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Correlation between Luting Agent Curing Mode and Ceramic Thickness on Color of Ceramic Veneers

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Abstract *Objective:* The aim of the study is to assess the influence of ceramic thickness and type of luting agent on color variation of IPS empress press ceramic system. *Methodology:* Thirty ceramic specimens were prepared and divided according to thickness into 2 groups of 15 each (G1: 1mm, and G2: 2mm thick). Specimens were further subdivided according to the type of luting agent into 3 subgroups (5 each) and seated on a dark background of resin composite. Two resinous cements namely; Rely X (3M ESPE) and G-CEM LinkAce were used for 2 subgroups, whereas the third subgroup received no cement and served as a control (C1: 1mm thick, C2: 2mm thick). Evaluation of the variation of color parameters was determined using the spectrophotometer (Spectra). The evaluation of the color parameters was determined using the CIE Lab system of colors using a dental colorimeter. Two-way analysis of variance (ANOVA) was used for the statistical analysis using SPSS version 21.0. *Results:* Spectra photometer was significantly affected by the ceramic thickness (P=0.000). Additionally, the use of the 2 mm thickness ceramic provoked the ΔE values. The highest mean ΔE was seen in control 2mm group (2.05). Whereas, the lowest ΔE was found in Control 1mm (0.65). The luting agent seems to have no effect on mean color difference (P=0.115). *Conclusion:* The color difference (ΔE) was significantly affected by different ceramic thickness (P=0.000), while the luting agent seems to have no influence on mean color difference. The color changes that determined are clinically acceptable.

Keywords: *Spectrophotometry, esthetics, IPS emax press, color, luting agents, ceramic thickness*

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1. Introduction

Rapid developments in dentistry permitted patients to have higher expectations of dental restorations in terms of mimicking shape, color and texture [1]. Also, the new era of minimally invasive esthetic dentistry contributed tremendously to the success of dental restorations. Therefore, the thickness of the restoration used would play an important factor in the final result. Ceramics are widely used due to their ability to provide excellent cosmetic results that mimics natural teeth. Also, they have superior strength, fracture toughness, hardness and excellent wear resistance [2]. Recently, lithium disilicate has been widely marketed, in virtue of its ability to be used in thin sections which advocates the concept of minimal invasive dentistry in preservation of tooth structure. Lithium disilicate restorations are manufactured by heat press-lost wax technique (IPS e.max Press) or by CAD/CAM technique (IPS e.max CAD). The heat press-lost wax technique has a high survival rate based on short [3] and long term [4] survival evidence for each single crown restoration and 3-unit FDP. Dental Ceramic restorations with their superior biocompatibility, light translucency and transmittance as well as adequate mechanical strength made it the most sought-after dental restoration in terms of fulfilling needs and satisfaction of both dentists and patients [5,6].

Replicating the appearance of tooth structure using ceramic restoration is a complex multifactorial procedure that remains to be an issue of concern [7]. The final shade of the ceramic restoration depends on several interrelated factors attributed to; a- shade of the underlying dental substrate, b- shade and color stability of the resin cement luting agent, and c- various characteristics of the ceramic restoration such as: degree of opalescence, translucency, fluorescence, surface texture, ceramic thickness, and fabrication technique [8]. Due to this combination, the ceramic shade chosen may not resemble the exact color of the dental complex, compromising the desired appearance of the final restorations. Consequently, the definitive restoration color produced should not be evaluated separately.

Objective color analysis depends on the use of tools that quantify color in terms of coordinated values. The CIE L*a*b* color system describes color by the three dimensional color values, the L*(Brightness), a*(red-green value,), and b*(yellow-blue value) [9].

The impact of luting agent shade on the color of ceramic veneers is greatly affected by ceramic thickness and opacity [10]. Therefore, the aim of this in-vitro study is to assess the effect of different luting agents and ceramic thicknesses on color variations of definitive ceramic restoration [10]. The null hypotheses tested were that the press lithium disilicate ceramic in the different tested thicknesses would not present perceived color variations with the use of either light cured or dual cured luting agents.

2. Materials and Methods

Thirty ceramic discs (IPS e.max, Ivoclar Vivadent, Liechtenstein, Europe) were prepared, fired, followed by glazing according to the manufacturers' recommendations. After firing, the disks were ground on the veneer side using 220-, 400-, and 600-grit sandpaper under water cooling to standardize the surfaces, then polished with silicone points. Specimens were then divided according to thickness into 2 groups of 15 each; G1& G2 of 1 & 2mm thick, respectively. Specimens of each thickness were then further subdivided into 3 subgroups, 5 each and seated on a dark background of resin composite to simulate the color of a dark underlying dental structure (C4 color background discs, 30 mm diameter). The first two subgroups were cemented with two resinous cements namely; Rely X (3M ESPE) and G-CEM LinkAce. The luting agents were applied and pressed onto the inner (non-glazed) surface. Another subgroup was used without cement, and served as a control. Evaluation of the variation of color parameters determined using the spectrophotometer (SpectroShade Micro II Dental Color Complete Tooth Analysis System, made in California, USA). The validity of the mean color difference (ΔE) was confirmed based on the parameters of (a, b, L, ΔE) L (lightness), a (green-red), b (blue-yellow), ΔE (difference between color of white plate and samples) were measured to determine the effect of ceramic thickness and luting cements on the color parameters. The evaluation of the color parameters was determined using the CIE Lab system of colors using dental colorimeter, SpectroShade.

2.1. Statistical Analysis

Data were subjected to statistical analysis using the two-way analysis of variance (ANOVA) statistical test using SPSS version 21.0. in conjunction with post hoc Tukey's test to further reveal statistical differences.

