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Translucency Of Cad/Cam Veneers Using Different Internal Relief Spaces And Luting Cement Shades

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ABSTRACT

Introduction: Previous literature has revealed a significant effect of various trial insertion pastes materials on the translucency of ceramic veneers. However, the evidence regarding the impact of cement thickness on the final shade of the glass-ceramic, feldspathic, and zirconia reinforced glass-ceramic veneers is inconclusive. Objective: The aim of the present study was to evaluate the translucency of three different CAD/CAM processed veneer materials with different internal relief spaces and cement shades. Methodology: Sixty acrylic samples were prepared and classified according to the type of materials into three main groups: IPS e.max CAD MT, VITA Vitablocs Mark II, and Vita Suprinity, comprising 20 samples each. Based on the internal relief spaces (100 µm and 30 µm), each group was subdivided into two subgroups (10 samples each). Each subgroup was further subdivided into six classes according to the type (10 samples each) and the shade of the trial cement used. Glycerin was used as the control class, and five different trial pastes (translucent, white opaque, A1/Light Yellow, A3 opaque/yellow opaque, and B0.5/ white shades) were used according to their shade. The color test was conducted using a reflectance spectrophotometer device (Vita Easy shade V). Color coordinates were measured in the body region of all laminate veneers with different combinations of laminate veneer material, internal relief space, and trial insertion paste color on composite resin abutment A3. The consistency of the translucency among the tested specimens was confirmed using a two-way ANOVA and the Tukey HSD post hoc test ($P< 0.05$). Results: The luminous transmittance exhibited a statistically significant dependence on different ceramic restorations in CAD/CAM veneers with various internal relief spaces and different combinations of cement shades ($P< 0.05$). Conclusions: The underlying color of the tested trial insertion pastes caused color change ($\Delta E>3.7$) for all ceramic material used.

Keywords: CAD/CAM. Translucency. Laminate veneers.

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INTRODUCTION

There are several innovations in dentistry; however, the primary challenge faced by the dentists is to achieve an esthetically acceptable restoration. Computer-aided design/ computer-aided manufacturing (CAD/CAM) ceramics are the most commonly indicated dental restorations owing to their superior esthetics, higher wear resistance, durability, color stability, and biocompatibility.[1,2] With the advent of the CAD/CAM technology in dentistry, the dentists utilized the novel treatment modalities and changed the design and applicability of all-ceramic restorations as the demand for esthetics multiplied.[3] CAD/CAM is a tool that is useful for digital impression making, designing, and the elaboration of monolithic restorations for ceramic materials.[4-6] Thus, the resulting restoration, which is fabricated from these CAD/CAM ceramic blocks under optimum conditions, has higher intrinsic strength.Translucency is regarded as the primary indicator of the esthetic outcomes as it provides the ceramic restorations with a natural esthetic appearance. It is a condition between complete opacity and transparency, allowing light to get diffused rather than be reflected or absorbed.An ideal esthetic restoration should reproduce the color and translucency of the neighboring natural teeth. The degree of translucency is a critical factor that affects the color masking ability.[12]

Masking ability is calculated by measuring the color difference (ΔE) between uniform thicknesses of the material on black and white backgrounds.[13] When there is no color difference ($\Delta E = 0$), the masking ability is considered optimal; however, $\Delta E \leq 3.7$ units are regarded as visually acceptable.[14] However, teeth related esthetic discrepancy is evident owing to the human eye being more sensitive to the difference in value (brightness) than hue or chrome.[17,18] Apart from the hue or chrome of the ceramics, the translucency is also associated with the light transmission and polymerization efficiency of the underlying resin-based luting agents. However, the literature regarding the translucency of contemporary CAD/CAM materials is limited. Recently, numerous studies have investigated the association between the translucency of ceramic veneers with different cementation materials. Other studies concluded a significant effect of luting film thickness on bond strength and ceramic strength.[21-23] Cement escape channels and Internal relief space for cement has been shown to increase the marginal fit between restoration and preparation of the tooth, decreasing the risk of cement breakup, plaque accumulation, chronic decay, and periodontal problems and restore support and load distribution to the restoration substrate.[24] All these advantages obtained from internal relief space might improve the fracture strength of cemented all ceramic crown.Nonetheless, no study has yet evaluated the effect of cement space thickness on the final shade color of Zirconia reinforced glass-ceramic veneers. Therefore, the present study was conducted to evaluate the translucency of three different CAD/CAM processed veneer materials with different internal relief spaces and cement shades.

