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Effect of Different Glass-Ceramics and Resin Cement Curing Modes on the Color Stability of Sectional Laminate Veneers Following Artificial Aging

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Ceramic laminate veneer, sectional laminate, color stability, resin cement, aging, spectrophotometer.

Abstract

Background: The purpose of this study is to evaluate the effect of two glass ceramic materials and resin cement curing modes on the color stability of sectional porcelain laminate veneers following artificial aging.
Methods: Forty sound human maxillary central incisors were prepared to receive sectional laminate veneers (SLVs) with a thickness of 0.5-0.7 mm. Prepared teeth were randomly divided into 2 equal groups according to ceramic materials used (N=20) as follows: Group I: IPS e.max press. Group II: Celtra press. Each main group was randomly subdivided into 2 equal subgroups according to resin cement used: light and dual cure resin cements (Relyx Veneer) (Relyx Ultimate) respectively. All samples were subjected to 10,000 cycles of thermo-cycling. Color change was measured by laboratory spectrophotometer before and after thermocycling. All the collected data were statistically analyzed by One-way ANOVA followed by Tukey's post hoc test.
Results: Color change between restoration and natural side of each sample before and after artificial aging did not reveal significant difference (P<0.05). IPS e.max press showed significant lower color stability with dual and light cure resin cement (ΔE 3.48- ΔE 3.4) than Celtra press (ΔE 2.6- ΔE 3.05). Light cured resin cement used with Celtra press showed statistically significant higher ΔE value than dual cured cement (P>0.05).
Conclusions: Celtra press glass ceramic is more color stable than IPS e.max press. Resin cement and aging process influenced the color stability of sectional laminate veneers. Results were clinically accepted for all tested materials in reference to natural teeth (ΔE<3.5). The results may help the patient to aesthetically correct their anterior teeth with a suitable material providing strength and natural teeth looking, in addition to conservation of tooth structure, with optimum esthetics.

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1 Introduction

Dental ceramics are a predominant materials used in restorative esthetic treatments due to their unique characteristics including optical properties, color stability, translucency, mechanical resistance and biocompatibility with the oral tissues. [1] Subsequently they affect the success and longevity of restorations by achieving the main criteria of strength, fit and esthetics. It is crucial to fulfill the patient's demands for aesthetic restorations that mimic the natural appearance of teeth. [2]

Modern esthetic restorative dentistry is mainly based on adhesion, especially with the improvements in dental resin cements and bonding ability of many types of dental ceramics that make it possible to minimize the amount of preparation. [3] Ceramic laminate veneers are considered as one of the most conservative approaches in esthetic treatments, as they provide superior translucency to match the optical properties of natural teeth by allowing the possibility to bond thin ceramic veneers to minimally prepared teeth. [4-5]

Ceramic laminate veneers are suitable for cases necessitating minor reshaping of teeth, enamel defects, closing diastemas or small class III and IV. [6-7] Higher survival rates were observed with preparations limited to enamel as resistance to fracture loads increases with increasing enamel thickness, moreover, the loss of more enamel structure increases coronal flexibility, leading to high amounts of stress and strain in addition to difficulty in mimicking the natural appearance between tooth and restoration. [8-9].

Recently, the tendency of the conservative approaches in dentistry have become popular as they preserve tooth structure. A new design of partial veneer (mini laminate), (sectional laminate) has been suggested by using a thin thickness of porcelain ranging from 0.1 to 0.3 mm bonded to the tooth to repair minor esthetic defects. [10]

The challenge with sectional laminate veneers restorations is to fulfill the optimum esthetics while maintaining long term color stability. This is affected by many factors that influence the long term success including ceramic fabrication techniques, materials, the thickness of the ceramic, shade of the resin cement, and polymerization method. [11-12]

Lithium-disilicate pressed glass ceramic veneers are one the preferred ceramic material for the construction of laminate veneers due to their strength and highly optical properties. It has also demonstrated a highly long term success clinically when compared to other ceramic materials. [13-14]

Celtra press is another ceramic material classified as heat-pressed zirconia reinforced lithium silicate heat-pressed glass-ceramic that has been modified in an attempt to increase its mechanical and aesthetic properties by adding 10% dissolved zirconia in a silica-based glass matrix [15-16]. It is claimed by its manufacturer to provide adequate color stability and high-strength glass ceramic regardless of the testing method used.

