

COMPOSITE RESIN SUSCEPTIBILITY TO RED WINE STAINING AFTER WATER SORPTION

ABSTRACT

Color stability of restorative materials is essential for longevity of esthetic composite restoration over time. The aim of this investigation was assess the effect of prior water immersion on the color stability of a composite resin to red wine staining. Seventy disc-shaped specimens (6 mm x 1.5 mm) were carried out and randomized in 7 groups (n = 10), according to distilled water immersion time at 0 (control), 24, 48, 72,120,192, and 240 h. Baseline color was measured according to the CIE L*a*b* system using a reflection spectrophotometer (UV-2450, Shimadzu). After that, the specimens were storage in red wine for 7 days. Color difference (ΔE) after aging was calculated based on the color coordinates before (baseline) and after storage period. Data were subjected to one-way ANOVA ($\alpha = 0.05$). The different times of immersion in .water before to the red wine storage showed similar behavior on the color stability, without statistical difference compared to control group, immersed directly in the wine ($p = 0.7057$). The previous water uptake of composite resin evaluated did not decrease the susceptibility to red wine staining.

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KEYWORDS

Composites resins. Physical properties. Color.

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INTRODUCTION

The esthetic restoration staining is one of the most common reasons for its replacement.¹⁻² Extrinsic and intrinsic sources may affect the color stability of materials. Extrinsic factors include intensity and duration of polymerization, and exposure to environmental factors, such as ambient and UV irradiation, heat, water, and food colorants.³⁻⁶ Intrinsic factors are related to the monomeric composition, filler content, photo-initiator type, and percentage of remaining carbon double bonds into the resinous material.³⁻⁶

Discolorations of resin-based materials may occur externally due to plaque accumulation and surface stains, in the surface or sub-surface by superficial degradation or slight penetration and sorption of staining agents within the superficial layer of material, or intrinsically resultant of physical-chemical reactions in the resinous matrix, in the surface and deeper layers of material, caused by ultraviolet irradiation, temperature changes, or humidity.^{1,6-8}

Visual color comparison is based on the subjective interpretation and with instrumental techniques this problem is eliminated; thus, even subtle color changes of materials can be detected using spectrophotometers and colorimeters.^{5-6,8-9} It has been reported that color difference (ΔE) greater 1 is visually perceptible, while that greater than 3.3 is critical for clinical

acceptability of esthetic restorations.^{8-9,11} No color difference ($\Delta E = 0$) indicates a material completely stable or unstained by colorations.¹⁰ The staining of resinous materials by mouth rinses, ultraviolet light, water, food and beverages colorants simulating long-term oral environmental has been related.¹⁻¹³

The hydrophobicity of resin matrix and the effective bonding between silane and fillers can influence the water uptake of resin-based materials⁵. Clinically, composite restorations are hydrated by saliva before of contact with dyes contained in foods and beverages. Thus, the aim of this study was to determine the influence of previous immersion time in water on the composite susceptibility to red wine staining. The hypothesis tested was that water sorption would decrease the composite resin susceptibility to staining.

MATERIAL AND METHODS

One methacrylate microhybrid composite resin (Filtek Z250, A2 shade, 3M ESPE, St. Paul, MN, USA) was used to confect 70 specimens ($n = 10$). The specimens were prepared in cylindrical polytetrafluoroethylene molds, with 6 mm in diameter and 1.5 mm thick. The molds were placed on a glass plate covered with a transparent Mylar strip to obtain a flat surface. The mold was covered with another transparent strip, which was pressed flush under a top glass plate. Each specimen was light irradiated according to

manufacturer's recommendations using quartz-tungsten-halogen unit (XL 3000, 3M ESPE, Grafenau, Germany), at 450 mW/cm² of irradiance monitored by a radiometer (model 100 - Demetron/Kerr, Danbury, CT, USA). Immediately after cure, specimens were removed from the molds and dry stored in lightproof containers at 37 °C for 24 h. The top surface of all specimens was then polished with medium, fine, and superfine polishing disks (Sof-Lex Pop-On, 3M ESPE, St. Paul, MN, USA), intermittently for 30 s with a low speed hand piece. The same operator carried out the polishing step.

