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Research Article

Influence of Cement Type on the Color Stability of Aged Laminate Veneer Ceramics of Two Different Thicknesses

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Abstract

Objectives: To assess the influence of cement type on the color stability of aged laminate veneer ceramics of two different thicknesses.

Material and Methods: A forty PMMA die material constructed simulating a prepared central incisor to receive a labial veneer. The materials of construction investigated were ultra-translucent zirconium and HT E-max shade A2 of two different thicknesses. The veneers were cemented by two cements light cured and dual cured translucent shade. ΔE was evaluated then, all of the specimens were aged at 7000 cycle between 5°C -55°C then immersed in coloring solution of different PH values. ΔE values then, measured after aging.

Results: Results was statistically analyzed at $P < 0.05$ using T-test showed that no significance effect as regarding type of cement at ($P \geq 0.05$). As regarding type of material there was no significance at ($P > 0.05$). A significant values of ΔE was recorded ($p \leq 0.05$) as regarded the two studied thicknesses (0.5 mm and 0.8 mm).

Conclusions: Thicknesses of ceramic has significant effect on ΔE. Aging has significant effect on thinner thicknesses of ceramic. The ΔE decreases when the thicknesses increase. No clinically differences were found between all recorded ΔE values as it was less than 3.

Keywords: *All Ceramics; Laminate Veneer; Color Stability; Aging; Resin Cement*

Abbreviations

ΔE: The Color Difference; a*: Red-green Axis; b*: Blue-yellow Axis; L*: Lightness; CAD/CAM: Computer Aided Design/Computer Aided Manufacturing; PMMA: Poly Methyl Methacrylate; mm: Millimeter; CIE: Commission International de L'Eclairage (International Commission on Illumination)

Introduction

Color is undoubtedly one of the parameters with the greatest weight when patients judge the quality of their restorations, above all in the anterior region of the mouth [1]. With improvements in dental ceramics and resin cements, various treatment options have become available for anterior teeth, and interest in esthetic restoration is increasing [2]. An important concern regarding the cementation step is to ensure optimal polymerization of the resin cement, since this influences its long-term color stability [3]. Discoloration of the cement layer may adversely affect the final color of all ceramic restorations with time [3]. Cement discoloration is usually associated with degradation of the unreacted polymer matrix during the polymerization and to extrinsic factors [4,5].

Turgut S., *et al.* (2011) experimented color stability of laminate veneers and effect of resin cement. He stated that resin cements are indicated for bonding of veneer restorations due to the low amount of retention of conservative preparations. He used UV ageing to test significant color change on ceramics and also cemented ceramics ($p < 0.05$). Discoloration was between 0.8 - 1.2 ΔE for ceramic discs and 1.4 - 3.1 ΔE for cemented ceramics. There is no significant difference on the color change of dual or light cured resin cements, which were polymerized beneath the porcelain substructure with 0.5 mm thickness [6].

Mohammed Q., *et al.* (2012) studied the effects of different shades of resin luting cement on the color of ceramic veneers. The purpose of this study was to quantitatively evaluate the effects of different shades of light-polymerized resin cement on the color of two different thicknesses (0.5 mm and 0.7 mm) of three different ceramic materials. the following conclusions were drawn.

The types of ceramic materials affect the mean of ΔE values, with higher values for leucite reinforced glass-ceramic followed by fluorapatite glass-ceramic, The lowest mean ΔE values were for lithium disilicate glass-ceramic, the use of 0.7-mm thicknesses of ceramic specimens decreased ΔE values when compared with 0.5-mm thicknesses, The White Opaque shade (WO) of resin cement created perceptible color differences (ΔE > 3.3) of both thicknesses (0.5 mm and 0.7 mm) of IPS Empress Esthetic Press and 0.5-mm thickness of IPS Empress ZirPress, Three shades of resin cement (A1, TR, and B0.5) made the ceramic specimens darker than the control group, while the other two shades (WO and A3) made the ceramic specimens lighter than the control group [7].

Materials and Methods

Study design

A total of 40 ceramics veneer were prepared from ultra-translucent zirconia and lithium disilicate glass ceramics with shade corresponding to A2 in the vita shade guide. A tooth colored substrate was constructed from PMMA of shade A3. All specimens were subjected to accelerated artificial aging and thermocycling. The color coordinate of ceramics veneer (CIE L*a*b*) were measured followed by spectrophotometer (Vita Easy Shade) evaluation on two different thicknesses and two different types of resin cement.

