Effect of lipstick on composite resin color at different application times

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ABSTRACT

Objectives: The aim of this study was to evaluate the influence of the contact of two lipsticks, one with common fixer and one with ultra fixer, on the color of a composite resin immediately, 30 min and 24 h after photoactivation. Material and Methods: Ninety specimens were prepared with a composite resin, Filtek-Z350. Specimens were polished and divided into 9 groups (n=10) according to time elapsed after photoactivation (A- immediately; B- 30 min; C- 24 h) and the contact with lipstick (UF- lipstick with ultra fixer; F- lipstick with common fixer). The control group was represented by specimens that did not have any contact with lipstick (C- without lipstick). Color measurements of the specimens were carried out using a spectrophotometer (Easyshade – CIE L* a* b* system). For UF and F groups, the baseline color of the specimens was measured immediately before pigmentation and the lipsticks were applied dry after 1 hour. The excess lipstick was removed with absorbent paper and final color checking was performed, including the control group. Differences between the final and baseline color measurements were calculated and data were analyzed statistically by the Kruskal-Wallis test at 5%. Results: The means between the differences of color values were: AUF: 16.0; AF: 12.4; AC: 1.07; BUF: 9.51; BF: 8.3; BC: 0.91; CUF: 17.7; CF: 12.41; CC: 0.82. Conclusion: Groups where lipstick was applied showed greater staining than the control group at the three evaluation times. The lipstick with ultra fixer stained more than the lipstick with common fixer. Time elapsed between photoactivation and contact with lipstick had a similar influence on the groups that received lipstick application.

Key words: Composite resins. Pigmentation. Color.

INTRODUCTION

Technological advances of composite resins have resulted in improvements in their physical and chemical properties, increasing their longevity. However, despite this evolution, problems related to the intrinsic and extrinsic discoloration of composite resins still remain. Among the intrinsic factors, the most commonly reported are intimately linked to the chemical mechanism of tertiary amines, and are mainly associated with the self-cured composite resins[1]. These tertiary amines aid staining, leading to a change in tone from a whitish to a yellowish aspect[3].

In the current light-cured composite resins, color alteration is usually related to extrinsic factors and depends on several factors, such as staining agents[2,9,16,17,20,32], surface roughness[5,22,24]; contact time with, or immersion in, coloring environments[19,20], and type of composite resin[2,8,15,22,26].

There has been great concern about staining agents, which are frequently mentioned by researchers[2,11,16,17,20,23,32]. The increased number of studies on staining of composites is most likely due to changes in modern habits where consumption of fluids with a high coloring power (coffee, wine, cola-soft drinks) is greater and, consequently, the report of intense staining is recorded. This increased consumption is the main reason for color changes

in restorations.

There are several methods known for color evaluation of teeth and dental materials. Visual techniques measure color by subjective comparison using different color scales, from acrylic resin scales to ceramic scales. On the other hand, instrumental techniques are objective measurements obtained by devices, such as spectrophotometers, colorimeters and computerized image analysis[4,12,14]. Instrumental color perception has been preferred over visual methods because the instrumental process is objective, quantifiable and fast[7]. Digital instruments, such as colorimeters and spectrophotometers, combined with computers, generate a numeric description of colors. The spectrophotometer measures wave lengths of reflected or transmitted light of an object and has been used to measure the visible light of vital or extracted teeth and restorative materials[12,14]. Regardless the equipment used, the (CIE) L*a*b* color space system is commonly employed in studies of composite resin color stability. This system consists of the following parameters: L*, which refers to luminosity (white to black); a*, which refers to the red-green color axis and b*, which refers to yellow-blue axis.

Due to the high staining index of coloring agents on composite resins, patients are recommended to avoid contact with coloring substances for at least 24 h after completion of composite resin restorations. This is indicated because water sorption by resinous materials[10] can continue for several days and depends on the composite resin matrix[27].

Although several studies evaluating coloring substances, such as coffee, tea, cola-soft drinks, chlorhexidine, silver nitrate, dental bacterial plaque disclosing solutions, and oral antiseptics, no reports were found with regards to lipstick's power of staining, although there is clinical evidence that this substance causes alterations in composite resin color. Taking into account that lipstick is a differentiated coloring agent, presenting hydrophobic characteristics and fixers that increase their duration on lips, and also considering the contact time with esthetic dental materials, it is included as a pigmenting agent. This clinical situation is commonly observed when a patient receives composite resin restorations on the buccal surface of anterior teeth. However, there is no consistent data in the literature that confirms the staining effect of lipstick and the necessary waiting period until it has no effect on the dental restorative materials.

This study evaluated, by photoreflectance, the color alteration of a composite resin superficially stained with two types of lipstick (one with a common fixer and one with an ultra fixer) immediately, 30 min and 24 h after composite photoactivation, considering composite resin without any lipstick contact as the control group.

