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Original Article

Effect of Bleaching on Surface Roughness and Color Parameters of Coffee-Stained Nanohybrid Dental Composites with Different Viscosities

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Abstract

Objective The aim of this study was to test the effect of different bleaching protocols on surface roughness, color stability, and translucency parameter of coffee-stained nanohybrid dental composites with different viscosities.

Materials and Methods Five nanohybrid dental composites with different viscosities ($n = 250$)—Neo Spectra LV, Neo Spectra HV, Neo Spectra Flow (Dentsply, Konstanz, Germany), Grandio, and Grandio Flow (Voco, Cuxhaven, Germany)—were used to test surface roughness, color stability, and translucency parameter after bleaching of coffee-stained specimens using either in-office bleaching, home bleaching, or a combination of both. The viscosity of the five types of dental composites was tested using a viscometer. A scanning laser microscope (SLM) was used to examine the surface topography of representative samples from each dental composite after the combined effect of both bleaching agents. Effect of composite type, bleaching protocol, and their interaction was assessed by two-way analysis of variance. For multiple comparisons, Tukey's post hoc test was used with Bonferroni correction.

Results Surface roughness of all coffee-stained dental composites increased after bleaching; however, those of Grandio and Grandio Flow increased significantly ($p < 0.0001$). This was confirmed by SLM images that showed rough surface with protruding fillers after in-office and home bleaching protocol. Results revealed that bleaching, regardless of the protocol, decreased the delta E values of all dental composites; however, it was still higher than the accepted threshold value of 3.7. Neither of the bleaching protocols enhanced translucency parameter of all dental composites. Neo Spectra Flow and Voco Flow had the highest translucency parameter after the three bleaching protocols.

Keywords
- bleaching agents
- color
- coffee
- composite resin
- viscosity

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Conclusion Bleaching does not improve color stability and translucency of coffee-stained nanohybrid dental composites regardless of the viscosity. Surface roughness of coffee-stained nanohybrid dental composites increases after application of bleaching agents.

Introduction

Dental composites have undergone several improvements either in the organic matrix composition or the inorganic filler technology to enhance physio-mechanical and biological properties.[1] To achieve better adaptation of dental composites to tooth structure for better sealing and with a tooth-restoration interface without gaps, dental composites with different viscosities are needed. Viscosity is dependent on matrix composition and filler size, percentage, and distribution.[2] Manufacturers supply different viscosities, ranging from flowable to low viscosity to high viscosity to bulk-fill dental composites.

Nanohybrids are dental composites containing nanofillers (<100 nm) and sub-micron particles (≤1 µm), which allow for more durable and esthetic restorations.[3,4] Surface roughness of nanohybrid dental composites is determined by the resin composite composition and polishing procedures. The size of filler particles in resin composites has been reported to have a significant impact on the transmittance and reflectance of the final restoration. The surface finish achieved during finishing and polishing methods affects composites' optical qualities, such as color, gloss, and texture.[5]

Color and surface topography changes in nanohybrid dental composites have been associated with diet type, oral hygiene habits, and type of dental composite. Beverages such as tea, coffee, and soft drinks may have a negative effect on surface roughness and color of dental composites.[6,7]

Composite resin discoloration can result from either internal or external sources. Internally produced discolorations are persistent and related to polymer quality, filler type, and amount and type of photoinitiator system. The resin's affinity for extrinsic stains is influenced by its degree of conversion and physicochemical properties, such as water sorption rate, adsorption of stains on the superficial layer, surface roughness, and polishing technique.[8]

Dental bleaching can be used to enhance the esthetics of discolored dental composites.[9] Bleaching products contain peroxides that act as powerful oxidizing agents, generating free radicals that break chromophores into smaller compounds. This might enhance the esthetic outcome of dental composites but also might have a detrimental effect on surface roughness, color stability, and translucency, according to the used protocol: either in-office bleaching, home bleaching, or a combination of both.[10]

Several studies have shown that bleaching has a negative effect on properties of nanohybrid dental composites such as microhardness, surface roughness, and color stability.[11–13] However, not enough studies are available on the effect of bleaching on properties of nanohybrid dental composites with different viscosities and compositions. Thus, the purpose of this study was to test the effect of different bleaching protocols on surface roughness, color stability, and translucency parameter of coffee-stained nanohybrid dental composites with different viscosities. The null hypothesis was that there will be no difference between unbleached and bleached coffee-stained nanohybrid dental composites with different viscosities, regarding surface roughness and color parameters.

