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Effect of In-office Bleaching on Color, Translucency, and Whiteness Variations in CAD-CAM Monolithic Materials

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Clinical Relevance

The optical properties of previously stained Lava Ultimate (LU)—Vita Enamic (VE) and Vita Suprinity (VS)—benefited by a single session of in-office bleaching, without adversely providing subsequent clinically unacceptable variations on their color, translucency, and whiteness.

SUMMARY

Little is known about the impact of bleaching on the optical properties of computer-aided design and computer-aided manufactured (CAD-CAM) monolithic materials. The aim of the present study was to evaluate the effect of one session of in-office bleaching on stain removal, staining susceptibility, translucency, and whiteness variations of CAD-CAM monolithic materials. Disks were fabricated from Lava Ultimate (LU), Vita Enamic (VE), Vita Suprinity (VS), and IPS e.max CAD (IPS). A spectrophotometer was used to register Commission Internationale de l'Eclairage L*a*b* coordinates. For stain removal, 80 specimens from each material were assessed at baseline (R_0) and after immersion in deionized water or coffee for 36.5 days followed or not by bleaching with 40% hydrogen peroxide (R_1). For staining susceptibility, 80 specimens from each material were analyzed at baseline ($R_{0'}$), and after having been bleached or not and immersed in deionized water or coffee ($R_{1'}$). Both analyses were

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calculated as the color difference (ΔE_{00}) between R_1-R_0 and $R_{1'}$-$R_{0'}$, respectively. Differences in translucency (ΔTP_{00}) and whiteness (ΔWI_D) between R_1-R_0 and $R_{1'}$-$R_{0'}$ were also calculated. Data were analyzed by three-way ANOVA and the Games-Howell post hoc test (α=0.05). Clinical significance was based on 50%:50% perceptibility and acceptability thresholds for ΔE_{00}, ΔTP_{00} and ΔWI_D, respectively. Surfaces were analyzed by scanning electron microscopy. Coffee increased ΔE_{00} in LU, VE, and VS, and decreased their translucency and whiteness, whereas the IPS had only its whiteness affected. Bleaching after immersion in coffee decreased ΔE_{00} in LU and VE, and increased translucency and whiteness of LU, VE, and VS. No effect was observed on IPS. Bleaching before immersion in coffee decreased translucency of LU, but within the acceptable interval, while VE exhibited lower ΔE_{00}, and became more translucent and less dark. Both VS and IPS were not affected. One session of in-office bleaching benefited optical properties of the previously stained LU, VE, and VS, without increasing their susceptibility to staining or adversely providing clinically unacceptable variations in their translucency and whiteness. All variations exhibited by the IPS were below the perceptible threshold.

INTRODUCTION

The possibility of obtaining, in a single patient visit, well-adapted restorations that meet the esthetic demand of demanding patients was achieved, thanks to advances in computer-aided design and computer-aided manufacturing (CAD-CAM) technology.[1,2] In recent years, CAD-CAM monolithic materials have been introduced, including composite resin, polymer-infiltrated ceramic, zirconia-reinforced lithium silicate glass ceramic, and lithium disilicate glass ceramic. Despite some common indications, they exhibit very different compositions and microstructures,[3] and, consequently, different behaviors towards the same challenge.[4-6]

These materials are exposed in the oral cavity in constant contact with beverages and foods rich in pigments, which may affect the optical properties in a higher or lower degree, depending on the materials' structure and chemical composition.[7] Some of these materials, especially those containing triethylene glycol dimethacrylate (TEGDMA) [Lava Ultimate (LU) and Vita Enamic (VE)] and bisphenol A-glycidyl methacrylate (Bis-GMA) (LU) monomers absorb water to a potentially harmful extent,[8] which makes them susceptible to staining.[9-13] This fact can be observed in some studies,[9-12] such as that by Acar and others,[9] who found unacceptable and perceptible color differences after LU and VE were thermocycled in coffee. Other studies[10-13] also reported clinically unacceptable color differences for both materials after immersion in different staining solutions. In addition, ceramic materials may also be stained, as can be seen in two studies,[12,13] in which the IPS Empress CAD showed a clinically unacceptable color difference in cress and red wine, and in the study by Eldwakhly and others,[14] who found that the Celtra Duo and Lava Plus were significantly stained by cola and ginger, respectively.

