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Effect of resin cement shades & thickness of zirconia reinforced lithium silicate ceramics (Vita Suprinity) on the optical properties using dark background compared to lithium disilicate glass ceramics (An in vitro study)

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Abstract *Introduction: This study investigated the effect of resin cement shades & thickness of zirconia reinforced lithium disilicate ceramics (Vita Suprinity) on the optical properties using dark background compared to lithium disilicate glass ceramics*
Method: The ceramic blocks used were Vita Suprinity (VS) shade A2 and translucent (T), and IPS e.max CAD (e.max) block A2 shade with Low translucency (LT). A slow-speed diamond saw was used to create fifty six (n=56) ceramics rectangular plates, twenty eight zirconia reinforced glass ceramic plates (group 1) and twenty eight lithium disilicate glass ceramic plates (group 2), with dimensions(14 x 12 mm). The plates were divided into two subgroups of two different thickness 1.0, 1.5 mm/group. Composite samples representing the dark background was constructed using a Teflon disc with rectangular central opening of 14 x 12 mm, thickness of 2 mm and a cement disks were constructed by copper mold with 2 different shades (yellow and transparent). After preparation of ceramic samples, dark composite background (C3) and cement shades samples, the color difference was measured by spectrophotometer after 24 hours. Results were statistically significant at $p \leq 0.05$.
*Results**:** It was found that highest ΔE value was obtained with Suprinity 1.5 mm with yellow cement, while lowest with was obtained e.max 1 mm with transparent cement. The ΔE of Suprinity 1 and 1.5 mm with yellow cement were 3.88 and 4.28 respectively. Comparing ceramic types Suprinity showed statistically significant higher mean ΔE than e.max. By comparing thicknesses, the mean ΔE with 1 mm thickness showed statistically significant lower mean value than 1.5 mm thickness. By Comparing cement shades, transparent cement showed statistically significant lower mean ΔE than yellow cement.*

Keywords: *Ceramic types, ceramic thickness, Cement shades color change and background*

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I. Introduction

Esthetic dentistry has become one of the most promising areas in the dental practice and the smile is one of the most essential human facial features that enhances the beauty of the face. Creating attractive smile need to quantify the lip-teeth relationship during the smile and interest in dental esthetics has increased rapidly during the last few decades among both patients and dentists. The development of new techniques and dental materials has led to a higher number of therapeutic options and consequently to an attractive outcome.

Dental esthetic affected by many factors, such as the color, shape, position of teeth as well as the shape of dental arch. These factors are governed by individual preferences, cultural and perception of tooth. Appearance could be influenced by gender, age and education level.

The dental restoration type and materials could be a challenge especially in anterior teeth in some situation as tooth damaged by restoration, caries or trauma and in cases of abnormal occlusion as the selection of the materials require accurate attention to the esthetic and mechanical properties

Dental ceramics are the most popular treatment for restoration of esthetic anterior teeth as they are used to treat morphological and structural defects and improve the esthetics of discolored teeth. It has been widely used as an esthetic restorative material owing to their chemical stability, high compression resistance, and color match to natural teeth.

Ceramic systems improve the color and translucency due to absence of the metal substructure and due to nature of these materials which allow clinicians to control the color parameters (value, chroma and hue), as well as the translucency. The final color of ceramic depends on the degree of opacity of the material, thickness, color of the substrate and cement shade. The esthetic dentistry aims to match the color reflected from natural teeth and artificial restoration.

The dentin form a large bulk of the tooth and to great extent is responsible for its color and a highly translucent ceramics allow more light to enter and scatter. The underlying structure has a great influence on the resultant color, this introduce large problem when the tooth is highly discolored or has a dark dentin and require translucent ceramic restoration to match the color of the natural tooth.

The variables between ceramic type, thickness, shade of underlying foundation and luting cement shade considered important factors that may play a role in solving many esthetics challenges, which needs further study.

Therefore, The aim of this study was to evaluate the effect of resin cement shades & thickness of zirconia reinforced lithium silicate ceramics (Vita Suprinity) using dark background on of the optical properties (color change) of the restoration compared to lithium disilicate glass ceramics (IPS e.max CAD). The null hypothesis was that there will be no difference in the optical properties between different ceramic thicknesses (Vita Suprinity) and resin shades using dark background compared to lithium disilicate glass ceramic (IPS e.max CAD).