Materials and Methods

Materials

Five nanohybrid dental composites with different viscosities and composition have been used in this study: Neo Spectra LV (LV), Neo Spectra HV (HV), Neo Spectra Flow (F) (Dentsply, Konstanz, Germany), Grandio (V), and Grandio Flow (VF) (Voco, Cuxhaven, Germany) (►**Table 1**).

Methods

Specimen Preparation

A total of 250 specimens were prepared to obtain ($n = 10$) specimens per subgroup of each material (►**Fig. 1**), based on sample size calculation by G*Power version 3.1.9.4 (Heinrich Heine; University of Dusseldorf, Germany) to achieve a power of 80%, a significance level of 0.05, and an effect size of 0.25. A custom-made Teflon mold was used to prepare disks (2 × 6 mm). A celluloid strip (Tor VM.; Moscow, Russia) and a microscope glass slide were placed on specimens before polymerization to achieve a smooth surface. A light curing unit (Bluephase style; Ivoclar Vivadent, Liechtenstein) was used to polymerize specimens, after the light intensity was checked using a radiometer (Bluephase meter II; Ivoclar Vivadent, Liechtenstein). Irradiation time was 10 seconds, following the recommendations of the manufacturer of each composite. All specimens were polished using a one-step dental composite polishing system (ComposiPro, Brasseler, United States) with cooling, to achieve a smooth surface. Polishing was done by a single operator to avoid variability and each specimen was polished for 15 seconds using a low-speed hand piece at a speed of 20,000 rpm.[14] Specimens were stored in distilled water at 37°C in an incubator for 24 hours.

Staining in Coffee

Specimens were immersed for 3 hours a day at 37°C for a 30-day staining period in 20 mL coffee (Nescafe Gold; Gatwick, United Kingdom). To prepare the staining solution, 6 g of coffee

Table 1 Nanohybrid dental composites and their composition

Material	Viscosity	Manufacturer	Matrix	Fillers	Filler wt.%	Lot number
Neo Spectra ST-HV (HV)	High	Dentsply, Konstanz, Germany	Methacrylate modified polysiloxane (organically modified ceramic) dimethacrylate resins	Spherical, prepolymerized SphereTEC fillers (15 µm), nonagglomerated barium glass (0.6 µm), and ytterbium fluoride (0.6 µm)	78–80	2101001138
Neo Spectra ST-LV (LV)	Low	Dentsply, Konstanz, Germany			76–78	2101000486
Neo Spectra ST-Flow (F)	Flowable	Dentsply, Konstanz, Germany	Ethoxylated bisphenol-A-dimethacrylate, dodecanediol dimethacrylate, and urethane modified Bis-GMA resin	Barium-aluminum-borosilicate glass, ytterbium fluoride, and highly dispersed silicon dioxide 0.1–3.0 µm	62.5	2108000560
Grandio (V)	Conventional	Voco, Cuxhaven, Germany	Bis-GMA, UDMA, and TEGDMA	1-µm sized glass ceramic microfiller, and 20–60 nm sized spherical SiO_2 nanofillers	87	2113163
Grandio Flow (VF)	Flowable	Voco, Cuxhaven, Germany	Bis-GMA, UDMA, TEGDMA, and HEDMA		80.2	2048319

Abbreviations: Bis-GMA, bisphenol-A-glycidyl methacrylate; HEDMA, hydroxyethyl dimethacrylate; TEGDMA, triethylene glycol dimethacrylate; UDMA, urethane dimethacrylate.

was dissolved in 250 mL of hot water and was reprepared daily. Specimens were immersed for 3 hours in the staining solution then removed and washed, and stored in distilled water for the rest of the 24 hours, before repeating same steps.[15]

Bleaching Procedure

An in-office bleaching agent containing 37.5% hydrogen peroxide (Pola office +; SDI, Australia) and a home bleaching agent containing 16% carbamide peroxide (Pola night; SDI, Australia) were used in this study. Coffee-stained dental composites were divided into subgroups ($n = 10$) according to the bleaching procedure, either in-office bleached, home bleached, or a combination of both (►**Fig. 1**). For in-office bleaching, gel was applied for 8 minutes, then washed and dried. The previous step was repeated three times, as recommended by the manufacturer. For home bleaching, gel was applied for 1.5 hours, then washed and dried. This step was repeated 14 times, according to manufacturer's instructions. For in-office and home bleached subgroup, both steps were combined.

