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Comparative Study Of Effect Of Many Commercial Types Of Oxygen Inhibitors On Resin Cement

Research Article

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Abstract

Purpose: The aim of this study is to compare the effect of many commercial types of oxygen inhibitors on color stability of resin cement.

Materials and Methods: A total of 40 specimens were prepared usingVariolink-N (, IvoclarVivadent AG, Schaan, Liechtenstein). Specimens were light-cured in air or in the absence of oxygen.The curing in the absence of oxygen wasachieved using three different types of oxygen inhibitors: (1) medical glycerine, (2) Liquid Strip(IvoclarVivadent AG, Schaan, Liechtenstein), (3) OXYGUARD‖, PANAVIA F 2.0 (Kuraray, Tokyo, Japan).Specimens were assessed forcolor stability after immersion in a staining solutionfor 7 days. The results were analyzed by one-way ANOVA to analyze color difference (ΔE), and Tukey's test, was applied for bilateral comparisons between study groups.

Results: The highest ΔE value was (2.3±0.5) for control group followed by (2.2±0.4) for Liquid Strip and Oxyguard groups. However, the lowest ΔE value was (2.1±0.4) for medical glycerin (p=0.870) .There was no significant difference between the study groups.

Conclusions: Color stability is not affected by the commercial type of oxygen inhibitor and the finishing is enough to remove the oxygen inhibited layer if it is possible well done.

Keywords: Oxygen Inhibited Layer; Glycerin; Monomer.

Introduction

Resin cements are low-viscosity composite materials with filler distributionmodified to allow for a low film thickness and appropriate working and setting times [1]. They are used for many applications, from inlays to fixed bridges, prefabricated posts and porcelain laminate veneers [2]. Resin cements are classified by activation mode to light cureor chemical cure or dual cure (combinations of light and chemical) [3].

The main advantages of light-cured resin cements for dual-cure and chemical-cure systems are color stability, and control of the working time [4]. Furthermore, the short curing time makes light-cured systems less sensitive to oxygen inhibition when compared with the chemically cured systems [2].

However, the propagating free radicalsare attracted to oxygen-more than the monomer molecule during the polymerization reaction in adhesive systems, and are oxidized into peroxy radicals, which don't have relatively reactivity toward the monomer and form peroxides, turning off polymerization if they interact [5].

R• + O2 → R-OO• (stable radical)[6]

This causes the formation of an oxygen inhibition layer on the superficial surface of light-cured resin cements and composite resin materials when these are cured in the presence of air. This sticky layer has a lot of unreacted monomers and oligomers, It is readily adopts overlying resin cements to make their contact area high and allows materials on both sides to correlate, creating a strong chemical bond [7, 8]. Previous studies have reported an oxygen inhibition layer (OIL) thickness for resin- based materials ranging from ~4 [9] to 40_m [10, 11] and 200 microns in some

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studies [12].

This resin-rich uncured layer affects the surface texture leading to a porous and weak structure, therefore plaque can accumulate and gingival inflammation develop on the edges of the restoration. furthermore, that porous surface can explain discoloration and influences the prognosis of dental restoration reducing its hardness and marginal adaptation [13, 14].

Last reasons have made the complete removal of oxygen inhibition layer in the interest scope of researchers. recently, topical application of glycerin was reported to be used on external surfaces of resin composite restorations and margins of indirect restorations and the results are encouraging [15].

Glycerin is hygroscopic, and Pure glycerin is not oxidized by the atmosphere, Glycerin concentration differs with solvent type,mixtures of glycerin with water, ethanol (95%), and propylene glycol are chemically stable [16].

The purpose of the present study was to compare the effect of many commercial types of oxygen inhibitor on color stability of resin cement and the null hypothesis was that there is no difference.

Materials and Methods

Preparation of samples

40 discs were milled by CAD/CAM from PMMA(poly methyl methacrylate), shade A2 (figure1). The dimensions of the disc were (external diameter 14mm,internal diameter 10mm). The light-cured resin cement used in this study was Variolink-N (, IvoclarVivadent AG, Schaan, Liechtenstein) shade A2,and was inserted into the PMMA mold (thickness, 1 mm) at a temperature of 23 °C.

Every specimen was placed on a dental vibrator to reduce possible voids causing by entrapped air on the uncured resin cementl inside the mold(figure2) and a microscope glass slab was gently pressed on the top surface of the specimen to extrude the excess material and, ensure a smooth surface.

The specimens were light cured using an LED curing device (Woodpecker Light Cure Led, Guangdong, China), which produces blue light with a wavelength of 420–480 nm and an output intensity of 1300 mW/cm2 for 40 seconds, and the light guide tip was directly placed at a distance of 1 mm from the specimen's surface (figure 3). The light intensity was checked every 3 samples with a radiometer to ensure consistent light output throughout the study.

The discs were randomly numbered from 1 to 40 on the bottom using a high speed small round bur and divided into four main groups (n= 10) based on different commercial types of glycerin : Group A: Specimens polymerized without any barrier between the surface of the resin composite and the light curing tip.(only finishing after the polymerization).

Group B: Specimens polymerized using a layer of medical glycerin applied on the surface of the composite prior to light-curing procedures (figure 4).

Group C: Specimens polymerized using a layer of glycerin (Liquid Strip, IvoclarVivadent AG, Schaan, Liechtenstein) applied on the surface of the composite prior to light-curing procedures(figure 5).

Group D: Specimens polymerized using a layer of glycerin (OXYGUAR ||, PANAVIA F 2.0 ,Kuraray, Tokyo, Japan) applied on the surface of the composite prior to light-curing procedures.

Every specimen was prepared and cured in a room with yellow light to avoid any unwanted effects from surrounding light sources.