II. Materials And Methods

II.1 Materials used in this study listed in **"Table 1."** were:

1-Zirconia reinforced glass ceramic (Vita Suprinity, Vita Zahnfabrik, Bad Säckingen, Germany)
2-Lithium disilicate ceramic (IPS e.max CAD;Ivoclar Vivadent, Schaan, Lichtenstein)
3-Tetric N-Ceram composite (Ivoclar Vivadent, Schaan, Lichtenstein)
4-Variolink N resin cement (Ivoclar Vivadent, Schaan, Lichtenstein))

Table (1) Types of materials used in this study

Material	Manufacture	Batch No.	Chemical composition
Zirconia-reinforced glass ceramic (Vita SuprinityA2-T)	VitaSuprinity,Vita Zahnfabrik,Bad Säckingen, Germany	58035	Zirconia (ZrO_2) and glass ceramic, ZrO_2 content of approx. 10 % by weight. -ZrO_2 (zirconia): 8 – 12% wt. -SiO_2 (silicon dioxide): 56 – 64% wt. -Li2O (lithium oxide): 15 – 21% wt.
Lithium disilicate Ceramic (IPS e.max CADA2-LT)	Ivoclar Vivadent,Schaan, Lichtenstein	V25662	-It consists of quartz, lithium oxide, phosphorous oxide, aluminium oxide and potassium oxide amongst other components -40% Lithium metasilicate (Li_2SiO_3) crystal embedded in glassy matrix in pre-crystallized status which become 70% lithium disilicate ($Li_2Si_3O_5$) after crystallization
Tetric N-Ceram composite (C3)	IvoclarVivadent,Schaan, Lichtenstein	V21458	-Urethane dimeyhacrylate: 15.0 % wt. -Ethoxylated Bis-EMA: 3.8 % wt. -Barium glass ytterbium trifluoride, mixed oxide, silicon dioxide: 63.5 % wt. -Prepolymers: 17.0 %wt. -Additives,stabilizers,catalysts, pigments: 0.7% wt.
Variolink N resin cement (Transparent and Yellow)	IvoclarVivadent,Schaan, Lichtenstein	V21458	-Barium glass filler, mixed oxide: 48.4 % wt. -Dimethacrylates: 26.3 % wt. -Ytterbiumtrifluoride: 25.0 % wt. -Inhibitor and Stabilzers: 0.3 %wt. -Pigments < 0.1 % wt.

II.2 Selection of ceramic blocks

The ceramic blocks used were Vita Suprinity (VS) shade A2 with level of translucency was a translucent (T), and IPS e.max CAD (e.max) block A2 shade with Low translucency (LT) which correspond to translucent shade in Vita Suprinity. Vita Suprinity block used was in Pre-crystallized (PC) status and need to be crystallized after milling, also IPS e.max CAD used was a partially crystallized blocks and need to become fully crystallized after milling. Vita Suprinity block and IPS e.max CAD blocks dimensions were 14 x 12 x 18 mm.

II.3 Samples preparation

2.3.1 *Ceramic samples preparation*

A slow-speed diamond saw (ISOMET 4000, Buehler Ltd., Lake Bluff, IL) was used under a constant flow of water, which serve as a lubricant and coolant to create fifty six (n=56) ceramics rectangular plates, twenty eight zirconia reinforced glass ceramic plates (group 1) and other twenty eight lithium disilicate glass ceramic plates (group 2), the dimensions of the plates were (14 x 12 mm). The plates were divided into two subgroups of two different thickness 1.0, 1.5 mm for each group of material. During cutting the ceramic plate samples the blocks were firmly holded by special clamp holder to fix the block during the ceramic plate samples preparation **"Fig. 1"**. A digital caliper was used to check that the specimen's thickness of both Vita Suprinity and IPS e.max CAD plates having the same thickness of 1.0 & 1.5 mm.