Surface Roughness

Surface roughness (Ra) of coffee-stained specimens from each composite type was measured before and after bleaching using a calibrated contact surface profilometer (Marsuf PS10; Göttingen, Germany) with a cutoff value of 0.25 mm. Three measurements were done for each composite disk, and mean was calculated.[16] Surface topography of representative specimens from the group that combined home and in-office bleaching were then investigated using a scanning laser microscope (SLM) (Keyence Vk-X100 Series; Osaka, Japan).

Color Stability

Coffee-stained dental composites color stability was evaluated after bleaching using the color parameters (L^*, a^*, b^*) measured over a white background ($L^* = 95.1$; $a^* = 0.1$, and $b^* = 3.1$), by a digital shade guide (Vita Easyshade V; Bad Sackingen, Germany). Color change (ΔE^*) was measured according to ISO/TR 28642:2016,[17] using the following formula:[18]

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

where ΔL^*, Δa^*, and Δb^* are the differences between the final (after bleaching of coffee-stained specimens) and initial (before coffee staining) color parameters L^*, a^*, and b^*, respectively.

Translucency Parameter

Translucency parameter was determined according to ISO/TR 28642:2016 standard. Color parameters (L^*, a^*, b^*) were measured on white ($L^* = 95.1$; $a^* = 0.1$, and $b^* = 3.1$) and black backgrounds ($L^* = 9.1$; $a^* = -0.1$, and $b^* = -1.3$) before and after bleaching of coffee-stained dental composites. Translucency parameter (TP) was calculated according to the formula:[18]

$$TP = \sqrt{(L_w - L_b)^2 + (a_w - a_b)^2 + (b_w - b_b)^2}$$

where, L_w, a_w, b_w, L_b, a_b, and b_b are color parameters measured on white and black backgrounds, respectively.

Viscosity

Viscosity measurements were assessed using a cone-plate viscometer (DV2T Brookfield Viscometer; Middleboro, United States); 0.25 g of each composite was dispensed on the plate and tested under the following parameters: 25°C temperature, 200 rpm speed, 1 $second^{-1}$ shear rate, and 15-second run time.[19] Three readings were recorded for each dental composite.

Statistical Analysis

Normal distribution was approved for all data by Shapiro–Wilk test and Q-Q plots; thus, mean and standard deviation were used for data presentation. Two-way analysis of variance