The luting agents available for laminate veneer restorations are either light, or dual-polymerizing resin cement. Discoloration may result from their mode of polymerization, literature have demonstrated that dual-polymerizing resin cement undergo higher color alteration than light-polymerizing cement as it contains aromatic tertiary amine and benzoyl peroxide in its composition that became darker over time, making light-cured resin cements the method preferred for bonding laminate veneers with thickness less than 1mm because of their color stability and their longer working time compared to dual-cured resin cements. [17-18]

Color changes can be assessed quantitatively by devices such as spectrophotometers that provide accurate measurements. Data is reported in the Commission Internationale de I'Eclairage (CIE) L*a*b* system which represents the color in 3 dimensional color space: L*measures brightness of the color, a* measures the red-green content, and b* measures the yellow-blue content. Then the color changes represented in (ΔE) are calculated using L* a* b*. [19]

Color stability following artificial aging may affect color matching between the tooth and the restoration.

The null Hypothesis were: (i) Different ceramic materials do not affect the color stability of sectional laminate veneer following artificial aging; (ii) Different resin cements curing modes do not affect the color stability of cemented sectional laminate veneer following artificial aging.

The aim of this study was to evaluate the effect of different ceramic materials and resin cement curing modes on

Commercial name of the material	Description	Manufacturer	Batch no.
IPS e.max press (Lithium-disilicate pressed glass ceramic)	Oxides: Weights (%) SiO2: 57.0 – 80.0 Li2O: 11.0 – 19.0 K2O: 0.0 – 13.0 P2O5: 0.0 – 11.0 ZrO2: 0.0 – 8.0 ZnO: 0.0 – 8.0 Al2O3: 0.0 – 5.0 MgO: 0.0 – 5.0 Colouring oxides: 0.0 – 8.0	Ivoclar Vivadent, Schaan, Liechenstein	Z013CG
Celtra press (Zirconia reinforced lithium silicate ceramic)	Oxides: Weight (%) SiO_2: 58.0 P_2O_2: 5.0 Al_2O_3: 1.9 Li_2O: 18.5 ZrO_2: 10.1 Tb_4O_7: 1.0 CeO_2: 2.0	Sirona Dentsply, Milford, DE, USA.	16003308
Rely X Veneer. (Light cure resin cement)	Bisphenol-A-diglycidylether dimethacrylate (BisGMA). Triethylene glycol dimethacrylate (TEGDMA) polymer. Zirconia/silica fumed silica fillers.	3M ESPE, USA	8714TR
RelyX™ Ultimate. (Dual cure resin cement)	**Base Paste** Methacrylate monomers, Radiopaque,silanated fillers, Initiator,Stabilizers,Rheological additives. **Catalyst Paste** Methacrylate monomers, Radiopaque alkaline (basic), Fillers components, Initiator components, Stabilizers Pigments, Rheological additives, Fluorescence dye Dark cure activator for Scotchbond Universal adhesive	3M ESPE, USA	7824424

the color stability of sectional porcelain laminate veneers following artificial aging.

2 Materials and Methods

This study was performed at the department of Fixed Prosthodontics, faculty of dentistry, modern science and Arts University (ethical approval number (ETH18)

Two ceramic materials were used in this study Lithium-disilicate glass ceramic (IPS e.max press) and Zirconia reinforced lithium silicate (Celtra press). Two types of resin cement used: light and dual cure resin cements (Relyx Veneer) (Relyx Ultimate). Material's composition, manufacturer and batch no are listed in **Table (1)**.

