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Evaluation of Cements Curing Modes Regarding Microleakage During Cementation of E-max Laminate Veneers

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Abstract

AIM: The aim of this study is to investigate the effect of three curing modes (Light cure mode of the Variolink Veneer, the self-cure mode, and dual-cure mode of the Multilink Automix) on the marginal leakage of lithium disilicate ceramic laminate veneers.

METHODS: A total number of forty-two extracted natural central incisors were prepared to receive ceramic laminate veneers, constructed using E-max ceramic divided into three groups cemented using three curing modes of two adhesive resin cements {light-cure mode of Variolink Veneer, self-cure mode of Multilink Automix and dual-cure mode of Multilink Automix adhesive resin cements}. Die penetration test was done using the methylene blue stain {qualitative assessment} for testing the die penetration along the tooth/ceramic interface.

RESULTS: Descriptive statistical analysis revealed that the self-curing mode recorded the significantly least degree of leakage compared to the light and dual-cure modes. The self-cure mode recorded (0.1 ± 0.3) which was significantly lower than light cure (1.2 ± 0.9) and dual-cure mode (1.2 ± 0.4), there was no statistical significant difference between the later two curing modes.

CONCLUSION: The self-cure mode of the resin cement is considered a more effective method for having the least marginal leakage at the tooth/ceramic interface. There was no difference between the light-cure mode and the dual-cure mode.

Introduction

The laminate is a conservative alternative to full coverage for improving the appearance of an anterior tooth [1]. Laminate veneers have evolved over the last several decades to become one of esthetic dentistry's most popular restorations. For any cemented restoration, the weak link is at the restoration – cement –tooth interface [2]. Moreover, the cervical enamel/luting composite interface has repeatedly been reported to be more vulnerable to microleakage than the incisal enamel/luting composite interface *in vitro* [3].

Heat-pressed ceramics are becoming increasingly popular in dentistry. The benefits of heat-pressed ceramics, as opposed to the more traditional method of sintering, are decreased porosity, increased flexural strength, and excellent marginal fit [4]. It is a point of interest to investigate the effect of different cementation techniques on marginal integrity of heat-pressed ceramic veneers. Zaimoglu *et al*. in 1992 [5] investigated the microleakage beneath porcelain laminate veneers; they were located according to the preparations made below or above the cementoenamel junction of extracted maxillary incisors. They found that greater microleakage was recorded at the dentine composite resin interfaces than at the enamel/composite resin interfaces. Some studies as done by Elkomy *et al*. in 2019 found that there is no difference in the color stability of veneers when cemented with light or cure modes of the cement [6]. The aim of this study is to evaluate the effect of different curing modes of resin cements: light-cure mode, self-cure mode, and dual-cure mode on the marginal leakage of laminate veneers fabricated on maxillary anterior teeth using heat pressed ceramic. The hypothesis is that there is a difference in the microleakage levels between the curing modes.

Methods

Forty-two freshly extracted maxillary central incisors were collected, scaled, cleaned with pumice. Power analysis was done to check the sample size. The teeth were chosen to be equal in the mesiodistal width and incisocervical length of the coronal portion as much as possible measured using a digital measuring caliber.