Fig. 1. Isomet disc used in sectioning Vita Suprinity block

II.3.2 Crystallization and Glazing

Vita Akzent® plus glaze material and finishing agent was applied over Vita Suprinity ceramic plate, while IPS e.max CAD Crystall glaze material was applied over surface of the IPS e.max CAD ceramic plate for glazing of specimens. A honeycomb tray and IPS object fix (Ivoclar Vivadent, Schaan, Lichtenstein) was used to fix the Vita suprinity plates and IPS e.max CAD plates over the firing tray to avoid contamination of specimen during crystallization. Crystallization and glazing was performed using Programat furnace (Ivoclar Vivadent, Schaan, Lichtenstein Programat® EP 3010 each group of ceramic plates were crystallized and glazed following manufacture instructions. When the plates get out from the furnace it were left to cool.

II.4 Ceramic samples classification:

The glazed crystallized samples were classified into two groups according to the type of ceramics Vita suprinity and lithium disilicate, each group was further subdivided into two subgroups according to thickness of the plate 1, 1.5 mm. **"Table 2."**

Table (2) showing groups and subgroups used for ΔE measurements:

Group No.	Ceramic type	Abbreviation	Subgroup Thickness	Abbreviation	No. of samples
1	Vita Suprinity	S	1 mm	S1	14
			1.5 mm	S1.5	14
2	IPS e.max CAD	E	1 mm	E1	14
			1.5 mm	E1.5	14
Total no. of samples					56

II.5 Composite background fabrication

For construction of composite samples, which represent the background for the ceramic sample plate, a Teflon disc with rectangular central opening of 14 x 12 mm and thickness of 2 mm was constructed. It has an outer holding assembly in form of metal copper ring of 3.1 cm in outer diameter, 2.5 cm in inner diameter and 2 mm thickness. Each composite resin plate has 2 mm thickness and 14 x 12 mm length and width. The Teflon mold former was placed over transparent glass slab **"Fig. 3-a"**, then composite resin plate was constructed by packing the material inside the rectangular opening of the mold former, the surface was then covered with a matrix (686 Mylar; Hawe Neos Dental, Bioggio, Switzerland) to avoid polymerization inhibition by oxygen. The specimens were covered with another transparent glass slab to obtain a smooth, bubble-free surface, and then polymerized through the transparent glass slab for 40 seconds using a light-polymerizing unit LED curing light LY- A180 (Demetron; Demetron Research Corp, Danbury, Conn) with wavelength range of 420-480 nm and light intensity (1200-2000 mw/cm), the light cure was holded with light emission window close as possible to the surface of the composite plate. Subsequently, the glass slab was removed and the specimens were further cured for another 20 seconds from all sides. The composite specimens were polished with silicone polishers and soflex discs. **"Fig. 3-b"**

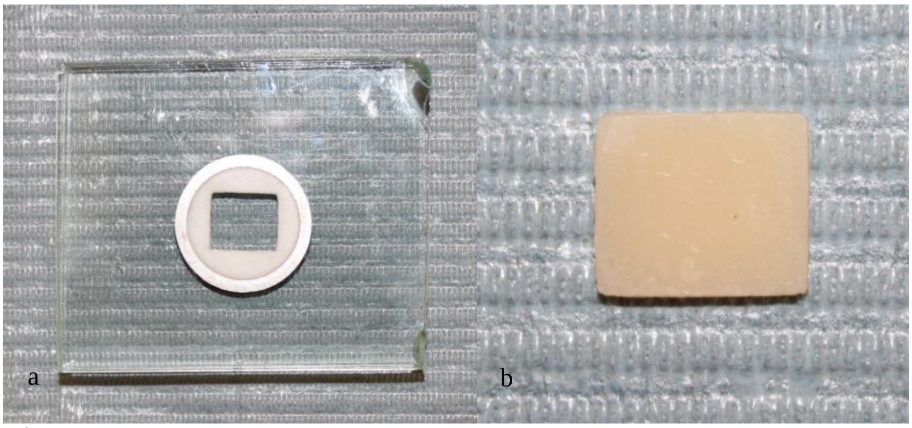

Fig.3 a-Mold former device between 2 glass slabs b-C3 Composite plate represent tooth dark background

II. 6 Cement plate construction

II.6.1 Cement mold construction

A specially designed copper split mold was constructed from copper to create resin cement plates of 0.2 mm in thickness, the mold consists of an outer and inner parts, the inner part was splited for easy removal of cement plate **"Fig.5"** the mold was 0.2 mm thickness and cement plate space was 14 x 12 mm in dimensions. **"Fig.6"** A Variolink N resin cement rectangular plates fig. (4) of 12 x 14 mm and thickness 0.2 mm were fabricated using cement mold former.

