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Evaluation of v of CAD/CAM Lithuim Disilicate Veneers of Different Thicknesses and Translucency

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ABSTRACT

Background: With the increasing patients' demand for a perfect smile, the call for highly aesthetic and yet minimally invasive veneers has surmounted. **Objective:** The aim of this study was to evaluate the colour of CAD/CAM lithium disilicate veneers fabricated in different thicknesses and different translucencies of the lithium disilicate blocks. ***Materials and Methods:*** Forty discs of lithium di-silicate glass-ceramic (IPS e.max CAD) of shade A1 of both high and low translucency (HT, LT) were tested for their colour reproduction. HT and low LT blocks were cut in the form of plates of dimensions (12 x 14 mm) and of different thicknesses (0.3 mm, 0.5 mm, 0.7 mm, and 0.9 mm). Twenty specimens of each translucency were classified into three sub-groups according to thickness (n=5). Colour reproduction (ΔE) was determined using VITA Easyshade Advance against a foundation block and compared with A1 shade tab. Data was collected for statistical analysis. Analysis of Variance (ANOVA), and pair-wise comparison tests were used. Significance level was set to P<0.05. ***Results:*** Two-way ANOVA test showed that the change in both thickness and translucency a well as the interaction between them had a significant effect over (ΔE) values. One-way ANOVA and Bonferroni's tests showed that the low translucency samples showed a statistically significant difference in (ΔE) values between all thickness groups except between the 0.3 mm and 0.7 mm as well as between the 0.5 mm and 0.9 mm thickness specimens. High translucency specimens showed a significant difference between all thicknesses. ***Conclusions:*** The final colour of laminate veneers could be highly affected by both the thickness and translucency of the ceramic material used. LT specimens produced much better colour reproduction than the HT specimens.

1. INTRODUCTION

Colour matching of dental restorations is regarded as one of the most critical elements for a successful aesthetic outcome. Consequently, thorough comprehension of the optical properties of teeth is considered crucial for precise and consistent reproduction of colour of any fixed dental restoration.[1]

Human eye is capable of easily distinguishing between a natural tooth and an artificial one even though there are only minuscule differences in colour and translucency. Yet, the interpretation of visual colour comparisons is still subjective and the threshold level for visually perceivable or clinically acceptable colour differences varies based on individual reports. [2-6]

The final colour of a restoration is not only influenced by the underlying tooth structure with its optical properties, but by many other variables as well. Thickness of the restoration, the number of firing cycles of the ceramic material, the shade, as well as the film thickness and type of the resin cement are all factors that could influence the final colour of the restoration. [7-11]

For superior aesthetic results, translucency of the used restorative ceramic material must be considered.[12] Translucency of dental ceramics is highly dependent on scattering of light, reflectance and transmission where the amount of light absorbed, transmitted or reflected is based on the crystal content within the ceramic material, its chemical nature, and the particles' size. [13]

It was also demonstrated that controlling the ceramic thickness might enable the clinicians to manage the overall translucency of the restoration which consequently affects its colour reproduction. It was revealed that the more translucent the ceramic was, the greater would be the change in translucency and consequently the aesthetic outcome of the final restoration would be more sensitive to thickness.[14-17]

Lithium disilicate glass-ceramics are widely used for highly aesthetic yet minimally invasive restorations where they have shown impressive in vitro strength results when used in thin sections together with having various translucencies. Lithium disilicate reinforced glass ceramics are characterized by their low refractive index and thus the material becomes very translucent inspite of its high crystalline content. [15-20]

The aim of this study was to evaluate the colour of CAD/CAM lithium disilicate veneers when fabricated in different thicknesses and using different translucencies of the lithium disilicate blocks. The null hypothesis is that neither the change in thickness nor translucency would affect the final colour of the restoration.

2. MATERIALS AND METHODS

A total of forty discs of lithium disilicate glass-ceramic material (IPS e.max CAD, Ivoclar Vivadent) of shade A1 and of both high and low translucency were tested for their colour reproduction.

High translucency and low translucency ceramic blocks were cut in the form of plates of dimensions (12 x 14 mm) and of different thicknesses (0.35 mm, 0.5 mm, 0.7 mm, and 0.9 mm) using a precision saw (IsoMet 4000, Buehler) with water coolant system. Twenty specimens of each translucency were classified into three sub-groups according to thickness (n=5) (table 1).