The 40 ceramics veneer were divided into two main groups according to the type of ceramic material n = 20:

1. Group I: Ultra-translucent zirconia.
2. Group II: Lithium disilicate glass-ceramic.

Each group was divided according to veneer thickness into two sub groups (n = 10):

1. Subgroup A: 0.5 mm.
2. Subgroup B: 0.8 mm.

Each subgroup was further subdivided according to the type of resin cement into two divisions:

1. Division 1: Dual cured resin cement.
2. Division 2: Light cured resin cement.

Preparation of tooth

1. The upper central incisor prepared.
2. Self-limiting depth-cutting (three wheel stone) of 0.5 mm and 0.8 mm were used to define the depth cuts, followed by a diamond bur to refine the preparation (Kerr dental, USA).
3. Two thickness of the labial surface will be prepared 0.5 mm and 0.8 mm and the preparation thickness guided by silicon index.
4. The preparation will be smoothed with a finishing bur (Kerr dental, USA).

Construction of PMMA

The PMMA dies (Figure 1) were obtained by scanning the prepared teeth (inEos X5, sirona, Germany) and cutting PMMA blanks A3 OD 98*14 mm (mcx5, sirona, Germany).

Figure 1: *PMMA die.*

Construction of Emax

- The PMMA dies scanned using laser scanner (inEos X5, sirona, Germany).
- Ceramic was milled from blocks (IpS e.max Cad, Ivoclar, schaan, Liechtenstein) into two thicknesses 0.5mm and .08 mm.
- Each specimen was autoglazed and then ultrasonically cleaned with distilled water for 10 minutes and all ceramic discs were checked over their corresponding teeth for seating (Figure 2).

Figure 2: *Emax veneers.*

Construction of zirconia

the veneers virtually designed using CAD/CAM software into two thicknesses 0.5 mm and .08 mm following the same steps of Emax CAD blocks (Figure 3).

Figure 3: *Zirconia veneers.*

Cementation of ceramic veneers

- Prophylaxis with pumice stone and rubber cup for 30s.
- Etching of lithium disilicate glass veneer with 10% hydrofluoric acid (Porcelain Etchant, BISCO, USA) for 20 s, cleaning by water and air spray, silane coupling agent (Bisco, USA) applied
- Zirconia ceramic samples will be sand blasted using sand blasting machine (Modulars, silfradent) (Figure 4) of 110/150 µm and then ultrasonically cleaned.
- Zirconia primer (Z-PRIME PLUS, BISCO, USA) applied following manufacture instructions (Figure 4).

Figure 4: *Cementation tools.*

Light cured cement

The cement (Figure 4) will be applied to the surface of the PMMA, and the specimen seated with the help of a delineator rod to guarantee parallelism during fixation of the veneer, on which a load of 380g was placed to standardize cement thickness before light activation. After removing the weight, the LED activator light was applied for 3s, and the excess cement removed with an exploratory probe. The cement was light polymerized through the ceramic surface for 40 seconds using a light-emitting diode polymerization unit (Demi; Kerr Corp).

Dual cured cement

Dual polymerizing cement (Figure 4) was mixed on a separate mixing pad with a plastic spatula before application. A clean glass-slide was placed on top of a 0.6-mm-thick stainless steel jig and pressed with a 9.8-N load for 20 seconds to attain a uniform cement thickness of 0.1 [8].

Color test

Initial color readouts (Vita Easy shade; VITA Zahnfabrik, Bad Säckingen, Germany) and spectrophotometer measurements were taken for all the samples.

The specimens will be subjected to accelerated aging process between 5c - 55c for 7000 cycle (Figure 5). The specimens will be subjected to simultaneously immersion in: lemon juice (acidic pH) (Figure 6a and 6b), coffee (Figure 6 a and 6b) and coca cola (a and b) for 530 hours. This system simulates the forces of nature, predicting the relative durability of materials exposed to the weather [9].