Even with the proven susceptibility to staining, only four studies[11,15-17] were found that investigated the effect of bleaching on the color parameters of CAD-CAM monolithic materials, being that, in only two of them,[11,15] the materials were stained prior to bleaching. Karakaya and Cengiz[11] observed partial or total recovery of translucency and whiteness after LU and VE were bleached with 40% hydrogen peroxide. Alharbi and others[15] also found favorable results in color difference (ΔE) after using the same bleaching agent on the same materials. Both studies[11,15] stated that bleaching can be considered as an alternative method for the treatment of stained restorations. In addition to the scarcity of information, these two studies did not evaluate ceramic materials that are also susceptible to staining.[12,13]

Another question that arises is whether these materials, once bleached, become more susceptible to staining. It is known that porcelains[18-23] and composite resins[24-27] exposed to bleaching gels may undergo changes in their topography, as well as an increase in roughness, which might render the materials even more susceptible to changes in their optical properties when subsequently exposed to pigments. To date, no study with a similar purpose involving CAD-CAM monolithic materials was found. The lack of studies that have evaluated the behavior of CAD-CAM monolithic materials after bleaching leaves the dentist without knowing whether it really is necessary to protect these materials from the bleaching agents, or if they might benefit from bleaching. Therefore, the purpose of the present *in vitro* study was to evaluate the effect of an in-office bleaching agent on stain removal, staining susceptibility, as well as on translucency and whiteness variations of CAD-CAM monolithic materials. The null hypothesis was that their optical properties would not be affected by one single session of in-office bleaching performed before or after staining.

METHODS AND MATERIALS

Specimen Preparation

The materials tested are listed in Table 1. CAD-CAM blocks were milled into cylinders (Ø=7.0 mm) and sliced into 1.2 ± 0.02 mm disks with a precision saw (IsoMet 1000; Buehler). Some burrs of the disks were finished with a ceramic polisher (Exa Cerapol 0361HP; Edenta AG), and the IPS e.max CAD (IPS), and Vita Suprinity (VS) disks were crystallized (Programat P310; Ivoclar Vivadent AG) according to the manufacturer's instructions. For the IPS, the standby temperature was 403°C followed by a 6-minute closing time. The first firing temperature of 820°C was reached with a heating rate of 90°C per minute and held for 10 minutes, and the second firing temperature of 840°C was reached with a heating rate of 30°C per minute and held for 7 minutes. The first vacuum was held between 550°C and 820°C and the second vacuum between 820°C and 840°C. The long-term cooling was at 700°C. For the VS, the standby temperature was 400°C followed by a 4-minute closing time. The firing temperature of 840°C was reached with a heating rate of 55°C per minute and held for 8 minutes. The first vacuum was held at 410°C and the second vacuum at 839°C. The long-term cooling was at 680°C. Next, the disks were polished with silicon carbide papers (600, 1200, 1500 grits) under water irrigation.

Staining Solutions

The coffee capsules (Ristretto; Nespresso) were prepared in the long mode of the coffee machine Essenza Mini (Nespresso). To simulate a 1-year exposure, the specimens were immersed in the coffee for 30 minutes daily for 36.5 days, considering an intake frequency of 3 cups/day, and an exposure time of 60 seconds/cup.[28] Following each 30 minute coffee exposure, the specimens were washed and stored in deionized water until the next exposure. The specimens of the control group were stored for 36.5 days in deionized water, which was changed daily.

Bleaching Procedures

The in-office bleaching with 40% hydrogen peroxide (Opalescence Boost PF; Ultradent Products Inc, South Jordan, UT, USA) was performed in one single session, consisting of three applications of 20 minutes each, according to the manufacturer's instructions. After each one of the three applications of the bleaching gel, the specimen was washed with distilled water and gently dried with absorbent paper.

Color Analysis

The color analysis was assessed using a spectrophotometer (CM-2600d/2500d; Konica Minolta) coupled with the OnColor V5; CyberChrome

Table 1: *Materials Evaluated*

Material/Batch	Classification	Composition	Manufacturer
Lava Ultimate (LU)/ NA666576	Resin nanoceramic	Agglomerated nanoparticles of silica and zirconia (80% by weight), highly cross-linked polymer matrix composed of bisphenol A-glycidyl methacrylate (Bis-GMA), urethane dimethacrylate (UDMA), bisphenol A diglycidyl methacrylate ethoxylated (Bis-EMA), and triethylene glycol dimethacrylate (TEGDMA) (20% by weight). Particle sizes: 20 nm silica particles, 4-11 nm zirconia particles	3M Oral Care (St Paul, MN, USA)
Vita Enamic (VE)/ 42650	Polymer-infiltrated ceramic network	Fine structure feldspathic ceramic (86% by weight), resin polymer composed of UDMA and TEGDMA (14% by weight)	Vita Zahnfabrik (Bad Sackingen, Germany)
Vita Suprinity (VS)/ 48945	Zirconia-reinforced lithium silicate ceramic	56%-64% SiO_2, 15%-21% Li_2O, 8%-12% ZrO_2, 1%-8% other oxides	Vita Zahnfabrik (Bad Sackingen, Germany)
IPS e.max CAD (IPS) (control material)/ T28586	Lithium disilicate ceramic	57%-80% SiO_2, 11%-19% Li_2O, 0%-13% K_2O, 0%-11% P_2O_5, 0%-8% ZrO_2, 0%-8% ZnO, 0%-5% Al_2O_3, 0%-5% MgO	Ivoclar Vivadent AG (Schaan, Liechtenstein)