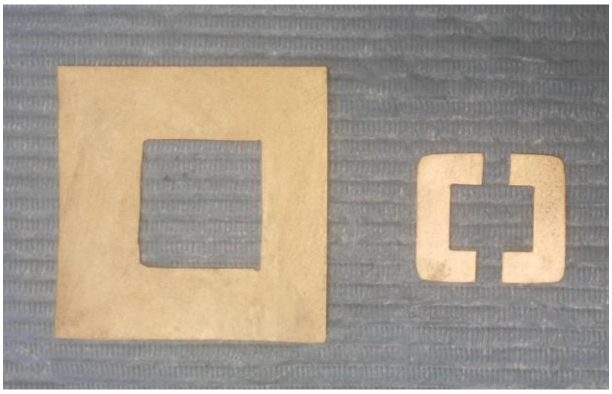

Fig.5 Disassembled cement mold

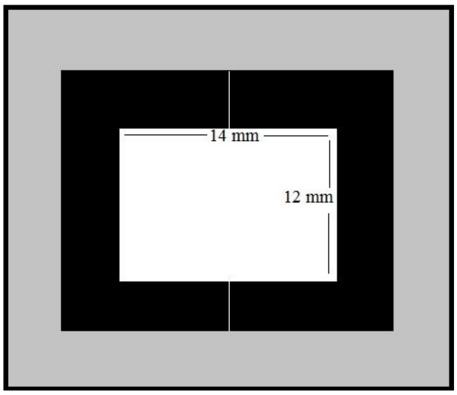

Fig.6 Diagram for the cement mold

2.6.2 Cement plate construction

The cement plate was constructed by applying the cement into copper mold former placed over the glass plate, covered by celluloid strips, and then covered by another glass plate to produce a smooth, voids free surface. Then polymerized for 20 seconds using a light-polymerizing unit LED curing light LY- A180 (Demetron; Demetron Research Corp, Danbury, Conn) with wavelength range of 420-480 nm and light intensity (1200-2000 mw/cm). Checking of the cement plate thickness was made using digital caliper. The cement plates were divided into 2 divisions (n=28) of two different shades, one division was made from the transparent shade and the other divisions was made from yellow shade. **"Fig. 5"**

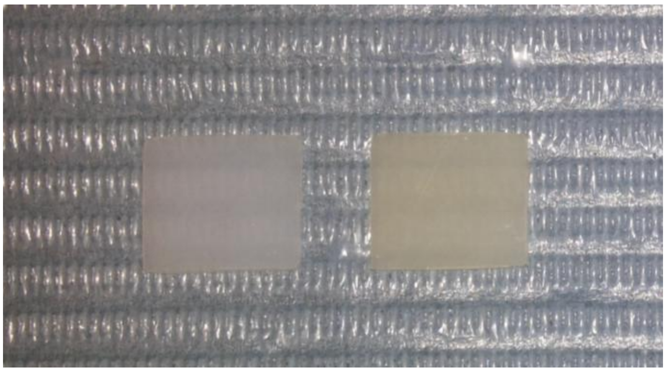

Fig. 5 Transparent and Yellow Variolink N cement plates

2.7 Classification of ceramics with dark background and different cement shades

For measuring color difference (**Δ**E) as a result of using dark background under ceramic plates and different cement shades were illustrated in **"Table 3."**

Table (3) showing groups, subgroups, subdivision and their background used for **Δ**E measurements:

Ceramic groups	**Subgroup of ceramic Thickness**	**Composite background**	**Division of Cement shades**	**Samples tested**	**No. of samples**
Suprinity (S)	S1	C3	Transparent (T)	S1 C3 T	7
		C3	Yellow (Y)	S1 C3 Y	7
	S1.5	C3	Transparent (T)	S1.5 C3 T	7
		C3	Yellow (Y)	S1.5 C3 Y	7
E.max (E)	E1	C3	Transparent (T)	E1 C3 T	7
		C3	Yellow (Y)	E1 C3 Y	7
	E1.5	C3	Transparent (T)	S1.5 C3 T	7
		C3	Yellow (Y)	S1.5 C3 Y	7
Total					56