The hypotheses tested were that 1) the composite resin presents color alteration when in contact with lipstick; 2) the composite resin presents less color alteration after longer time lapses following polymerization when compared to contact with lipstick after shorter post-polymerization time; 3) lipstick with an ultra fixer presents higher color alteration of composite resin than lipstick with a common fixer.

MATERIAL AND METHODS

Specimen Preparation:

Ninety specimens were made from the nanofilled composite resin (Filtek Z350 Shade A3 - 3M ESPE, St. Paul, MN, USA), using a Teflon matrix with internal dimensions of 6 mm (diameter) x 2 mm (thickness). Composite resin was placed in one increment and a polyester band was placed over the surface to produce a superficial smoothness. Using a glass slide to apply pressure to the polyester matrix extruded excess composite resin. The specimen was photoactivated for 20 s using a LED light source (Optilight LD MAX; Gnatus, Ribeirão Preto-SP, Brazil) with an approximate intensity of 350 mW/cm^2 as measured with a radiometer (L.E.D. Radiometer, Demetron-Kerr, Danbury, CT, USA). The specimens were polished with fine and ultra-fine aluminum oxide abrasive disks (Sof-Lex Pop-On; 3M ESPE, St. Paul, MN, USA). After, specimens were divided into 9 groups (n=10) according to time elapsed between composite resin photoactivation and contact with the pigmenting agent, as shown in Figure 1.

Two red lipsticks with hydrating characteristics represented pigmenting agents. One lipstick had an ultra fixer (Perfect Wear Lipstick Ultrafixation FPS 12; Avon, São Paulo, SP, Brazil) and other had a common fixer (Color Trend Hydrating Lipstick; Avon). The compositions of both lipsticks are described in Figure 2.

Color evaluation:

Color parameters of *Sp* were measured with a spectrophotometer (Easyshade; Vita Zahnfabrik, Bad Saeckingen, Germany) using CIE L*a*b* (Comission International l´Eclairage). The analyzed parameters were the values for L*, a* and b*, where L* is the coordinate of luminosity with values between zero (black) and one hundred (white). The a* and b* variables are coordinates relative to color on the red-green and yellow-blue axes, respectively. A positive a* value indicates a tendency for red, while negative values indicate a proximity to green. Similarly, positive b* values indicate a tendency to yellow and negative values indicate a tendency

to blue.

Before analyzing the color, the spectrophotometer was calibrated according to the manufacturer's recommendations, using a white calibration standard provided with the equipment. A mortise device was placed over the white opaque Teflon which was positioned over the specimens to allow the contact of tip of the spectrophotometer with specimen surface at 90° angle, standardizing all readings. To calculate the differences between the initial and final colors, the total color variation (ΔE) was calculated according to the following equation: $\Delta E = ((\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2)^{1/2}$; where: $\Delta L = I1 - I0$ (final reading – initial reading); $\Delta a = I1 - I0$ (final reading – initial reading); e $\Delta b = I1 - I0$ (final reading – initial reading).

Sequence of tests

For the immediately after photoactivation (0 h) groups (G1, G4 and G7): 1) surface was cleaned with absorbent paper; 2) the initial color of the specimen was recorded (average of 3 readings); 3) control group (G1) was not stained and test groups (G4- lipstick with common fixer and G7- lipstick with ultra fixer) were stained with the respective lipsticks; 4) after 1 h in a dry condition, the excess lipstick was removed with dry absorbent paper; 5) the final color reading of the specimen was taken (average of 3 readings).

For the 30 min after photoactivation groups (G2, G5 and G8): 1) the specimens were immersed in deionized water for 30 min; 2) surface was cleaned with absorbent paper; 3) the initial color of the specimen was recorded (average of 3 readings); 4) control group (G2) was not stained, and test groups (G5- lipstick with common fixer and G8- lipstick with ultra fixer) were stained with the respective lipsticks; 5) after 1 h in a dry condition, the excess lipstick was removed with dry absorbent paper; 6) the final color reading of the specimen was taken (average of 3 readings).