The teeth were stored in normal saline solution at room temperature. A specially designed circular mold of 2.5 cm diameter and 3 cm height was constructed. The mold was formed of two parts: inner split ring and outer assembling ring. Standardized preparations were done in the labial surface of all teeth. The reduction was performed using a diamond depth cutter wheels. Standardized preparations were done with depth of 0.5 mm at the incisal half using LVS #1* and 0.3 mm depth at the cervical half using LVS#2*.Special two-grit diamond stones (LVS #3 and #4*) were used to remove the excess enamel till the depth of the original grooves to uniformly reduce the labial surface. This unique LVS two-grit diamond is specifically designed for bulk reduction with coarse grit to facilitate added retention and better refraction of the light being transmitted back out through the laminate. The marginal area was prepared with fine-grit that created definitive, smooth finish line to enhance the seal at the periphery.(*Komet, GEBR BRASSELER Gmbh and KG, Trophagener Weg 25.32657 Legmo, Postfach 160.32631 Legmo, Germany. LVS set for porcelain laminate veneers. Set 4151.) A specially designed perforated circular tray of 2.5 cm diameter and 3 cm height was constructed for impression making. After the application of separating agent, the wax pattern was done using cervical wax at the marginal areas until the finish line. Then body wax was used for the build-up of the laminate veneer wax pattern. A Special silicon ring former was used, slipped into the plastic ring base. Special investment was mixed following the manufacturer's instructions using machined vacuum mixer. The ring was then placed in a preheated burnout furnace at a temperature of 850°C for 60 min for wax elimination following the manufacturer's instructions. Special porcelain furnace was used for the ceramic pressing. Thickness of the veneers was standardized using calliper to adjust the thickness by the same technician in all the samples. The use of Variolink Veneer and Multilink Automix cements were performed according to manufacturer's instructions as they are indicated for veneers cases (also Variolink Esthetic could be used). The test samples were divided into equal groups of fourteen specimens each according to the curing mode of cement employed. Group 1: The constructed laminate veneers were cemented by light-cure mode of Variolink Veneer (same light source was used for all samples, by the same operator, and at constant distance for standardization). Group 2**:** The constructed laminate veneers were cemented by self and dual curing modes of Multilink Automix. The ultrasonic unit SONICflex 2003x Airscaler was set at power 2 and was turned on each time for 5 s to minimize the up heating of the cementation tip (SONICflex cem #12). The total ultrasonic seating time was 30 s applied on several points with different angulations over the surface.

After cementation, the teeth were stored in distilled water for twenty-four hours, then subjected to thermocycling between two water baths at (5°C–55°C) for one hundred cycles (1 min in between each cycle). The specimens were sealed with two layers of varnish

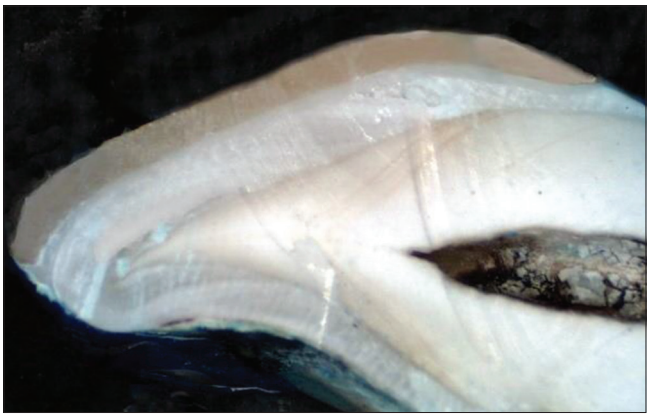

Figure 1: A photomicrograph showing the degree of microleakage (scale 0) at ×15 magnification using the stereomicroscope

except for 1-2 mm around the margins of the veneers. Then, immersed in a 2% methylene blue dye solution for 24 h after which they were retrieved and rinsed. Each specimen was sectioned through the center in incisocervical direction using a hard diamond disk 7/8 inch mounted at a low–speed headpiece with water coolant. The extent of dye penetration along the tooth/veneer interface was examined under a stereomicroscope at ×25 magnification and scored according to the following scale: (Figures 1-4).

0=No leakage at the tooth/veneer interface.

1=Penetration of the dye along the incisal or cervical margins.

2=Penetration of the dye up to the incisal or cervical one-fourth of the tooth/veneer interface.

3=Penetration of the dye up to half of the interface.

4=Penetration of the dye along the entire tooth/veneer interface.

Results were recorded, tabulated, and statistically analyzed.

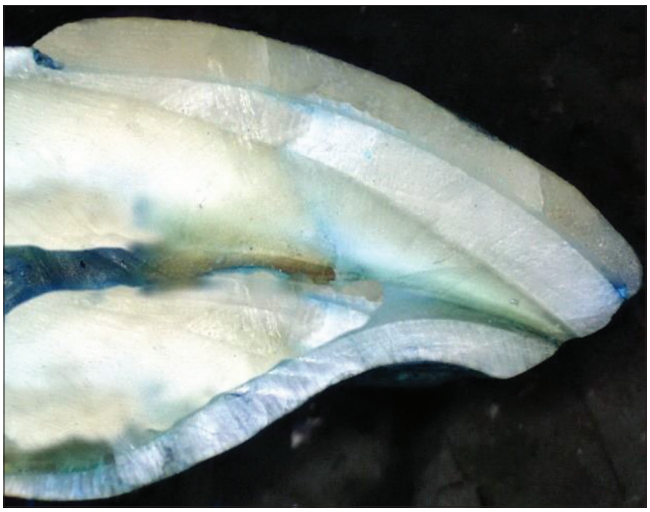

Figure 2: A photomicrograph showing the degree of microleakage (scale 1) at ×15 magnification using the stereomicroscope