MATERIALS AND METHODS

Materials

Three different types of ceramic CAD/CAM blocks were used in this study, as seen in Table 1.
Table 2 shows the different shades of trial insertion pastes used (five different shades).
The definitive dies used were machined from a composite resin blank (Tempo CAD, 98.5 mm x 20 mm; On Dent dental systems) with shade A3 used as a control. Therefore, six different color trial insertion paste materials were used for the cementation of all ceramic veneers with two different internal relief spaces over the composite resin abutments.

METHODOLOGY OF THE STUDY

Acrylic tooth preparation

Veneer preparation was done using an acrylic maxillary left lateral incisor on an acrylic model cast (Model #R861; Columbia Dentoform Corp, Long Island City, NY, USA).
Tooth/crown preparation was performed using microvision kit (Komet, REF TD2194). The facial surface reduction was performed in two planes (cervical and incisal two-thirds) using depth cuts of 0.5 mm each to control the depth of crown preparation. The facial reduction was completed using tapered stone with a round end, making a uniform chamfer finish line of 0.5 mm. The incisal edge reduction of 1 mm was performed with a butt joint design using a 0.5 mm depth cut to control the incisal depth, and tapered stone with a round end was used to complete the incisal reduction.

Abutment fabrication

An impression of the prepared tooth with adjacent teeth was made with polyvinylsiloxane impression material (Aquasil Ultra digit XLV Regular Set; Aquasil Monophase; Dentsply Intl, NY). Type IV die stone (Jade Stone; Whip Mix Corp, Louisville) was used to pour the impression to fabricate the definitive cast.The definitive cast was scanned using Dentsply Sirona in Eos X5 extraoral scanner, and the restoration site was designed with CAD technology (Sironain lab SW 15.1 software). The abutment design was exported to the CAM software (Sironain lab 16 cam software), and milling was performed according to the manufacturer's instructions using the Sirona MCX5 milling machine. The composite resin abutment was machined from composite resin blank with A3 shade.

Fabrication of Veneers

Veneer fabrication was done from three different types of ceramic (CAD/CAM) blocks. The blocks were machined using CAD/CAM technology (SIRONA INLAB 3D CAD/CAM; Sirona Dental Systems LLC, Charlotte, NC) according to the manufacturer instructions, as shown in Figure 1.

Application of trial insertion paste cement

Each laminate veneer was loaded with six types of trial cement paste separately. Glycerin was used as the control class, and five different trial pastes (RelyX Try-in paste; 3M ESPE; Translucent, White Opaque, A1/Light Yellow, A3 Opaque/Yellow Opaque, and B0.5/White Shade) were used according to their shade prior to the color testing.

Color Testing (colorimetric evaluation)

The color was tested using a reflectance spectrophotometer device (VITA Easyshade V) (Figure 2). Color coordinates were measured in the body regions of all laminate veneers with different combinations of laminate veneer material, internal relief spaces, and trial insertion paste color on composite resin abutment A3 and readings were repeated thrice for each combination.The color changes (ΔE) were calculated between the control laminate veneers (with 30 μm internal relief spaces and glycerin on the composite resin abutment A3) and the experimental laminate veneers (with a combination of two internal relief spaces and five trial insertion paste colors on the same composite resin abutment) in the three distinct regions of the tooth (incisal, middle, and cervical) with the following equations.

$\Delta E = [(E\ control - E\ experiment).^{2\ 1/2}$ and ΔE = 3.7 was considered as the perceptibility threshold.

The mean and standard deviation (±SD) of ΔE for each veneering material was calculated, and an average for the combinations of the internal relief space and trial insertion paste color in each veneer region was calculated. The two-way analysis of variance (ANOVA) test was used to draw comparisons between different groups and shades for each thickness at various sites. When the ANOVA was statistically significant, Tukey's honestly significant difference (HSD) test was used to determine the significantly different comparisons.

RESULTS

The following is suggestive of the comparative analysis of ΔE between different groups of ceramic veneer materials and different shades of trial cement pastes.

Effect of 30 μm internal relief space

Comparison of ΔE between different groups of ceramic veneer materials and different shades of trial cement paste for 30 μm internal relief space is presented in Table 3. Multiple comparisons between groups are presented in Figure 3.