Table 1:

Samples Grouping

Ceramic Material Translucency	IPS. e.max CAD High Translucency (HT) n=20				IPS. e.max CAD High Translucency (LT) n=20			
Thickness	0.3mm n=5	0.5mm n=5	0.7mm n=5	0.9mm n=5	0.3mm n=5	0.5mm n=5	0.7mm n=5	0.9mm n=5

All specimens were finished and wet polished using waterproof silicon carbide sand-paper (Matador SoftFlex, Germany) of grit sizes that range from 600 to 1200 with a grinder-polisher machine (Buehler EcoMet 250 Grinder-Polisher and AutoMet 250 Power Head). Each specimen thickness was measured with a digital calliper (GA182, Grobet Vigor) to ensure the precise final thickness of the specimens in each thickness group.

All specimens were then ultra-sonically cleaned in distilled water for 10 minutes before glazing and crystallization. A layer of neutral-shade glaze (IPS e.max crystal/ glaze paste Ivoclar Vivadent, Schaan, Liechtenstein) was coated on the smooth finished side of each specimen. Specimens were placed over cotton and honey combed firing tray with the glazed surface facing upwards and fired in Programat P300/G2 (Ivoclar Vivadent, Schaan, Liechtenstein) as recommended by the manufacturer to obtain fully crystallized and glazed specimens

After crystallization and glazing, the unglazed surfaces of all specimens were etched with 5% hydrofluoric acid (IPS Ceramic Etching Gel; Ivoclar Vivadent, Schaan, Liechtenstein) for 20 seconds, rinsed and air dried.

A composite block of shade A2 (Nexcomp, META BIOMED, Korea) having the same dimensions as the ceramic specimens and 2 mm in thickness was constructed using a special mould and used as background for colour measurement later. A 100 Um thick layer of translucent light cure resin cement (RelyX Veneer, 3M ESPE, USA) was loaded over the composite block and cured for 90 seconds through a cover glass slab. Cement thickness was controlled through pressing the surface of a glass with one end of a manual micrometre (Outside micrometre M1 I10-50, Mitutoyo) after loading the cement onto the composite block. [21]

Colour reproduction (Δ E) was determined using VITA Easyshade Advance (Vita, Zahnfabrik H. Rauter GmbH&Co. KG.) that was set to the "Single tooth mode". L*, a*, and b* values were obtained and compared to the corresponding values of A1 shade tab of Vivadent shade guide (Ivoclar Vivadent) so that ΔE values could be calculated according to the following equation;

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where L*coordinate shows the lightness-darkness of the specimen. The a* coordinate represents the chroma along the red-green axis. The b* coordinate measures chroma along the yellow-blue axis. ΔL*, Δa* and Δb* represent the differences in the CIE colour space parameters between the values of the AI shade tab and those of the measured specimens. The EasyShade device was calibrated before each measurement in order to standardize the reproducibility. Each specimen was measured three times and an average was recorded.

In all colour measurements, specimens were placed against the previously fabricated foundation composed of the composite block together with the resin cement layer. A glycerine drop was applied between each specimen and the backing to seal the air space and reduce the edge loss effect. [22]

Data was then collected and tabulated to be statistically analysed. Analysis of Variance (ANOVA), both two way and one way were used in testing the significance for the effect of both thickness and translucency and their interactions on mean colour change. Bonferroni's post-hoc test was used for pair-wise comparison when ANOVA showed significance where significance level was set to $P<0.05$.

3. RESULTS

Two-way ANOVA test showed that the change in both thickness and translucency as well as the interaction between them had a statistically significant effect over (ΔE) values.

One-way ANOVA and Bonferroni's tests showed that the low translucency samples displayed a statistically significant difference in (ΔE) values between all thickness groups except between the 0.3 mm and 0.7 mm as well as between the 0.5 mm and 0.9 mm thickness specimens (table 2). The highest (ΔE) value was reported for the 0.5 mm thick specimens while the lowest value was reported for the 0.9 mm thick specimens (figure 1). On the other hand, there was a statistically significant difference between all thickness groups for the high translucency groups specimens with the highest (ΔE) value recorded for the 0.9 m thick specimens and the lowest value recorded for the 0.3 mm thick specimens (table 2).

Table 2:

Mean (SD) ΔE values for different thicknesses of LT groups

Thickness	Mean	SD
0.3 mm	4.26^{ac}	0.43
0.5 mm	3.19^{bd}	0.35
0.7 mm	4.04^{ac}	1.37
0.9 mm	2.49^{bd}	0.32

Different small superscripts indicates significance between different thicknesses in LT group

Table 3:

Mean (SD) ΔE values for different thicknesses of HT groups

Thickness	Mean	SD
0.3 mm	4.06^{A}	0.17
0.5 mm	4.85^{B}	0.46
0.7 mm	7.61^{C}	0.13
0.9 mm	8.22^{D}	0.19

Different capital superscripts indicates significance between different thicknesses in HT group