2.1 Sample size:

A power analysis was designed to have adequate power to apply a statistical test of the research hypothesis (null hypothesis) that there is no difference regarding the color stability of sectional laminate veneer made of different materials and cemented with different risen cement systems following cyclic loading. By adopting an alpha (α) level of 0.05 (5%), a beta (β) level of 0.20 (20%) i.e. power=80%, and an effect size (f) of (0.677) calculated based on the results of Lee, Seong-Min, and Yu-Sung Choi.[19] ,the predicted sample size as a total of twenty eight samples .i.e. seven samples per group. Sample size calculation performed using G*Power version 3.1.9.2.[20]

2.2 Sample selection:

Forty intact, sound, freshly extracted human central incisor teeth were collected for the study from the Oral Surgery Department Faculty of Dentistry, October University for Modern Sciences and Arts. Each patient had read the steps and the reasons of the research and explained orally then informed consent was obtained from each patient. Extracted teeth were washed under running water to remove blood, scaled with ultrasonic scaler (Acteon satelec suprasson P5 ultrasonic scaler, France) to remove calculus and remnants of periodontal ligament. Teeth were then polished with prophylaxis paste (Alpha-pro prophylaxis paste, USA) and soft rubber cups at low speed, examined under 10x magnification clinic microscope (Leica M320 F12) and stored in a box with saline changed every three days. The teeth in this study were selected to be as close as possible in color (A2) using shade measuring unit (Vita Easyshade V) and dimensions with an average crown length of 11.0 mm (±0.5 mm) and mesiodistal diameter of 9.0 mm (±0.5 mm) measured by digital caliper.

2.3 Fabrication of epoxy resin blocks:

Roots of all teeth were scanned using extraoral dental lab scanner, then a digital designing exocad software (dentalDB 3.0 Galway) was used to fabricate a twenty epoxy resin blocks (2×2×2cm) to accommodate each tooth at 2.0 mm below the cement-enamel junction. Epoxy resin blocks were milled by CAD/CAM machine (Medit Identica Hybrid 3D) using a custom made epoxy resin disc (CMB Kemapoxy 150-3D Clear Epoxy Resin) **Figure (1).**

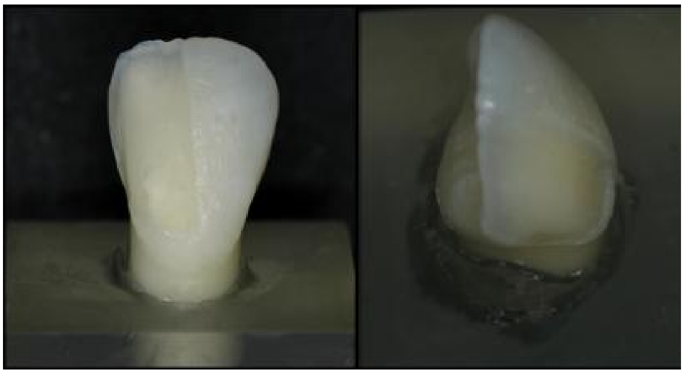

Figure (1): Tooth seated in milled epoxy resin.

2.4 Sectional laminate veneers tooth preparation design:

The teeth were embedded in the epoxy blocks after filling the root space with polyether impression material (3M ESPE Impregum). An index (proximally and incisally) was constructed for each tooth individually using additional silicon putty impression material (Elite H-D Putty). The preparation was performed by one operator using the 0.5 mm depth cutter (Tiefenmarkierer depth marker 834). A round-ended tapered diamond cutting stone (Diamond instruments 856P) was used to connect the depth cuts. The reduction was increased to 0.7 mm in the incisal third. Preparation extended 1mm above cemento-enamel junction in the middle of the tooth at the most concave point on labial surface to the most convex point on proximal surface. The preparation rechecked and measured in three points by scanning of the tooth using digital scanner to design a virtual restoration of the tooth. Corrections were done to acquire the desired depth in an attempt to standardize the depth of the reduction. **Figure (2).**

Figure (2): Tooth after preparation.