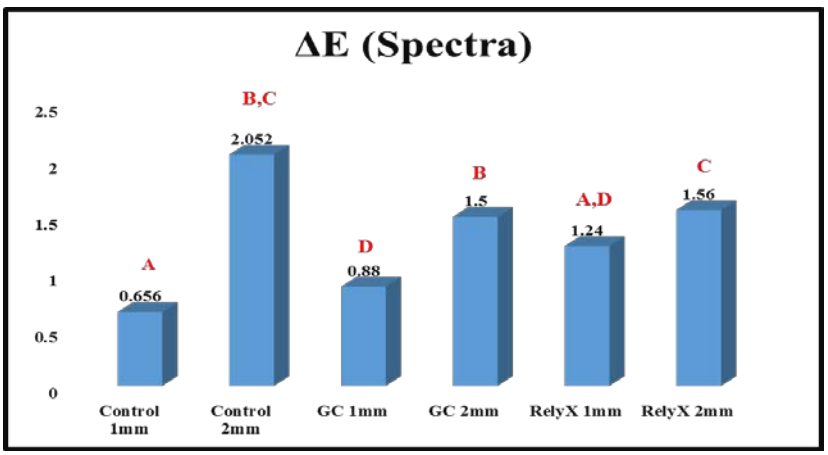
3. Results

The mean color difference (ΔE) of the two-way analysis of variance (ANOVA) using Spectra photometer were significantly affected by the ceramic thickness (P=0.000). The luting agent seems to have no effect on mean color difference (P=0.115). However, the interactive effect of ceramic thickness and luting agent was observed to be statistically significant (P=0.000). Additionally, the use of the 2 mm thickness ceramic provoked the ΔE values and a steep rise in ΔE values were observed in all 2 mm thickness ceramic groups. The highest mean ΔE was observed in Control 2mm group (2.05). Whereas, the lowest ΔE was found in Control 1mm (0.65). Details are summarized in Table 1 and Figure 1.

Table 1. The two-way ANOVA table for the differences in responses of the study groups according to luting agent and ceramic thickness using Spectra spectrophotometer

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.333[a]	5	1.267	24.633	.000
Intercept	51.850	1	51.850	1008.437	.000
Ceramic thickness	4.547	1	4.547	88.442	.000
Luting agent	.244	2	.122	2.370	.115
Ceramic thickness * Luting agent	1.542	2	.771	14.992	.000
Error	1.234	24	.051		
Total	59.417	30			
Corrected Total	7.567	29			

Dependent Variable: ΔE (Spectra).



Key: Same uppercase alphabets show statistical differences between the luting agents groups

Figure 1. The graphical representation of the mean ΔE values of the tested groups using Spectra spectrophotometer device

The post hoc Tukey's test further revealed statistical differences between control 1mm and RelyX 1mm; between GC 1mm and RelyX 1mm; between control 2mm and GC 2mm; and between Control 2mm and RelyX 2mm study groups. The details are shown in Figure 1.

4. Discussion

First of all, it is important to have thin ceramic thickness in order to preserve tooth structure with the minimally invasive veneers preparation, which is why two different ceramic thicknesses were measured in this study, 1mm and 2mm. While conventional cements offer easy handling, adhesive resin cements are highly versatile and provide strong adhesion and high esthetics [11] which is especially important for the cementation of state-of-the-art all-ceramic restorations. As RelyX unicem and G Cem has been classified to be one of the most commonly dental cements used. SpectroShade Micro II Dental Color Complete Tooth Analysis System is the most accurate and reliable imaging spectrophotometer to provide complete measurements of both natural and prosthetic tooth coloring under any environmental conditions. Spectro Shade Micro II device is equipped with the LED spectrophotometer and a digital camera that ensures accuracy while acquiring measurements, images and data for shade-mapping and analyzing. Using the latest technology and software, you can then objectively evaluate and determine the correct tooth shading for your patient based on topographical color mapping of the whole tooth, it is simple to use with measuring speed - less than 1 second/image, Links to all existing ceramic standards, provide accurate results and objective reading of the chromatic spectrum of the teeth and crowns and immediately links to all the existing standards.

Recent studies have showed that the opacity of resin cement does not affect the color match [12]. Moreover, the final color of porcelain veneers is the product of the interaction of color of the original tooth, and the translucency and thickness of both the resin cement and the ceramic veneer. Controlling color in thin sections appears to be a difficult task, as the thin ceramic veneers must on one hand mask the color of the underlying tooth structure, and on the other hand must not be too opaque in order not to compromise esthetics [13]. Previous study showed that the final shade was almost comparable using high and low opacity resin cements. Recent studies have showed that the opacity of resin cement does not affect the color match [14]. Moreover, the final color of porcelain veneers is the product of the interaction of color of the original tooth, and the translucency and thickness of both the resin cement and the ceramic veneer [12]. A systematic review of in vitro studies revealed that the shade aspects of luting agents, translucency and value showed the greatest visible color differences for ceramic laminate veneers CLV [9]. For the ceramics thickness, it was reported that the color difference (ΔE), increases as veneering thickness increase [15,16,17,18].

In minimally invasive veneer preparation, reduced ceramic thickness is required. Thus, controlling color in thin sections appears to be a difficult task, as the thin ceramic veneers must on one hand mask the color of the underlying tooth structure, and on the other hand must not be too opaque in order not to compromise esthetics. Knowledge of the color properties of ceramics enables the clinician to make appropriate choices when a restorative material is chosen in esthetic challenging cases.

5. Conclusion

Within the limitations of this study, it can be concluded that the luting agent seems to have no effect on color difference. On the other hand, ΔE was significantly affected by different ceramic thickness. Therefore presenting higher capacity for masking a dark substrate when fabricated with higher thickness.

Conflict of Interest

None of the authors that were a part of the study in any capacity have any shape, size or form of conflict of interest to declare.

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