All specimens were finished for 15 seconds using a composite finishing bur (852.016.Coltene/Whaledent G, Altstätten ,Switzerland), and then exposed to thermocycling for 5,000 cycles between 5ºC and 55ºC water temperature, with a 30 second dwell time (Thermocycler, GMBH, MiebacherStrabe, Germany).

Color Stability Evaluation

All the specimens were stored in 37°C distilled water for 24 h. To evaluate color, the specimens were placed onto a white background and a drop of distilled water was placed in the space between the disc and the backing to confirm that the specimen was in perfect contact with the backing during the spectrophotometric measurements. All initial assessments were performed by one trained operator usinga spectrophotomer(Vita Easy Shade; Wilcos, Rio de Janeiro, Brazil) (figure 6) and the CIE Lab system of color and.3 measurements were performed in the central area of each sample and the mean was calculated (L0 , a0 ,b0). A calibration was done for the spectrophotometer every 5 measurements.

After initial measurements, every specimen was coated with a layer of nail varnish except the surface was coated from the borders of the disc to 1 mm of resin cement, then all specimens were immersed in a staining solution coffee (Nescafé, Gran Aroma coffee soluble, 6 g in 200 mL of distilled water) for 7 days at 37°C. The staining solution was replaced every day to avoid excessive bacterial proliferation. After 7 days, nail varnish was removed using acetone All specimens were soaked in distilled water for 5 minutes then dried with paper. and the spectrophotometric measurements were recorded (L1, a1, b1).

The color change values(ΔE) between the specimens after immersion in coffee and initial values were calculated from the mean DL*,Da* and Db* values for each specimen with using the following formula:

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

Normal distribution of data was assessed by applying the Shapiro-Wilk test. One-way ANOVA test was used to analyze color difference (ΔE), and Tukey's test, was applied for bilateral comparisons between study group.

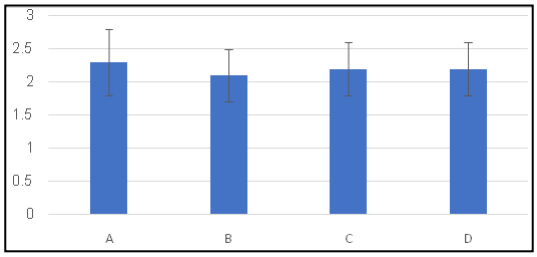
Results

The means ± standard deviation of ΔE values for different study

Table 1. Description statistic for ΔE values in study groups.

Group	Mean	Standard Deviation
A	2.3	0.5
B	2.1	0.4
C	2.2	0.4
D	2.2	0.4

Figure 1. Means ± standard deviations of ΔE values after immersion in coffee.



groups are shown in Table 1. The highest ΔE value was (2.3 ± 0.5) for control group followed by (2.2 ± 0.4) for Liquid Strip and Oxyguard groups. However, the lowest ΔE value was (2.1±0.4) for medical glycerin (p=0.870). One- way ANOVA results showed that ΔE values were not significantly affected by the commercial type of oxygen inhibitorand Tukey's results indicated no statistically significant difference between groups.

Discussion

The degree of conversion (DC) is the percentage ratio of the amount of monomers converted in a polymer during the polymerization [2], and the level of DC influences the aesthetic and mechanical properties of resin luting agents such as hardness ,surface roughness and color stability [17]. The oxygen inhibited layer is rich in unreacted monomers and this results in less degree of conversion (DC) [18]. Therefore, causes marginal discoloration of the indirect restoration cemented by resin cements [19]. So in this study , color stability of resin cement has been studied as an indirect method to evaluate the effect of oxygen inhibitors on preventing oil formation.

There are many factors can cause staining of resin cement. Intrinsic factors such as initiator type, filler size and hydrolysis in theresin matrix [20, 21]. For last reason, the type of resin cement and the distance between the specimen and the curing device were uniform in all study groups. The resin cement thickness (1 mm) is much higher than the clinical thickness, This was for reliable results because the spectrophotometers require a certain sample thickness according to the ISO standards [22] and due to the limitations of the in vitro testing methods.

In this study, The staining solution was coffee because it is usual drunk routinely by patients with a high potential to stain resin cement , and Nail varnish was used to ensure that only the superficial surface has been affected by coffee. Furthermore, finishing time was equal for all the specimens because the surface texture is one of the extrinsic factors that can cause discoloration and finishing is required after adhesion with resin cement [15]. The specimens were immersed in distilled water to mimic the oral environment and because the polymerization reaction finishes within 24h after the curing.In this study, the CIE L*a*b* system was used, since this method remains the most accuratemethod to measure the color stability [23].

ΔE values in all study groups were <3.3 and >1.1 which means that discoloration of resin cement was perceptible to the human eye but clinically acceptable [18], and the results showed that no significant differences were found between the groups. So, The null hypothesis of this study was acceptedand there was not difference in color stability with the type of oxygen inhibitor.Furthermore, no significant difference was found betweenthe control group and the other groups , which confirms that finishing was sufficient to remove the oxygen inhibited layer and this agrees withTopaloglu-Ak et al 2020 [13] andStrnad Get al 2015 [14] in the role of finishing and polishing for removing the oil whereas the finishing can remove 0.2 mm from the surface of resin cement. By contrast, Marigo Let al 2019 [18] tested Influence of different air-Inhibition coatings on color stability, but reported thatthe use of glycerin may be suitable for light-curing procedures and improve the chemicophysical and aesthetics properties.

Conclusion

There is no difference between the commercial types of oxygen inhibitors in this study, and finishing is enough to remove the oxygen inhibited layer if it is possible well done.

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