2.5 Grouping of the specimens:

After preparation, all teeth were randomly assigned to groups and subgroups: group I (EL): IPS e-max press bonded with light cure resin cement (n=10), group II (ED): IPS e-max press bonded with dual cure resin cement (n=10), group III (CL): Celtra press bonded with light cure resin cement (n=10), group IV (CD): Celtra press bonded with dual cure resin cement (n=10).

2.6 Sectional-porcelain laminate veneers fabrication:

- **Scanning of prepared samples:**

All the samples were constructed using LT A2 ceramic ingots. All teeth were scanned by inlab dental scanner (Ceramill map 600, Amann Girrbach AG) after spraying with scanning spray (D-SCAN) to obtaining a three dimensional image for each prepared tooth.

- **Wax pattern fabrication:**

Virtual wax pattern were designed and extended 1mm proximally, the cement gap was set at (0.04 mm, 1mm away from margins) by exocad software (dentalDB 3.0 Galway). The insertion of the sectional veneers was obtained. The sectional wax veneers received a semi-anatomic shaping in the software in order to obtain ceramic veneer thickness. Milling of dental wax was started using a CAD/CAM machine (Ceramill motion 2, Amann Girrbach AG).

Then, the manufacturer's instructions were followed during the fabrication of each veneer material (IPS e.max, Celtra press) groups.

2.7 Sectional laminate veneer cementation:

All specimens were ultrasonically cleaned for 10 min before cementation. A dual cured resin cement (RelyX Ultimate 3M ESPE, USA) and light cured resin cement (RelyX Veneer 3M ESPE, USA) with translucent shade were used to bond the restorations according to their assigned groups.

The intaglio surface of the IPS e.max press groups and the Celtra press groups were etched with a 9.5 % hydrofluoric acid gel (Zhermack dental, Poland) for 20 sec, rinsed with water spray for 60 sec, and thoroughly dried with oil-free air. Sectional laminate veneers were subjected to post etching cleaning using phosphoric acid with a brushing motion for 1 minute followed by rinsing for 20 seconds. The silane coupling agent was applied to the pretreated surfaces with a microbrush.

The prepared area was etched for 30 seconds with 37 % phosphoric acid (Ivoclar, Vivadent) rinsed, and dried. The bonding agent was applied (Scotchbond™ Universal 3M ESPE, USA). The dual curing luting resin cement (RelyX Ultimate) was applied as manufacturer's instructions to the surface of the prepared teeth. Then, each restoration was seated to its respective prepared tooth using gentle finger pressure. Excess resin was removed gently with cotton pellet and then light curing was done for 20 sec at 5mm distance to labial, proximal and palatal surfaces.

The light cure resin cement (RelyX Veneer) was applied on the fitting surface of the restorations and the veneers were placed over the teeth in the same way. Excess cement was removed followed by light curing for 40 seconds. The restorations were stored in distilled water at 37°C for 24 hour to ensure that auto-polymerization of the luting resin was complete **Figure (3).**

2.8 Color stability testing:

After cementation initial color measurements of all samples were recorded by Spectrophotometer device (Agilent Cary 5000 UV-Vis-NIR, USA). The color was measured following the CIE L*a*b* system. Every sample was measured twice on the restoration side and natural tooth side.
All specimens were thermo-cycled in a thermo-cycler machine (Thermocycler THE-1100 ,SD sd-mechatronik, Germany) for 10,000 cycles between 5° and 55°C in tap water with a 30 second dwell time at each temperature and transfer time 20 second to resemble one year of clinical service.
Color measurement was recorded again after subjection to aging process and ΔE values were calculated from the L*, a*, and b* values before and after artificial accelerated ageing.