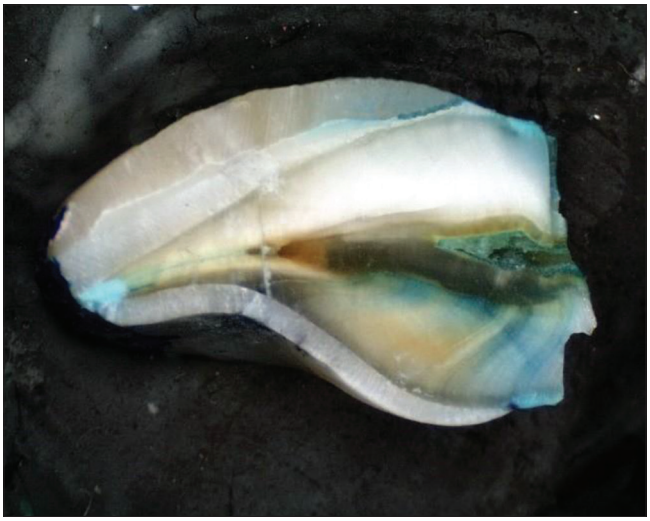

Figure 3: A photomicrograph showing the degree of microleakage (scale 2) at ×15 magnification using the stereomicroscope

Results

Descriptive statistics was presented as means ± standard deviations (frequency distributions).

Analytical tests used included Independent – samples T-test for comparing two groups. Significance level of $p < 0.05$ was used throughout all statistical tests within this study.

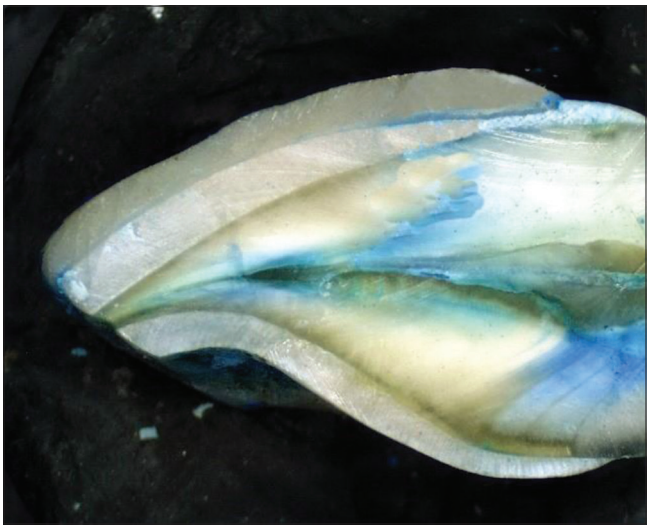

Figure 4: A photomicrograph showing the degree of microleakage (scale 3) at ×15 magnification using the stereomicroscope

Groups sharing same letters are insignificantly different while groups with different letters are significantly different with $p < 0.05$. Descriptive statistical analysis revealed that the self-curing mode recorded the significantly least degree of leakage compared to the light and dual-cure modes. The self-cure mode was recorded (0.1 ± 0.3) which was significantly lower than light cure (1.2 ± 0.9) and dual-cure mode (1.2 ± 0.4). However, there was no statistically significant difference between the latter two curing modes (Figure 5 and Table 1).