Measurements

Color difference measurements

After preparation of ceramic, dark composite background (C3) and cement shades samples, spectrophotometer was used to measure the color difference after 24 hours with changing the cement shades (transparent, yellow), (Agilent Cary 5000 UV-Vis-NIR, Agilent Technologies, USA). Ceramic specimens with specific thickness was optically connected using drop of distilled water (refractive index close to 1.7)[1] to the specific cement shade in the same group which is then optically connected to C3 composite dark background. Each specimen, along with the tested cement shades and dark background was placed in a specimen holder inside a black box, which served to eliminate the impact of external light. The spectrophotometric measurement was obtained in means of L*, a* & b* for each specimen assembly and **Δ**E (difference color) was calculated between the all groups, subgroups and divisions using the following equation (1):

"$\Delta E^* = \sqrt{(L^*_0 - L^*_w)^2 + (a^*_0 - a^*_w)^2 + (b^*_0 - b^*_w)^2}$

Where

ΔE*: color change

0: ceramic- background assembly without cement

w: ceramic- background assembly with cement

L*: is a measure of the Lightness of an object, ranging from 0 (Black) to 100 (White).

a*: is a measure of of redness ($a > 0$) or greenness ($a < 0$).

b*: is a measure of yellowness ($b > 0$) or blueness ($b < 0$).

Statistical Analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). All data showed non-normal (non-parametric) distribution. Data were presented as mean, median, standard deviation (SD), minimum, maximum and 95% Confidence Interval (95% CI) for the mean values. Mann-Whitney U test was used to compare between the two ceramic types, the two cement types as well as the two thicknesses. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

III Results

Descriptive statistics for ΔE

ΔE were calculated from L*, a* and b* values between ceramic types with background assemblies without cement and ceramic types with background assemblies with cement among all groups, subgroups and divisions, it was found that highest ΔE value was obtained with Suprinity 1.5 mm with yellow cement, while lowest with was obtained e.max 1 mm with transparent cement. The ΔE of Suprinity 1 and 1.5 mm with yellow cement were 3.88 and 4.28 respectively, which were above the perceptible level. 3.7. As illustrated in **"Table 4"**

Table (4): Descriptive statistics for ΔE values of the different groups, subgroups and divisions

Group Ceramic type	Subgroup Thickness	Division Cement type		Mean	SD	Median	Minimum	Maximum	95% CI Lower bound	95% CI Upper bound
Suprinity (S)	1 mm	Transparent	S1 T	1.83	0.73	1.72	1.19	2.47	1.13	2.93
		Yellow	S1 Y	3.88	0.36	3.92	3.38	4.35	3.43	4.33
	1.5 mm	Transparent	S1.5 T	2.89	0.31	2.86	2.46	3.34	2.50	3.27
		Yellow	S1.5 Y	4.28	0.81	4.00	3.52	5.57	3.26	5.29
E.max (E)	1 mm	Transparent	E1 T	0.96	0.49	0.94	0.47	2.75	0.53	1.39
		Yellow	E1 Y	1.57	0.85	2.92	1.74	4.09	0.82	2.32
	1.5 mm	Transparent	E1.5 T	1.86	0.63	1.96	0.87	2.56	1.08	2.64
		Yellow	E1.5 Y	2.16	0.94	2.03	0.71	3.15	1.34	2.98

Effect of ceramic material

By comparing ceramic types, either with 1 or 1.5 mm thicknesses using transparent or yellow cement; Suprinity showed statistically significant higher mean ΔE than e.max.

Effect of ceramic thickness

By comparing thicknesses, with either Suprinity or e.max using transparent or yellow cements; the mean ΔE with 1 mm thickness showed statistically significant lower mean value than 1.5 mm thickness.