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

Then the color changes represented in (ΔE) are calculated using L* a* b*. [19]

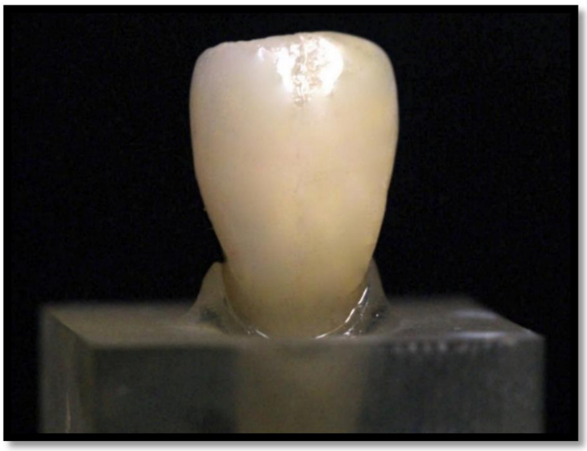

Figure (3): Laminate after cementation.

2.9 Statistical analysis:

Numerical data were explored for normality by checking the data distribution using Shapiro-Wilk test. Data showed parametric distribution so; they were represented by mean and standard deviation (SD) values. One-way ANOVA followed by Tukey's post hoc test was used to analyze intergroup comparisons for material and cement type. Paired t-test was used to analyze intergroup comparisons for aging and restoration side. The significance level was set at p ≤0.05 within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

3 Results

Mean and standard deviation (SD) values

of color change between natural and restoration sides (ΔE) for different materials within other variables were presented in **Table (2)** before and after thermocycling, for both types of cements, there was no significant difference between IPS e.max press and Celtra press. ($p>0.05$).

(ΔE) after aging for ceramic materials within other variables were presented in **Table (3).** The restoration side with both type of cements, Emax samples had significantly higher value than Celtra samples ($p<0.05$).

Mean and standard deviation (SD) values of color change between natural and restoration sides (ΔE) for different cements within other variables were presented in **Table (4).** There was no significant difference between light cure and dual cure resin cements ($p>0.05$), before and after thermocycling for both materials.

Mean and standard deviation (SD) values of color change after aging (ΔE) for different cements within other variables **Table (5).** Regarding restoration side, there was no significant difference between both cements within e.max samples ($p=0.181$). While for Celtra samples, light cured cement had statistically significantly higher value than dual cured cement ($p<0.001$).

Table (2): Mean ± standard deviation (SD) of color change between natural side and restoration side (ΔE) for different ceramic materials within other variables.

Side	Material	Color change (ΔE) (mean±SD)		p-value
		Dual cured	Light cured	
Restoration	Celtra	2.60±0.15	3.05±0.17	<0.001*
	Emax	3.48±0.19	3.40±0.22	0.181ns

Table (3): Mean ± standard deviation (SD) of color change after aging (ΔE) for IPS e.max press and Celtra press within other variables.

Thermocycling	Material	Color change (ΔE) (mean±SD)		p-value
		Dual cured	Light cured	
Before	Celtra	1.94±1.08	2.28±0.74	0.430ns
	Emax	2.05±0.86	2.41±0.71	0.319ns
After	Celtra	1.83±1.11	1.93±0.79	0.831ns
	Emax	2.36±1.00	2.36±0.72	0.994ns

Table (4): Mean ± standard deviation (SD) of color change between sides (ΔE) for light cure and dual cure resin cements within other variables.

Thermocycling	Cement	Color change (ΔE) (mean±SD)		p-value
		Celtra	Emax	
Before	Dual cured	1.94±1.08	2.05±0.86	0.811ns
	Light cured	2.28±0.74	2.41±0.71	0.693ns
After	Dual cured	1.83±1.11	2.36±1.00	0.281ns
	Light cured	1.93±0.79	2.36±0.72	0.219ns

Table (5): Mean ± standard deviation (SD) of color change after aging (ΔE) for light cure and dual cure resin cements within other variables.

Side	Cement	Color change (ΔE) (mean±SD)		p-value
		Celtra	Emax	
Restoration	Dual cured	2.60±0.15	3.48±0.19	<0.001*
	Light cured	3.05±0.17	3.40±0.22	<0.001*

4 Discussion:

The tendency of conservative approaches in dentistry has increased due to the evolution in dental materials and to the popularity of the concept of minimalism which is a defect oriented approach. Consequently, sectional, partial or fragment laminate veneers have developed and were published in several clinical report studies. [10,21] However, there is a lack of relative in vitro laboratory studies on sectional laminate veneers application.