For the 24 h after photoactivation groups (G3, G6 and G9): 1) the specimens were immersed for 24 h in deionized water; 2) surface cleaning with absorbent paper; 3) the initial color of the specimen was taken (average of 3 readings); 4) control group (G3) was not stained and test groups (G6- lipstick with common fixer and G9- lipstick with ultra fixer) were stained with the respective lipsticks; 5) After 1 h in a dry condition, the excess lipstick was removed

Time elapsed after photoactivation	Pigmenting agents		
	Control (without coloring)	Lipstick with common fixer	Lipstick with ultra fixer
Immediately (0 h) 30 min 24 h	Group 1 Group 2 Group 3	Group 4 Group 5 Group 6	Group 7 Group 8 Group 9

Figure 1- Study groups divided according to time elapsed between photoactivation and contact with lipstick, and according to the type of the lipstick fixer

Material	Composition
Composite resin Filtek Z 350 (Batch - 8NU)	Silane treated ceramic; dimethacrylate of bisphenol-A; polyethylene glycol diether; diurethane dimethacrylate; silane treated silica; methacrylate of bisphenol-A; diglycidyl ether; dimethacrylate of 2,2'; ethylenedioxydiethylo, water.
Ultra-fixer lipstick (Batch - B2417)	Cyclomethicone; diphenyl; dimethicone; polyethylene; ethylhexyl methoxycinnamate; acrylates/stearyl acrylate/dimethicone methacrylate copolymer; cera microcristalina; isopropryl isostearate; phenyl trimethicone; titaniumdioxide; acrylates/dimethocone copolymer; polymethilsilsequioxisano; glycerin; water; PVP/hexadecenecopolymer; sucrose distearate; acrylatescopolymer; perfume; PVM/MA copolymer; PVP/eicosene copolymer; simmondsia chinensis cera; perflurooctyl triethoxysilane; lecithin/C12-15 alkyl benzoate/tocopheryl acetate/ascorbyl palmitate/betacarotene/retinyl palmitate; retinyl palmitate.
Common-fixer lipstick (Batch - B2327)	Ricinus communis; oil; petrolium; isopropyl palmitati; caprylic/capric triglyceride; polybulene; paraffin; ozakerite; cetyl ricinoleate castor oil; lanolin; octyl hydroxystearato; polyethyene; triisostearyl citrate; myristyl lactate; perfume; caprylyl glycol; tocopherylacetato; acrylates copolymer; silica.

Figure 2- Composition and batch numbers of studied materials

Table 1- Mean (standard deviation) of Delta E (∆E) values for all nine experimental groups

Coloring Evaluation time	Control (without coloring)	Lipstick with common fixer	Lipstick with ultra fixer
Immediately after light activation	1.07 (±0.3)	12.44 (±2.1)	16.04 (±4.3)
30 min after light activation	0.91(±0.4)	8.31 (±3.4)	9.51 (±3.6)
24 hours after light activation	0.82 (±0.5)	12.41 (±3.8)	17.70 (±5.8)

Table 2- Multiple comparisons verified with a Kruskal-Wallis statistical analysis

	0 h	30 min	24 hours
Control X Ultra	0.1	0.1	0.1
Control X Common	0.1	0.1	0.1
Common X Ultra	5	ns	5
	Control	Common	Ultra
0h X 30min	ns	1	0.1
0h X 24h	ns	ns	ns
30min X 24h	ns	1	0.1

Control – control groups; Common – groups with common-fixer lipstick; Ultra – groups with ultra-fixer lipstick; ns – not significant; 0.1 – statistical difference at 0.1%; 1 – statistical difference at 1%; 5 – statistical difference at 5%

with dry absorbent paper; 6) the final color reading of the specimen was taken (average of 3 readings).

Analysis of data

Data were calculated to obtain the difference between initial and final color (∆E) of each specimen and means of the 10 specimens of each group were calculated. Data were submitted to analysis by Kruskal-Wallis test for comparison at 5% significance level.

RESULTS

Means and standard deviations are presented in Table 1. There were no statistically significant differences between the control groups (p>0.05) at the three evaluated times. The composite resin color had a more statistically significant color change at all time periods with both lipsticks than the control groups did. Groups that received the lipstick with ultra fixer stained more than the groups that received common fixer lipsticks, except after 30 min of application. However, there was no statistical difference observed for this color difference. The common-fixer and ultra-fixer lipsticks showed greater staining values at "0 h" and after "24 h" than after "30 min", with no statistically significant differences between "0 h" and "24 h". Table 2 presents the statistical analysis (Kruskal-Wallis) of the results verified between groups.

DISCUSSION

Color determination in dentistry is frequently measured by measuring reflected light by instrumental and visual means[21]. The instrumental method reduces the subjective potential of error on the color analysis, increases the reliability of color reading and presents great acceptance in the literature[2,7,25,26]. Based on these facts, the present study used the instrumental technique with a spectrophotometer, recording the color values with the CIE (Comission International l´Eclairage) L* a* b* system. This system has the ability to determine the difference between initial and final colors (∆E) applying an equation using three co-ordinates: L* - the luminosity of a color (from white to black), a* - the color position on the red-green axis and b* - the color position on the yellow-blue axis.