Figure 5: *Thermo cycling machine.*

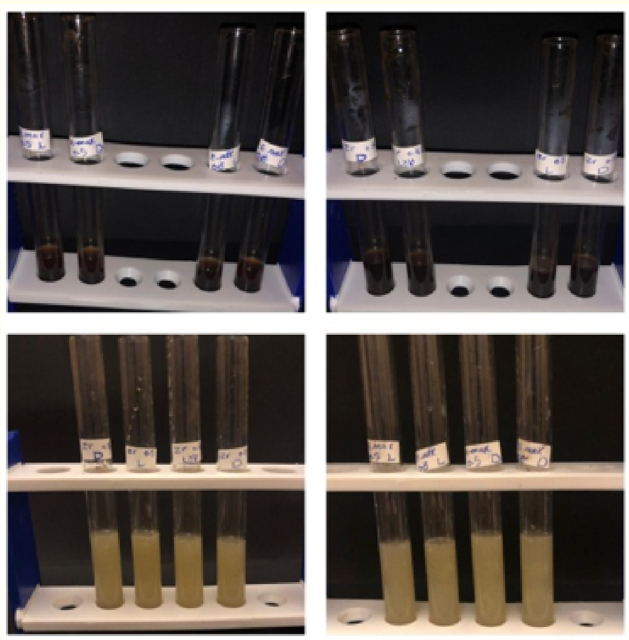


Figure 6: *Accelerated aging (AAA).*

New color readouts were taken by spectrophotometer and the color change (ΔE) calculated by means of the following formula: $\Delta E=[(\Delta L)^2+(\Delta a)^2+(\Delta b)^2]^{1/2}$; where ΔE=color change; ΔL=lightness difference (L^*), so that the greater L^* values, the higher the brightness of the sample; Δa=axis a* difference; so that positive values for Δa means redder samples and negative values, greener; Δb=axis b* difference; so that positive values for Δb mean yellower samples and negative values bluer, where: ΔL=L*F-L*I; Δa=a*F-a*I Δb=b*F-b*I, where L*I, a*I e b*I are referred to as the initial color measurement and L*F, a*F and b*F as the final color measurement mm.

Results and Discussion

Data analysis

Data were fed to the computer using IBM SPSS software package version 20.0. Quantitative data were described using mean and standard deviation for normally distributed data.

The ΔE* values were entered into SPSS 20 and analyzed using analysis of variance ($p < 0.05$ and 95% confidence intervals)

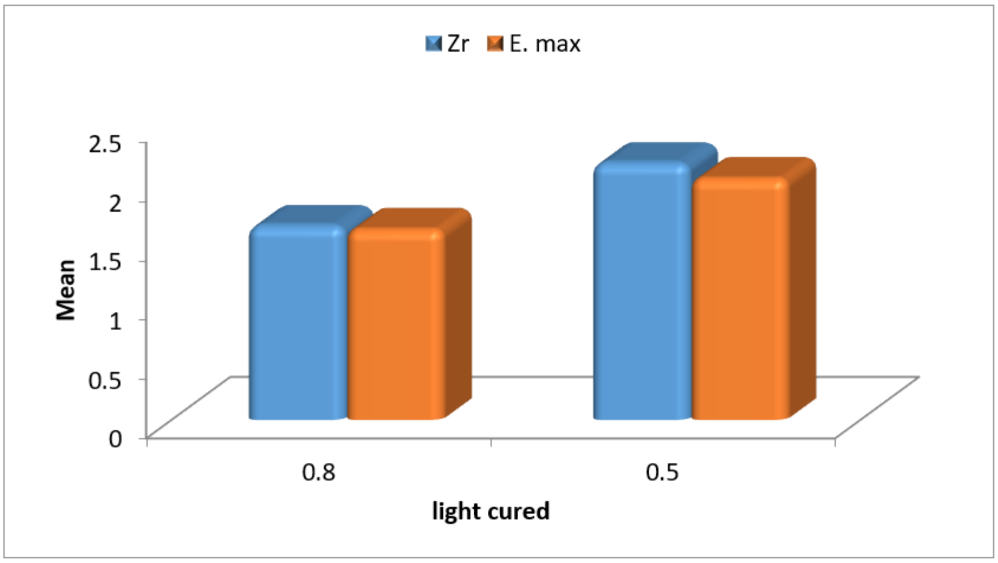
(ΔE) calculated by means of the following formula: $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$; where ΔE=color change.

Comparison between Zr and E. max in light cured 0.8 and 0.5

The light-cured cement presented greater color change when used for bonding thinner veneers, with statistically significant difference ($p < 0.05$) in comparison with the 0.8 mm thick veneer as shown in table 1 and graph 1. The opacity of ceramic varies and may serve to mask the color change of the cement under it, which is dependent on the thickness of the material and 0.5 mm thick porcelain is unable produce this effect.

Light cured	Zr	E. max	t-test	P1
0.8				
Mean S.D.	1.64±0.05	1.61±0.10	0.85	0.42
0.5				
Mean S.D.	2.17±0.08	2.04±0.02	0.91	0.385
t-test 2	2.82	2.22		
P2	0.005*	0.013*		

Table 1: *Comparison between Zr and E. max in light cured 0.8 and 0.5.*
**: Significant at level 0.05.*
***: Highly significant at level 0.01*
P1 comparison between Zr, and E. max in the same thickness.
P2 comparison between 0.8 and 0.5 in the same material.
T-test = Student t-test.