The first null hypothesis regarding the effect of different ceramic material had no significant difference on the color stability of sectional laminate veneer following artificial aging was partially accepted, as there was no significant differences when restoration sides compared with natural side of the tooth but when ceramic materials compared to each other there was a significant difference.

The color change results ΔE values of 3.5 or higher can be considered visually perceptible and clinically unacceptable. Therefore, in the present study, ΔE values lower than 3.5 were considered as clinically acceptable even in cases where there was statistically significant difference. [19,22,23]

According to **Bekheit et al, (2021)** [24] Celtra press and e-max press restorations have color matching with adjacent natural teeth and excellent patient satisfaction that indicate that both materials to be used in aesthetic areas. Moreover, **Fasbinde et al, (2010)** [25] found that after 2 years follow up of lithium disilicate crowns, they recorded Alpha score which is the highest score of acceptance according to the United States public health service.

However, when both ceramic materials were compared to each other after aging process, e.max samples ΔE values (3.48±0.19 - 3.40±0.22) showed statistically significant higher color change value than Celtra press samples ΔE values (2.60±0.15 - 3.05±0.17). As in the present study, **Rinke et al, (2015)** [26] stated that the highly esthetic property and color stability of zirconia reinforced lithium silicate may be due to the very fine homogenous microstructure of lithium disilicate and lithium metasilicate crystals that ranges from 0.5 μm to 0.7 μm that up to 8 times smaller than lithium disilicate ceramics as the results of current study, **Alp et al, (2018)** [27] attributed the improved aesthetic properties of zirconia reinforced lithium silicate due to its finer, homogenous rod like crystalline structure which are 4 to 8 times smaller when compared to lithium disilicate glass ceramics.

This ensures the longevity and color stability thus reducing the drawbacks of laminate veneers, **Vasiliu et al, (2020)** [16] supported these results as they suggested that the materials with 0.7μm crystals or smaller have better resistance to thermo-cycling by increasing the energy required to remove the grain contained in the matrix.

Nevertheless, **Allam et al, (2021)** [28] also agreed with current study outcomes as they found that zirconia reinforced lithium silicate glass ceramic was more color stable than other tested ceramics. **Chaiyabuter et al, (2011)** [29] suggested that the color change of glass ceramic lithium disilicate may be due to optical properties of the ceramic itself or the underlying substrate.

Subsequently, the higher color stability of zirconia reinforced lithium silicate glass ceramic materials might be due to its lower translucency than lithium disilicate glass ceramic [30]. **Lee et al, (2018)** [19] found that high translucent lithium disilicate glass ceramic exhibited a greater tendency for color change, as they are considered to be less effective in masking the discoloration of the resin cement than ceramics of lower translucency.

Another explanation may be attribute to the scattering effect of the light as a result of the smaller particles size in Celtra press resulting in higher relative opacity when compared to e.max. [31]

In current study, results showed that all samples L* values were decreased and a* and b* values were increased, indicating that decrease in brightness and tendency to become reddish and yellowish or to be darker after aging. These finding are similar to previous studies reported that ceramics get darker, reddish, or yellowish. [19,22,32]

The second null hypothesis regarding the effect of different resin cements curing modes on the color stability of cemented sectional laminate veneer following artificial aging was partially accepted.

Turgut et al, (2011) [22] found that resin cements were the main factor in color change of cemented veneers, ceramics undergo just a minimal discoloration. Cement discoloration is related to the degradation of unreacted polymer matrix during polymerization besides the extrinsic factors. These results came in accordance with **Elter et al, (2021)** [32] as they reported that no significant differences between light cure and dual cure resin cements after conducting an in vitro study of sectional laminate veneers cemented to bovine teeth. In addition to **Marchionatti et al, (2017)** [33] results showed that there was no significant difference between light cure and dual cure resin cements in a split mouth randomized clinical trial when cementing non-prepared 0.3 mm lithium disilicate (e-max press) laminate veneer and after 2 years follow up. **Magalhaes et al, (2014)** [34] also reported that the color stability of 0.6 mm leucitereinforced glass ceramic laminate veneers (IPS Empress Ethetic) cemented with light and dual cure resin cements after accelerated aging revealed no significant differences between light and dual cure resin cements.