Baseline color measurement was determined according to the CIE L*a*b* color scale (Commission Internationale de l'Eclairage) relative to the standard illuminant D65 over a white background using a reflection spectrophotometer (UV-2450; Shimadzu Corp., Kyoto Japan). The CIE L*a*b* color system is a three-dimensional color measurement: L* refers to the lightness coordinate and its value ranges from 0 for perfect black to 100 for perfect white. The axes a* and b* are chromaticity coordinates on green-red (-a* = green; +a* = red) and blue-yellow (-b* = blue; +b* = yellow).^{8,12-13}

After baseline color measurement, 10 specimens from each experimental group were individually immersed (n = 10) in vials containing 5 ml of distilled water for 0 (control

- without water storage), 24 (1), 48 (2), 72 (3), 120 (5), 192 (8), and 240 (10) hours (days). Then, the specimens were carefully wiped with an absorbent paper and immersed in 5 ml of red wine (Concha y Toro Cabernet Sauvignon 2004, pH 3.41, Chile) for a 7-day test period, maintained in incubator (ECB-2. Adamo Products for Laboratory Ltda., Piracicaba, SP, Brazil), at 37 °C. The vials were sealed to prevent evaporation of staining solution.

Color stability (ΔE) after red wine storage was calculated by difference between the color coordinates before (baseline) and after aging treatment, applying the formula $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$. The ΔE values were analyzed by one-way ANOVA at pre-set alpha of 0.05.

RESULTS

The different times of immersion in distilled water previously to the red wine storage showed similar behavior on the color stability, without statistical difference compared to control group, immersed directly in wine (p = 0.7057), as illustrated in the Table 1.

Table 1. Color difference (ΔE) for composite resin according to prior distilled water immersion time

Water immersion time	Color difference (ΔE)
0 h / 0 day	3.57 (2.00)
24 h / 1 day	3.69 (1.48)
48 h / 2 days	3.43 (1.55)
72 h / 3 days	2.70 (0.91)
120 h / 5 days	3.61 (1.75)
192 h / 8 days	3.04 (1.73)
240 h / 10 days	3.93 (1.41)

There is no difference on the color change for different previous immersion times in water used ($p = 0.7057$).

DISCUSSION

The longevity of aesthetic restorations are strongly influenced by the color, its change is the most reasons for replacement of restorative materials by unacceptable color match.⁸ This study evaluated the influence of prior water uptake on the color stability of a composite resin stored in red wine. The water was used instead of saliva because any difference in color was observed when the specimens were immersed in artificial saliva or distilled water.⁵

The methodologies used in the researches reported 24 h of dry or wet storage before solution staining period.^{4,6,10} Thus, the prior immersion of specimens in water could increase the color stability of resinous materials to food and beverages colorants, whereas in a moist environment the water sorption and post cure are completed after 7 days.⁵

A previous investigation stated that staining may be related to water sorption;⁷ thus, the water acts as a carrier for staining

agents,⁸ therefore, adsorption of dyes tends to follow the evolution of water uptake, occurring mainly during the first week.⁷ However, the previous hydration of material did not decrease its susceptibility to red wine staining, therefore the hypothesis tested was rejected.

Red wine is reported to cause most severe discoloration compared with other solutions and ultraviolet irradiation.^{6,11} The sorption of alcohol molecules contained in beverages and rinses into the resinous matrix could increase the softening of composite surface and contribute to staining.¹³⁻¹⁴ In the most of cases, color difference was close to the critical value (3.3) for clinical acceptability of aesthetic restorations.^{8-9,11}

Resin-based materials in aqueous environmental soften by swelling of polymer network and reduction of frictional forces between polymer chains.¹⁵ Physical properties of these materials are dependent on the polymer quality formed, once insufficient cross-links result in more susceptibility to plasticization effect by chemical substances

which enter during eating and drinking,¹⁶ resulting in greater susceptibility to color change of composite restorations over time.

In this way, an adequate polymerization process, which is co-determined by clinical performance,¹⁷⁻¹⁸ could increase the color stability of resin-based restorations; thus, clinicians should be attempted to obtain improved physical properties by better monomer conversion into structured polymer with more cross-links, using adequate curing light units and extended polymerization time, among other factors.¹⁸

CONCLUSION

The prior water sorption of composite resin tested did not decrease the susceptibility to red wine staining.

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