software, with UV excluded, D65 primary illuminant, d/2° (diffuse illumination, 2° viewing angle), in MAV mode so that the device reads the entire surface of the specimen. The intrinsic error of the device was ΔE_{00}=0.22. Before the readings, a reproducibility study of the color measurements was performed, in which four specimens from each material were submitted to color reading at two different times by one single operator who performed all the readings in the present study. Concordance was assessed using the intraclass coefficient (ICC) and 95% confidence intervals, with the following results: L^*ICC=0.998 (95% CI, 0.993-0.999) $p<0.001$; a^*ICC = 0.999 (95% CI, 0.997-1) $p<0.001$; b^*ICC=1 (95% CI, 0.999-1) $p<0.001$.

The Commission Internationale de l'Eclairage (CIE) L^*, a^*, and b^* color coordinates were measured three times for each specimen on black (L^*=27.80, a^*=-0.13, and b^*=-0.95) and white (L^*=99.46, a^*=-0.12, and b^*=-0.14) ceramic backgrounds. For the stain removal analysis, 80 specimens from each material were analyzed after storage in deionized water for 24 hours (R_0). Specimens were then immersed in deionized water (control group) (n=40) or coffee (n=40), and exposed (n=20) or not (n=20) to in-office bleaching before the second reading (R_1), which was also performed after storage in deionized water for 24 hours. Stain removal was calculated as the color difference between R_1–R_0. For the staining susceptibility analysis, the color of 80 specimens from each material was registered after storage in deionized water for 24 hours ($R_{0'}$). Next, the specimens were bleached (n=40) or not (n=40) and immersed in coffee (n=20) or deionized water (n=20) before the second reading ($R_{1'}$). The staining susceptibility was the color difference between $R_{1'}$ and R_0, that is ($R_{1'}$-$R_{0'}$).

Color differences were calculated by using the CIEDE2000 formula (1:1:1)[29]:

$$\Delta E_{00} = [(\Delta L'/K_L S_L)^2 + (\Delta C'/K_C S_C)^2 + (\Delta H'/K_H S_H)^2 + R_T (\Delta C'/K_C S_C)(\Delta H'/K_H S_H)]^{1/2}, \quad (1)$$

where ΔE_{00} defined the color difference between the two readings, and $\Delta L'$, $\Delta C'$, and $\Delta H'$ are the differences in lightness, chroma, and hue between the two readings. The parametric factors K_L, K_C, and K_H are correction terms for experimental conditions. S_L, S_C, and S_H are weighting functions for adjustment of the total color difference for variation in perceived magnitude, with variation in the location of the color coordinate difference between two color readings. R_T (rotation function) is a function that accounts for the interaction between the chroma and hue differences in the blue region. Since the oral cavity is dark, the L^*, a^*, and b^* color coordinates used to calculate the ΔE_{00} were those registered on a black background.[30] For color differences (ΔE_{00}), a 50%:50% perceptibility threshold and 50%:50% acceptability threshold were taken as 0.8 and 1.8,[31] respectively, being that: $\Delta E_{00} \leq 0.8$ (imperceptible), $0.8<\Delta E_{00}\leq 1.8$ (acceptable), and $\Delta E_{00}>1.8$ (unacceptable).

The Translucency Parameter (TP_{00}) values were calculated according to the CIEDE2000 (1:1:1) formula[32]:

$$TP_{00} = \{[(L'_B - L'_W)/K_L S_L]^2 + [(C'_B - C'_W)/K_C S_C]^2 + [(H'_B - H'_W)/K_H S_H]^2 + R_T [(C'_B - C'_W)/K_C S_C][(H'_B - H'_W)/K_H S_H]\}^{1/2}, \quad (2)$$

where letters B and W represent the color factors over black and white backgrounds. TP_{00} changes between 0 and 100. Values close to 100 represent high translucency and close to 0 represent high opacity.

Differences in TP_{00} between R_1-R_0 and $R_{1'}$-$R_{0'}$ were evaluated considering the 50%:50% perceptibility and 50%:50% acceptability thresholds for translucency already determined in the literature, being: $\Delta TP_{00}\leq 0.62$ (imperceptible), $0.62<\Delta TP_{00}\leq 2.62$ (acceptable), and $\Delta TP_{00}>2.62$ (unacceptable).[32] A negative ΔTP_{00} means that the final TP_{00} was less translucent than the baseline.