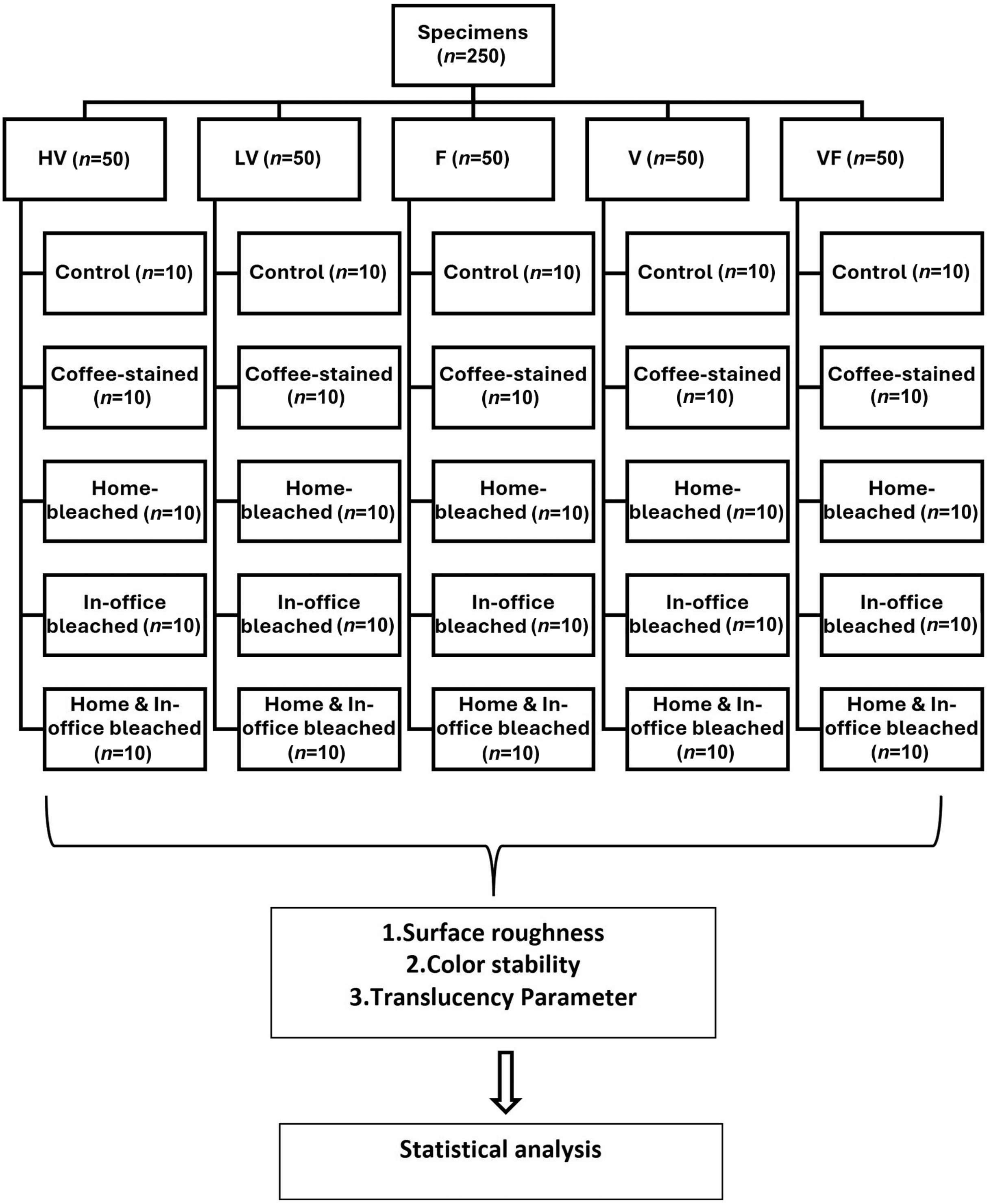

Fig. 1 Flowchart showing subgroups according to composite type and bleaching protocol.

(ANOVA) was used to assess the effect of composite material and bleaching protocol and their interaction on dependent outcomes (surface roughness, and color and translucency parameters). Tukey's post hoc test was performed with Bonferroni correction for multiple comparisons adjustments. Significance level was set at p-value ≤ 0.05. Data were analyzed using IBM SPSS for Windows, version 23 (Armonk, New York, United States).

Results

There was no significant difference ($p > 0.05$) between HV, LV, and V dental composites regarding viscosity. However, their viscosity was higher ($p < 0.0001$) than that of the flowable composites F and VF, and there was no significant difference ($p > 0.05$) between viscosity of both flowable composites (►**Table 2**). Surface roughness of all coffee-stained dental

Table 2 Mean and standard deviation of viscosity of nanohybrid dental composites

	LV	HV	F	V	VF
Viscosity (kg/m.s)	$861.6 \pm 99.08^{a,c}$	$931.8 \pm 178.3^{a,c}$	74.44 ± 7.26^{b}	815.20 ± 62.85^{c}	34.62 ± 4.02^{b}
***F*-test** *p*-Value	220.51 $<0.0001^{*}$				

Abbreviations: F, Neo Spectra ST-Flow; HV, Neo Spectra ST-HV; LV, Neo Spectra ST-LV; V, Grandio; VF, Grandio Flow.
^{a,b,c}indicates significant difference between groups in the same. row.
*Statistically significant difference at *p*-value ≤ 0.05.

Table 3 Mean and standard deviations of surface roughness, color stability, and translucency parameter of coffee-stained dental composites after bleaching