Effect of cement shades

By Comparing cement shades, with either Suprinity or e.max at 1 or 1.5 mm thicknesses; transparent cement showed statistically significant lower mean ΔE than yellow cement. As illustrated in **"Table 5"** and **"Fig. 6"**

Table (5). Mann-Whitney U test for comparison between ΔE of the two ceramic types, two thicknesses and the two cement types

Subgroup of Thickness	Division of Cement type	Suprinity (Group1) Mean	Suprinity (Group1) SD	E.max (Group2) Mean	E.max (Group2) SD	*P*-value *(Between ceramic types)*
1 mm	Transparent	1.83	0.73	0.96	0.49	0.036*
	Yellow	3.88	0.36	1.57	0.85	0.020*
	P-value *(Between cement types)*	0.008*		0.005*		
1.5 mm	Transparent	2.89	0.31	1.86	0.63	0.016*
	Yellow	4.28	0.81	2.16	0.94	0.001*
	P-value *(Between cement types)*	0.008*		0.042*		
P-value *(Between thicknesses)*	Transparent	0.030*		0.032*		
	Yellow	0.040*		0.047*		

**: Significant at $P \leq 0.05$*

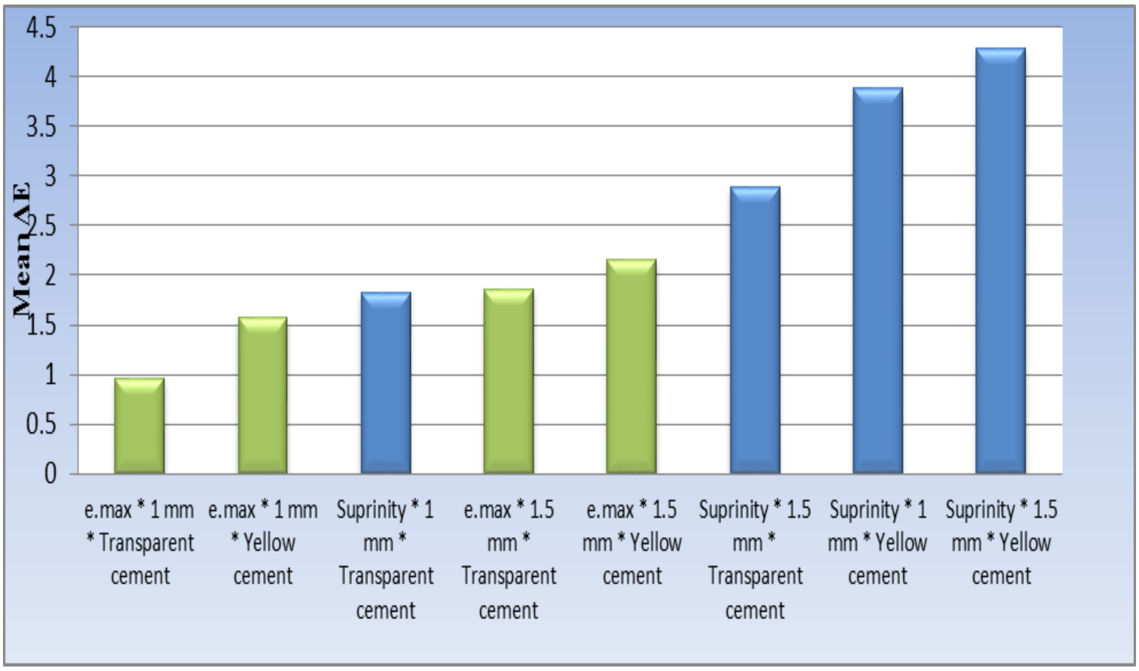

Fig. 6 Bar chart representing mean values for ΔE of the different interactions in ascending order

IV. Discussion

The increase demands for superior dental esthetics and high-quality restorations have led to the development of ceramic materials which are characterized by enhanced esthetic properties, optimal integration to gingival tissues, and biocompatibility.(2) Ceramics have varied degree of translucency, ranging from a very translucent material to an opaque core ceramic. The varied translucency of ceramics may affect matching to neighboring teeth in terms of color and translucency. The translucency of ceramic materials depends on several factors such as relative refractive index, wavelengths of the light sources, numbers and sizes of porosity and inclusions.(3)

The use ceramic restoration may be problematic when it's used to mask the dark color of underlying structure and create high esthetic translucent restoration. The use of ceramic materials in such cases require careful treatment plan to select the proper material type, thickness and cement shade to give the best recommended esthetic result. The aim of this study is to evaluate the effect of resin cement shades & thickness of zirconia reinforced lithium disilicate ceramics Vita Suprinity) using dark background on of the optical properties L*, a*, b* and color change (ΔE) of the restoration compared to lithium disilicate glass ceramics (IPS e.max CAD).