The Whiteness Index for Dentistry (WI_D) values were calculated according to the following equation[33]:

$$WI_D = 0.511L^* - 2.324a^* - 1.100b^*. \quad (3)$$

As for the calculation of the ΔE_{00}, the L^*, a^*, and b^* color coordinates used to calculate WI_D were those registered on a black background.[34] Higher and lower WI_D values indicate whiter and darker specimens, respectively.

Differences in WI_D between R_1-R_0 and $R_{1'}$-$R_{0'}$ were evaluated considering the 50%:50% perceptibility and 50%:50% acceptability thresholds for whiteness determined in the literature: $\Delta WI_D\leq 0.94$ (imperceptible), $0.94<\Delta WI_D\leq 2.95$ (acceptable), and $\Delta WI_D>2.95$ (unacceptable).[34] A negative ΔWI_D indicates a decrease in whiteness compared to that of the baseline.

Scanning Electron Microscopy (SEM)

For the SEM analysis, two additional specimens from each material were obtained—one being bleached

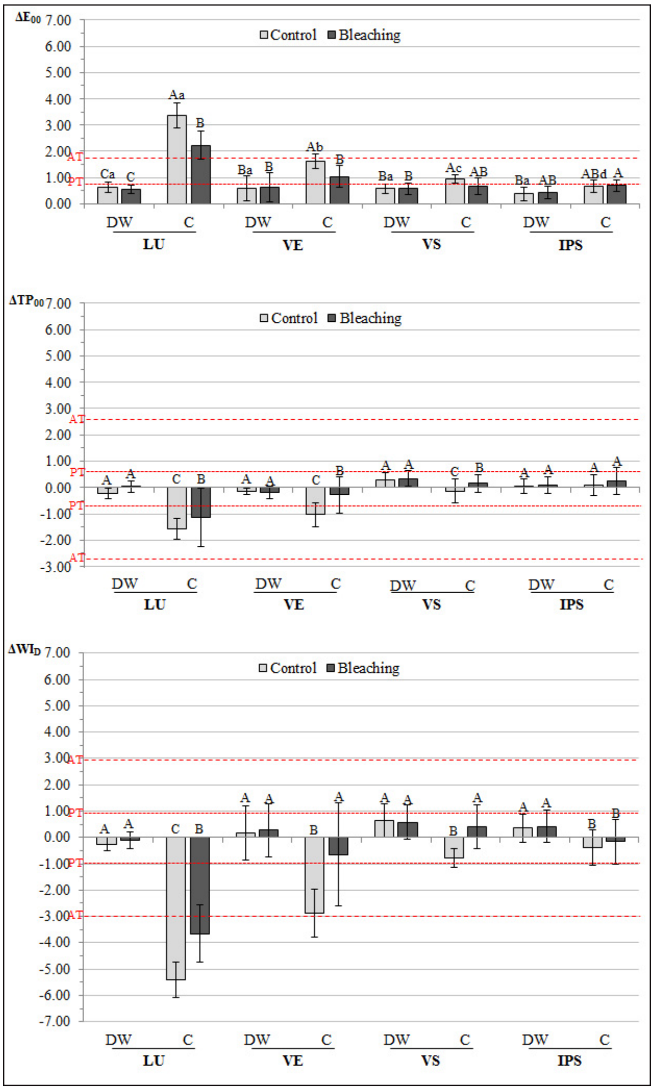

Figure 1. *$\Delta E00$ (R_1-R_0), ΔTP_{00} (R_1-R_0), and ΔWI_D (R_1-R_0) mean values and statistical comparisons. Different uppercase letters indicate significant difference in bars within each material; different lowercase letters indicate significant difference (ΔE_{00}) within the control groups among the materials. Doted red lines: PT, perceptible threshold; AT, acceptable threshold; DW, deionized water; C, coffee.*