Graph 1: *Comparison between Zr and E. max in light cured 0.8 and 0.5.*

Comparison of ΔE values (M±SD) of Zr and E. max cemented with dual cured 0.8 mm and 0.5 mm thickness

The conventional dual -cured cement sowed color change when used for bonding thinner veneers, with statistically significant difference ($p < 0.05$) in comparison with the 0.8 mm thick veneer as shown in table 2 and graph 2. The opacity of ceramic varies and may serve to mask the color change of the cement under it, which is dependent on the thickness of the material and 0.5 mm thick porcelain is unable produce this effect.

Dual cured	Zr	E. max	t-test	p
0.8				
Mean S.D.	1.73±0.03	1.68±0.18	0.81	0.40
0.5				
Mean S.D.	2.79±0.34	2.82±0.36	1.01	0.311
t-test 2	3.01	2.98		
P2	0.001**	0.004*		

Table 2: *Comparison between Zr and E. max in dual cured 0.8 and 0.5.*

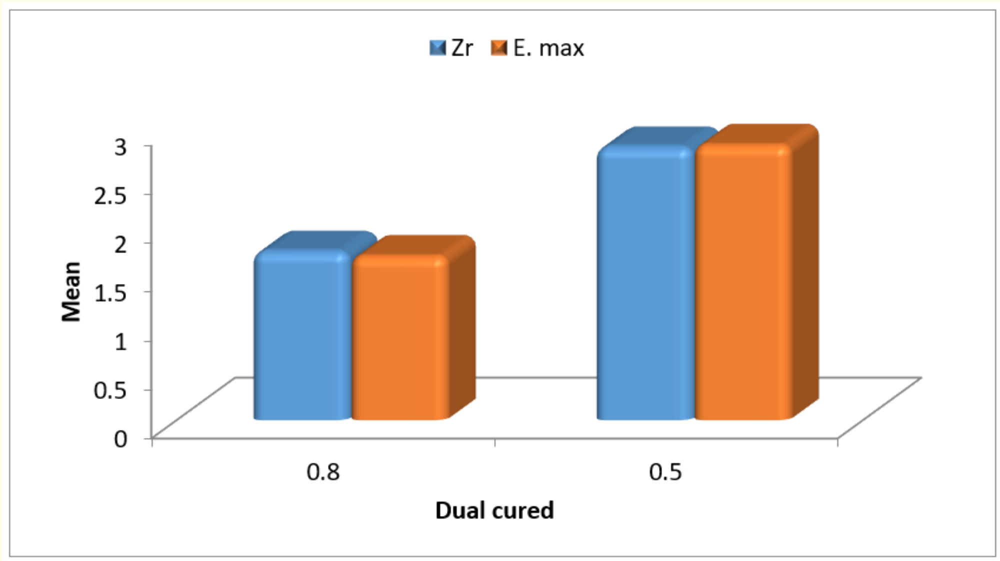
**: Significant at level 0.05*

***: Highly significant at level 0.01*

P1 comparison between Zr, and E. max in the same thickness.

P2 comparison between 0.8 and 0.5 in the same material.

T-test = Student t-test.



Graph 2: *Comparison between Zr and E. max in dual cured 0.8 and 0.5.*

Discussion

The increasing patient demands for aesthetics necessitate a thorough selection in dental materials. Adhesive resin cements, as the generally used luting agent for aesthetic all ceramic restorations come in various polymerization types and brands. This study evaluated different light and dual-cure resin cements in terms of internal color stability. The focus was on the possible impact of this phenomenon on the appearance of ceramics. The translucent ceramic material is considered color stable but it may not be able to mask the discoloration of the underlying resin cement [10].

In this study, samples 0.5 and 0.8 mm thick were used; it is known that a standard laminate thickness is 0.7 mm. However, in a clinical situation, it is not always possible to get laminates of that exact measure, so we considered important to foresee what would happen with greater or lesser thicknesses. The incisal color was selected for the study because it is the most translucent color, so the changes that could occur would be greater than in more opaque colors.

The conventional dual and light-cured cements presented greater color change when used for bonding thinner veneers, with statistically significant difference ($p < 0.05$) in comparison with the 0.8 mm thick veneer, results similar to those of Kucukesmen., *et al* [11].

Conclusion

Within the limitations of this study the following can be concluded:

- The discoloration observed after the ageing process was within a clinically acceptable level and could not be detected visually.
- Both materials posed high color stability even after accelerated aging (AAA).
- Thicknesses has inversely proportional to the perceived ΔE.
- Both cement type had no adverse impact on ΔE.

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