Bleaching protocols	**LV** ($n = 10$)	**HV** ($n = 10$)	**F** ($n = 10$)	**V** ($n = 10$)	**VF** ($n = 10$)
	Surface roughness (Ra) in µm				
Control	0.04 ± 0.02	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.03	0.09 ± 0.02
Coffee + Home bleaching	0.14 ± 0.05	0.14 ± 0.03	0.09 ± 0.01	0.44 ± 0.04	0.75 ± 0.08
Coffee + In-office bleaching	0.13 ± 0.03	0.14 ± 0.03	0.11 ± 0.01	0.24 ± 0.14	0.67 ± 0.09
Coffee + Home + In-office bleaching	0.13 ± 0.03	0.16 ± 0.04	0.10 ± 0.01	0.42 ± 0.03	0.69 ± 0.08
	Color stability (ΔE)				
Control	2.14 ± 1.91	2.55 ± 0.96	2.98 ± 1.54	2.84 ± 0.97	2.53 ± 2.17
Coffee	7.11 ± 2.25	5.79 ± 1.56	11.72 ± 2.82	8.66 ± 2.20	25.44 ± 5.20
Coffee + Home bleaching	6.25 ± 1.30	5.06 ± 2.84	11.25 ± 3.20	6.32 ± 1.14	14.51 ± 0.78
Coffee + In-office bleaching	6.53 ± 2.44	4.61 ± 1.74	6.25 ± 1.28	6.70 ± 1.60	18.08 ± 3.05
Coffee + Home + In-office bleaching	6.17 ± 2.89	4.39 ± 1.33	7.23 ± 1.08	7.22 ± 0.56	21.10 ± 4.94
	Translucency parameter (TP)				
Control	10.55 ± 2.13	9.73 ± 2.14	11.86 ± 1.94	9.70 ± 5.19	10.36 ± 1.24
Coffee	10.11 ± 2.25	8.00 ± 1.83	9.79 ± 3.10	7.69 ± 1.45	6.61 ± 1.03
Coffee + Home bleaching	8.47 ± 1.66	8.16 ± 3.13	6.20 ± 2.21	7.74 ± 0.69	10.30 ± 1.42
Coffee + In-office bleaching	7.23 ± 1.68	7.81 ± 2.74	8.81 ± 1.95	8.97 ± 2.01	8.97 ± 2.10
Coffee + Home + In-office bleaching	6.61 ± 1.20	8.02 ± 1.96	9.22 ± 1.98	8.38 ± 0.91	7.37 ± 1.24

Abbreviations: F, Neo Spectra ST-Flow; HV, Neo Spectra ST-HV; LV, Neo Spectra ST-LV; V, Grandio; VF, Grandio Flow.

composites increased after bleaching; however, those of V and VF increased significantly ($p < 0.0001$) (►**Table 3** and ►**Fig. 2**). Two-way ANOVA revealed a significant effect of composite type ($p < 0.0001$), bleaching protocol ($p < 0.0001$), as well as their interaction ($p < 0.0001$) on surface roughness (►**Table 4**). SLM images showed rougher surface of V and VF, with protruding fillers after in-office and home bleaching protocol (►**Fig. 3**).

Results revealed that bleaching, regardless of the protocol, decreased the ΔE values of all dental composites (►**Table 3** and ►**Fig. 2**). Two-way ANOVA revealed a significant effect of composite type ($p < 0.0001$) and bleaching protocol ($p < 0.0001$) on color stability, but no effect of their interaction ($p = 0.113$) on color stability (►**Table 4**). Both in-office bleaching and home and in-office bleaching protocols decreased translucency parameters of all dental composites (►**Table 3** and ►**Fig. 2**). Two-way ANOVA revealed no significant effect of composite type ($p = 0.366$), but a significant effect of bleaching protocol ($p < 0.0001$) and their interaction ($p < 0.001$) on translucency parameter (►**Table 4**).

Discussion

This study aimed to test the effect of different bleaching protocols on surface roughness, color stability, and translucency parameter of coffee-stained nanohybrid dental composites with different viscosities. The null hypothesis was rejected as there was an effect of bleaching on the tested parameters of nanohybrid dental composites with different viscosities.

Dental composites are clinically subjected to different staining beverages such as coffee, tea, and soft drinks, which have a detrimental effect on color stability and surface topography. In this study, specimens were aged in coffee for 3 hours a day at 37°C for a 30-day staining period to simulate 5 years of clinical usage.[15] Coffee is commonly used as an artificial staining solution and it has been reported that coffee stains are more resistant to be removed compared with tea.[20] Coffee stains are caused by water-soluble polyphenols such as melanoidins, tannin, and caffeine, which can penetrate deeply into the resin matrix.[21,22]