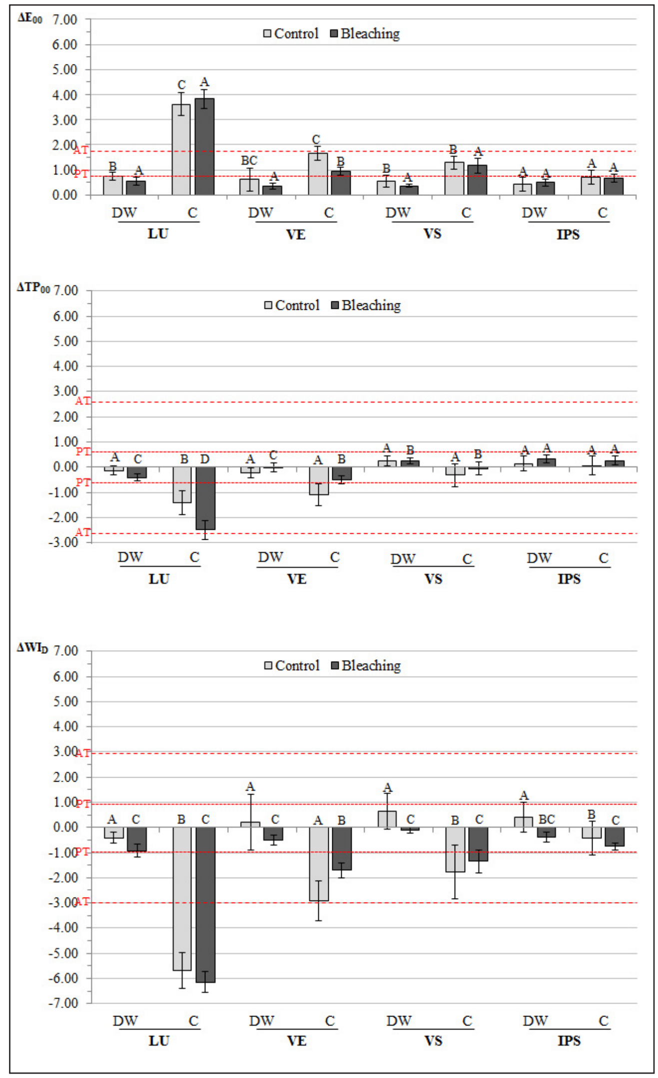

Figure 2. *ΔE_{00} ($R_{1'}$-$R_{0'}$), ΔTP_{00} ($R_{1'}$-$R_{0'}$), and ΔWI_D ($R_{1'}$-$R_{0'}$) mean values and statistical comparisons. Different uppercase letters indicate mean difference in bars within each material. Doted red lines: PT, perceptible threshold; AT, acceptable threshold; DW, deionized water; C, coffee.*

and the other not. The specimens were mounted on metallic stubs and analyzed under a high-resolution field emission scanning electron microscope (model JSM-6610LV), which operated at 25000× magnification with an accelerating voltage of 2.0 kV.

Statistical Analysis

Normality and homoscedasticity were verified using the Shapiro-Wilk and Levene tests. Some groups did not meet these assumptions. We chose to proceed with the three-way ANOVA, which is known to be robust for moderate deviations from normality/homocedasticity when a block design with balanced groups results in a sufficiently large sample size.[35] Thus, the data were submitted to a three-way ANOVA (material, immersion, and bleaching), followed by the Games-Howell post hoc test for multiple comparisons. The level of significance was set at 0.05. All statistical analyses were performed using the IBM SPSS Statistics, v22.0 statistical software (IBM Corporation).

RESULTS

The ΔE_{00} (R_1-R_0), ΔTP_{00}(R_1-R_0), and ΔWI_D(R_1-R_0) results are presented in Figure 1. For the ΔE_{00}, all isolated factors and interactions were significant ($p<0.001$). The post hoc test presented $p\leq0.017$. In deionized water, materials showed statistically similar stainability, which was below the 50%:50% perceptibility threshold. In coffee, the order of stainability was LU>VE>VS>IPS. When compared to deionized water, coffee increased the ΔE_{00} unacceptably for LU, and acceptably for VE and VS. Bleaching did not affect the optical properties of the groups immersed in deionized water. In coffee, bleaching decreased the ΔE_{00} in LU and VE, providing partial and total recovery in relation to the groups only immersed in deionized water. Bleaching did not significantly decrease ΔE_{00} in VS, but changed it from acceptable to imperceptible. No effect was found on IPS. For ΔTP_{00}, all isolated factors ($p<0.001$) and material*immersion ($p<0.001$) and immersion*bleaching ($p<0.01$) were significant. The post hoc test presented $p\leq0.014$. In comparison with deionized water, coffee decreased the translucency in LU, VE, and VS. This change was acceptable for LU and VE, and imperceptible for VS. In the groups immersed in coffee, bleaching increased the translucency of LU, VE, and VS with partial recovery. In addition, ΔTP_{00} of VE changed from acceptable to imperceptible. For ΔWI_D, all isolated factors ($p<0.001$) and interactions ($p<0.01$) were significant. The post hoc test presented $p\leq0.032$. In comparison with deionized water, coffee decreased the whiteness of all materials, unacceptably for LU, acceptably for VE, and imperceptibly for both ceramics. In the groups immersed in coffee, bleaching increased the whiteness of the LU, VE, and VS with partial (LU) or total recovery (VE and VS). In addition, ΔWI_D of VE changed from acceptable to imperceptible. In IPS, the imperceptible decrease in whiteness provided by coffee was not recovered by bleaching.