On the other hand, other studies revealed controversial results, **Ural et al, (2016)** [35] evaluated the color stability of light cure and dual cure resin cements after 4 weeks immersion in distilled water (37 °). They stated that dual cure resin cement was less color stable than light cure resin cement but with no significant difference as the cement was free of tertiary amine that the main cause for discoloration in dual cure resin cement. However, **Pissaia et al, (2019)** [36], **Almeida et al, (2015)** [37] and **Archegas et al, (2011)** [38] suggested that light cure resin cements were more color stable than dual cure resin cement as they used conventional dual cured resin cement containing tertiary amine. These studies evaluated one type of ceramic veneers unlike the present study which used two types of ceramic laminate veneers and a dual cure resin cement free of aromatic tertiary amine.

Interestingly, after thermo-cycling there were no significant differences between both cements within e-max samples, while for Celtra samples with light cured cement ΔE value (3.05) had significant higher ΔE value than dual cured cement (2.6).

This might be due to zirconia reinforced lithium silicate (Celtra press) containing 10% zirconia particles that resulting in increase of the ceramic opacity and decreasing its translucency which is less liable to color change. [16] It might be a reason for inhibiting a complete polymerization of light cure resin cement that lead to more liability to discoloration.

The dual cured resin cement used in the current study (Relyx Ultimate) utilize a non-aromatic tertiary amine initiator which is claimed by the manufacturer to be more color stable than aromatic tertiary amine, **Mesbah et al, (2016)** [39] compared the color stability of 3 resin cements after thermo-cycling. Their results revealed that the dual cured resin cement (Relyx ultimate) was more color stable than light cure resin cement (Relyx veneer), these findings are in agreement with the present study.

Rayan et al, (2019) [40] and **Ghavam et al, (2010)** [41] reported that dual cure resin cement showed higher color stability than light cure resin cement of the same brand (Variolink Esthetic) due to the aromatic tertiary amine that remain intact in light cure cement.

Pissaia et al, (2019) [35] measured the color stability of a free tertiary amine light and dual cure resin cement (NX3). The dual cure resin cement showed lower ΔE values in color change than light cure resin cement with clear and white shades after 3 years.

Furthermore, other studies were reported that artificial accelerated aging significantly affected on the color stability of ceramic and resin cemented ceramic but within clinically accepted range as in the current study. [18, 22] Nevertheless, the main cause for color change of the resin-cemented laminate veneers was the resin cement itself, due to the internal discoloration of the resin composite luting agents by hydrolysis reaction while the ceramic has the lowest effect on discoloration. [31, 36]

This might explain why the aging process had a greater effect on the restoration side than the natural side, as the restoration side has many interfaces of ceramic, resin cement and tooth itself and all of them are liable to discoloration.

This study has some limitations. First, the study only tested preparation thickness of the preparation of 0.5 mm and 0.7 mm while other thicknesses may yield different results. Samples were exposed to accelerated artificial aging by thermal cycling process, however, the anterior teeth are daily subjected to ultraviolet light that may stimulate the oxidation of amine accelerator in luting resin cements. The study used resin cement material from one manufacturer, the use of various manufacturers is recommended to ensure an applicable results. Midline definite margins are hard to conceal but were chosen in the current study to standardize the samples.

5 Conclusion:

Within the limitations of the study the following conclusions may be drawn:

1. Zirconia reinforced lithium silicate (Celtra press) are more color stable than Lithium disilicate glass ceramic (IPS e-max press).
2. Dual cured resin cement showed higher color stability following accelerated artificial aging.
3. The discoloration observed after aging process between the natural and restoration sides were in a clinically accepted level (ΔE<3.5).

Conflict of interest:

The authors have declared no conflict of interest.

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