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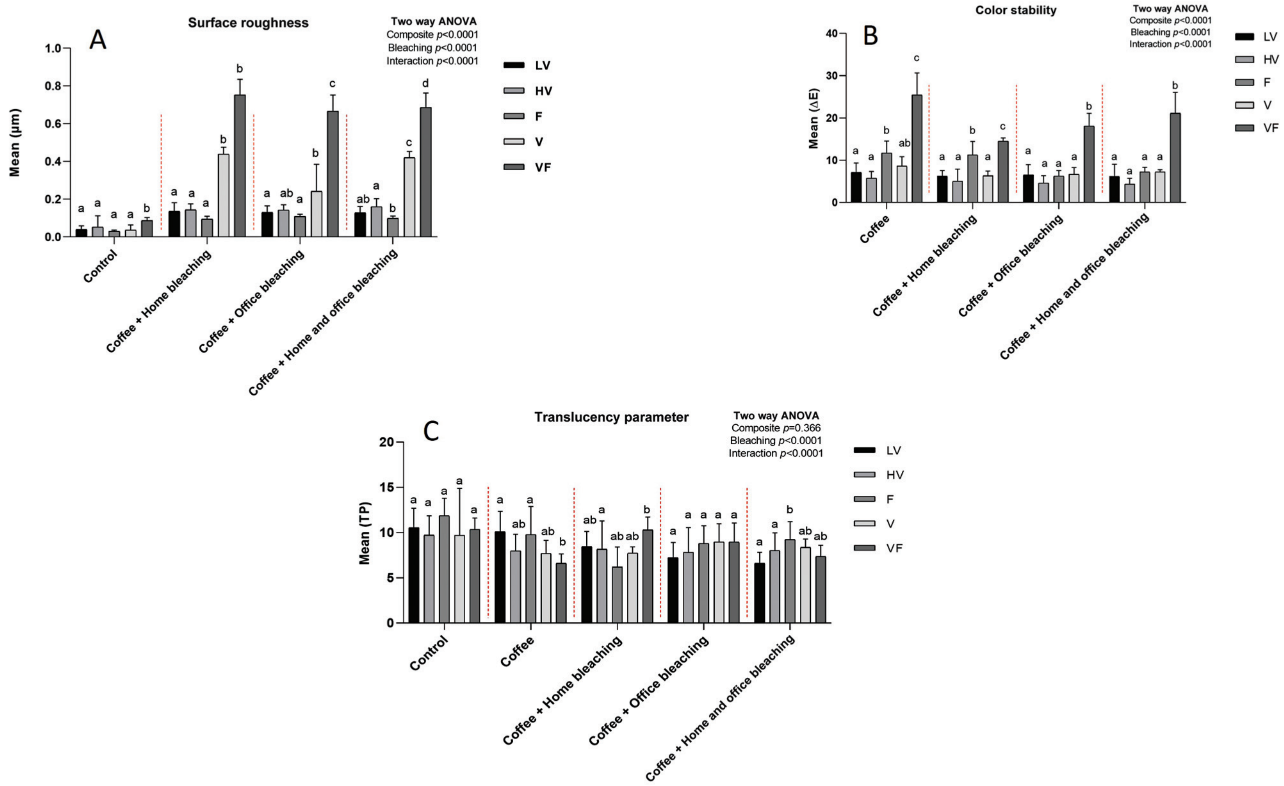

Fig. 2 Graphs showing difference between coffee-stained dental composites after bleaching, regarding (**A**) surface roughness, (**B**) color stability, and (**C**) translucency parameter.

Table 4 Two-way analysis of variance assessing the effect of composite material, bleaching protocol, and their interaction on surface roughness, color stability, and translucency parameter

	Mean square	*F*-test	*p*-Value	η^2
	Surface roughness (Ra)			
Composite	1.524	574.362	<0.0001[a]	0.927
Bleaching	0.777	292.672	<0.0001[a]	0.830
Composite x bleaching	0.151	56.954	<0.0001[a]	0.792
Corrected model	0.539	203.100	<0.0001[a]	0.955
	Color stability (ΔE)			
Composite	1,405.441	220.018	<0.0001[a]	0.830
Bleaching	115.370	18.061	<0.0001[a]	0.231
Composite x bleaching	48.129	7.535	0.113	0.334
Corrected model	344.496	53.930	<0.0001[a]	0.851
	Translucency parameter (TP)			
Composite	5.056	1.083	0.366	0.019
Bleaching	51.154	10.957	<0.0001[a]	0.163
Composite x bleaching	15.551	3.331	<0.0002[a]	0.192
Corrected model	19.736	4.227	<0.0001[a]	0.311

[a]Statistically significant difference at *p*-value ≤ 0.05; η^2: Partial Eta squared, adjusted R squared = 0.95, 0.835, and 0.237, respectively.

