>0.30±0.20$^d$</td>
<td>0.52±0.77$^d$</td>
<td>12.54±0.69$^b$</td>
</tr>
</tbody>
</table>

Groups in the same row with the different letters show statistically significant differences ($P<0.05$)
In fact, studied the optical effect of composite resins on different colored resin cements. However, to date, there are no published standards for resin cement shade classification. The results of the present study show that cements of the same shade exhibit different color parameters. It has been reported that resin cement systems of the same shade exhibit different color parameters. However, those studies showed that this effect was not significant, but several others suggested that the type or color of cements have the ability to mask the underlying tooth color. Therefore, it is important to understand the coloration results of ceramic-resin bonding the crown to the prepared tooth and modifying the final restoration color and masking the underlying titanium color. The presence or absence of a metal core material on the final color of the zirconium oxide core material on TP values, the thickness of resin cement thickness has a significant effect on the TP values. In the current study, to compare the effect of different colored resin cements on TP values, the thickness of resin cement thickness was 0.4 mm, which was not applied and not tested in the study. Second, veneering material directly with clinical studies. First, veneering material performance with different core and veneering porcelain showed the reflection of incident light by a dark metallic structure. The clinical and artificial light sources reflect different light intensities, and the structure at the interface of zirconia ceramics, human dentine, and bovine dentine. J Dent 2012;40 Suppl 2:e34‑40. The results of the current study showed no statistically significant differences in the TP values of two different colored resin TR resin cements. In addition, there were also no significant differences in the TP values of two different colored resin cements. This could be the result of them having almost the same amount of filler contents. Within the limitations of the study, the following conclusions can be made: 1. Different colored resin cements showed different outcomes. By mixing cements, a clinician may be able to adjust the color of the restoration. 2. The addition of a zirconia core under the resin cement dramatically reduced the TP values in the same thickness. 3. The translucency effect of different colored resin cements showed the reflection of incident light by a dark metallic structure. Similarly, A1 and A2 shades had different L*, a*, and b* values. The white opaque and TR shades do not match. In terms of opacity or translucency, in the CIELAB system, the white opaque and TR shades do not match. First, TP values of different colored resin cements are not significantly different from each other. However, third, the resin cement thickness was 0.4 mm, which was not applied and not tested in the study. Second, the presence of a zirconia core material on the final color of the zirconium oxide core material on TP values, the thickness of resin cement thickness was 0.4 mm, which was not applied and not tested in the study. Third, the resin cement thickness was 0.4 mm, which was not applied and not tested in the study.