The ΔE_{00} ($R_{1'}$-$R_{0'}$), ΔTP_{00} ($R_{1'}$-$R_{0'}$), and ΔWI_D ($R_{1'}$-$R_{0'}$) results are presented in Figure 2. For ΔE_{00}, the isolated factors and interactions were significant ($p<0.001$), except for immersion*bleaching. The post hoc test presented $p\leq0.034$. Among the groups immersed in deionized water, bleaching imperceptibly decreased ΔE_{00} in LU. In coffee, the only significant change was in VE, which exhibited lower ΔE_{00}, with total recovery. VS and IPS were not affected by bleaching. For ΔTP_{00}, the isolated factors and interactions were

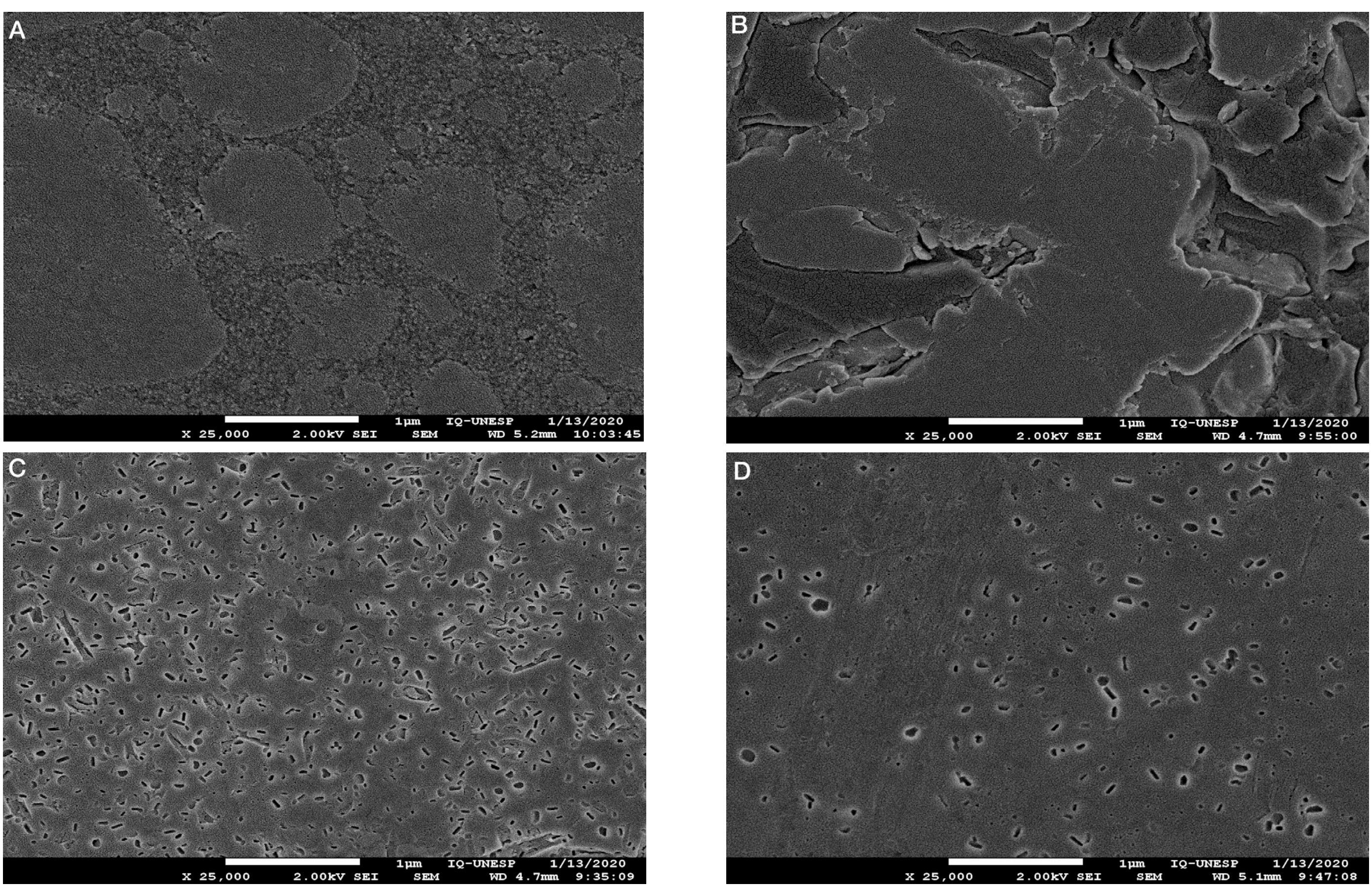

Figure 3. *Scanning electron microscope images (original magnification ×25,000) of the nonbleached materials. A, Lava Ultimate (LU); B, Vita Enamic (VE); C, Vita Suprinity (VS); D, IPS e.max CAD (IPS).*