The selected ceramic blocks either Vita Suprinity or IPS e.max CAD had the same shade A2 because it is one of the most commonly used shade as **Elamin et al. 2015**(7)did a survey for the shade of central incisor and found that shade A2 represented in 78.5% of the candidates.

The degree of translucency was translucent (T) for Vita Suprinity and Low translucency (LT) for IPS e.max, which correspond to translucent shade in Vita Suprinity for standardization. The block dimensions of Vita Suprinity and IPS e.max. CAD of both ceramic blocks was 14 x 12 x 14 mm in order to match study done by **Niu et al. 2014**(8) which found that to minimize the impact of edge loss, the ceramic specimens for the study were made at a large dimension (12 x 14 mm) with flat ground surfaces

The thicknesses 1 and 1.5 mm were selected as they are the most commonly used thicknesses for ceramic restoration also, this thicknesses were applied in many types of preparation such as veneers and full coverage preparation. Besides, it is the appropriate thickness to mask the discoloration as less than 1 mm will not be effective and more than 1.5 will compromise the retention and resistance features of the preparation and may lead to pulpal involvement especially in anterior teeth. **Pires et al 2017**(9) illustrated that the amount of reduction required for ceramics in anterior teeth is 1 mm in the cervical region, 1.2 mm at the axial walls, and 1.5 mm at the incisal aspect and for the posterior teeth.

Combined crystallization/glazing cycle of the ceramic plates were performed according to manufacture instructions to achieve smooth surface and natural looking restorations, **Coşkun et al 2014**(10) found that ceramic restorations having the smooth surface was obtained after glazing among other different surface treatments, it was found that surface finishing protocol slightly change the translucency of lithium disilicate glass ceramic.

Composite resin plate was 2 mm thick to allow good penetration of light for proper degree of polymerization**.** The composite specimens were polished with silicone polishers and soflex discs, because surface finishing during restorative procedures influenced optical properties of the dental composite resins. Rough surface may reflect the individual segment of the specular beam at slightly different angle result in change of composite color.(11)

A specially designed copper mold assembly was constructed to create resin cement plates of 0.2 mm in thickness and 12 x 14 mm dimensions. It was made from copper to allow construction of mold in very thin thickness with a good degree of strength.

The cement thickness used in this study was 0.2 mm based on the study done by **Niu et al. 2014**(8) who studied the influence of cement thickness on the color of glass ceramic. He found that differences in cement thickness (0.1 or 0.2 mm) had small effect on the resultant colors of glass ceramic, while increasing cement thickness to 0.3 mm did not improve the resultant shades however an increased cement thickness created a resultant shade that exceeded the clinically acceptable threshold $\Delta E > 5.5$. In addition, thicker cement layers have been reported to be related to decreased bond strength.

Spectrophotometers used the CIE L*a*b* color system because it approximates uniform distances between color coordinates while entirely covering the visual color space. The strength of this system is in its ability to be clinically interpreted, as equal differences across the CIE L*a*b* color space (color differences or ΔE) represent approximately uniform steps in human color perception, improving the interpretation of color measurements.

Ceramic assemblies were optically connected with distilled water to dark composite background to measure the color with cement. The addition of the distilled water was performed to enhance the optical contact during the spectrophotometric measurements, which serve to minimize the loss of light through the margins of the specimens (known as edge-loss).(1)

Results revealed that, among all tested groups, the mean ΔE ranged from 0.96 to 4.28. All mean ΔE were below clinically acceptable level except for Vita Suprinity with yellow cement either with 1 or 1.5 mm thickness as ΔE was 3.88 and 4.28 respectively

By comparing ceramic types, either with 1 or 1.5 mm thicknesses using transparent or yellow cement; Suprinity showed statistically significant higher mean ΔE than e.max, this result proved that Vita Suprinity has higher ability to mask the color of underlying structure than IPS e.max CAD. This results is in agreement with **Volpato et al. 2009**(13) who found that the color differences (ΔE) found in the IPS-Empress 2 + Eris ceramic veneering material was smaller than those found in the IPS-Empress system.'