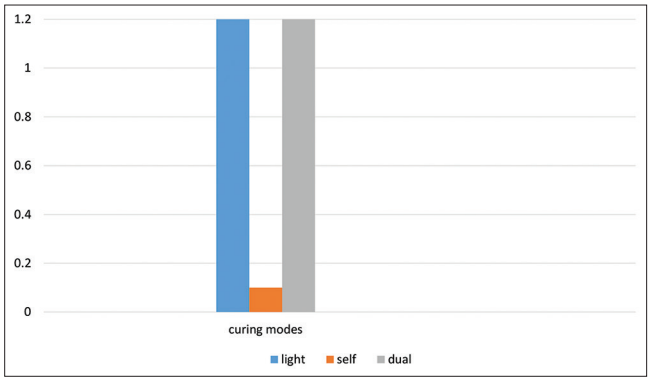

Figure 5: Bar graph of the mean dye penetration degree of the three curing modes

Discussion

Today, porcelain veneers are no longer in the experimental stage; they have gained respect as a durable and reliable restorative treatment method. The adhesive interface is formed of cement line between the ceramic and the tooth structure [7]. Bonding of ceramics to natural tooth substrate is reported to be stronger at the enamel layer as reported by Atsu *et al*. [8]. The long-term clinical performance of laminate veneers depends on a number of factors, with marginal adaptation being one of the significance. It is critical to establish an acceptable marginal adaptation in laminate veneers because of the inherent limitations of composite resin luting agents, such as relatively high polymerization shrinkage [9].

Table 1: The mean values and standard deviations for scores of leakage (dye penetration) for the different curing modes of the luting cements

Curing modes of the cements	Degree of leakage (die penetration)					Mean ± SD
	0	1	2	3	4	
	Number of samples (n)					
Light	4 n	2 n	8 n	0 n	0 n	1.29 ± 0.95[a]
Self	12 n	2 n	0 n	0 n	0 n	0.14 ± 0.37[b]
Dual	0 n	10 n	4 n	0 n	0 n	1.29 ± 0.49[a]

Techniques and ceramic materials have been always in a process of development in an attempt to improve the marginal fit of the restorations.

The polymerization shrinkage of resin-based composites under confined conditions and difference of coefficient of thermal expansion between resin cement, tooth, and ceramic generates stresses at the tooth/resin and resin/ceramic interfaces, the interface with lower adhesive forces will fail and then microleakage will occur leading to staining, post-operative pain, and recurrent caries [10]. Many techniques are used to test the microleakage as using bacteria, compressed air, chemical or radioactive tracer, electrochemical investigation, scanning electron microscope, and dye penetration [11]. In this research, dye penetration is used, as it is common and cheap. Many recent studies are concerned with reducing microleakage in indirect restorations. Different techniques used during the adhesion of ceramic veneers have an effect on its adaptation.

Dual-cure resin cement has been suggested before for cementing laminate veneers, as the self-cure mode will guarantee the curing of the cement at the regions where the light is not reaching. However, many practitioners due to its easiness in use and controlling working time prefer the light cure mode [12]. In this study, the dual-cure mode of cementation showed score 1.2, which is near that found by Haralur in 2018 who reported 0.90 score [11]. These results was in accordance with previous study by Bott *et al*. stating the there is good marginal adaptation with dual and self-cure cements [13]. In this study, the self-cure mode showed the best results regarding microleakage, and this was in opposing to Frankenberger *et al*. who found poor marginal integrity with self-cure mode for cementation but this difference is explained as they were cementing inlays [14]. Also opposing Ibarra *et al*. who found poor results with self-cure cements and suggested separate etching procedure before cementation to decrease microleakage [15] Hana *et al*. in 2020 found in a study that light and dual curing increased the bond strength and the adaptation over the self-cure mode [16]. The polymerization shrinkage of light-cured cements depends on many factors as veneers thickness, shade, and light source. The polymerization of resin towards the light may affect the resin tooth interface negatively leading to microleakage; this explains the higher score of light cure group [17]. In accordance with our study, other study by Novais *et al*. in 2017 showed that the dual-cure mode was better than light-cure mode regarding degree of conversion and bond strength and consequently less microleakage [18].

Further studies are recommended to evaluate the effect of different thicknesses of laminate veneers with different curing modes of the used cements on microleakage. From the limitations of this study that it needs more clinical studies to support.

Conclusion

Within the limitations of this study, the self-cure mode of the resin cement is considered a more effective method for having the least marginal leakage at the tooth/ceramic interface. There was no difference between the light cure mode and the dual-cure mode.

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