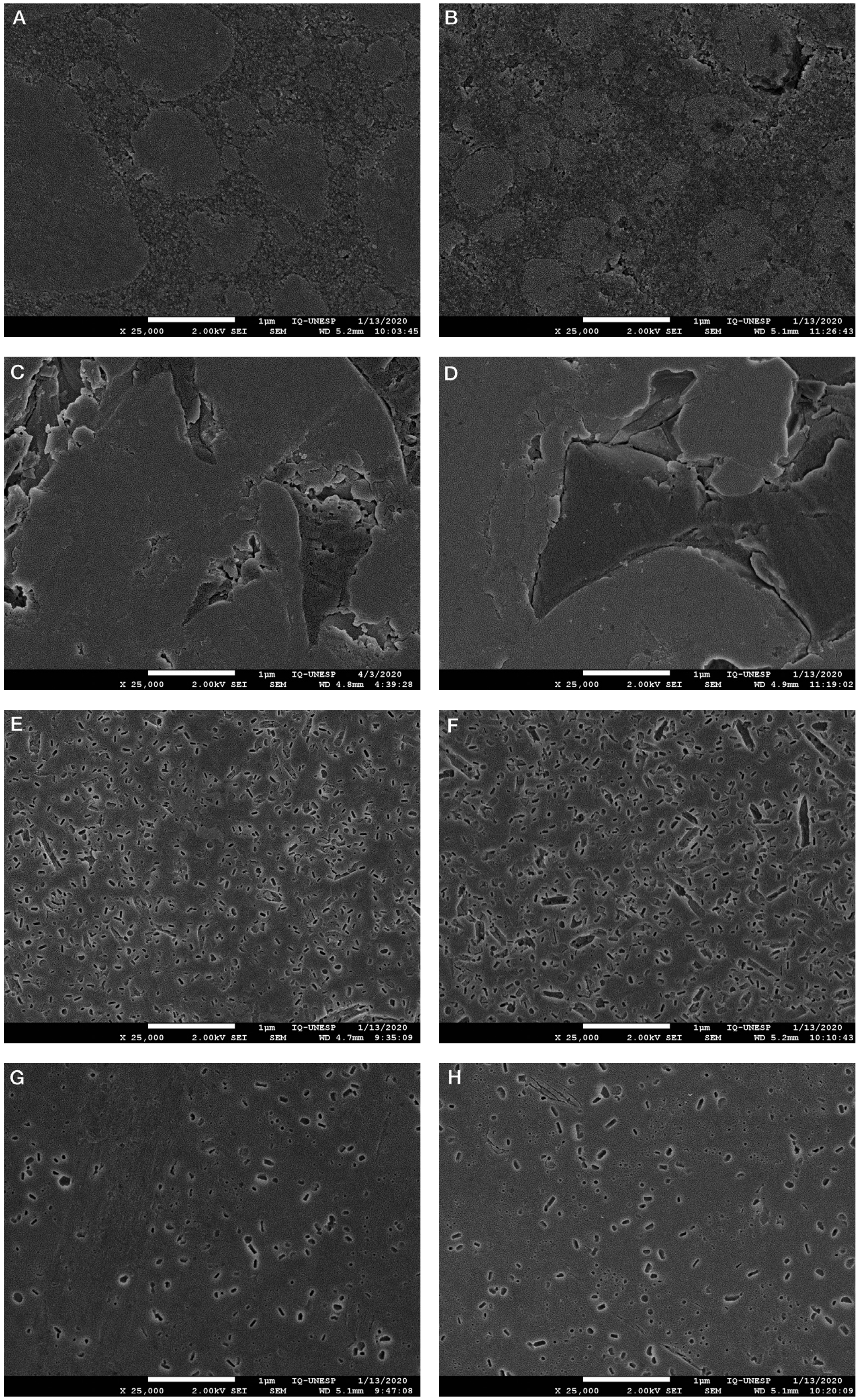

Figure 4. *Scanning electron microscopy images (original magnification ×25,000) of the, respectively, nonbleached and bleached materials. A and B, Lava Ultimate (LU); C and D, Vita Enamic (VE); E and F, Vita Suprinity (VS); G and H, IPS e.max CAD (IPS).*

significant (p<0.001), except for the immersion and the interaction immersion*bleaching. The post hoc test presented $p \leq 0.014$. Among the groups immersed in deionized water, bleaching imperceptibly decreased the translucency of LU. In coffee, LU became less translucent, but maintained the acceptability interval, while VE became more translucent, having ΔTP_{00} changed from acceptable to imperceptible, with partial recovery in relation to the groups only immersed in deionized water. VS and IPS were not affected by bleaching. For ΔWI_D, all isolated factors and interactions were significant (p<0.001). The post hoc test presented $p \leq 0.021$. Among the groups immersed in deionized water, bleaching imperceptibly decreased the whiteness of LU, VS, and IPS. In coffee, VE became less dark, with partial recovery, while LU, VS and IPS were not affected. SEM images are shown in Figures 3 and 4.