The higher masking ability of Vita Suprinity than IPS e.max CAD could be attributed to difference in chemical composition as incorporation of 8–10 wt. % zirconium oxide leads to an improved strength. So after crystallization, Vita Suprinity has a homogeneous texture with mean grit size approximately 0.5–0.7 μm. The formed crystals are 4 to 8 times smaller than lithium disilicate crystallites. Zirconia reinforced lithium silicate (ZLS) ceramics consist of a dual microstructure: the first component is very fine lithium metasilicate with lithium disilicate.(5)

By comparing thicknesses, with either Suprinity or e.max using transparent or yellow cements; the mean ΔE with 1 mm thickness showed statistically significant lower mean value than 1.5 mm thickness. This could be attributed to lower masking ability of ceramic with 1 mm thickness, so the color of dark background significantly affect the final color either with or without using cement. This was in agreement with **Volpato et al. 2009**(13) found that the influence of the substrates was larger for the smallest thickness, this could be explained by the smaller amount of particles present, facilitating the light transmission process. **Chaiyabutr et al. 2011**(14) showed that the color difference (ΔE) of a CAD/CAM glass-ceramic lithium disilicate-reinforced restoration is affected by the tooth abutment color, cement color, and ceramic thickness.

Wang et al. 2013(15) studied the effect of the type of materials in the term of translucency and the thickness of ceramics in the final color of the restoration. It was revealed that the more translucent ceramic showed a greater change in translucency when its thickness changed. This was in agreement with our study as the thickness of Vita Suprinity has the little influence in changing the color of the final restoration in respect to other variants

By comparing cement shades, with either Suprinity or e.max at 1 or 1.5 mm thicknesses, transparent cement shade showed statistically significant lower mean ΔE than yellow cement shade. This could be explained by higher masking ability of yellow cement than transparent cement, which may be due to increased b* value of yellow cement, which may could attributed to pigment particles within cement. The results was in agreement with **Zebeda et al. 2013**(16) who found that the use of an opaque luting agent resulted in higher ΔE values when compared to the translucent cement. Besides, Turgut and Bagis 2013(17) agreed that resin cements affect the final color of laminate restorations as the color change was higher than the perceptible level of 3.5 ΔE units . Also **Niu et al. 2013**(8) concluded that the colors of machinable lithium disilicate ceramic restorations placed on Ag-Pd foundation were affected by both the color and thickness of cements

These results were in contradiction with a study done by **Salamah et al. 2014**(18) as they showed that neither the translucency of the ceramic block nor the opacity of resin cement improved the color match, the author justify that it may be due to the use of leucite materials. Moreover, Chen et al. 2015(19) mentioned that the yellow shade have little influence on the color changes of ceramic disks which in contradiction with our study and opaque shades obviously resulted in an increase in the brightness and a decrease in the chroma of the ceramic disks.

Our results was also partially disagreed with **Pires et al. 2017**(9) they showed that at certain thickness neither the background nor cement have effect in the final color as they concluded that the high opaque ceramic presented similar ΔE values between different substrates when 1.5 mm thickness ceramic was used.

Also, **Pires et al. 2017**(9) concluded that the substrate color, type, thicknesses of ceramic and the presence of cement significantly influenced the resultant optical color.

Our study showed that highest ΔE values with Vita Suprinity samples with yellow cement either with 1 or 1.5 mm thickness as ΔE was 3.88 and 4.28 respectively which indicated that the type of ceramic used and shade of the cement was much more important in masking the color of the discoloration than the thickness of the materials. So the hypothesis fully rejected

V. Conclusion

1. Zirconia reinforced lithium silicate ceramics (Vita Suprinity) could decrease the effect of color change of dark background more significantly than lithium disilicate glass ceramic (IPS e.max CAD)
2. Increasing the thickness of both ceramic types could increase color change and mask the color of dark background.
3. Yellow cement shade could significantly mask the color of dark background than the transparent cement shade either with Zirconia reinforced lithium silicate ceramics (Vita Suprinity) or lithium disilicate glass ceramic (IPS e.max CAD).
4. Zirconia reinforced lithium silicate ceramics (Vita Suprinity) could significantly mask the color of dark background in small thicknesses using yellow cement

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