Restoration of esthetics of dental composites can be done by repolishing with or without bleaching or even replacement. Bleaching gels are composed of carbamide peroxide and hydrogen peroxide with different concentrations, whether used as in-office bleaching or home bleaching agents. Carbamide peroxide breaks down into urea and hydrogen peroxide. Hydrogen peroxide has a potent oxidizing effect by forming free radicals, anions, and reactive

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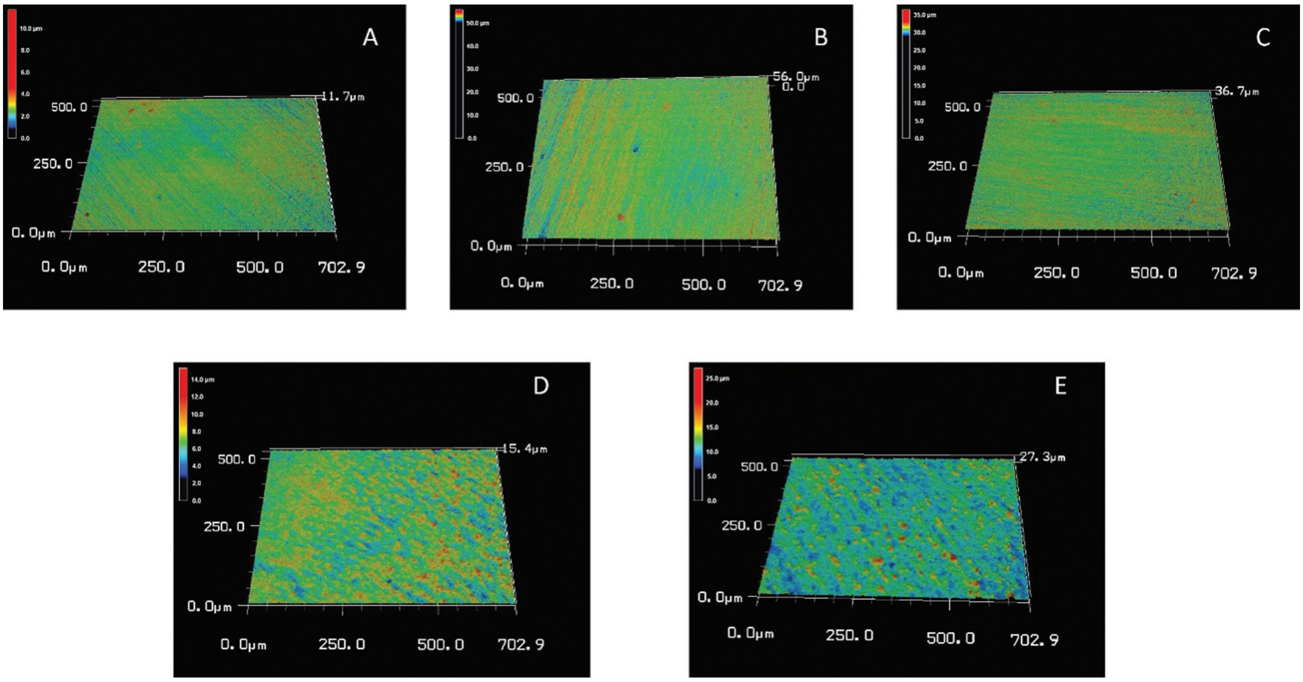

Fig. 3 Scanning laser microscope images of home and in-office bleached coffee-stained dental composites (**A**) Neo Spectra HV, (**B**) Neo Spectra LV, (**C**) Neo Spectra Flow, (**D**) Grandio, and (**E**) Grandio Flow, showing rough surface of the latter two dental composites with protruding filler particles.

oxygen species. This might have a detrimental effect on dental composites through softening and degradation of the resin matrix, causing changes in color, translucency, and surface roughness.[10]

In this study two families of nanohybrid dental composite were used: (1) Neo Spectra family, supplied as high viscosity, low viscosity, and flowable dental composites. Neo Spectra dental composites are claimed by the manufacturer to have an advanced granulated filler technology that provides better handling properties with a single translucency that matches surrounding teeth. (2) Voco Grandio family, supplied as a conventional composite and a flowable composite. Voco Grandio dental composites have higher filler loading than Neo Spectra family as shown in ►**Table 1**. Viscosity testing results revealed no significant difference ($p > 0.05$) between the three composites of both families (LV, HV, and V) and no difference ($p > 0.05$) between the flowable composites of both families (F and VF). Flowable composites have a reduced filler load, improved flowability, weaker mechanical properties, and lower viscosity. Flowable composites offer the advantages of ease of handling properties, a lower shrinkage rate than conventional composite materials, and better adaptation to cavity walls.[23]