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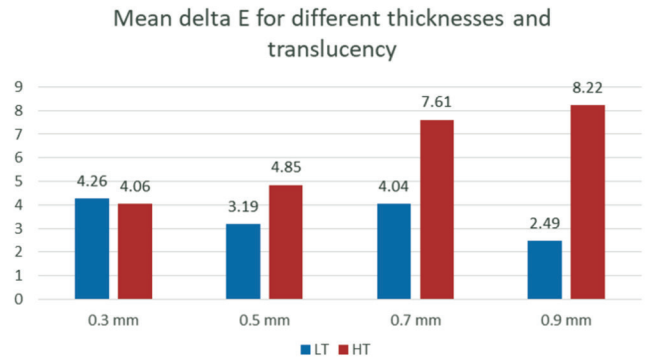

Figure (1) — Bar chart for mean delta E values for different thicknesses and translucency

4. DISCUSSION

Colour matching of dental restorations is one very critical aspect controlling the aesthetic outcome, a reason why numerous studies and research focused on optimizing the colour and translucency of aesthetic restorations.[1]

The final colour of the restoration is influenced by many variables including; the restoration thickness, the resin cement shade and type, the underlying supporting, as well as the translucency of the ceramic material used. For this purpose, most ceramic systems are supplied in different translucencies according to the clinical case requirements. [7-11]

Among these ceramics, and one of the most famous nowadays in market for its good optical properties and strength allowing it to be used in thin sections, is lithium disilicate. Lithium disilicate (IPS e.max CAD) was selected for this study where it's classified as a glass ceramic consisting of 70% wt. needle like crystals having very low refractive index similar to that of the matrix in which they are embedded. [18],[19]

For our study, shade A1 was selected because it's regarded as the lightest most commonly selected shade for laminate veneers.[21- 23] Specimens' thicknesses were chosen to range between 0.3 mm up to 0.9 mm with 0.2 mm thickness difference between each group because several studies have shown that 0.2 mm thickness is required for every shade change. [24-26]

Since different thicknesses of the cement might affect the final colour of the cemented laminate veneers, cement thickness in our study was set to 100 Um imitating the maximum accepted cement thickness below a laminate veneer. This thickness was also regarded as being suitable for proper internal fit of the laminate veneers as recommended by multiple previous studies. [22],[27]

A translucent shade was chosen for the cement so as to reduce the number of factors affecting the final shade of the restoration. [22]

Colour measurements were done using Vita EasyShade Advance using the single tooth mode where L*, a*, and b* values were obtained and compared to the corresponding values of A1 shade tab of Vivadent shade guide (Ivoclar Vivadent) so that ΔE values could be calculated. [21],[22],[27],[28]

Since the capacity of the human eye to recognize small differences in colour is limited together with the subjectivity of interpretation of visual colour comparisons, the threshold level for visually perceivable or clinically acceptable colour differences varies in literature. While Douglas RD et al [5] designated a value of 1.7ΔE_{ab} as the acceptable threshold for colour difference among metal ceramic crowns, others considered the acceptable threshold for colour difference to be 3.3 ΔE_{ab}.[6] In another study, Douglas RD et al [4] concluded that the perceivable colour difference for fifty percent of the dentists was 2.6 ΔE_{ab} while that at which fifty percent of the dentists would decide on going for re-make of the restoration because of mismatch of colour was 5.5, a guidance that was adopted in the current study.

In our study, the mean ΔE values were all within the acceptable range < 5.5 except for the 0.7 and 0.9 mm thick high translucency specimens.

The null hypothesis that neither the change is thickness nor translucency would affect the final colour was rejected where the change in both thickness and translucency of the specimens had a significant effect on colour.

The increase in the veneer thickness was associated with decrease in colour change values for the LT groups where high translucency lithium disilicate blocks are characterized by their chameleon effect exhibiting higher translucency and lower brightness than the low translucency specimens.[15] Also the fact that increasing the thickness would lead to decreased diffused reflections in the underlying material could be a reason explaining that reduction in colour change values with increasing the thickness of the material.[29]

However, in the high translucency group specimens, the increase in the veneer thickness was associated with increase in the mean values of ΔE which was against what was found by Alfouzan A. et al [30] in their study. Yet, the reason behind this could be attributed to the fact that low translucency blocks have more lithium di-silicate crystals than high translucency blocks where crystals tend to decrease the internal scattering of light when it passes through the material. [23],[31]

Further research is still needed investigating the different behaviour of low translucency and high translucency specimens. It's also advised to carry on more research to see the effect of the luting cement shade and thickness as well as the shade of the underlying tooth structure on the final colour of the restoration.

5. CONCLUSIONS

Within the limitations of our study, it was clear that the final colour of laminate veneers could be highly influenced by both the thickness and translucency of the ceramic material used. LT specimens produced much better colour reproduction than the HT specimens.

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