DISCUSSION

The present study was conducted to evaluate how one single session of in-office bleaching affects the optical properties of CAD-CAM monolithic materials that were previously or subsequently stained. The null hypothesis was rejected, since, in both situations, the optical properties were affected to a greater or lesser extent depending on the material.

In terms of color stability, the equivalent of 1-year exposure in coffee adversely and significantly affected the color, translucency, and whiteness of LU, VE, and VS, more pronouncedly in this order, while IPS had only its whiteness decreased. This is probably due to the hydrophilic nature of the ether linkage in the TEGDMA present in LU and VE, and of the hydroxyl groups in the Bis-GMA also present in LU.[8] Since water acts as a carrier for staining agents, materials with highly hydrophilic monomers tend to exhibit more discoloration,[11] as observed in the present study, whose results are in agreement with those of other studies.[9-13] In addition, the SEM images show that the surfaces of LU and VE are highly heterogeneous. The higher polymer content of LU (20%) in comparison with the polymer content infiltrated in the structure of feldspathic ceramic in VE (14%) explains their difference in color stability.[11,13] Regarding the ceramics, VS was affected more by the coffee than IPS, although the differences found in the optical properties of VS were imperceptible or acceptable. This finding is in line with a previous study[10] reporting higher color stability of IPS, when both materials were tested for the thickness of the laminate veneer (0.7 mm). However, considering that the mean crystal size of VS is four to eight times smaller than lithium disilicate crystallites in IPS,[7] and that the roughness of VS was similar[5,6] or lower[4] than that of IPS, it was expected that VS would behave similarly or better than IPS regarding the optical properties, which did not occur. Although no explanation is available in the literature, the SEM images in the study by Sen and Us[7] and in ours revealed that, when compared to IPS, VS exhibited a more porous and heterogeneous surface, which could explain its lower stability. In addition, it is not known if the presence of zirconia particles throughout the entire surface of VS might have some role in the behavior of VS.[3]

Bleaching after staining in coffee benefited the optical properties of LU, VE, and VS by providing partial or total recovery of their original color, translucency, and whiteness, and, in some situations, changing the differences from acceptable to imperceptible, while no effect was observed in IPS. These results found for LU and VE are supported by previous studies[11,15] in which a 40% hydrogen peroxide bleaching agent was also applied on both the materials, while no study with a similar scenario was found with VS and IPS for comparison. It is known that hydrogen peroxide releases OH• and H• free radicals, which are strong oxidizing agents[18] capable of oxidizing organic compounds such as chromophores present in the dental structure. Being small and highly reactive, the H• have a high capability to penetrate the surface of the materials, even the ceramic ones.[18] In resinous materials, hydrogen peroxide induces oxidative cleavage of polymer chains,[17,23] leaching of monomers and oxidation of surface pigments.[11] It is possible that IPS did not suffer significant changes, neither by coffee nor by bleaching, because it has a more homogeneous surface than VS.

In the comparison between the groups subsequently immersed in deionized water, although bleaching promoted significant differences in LU, VS, and IPS, all of them were below the imperceptible threshold. In coffee, the optical properties of VS and IPS were not affected, but the surface of VS seems to have been slightly affected by the bleaching when observing the SEM images. LU became less translucent, but still within the acceptability interval, and showed a tendency, although not statistically significant, to increase the staining susceptibility and to become more dark. Although no studies were found to compare with the results of the current study, the SEM images of LU suggest that bleaching affected its surface, which became more porous, and we wonder if additional bleaching sessions would render this material more susceptible to staining. On the other hand, bleaching before staining in coffee benefited all the optical properties of VE, making them closer to the groups only immersed in deionized water, for which no explanation was found, not even in the SEM images. Due to the heterogeneous surface topography of the VE, it is difficult to determine if bleaching affected this material. One of the limitations of the present study is that roughness before and after bleaching was not presented, which is a property closely related to the optical properties. Another aspect is that the effect of just one single session of in-office bleaching was evaluated, which does not correspond to the high demand from patients. Our research group is evaluating both aspects in parallel studies. In addition, very little is known about how the mechanical properties of these materials, such as hardness, strength, among others, behave after in-office bleaching. Studies that investigate this issue are also essential in making a decision whether or not in-office bleaching is a safe procedure to be performed on these materials.

CONCLUSIONS

Within the limitations of the present study, one session of in-office bleaching benefited the optical properties of the previously stained LU, VE, and VS, without increasing their susceptibility to staining or adversely providing clinical unacceptable variations in their translucency and whiteness. The surface topography of the LU and VS suffered alterations after bleaching. All variations exhibited by the IPS were below the perceptible threshold.

Conflict of Interest

The authors of the present study certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in the present article.

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