Comparison between different groups of ceramic veneer materials

A significant difference was observed between groups for the shades translucent (p=0.005), white opaque (0.001), A1 (0.001), A3 (p=0.001), and B 0.5 (p=0.001). For translucent shade, the order of ΔE was mark II > emax > suprinity. No significant difference between emax and suprinity was noted. For white opaque, the order of ΔE was suprinity>markII >emax. There was a significant difference between each group. For A1, the order of ΔE was markII> emax> suprinity. No significant difference between emax and suprinity was noted. For A3, the order of ΔE was suprinity> emax> markII. No significant difference between mark II and emax was noted. For B 0.5, the order of ΔE was suprinity> emax> markII. No significant difference between emax and suprinity was noted.

100 μm internal relief space

Comparison of ΔE between different groups and different shades of trial cement paste for 100 μm internal relief space is presented in Table 4. Multiple comparisons between groups are presented in Figure 4.

Comparison between different groups of ceramic veneer materials

There was a significant difference between groups for shades translucent (p=.001), white opaque (.024), A1 (.001), A3 (p=.001), and B 0.5 (p=.001). For translucent shade, the order of ΔE was markII> emax> suprinity. There was a significant difference between each group. For white opaque, the order of ΔE was suprinity> markII> emax, and no significant difference between mark II and emax was noted. For A1, A3, and B 0.5, the order of ΔE was markII> emax> suprinity, suprinity> emax> markII, and suprinity> emax> markII, respectively, with a significant difference between each group.

Comparison between different shades of trial cement paste

There was a significant difference between shades for emax (p=.004) and for suprinity (p=.007) only. Multiple comparisons between shades for each group was presented in the same table (Table 6). For emax, the order of ΔE was shade B0.5 >translucent>A1>A3>white opaque. There was a significant difference between white opaque and all other shades. No difference between other shades was noted. For mark II, the order of ΔE was shade translucent> A1 >white opaque> A3 > B 0.5. There was a significant difference between A1, white opaque, and translucent. For suprinity, the order of ΔE was shade A3>B0.5>white opaque >A1>translucent. There was a significant difference between white opaque and all other shades.

Comparison of delta E between different internal relief spaces

a. E-max

A comparison of ΔE between the two internal relief spaces with different shades of trial cement paste is presented in Table 5 and Figure 5. There was no significant difference in ΔE between the two internal relief spaces for all shades except A3 and translucent. For A3 and translucent, 100 µm recorded a significant higher ΔE than 30 µm.

b. Vita Mark II

A comparison of ΔE between the two internal relief spaces with different shades of trial cement space is presented in Table 6 and Figure 6. There was no significant difference in ΔE between the two internal relief spaces for all shades except translucent. For translucent, 100 µm recorded significantly higher ΔE than 30µm.

c. Vita Suprinity

A comparison of ΔE between the two internal relief spaces with different shades of trial cement paste is presented in Table 7 and Figure 7. There was no significant difference in ΔE between the two internal relief spaces for all shades except white opaque. For white opaque, 30 µm recorded a significant higher ΔE than 100 µm.

DISCUSSION

Ceramic laminate veneers are regarded as one of the best treatment modalities for altering the color and shape of unesthetic teeth. Preparations for ceramic veneers are highly conservative. This suggests using ceramic materials with minimum thickness and enhanced translucency; however, the underlying discolored tooth structure should be masked without increasing their thickness.[26]

The findings of the present study were confirmatory regarding the effect of trial cement paste shades on the final color of the laminate veneers. The findings of our study were in accordance to the findings of Xing W et al[26] where a significant effect from the trial cement paste shades on the final color of all laminate veneers placed with 30 µm and 100 µm internal relief spaces were also seen. A few shades created a perceptible color change in the final color of veneer with a thickness of 0.5 or 0.8 mm.