Despite the fact that instrumental methods of color reading register absolute numbers, there is the possibility of clinical extrapolation of these values, as described by Johnston and Kao[13] (1989). These authors suggest that values of ∆E greater than 3.3 indicate a clinically visual perception of color change. The current study observed that, on composite resins where lipstick with common or ultra fixer was applied, a high staining index was present when compared to composite resins that had no lipstick applied, confirming our first hypothesis. It is interesting to point out that the alteration of the composite resin color by this pigmenting agent at different times after photoactivation (corresponding to ∆E values from 8.31 to 17.70), exceeded the clinically perceptive values (∆E=3.3) as described by Johnston and Kao[13] (1989) and the values that are considered as a clinically unacceptable color match, according to Douglas, et al.[6] (2007). Additionally, when the composite resin was not in contact with lipstick, independent of water immersion, there was little color alterations between final and initial readings (from 0.82 to 1.07). The alteration of color between the initial and final measurements on groups that were only stored in water might have been caused by dehydration of composite resin during the dry condition (1 h) between the first and second readings, which was used to standardize the control groups and the groups in which the material was in contact with lipstick (1 h). For the "immediate"

group (without water), this alteration was accepted as normal and can be explained as a continuation of cure that occurred in this first hour. The subtle discoloration that occurred with the control groups was not an important factor, since the values of ΔE were much lower at the three evaluated periods of application than the clinically relevant ΔE suggested for clinical visualization.

Among the possible reasons for the increased staining caused by lipstick are the susceptibility of the polymer for water sorption and the hydrophilic nature of its matrix[29]. This water sorption is important because, if the composite resin can absorb water, it is also capable of absorbing other fluids, such as the red pigment contained in lipstick, which would result in the resin discoloration. The methodology used in the current study applied lipsticks after different time periods after photoactivation was proposed because it has been suggested that, due to composite resin present initially high sorption[10], the absorption of pigment is initially higher. However, the discoloration of composite resin was high even when lipstick was applied after 24 h had past after light activation, similar to the color alteration noted immediately after photoactivation. The second hypothesis of the present study was rejected, as staining by lipstick occurred not only during the first h after the conclusion of restorative procedure, but also after extended times from photoactivation. It is believed that hydration of the composite resin occurred from 24 h immersion in water. Thus, when water was removed for the application of lipstick, dehydration could have occurred in that 1 h period that the Sp stayed in the dry condition and in contact with the lipstick. Due to the hydration capacity of the lipsticks, the dehydrated composite resin could have absorbed pigments from these products. A surprising findings was the fact that the composite resins were hydrated during the 30 min after photoactivation and had surface painted with lipstick. Despite the presence of significant color alterations in the 30 min groups, they presented less staining than the groups where lipstick was applied immediately or 24 h after photoactivation.

This reduced staining of composite resin after "30 min", for both lipsticks, is most likely explained by the existence of no difference in color alteration between groups with common and ultra fixer during this time. Composite resins showed higher color alteration both immediately and after "24 h" when ultra-fixer lipstick was applied, as compared to the lipstick with common fixer. This finding confirms the third hypothesis of the current study that the excess ultra-fixer lipstick was more difficult to remove prior to evaluation.

It is already known that composite resins present color alteration when subjected to a coloring environment[11]. Several studies have shown the influence of probable pigmenting agents that are frequently utilized by patients. In a great number of studies, drinks such as coffee, tea and wine[2,11,23,28,32], oral antiseptics, such as chlorhexidine[19], water aging[14,26,30] or whitening agents action are commonly used[18,31]. Another aspect observed in the literature is the evaluation of contact time with coloring agents and which products produce the greatest amount of staining[2,32].

According to the results of this study and considering the close contact of the lips with the buccal surface of the maxillary anterior teeth, lipstick wearers should be warned to avoid the use of highly colored lipstick with ultra fixer after receiving aesthetic composite resin restorations in these teeth.

Studies analyzing possible color alteration caused by lipstick were not found in the current literature, a fact that indicated the necessity of more studies for a greater understanding of the effect of this substance on composite resins. It is valid to point out the importance of evaluating other considerable aspects of composite resins as related to staining with lipstick, such as polishing methods, application times and contact duration, as well as different kinds of composite-resin and lipstick combinations, and different brands and formulations of lipsticks. Other clinical variables should be further analyzed, such as the frequency of reapplication of lipstick, the influence of saliva and the action of the tongue in terms of cleaning the stained resin restoration surface, and others. Eventually, laboratory studies with clinical evaluations will enable the determination of parameters and protocols to reduce staining promoted by the use of products for esthetic restorations of composite resins.

CONCLUSION

Groups where lipstick was applied showed greater staining than the control group at the three evaluated time periods. It was also observed that ultra-fixer lipstick caused greater staining than the common-fixer lipstick. Application times had similar influence on the groups where lipstick was applied.

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