The outcome of the trial cement shade on the final color of different laminate veneers with 30 µm internal relief space for translucent and A1 trial cement shade groups was found to be superior to Vitabloc Mark II followed by IPSe.max CAD than Vita Suprinity .This phenomenon can be explained by the greater translucent effect of feldspathic (Vitabloc Mark II) than glass-ceramics (IPS emax CAD), and zirconia reinforced glass-ceramic (Vita Suprinity). These results were in line with the study by Karine et al[28] who reported that statistically significant difference could be observed in the translucency parameter among porcelain systems indicated for veneers in the following order: Vita VM9>Vita PM9, Empress Esthetic > Empress CAD >Mark II, Everest, emax CAD >emax Press > Lava zirconia. Additionally, significant differences were observed in the comparison of different shades and thicknesses. In white opaque trial cement shade groups, it was noted that the color difference was significant for Vita Suprinity followed by Vitablocs Mark II then IPS emax CAD. For A3 opaque yellow and B 0.5 white trial cement shade groups, the color difference was superior for Vita Suprinity followed by IPS emax CAD than Vitablocs Mark II.The color difference for Vita Suprinity could be explained by increasing the effect of the darker shades trial cement and relatively dark abutment shade A3 on the final color of zirconia reinforced glass-ceramic with a lower translucency than Vitablocs Mark II and IPS emax CAD. Other studies demonstrated a larger color difference for various types of zirconia, such as 1.99 to 2.89 for DC-Zirkon,[29] 1.8 to 3.6 for Digident Digizon,30 2.1-3.6 for Vita 2000 YZ cubes and 0.9-2.1 for Katna.[31]

The shade of the luting agent was also observed to affect the color masking ability of the veneers. The use of an opaque luting agent resulted in lower Δ E values when compared to the A1 cement. This could be explained owing to the difference in color between different resin cement because of the variable quantity of opacity materials in the cement.[32] Furthermore, the inorganic fillers cause subsequent scattering of light and different degrees of translucency.[33] This is in accordance with the findings by Ozturk et al.[34,] who concluded a significant effect of resin cement shade on the ceramic opacity, and Xing et al.[35] who concluded that the white opaque shade can cause perceptible color changes. The decrease in ceramic thickness to 0.5 mm is reported to significantly increase their relative translucency and become more affected to change in resin cement shades.[36]

The study had several limitations. The limitations of correlations between *in vitro* simulations of intraoral function are recognized. In this study, the simulations did not include light aging. However, the data on zirconia laminate veneers provide an initial step in enhancing our knowledge regarding the optical properties of zirconia as a laminate veneer restoration.

CONCLUSION

Within the limitations of this study design, this study conclusively demonstrated the effect of trial insertion paste on the ceramic veneers. The underlying color of the tested trial insertion pastes caused color change for all ceramic materials used in this study. For translucent and A1 trial cement shade groups, Vitablocs Mark II laminate veneers demonstrated that the trial insertion paste color had a greater effect than IPS emax CAD followed by Vita Suprinity laminate veneers. The latter with relative opaqueness was more affected by opaque trial insertion pastes (White Opaque Shade, A3 Opaque/Yellow Opaque Shade, and B0.5/ White Shade) than Vitablocs Mark II and IPS emax CAD laminate veneers. Additionally, no significant effect of the two internal relief spaces (30 µm and 100 µm) was observed with different shades of trial cement paste on translucency of each ceramic material used.

Further *in vivo* studies should be conducted to determine the longevity of suprinity laminate veneers and their color stability in the oral environment.

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Conflict of Interest: Nil

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Figure Legends

Figure 1: SIRONA INLAB CAD/CAM system

Figure 2: VITA Easyshade V

Figure 3: Comparison of ΔE between different groups of ceramic veneer materials and different shades of trial cement paste for 30 µm internal relief space

Figure 4: Comparison of ΔE between different groups of ceramic veneer materials with 100 µm internal relief space

Figure 5: Comparison of ΔE between the two internal relief space with different shades of trial cement paste for emax group.

Figure 6: Comparison of ΔE between the two internal relief spaces with different shades of trial cement paste for Mark II group.

Figure 7: Comparison of ΔE between the two internal relief spaces with different shades of trial cement paste for Mark II group.

Table Legends

Table 1: Different ceramic materials used.

Table 2: Various shades of the trial insertion pastes.

Table 3: Comparison of ΔE between different groups of ceramic veneer materials and different shades of trial cement paste for 30 µm internal relief space.

Table 4: Comparison of ΔE between different groups of ceramic veneer materials and different shades of trial cement paste with 100 µm internal relief space.

Table 5: Comparison of ΔE between the two internal relief spaces with different shades of trial cement paste for emax group.

Table 6: Comparison of ΔE between the two internal relief spaces with different shades of trial cement paste for Mark II group.

Table 7: Comparison of ΔE between the two internal relief spaces with different shades of trial cement paste for Suprinity group.