Results revealed that VF dental composite had higher surface roughness values regardless of the bleaching protocol, followed by V dental composite. Neo Spectra dental composites had lower surface roughness values before and after bleaching, that did not exceed 0.2 μm, which aids in the decreased accumulation of plaque, caries, and periodontal inflammation.[24] Resin matrix composition and fillers play a crucial role in determination of surface roughness of dental composites. In VF and V dental composites, the resin matrix is made of hydrophilic bisphenol-A-glycidyl methacrylate (Bis-GMA), urethane dimethacrylate, and triethylene glycol dimethacrylate (TEGDMA). Ethoxy groups in TEGDMA render it hydrophilic in nature and this leads to increased water sorption from staining solutions, which leads to matrix-filler interface degradation, and when bleaching agents are applied this further enhances chemical degradation of the resin matrix, leaving fillers protruding and increasing surface roughness.[25]

Surface roughness of nanohybrid dental composites is also dependent on filler size, percentage of surface area occupied by filler particles, and filler hardness. Variations in interparticle spacing, filler dispersion, the existence of filler agglomeration and clusters, and the degree of filler adhesion to the matrix may all influence surface roughness.[26] Neo Spectra dental composites contain perfectly spherical fillers and are thoroughly impregnated with resin, which is an organically modified ceramic, and not distinguishable from other parts of the filler system, thus the lower surface roughness.[27] These findings agree with Chakraborty et al who found that surface roughness of dental composites with spherical fillers is not affected by bleaching because the prepolymerized filler particles of nonagglomerated barium glass and ytterbium fluoride, as well as a resin matrix containing highly distributed methacrylic polysiloxane nanoparticles, have chemical properties similar to glass and ceramics. This filler formulation is more resistant to abrasion and inorganic filler loss on the surface.[28]

SLM offers a three-dimensional measure and view of surface roughness using a noncontact and nondestructive measurement technique across X, Y, and Z axes as opposed to the two-dimensional contact destructive profilometry technique.[29] SLM images (►**Fig. 3**) showed rough surface of VF and V dental composites with protruding fillers on the surface following in-office and home bleaching.

Color stability of all coffee-stained composites decreased after bleaching but still was higher than the threshold value of 3.7, thus color changes were perceptible.[30] VF dental composite showed the highest color change, followed by F dental composite. This can be attributed to the composition of VF dental composite that has hydrophilic Bis-GMA, hydroxyethyl dimethacrylate, and TEGDMA monomers; thus, coffee stains penetrate deeply into the composite resin and bleaching was unable to decrease ΔE values regardless of the protocol used. This agrees with Erturk-Avunduk et al who found that nanohybrid flowable dental composites have lower color stability after application of whitening agents when compared with composites with higher viscosity.[31]

Translucency parameter, TP, is the difference in color of a material with a given thickness measured over black and white backgrounds. A material's TP would be zero if it were completely opaque and a material with high TP values has greater translucency, and this is important to simulate natural tooth appearance. The factors controlling translucency include the amount of opacifier, degree of polymerization, filler particles, as well as the extrinsic factors such as thermal changes, stains, and bleaching agents.[32,33] Results of this study revealed that F dental composite had the highest TP regardless of the bleaching protocol. This can be attributed to the new filler technology and resin matrix composition. This finding agrees with the findings of Gurgan et al who found that Neo Spectra dental composites have the highest translucency parameter after coffee staining and polishing.[27]

Nanohybrid dental composites differ in the resin matrix and composition, which in turn affects its properties although they are all marketed under the same category. It is not necessary that an increase in filler weight percentage enhances physical and mechanical properties. However, advancements in filler technology and resin matrix composition can enhance properties of dental composites. Limitations of this study include the need to test bleaching effect on stained nanohybrid dental composites with various staining solutions other than coffee. There is a need to test clinically bleaching effect on esthetic outcomes of nanohybrid dental composites, as dentists might consider replacement of nanohybrid dental composites rather than using bleaching to restore esthetics.

Conclusion

Bleaching does not improve color stability and translucency of coffee-stained nanohybrid dental composites regardless of the viscosity. Surface roughness of coffee-stained nanohybrid dental composites increases after application of bleaching agents.

Clinical Significance

Bleaching does not enhance color and surface properties of coffee-stained nanohybrid dental composites. More clinical studies are needed to test effect of bleaching agents on nanohybrid dental composites because the results of this in vitro study suggest that dentists might consider replacement of coffee-stained nanohybrid dental composites rather than bleaching to achieve better esthetic outcomes.

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Conflict of Interest
None declared.

References

1 Cho K, Rajan G, Farrar P, Prentice L, Prusty BG. Dental resin composites: a review on materials to product realizations. Compos, Part B Eng 2022;230:109495
2 Loumprinis N, Maier E, Belli R, Petschelt A, Eliades G, Lohbauer U. Viscosity and stickiness of dental resin composites at elevated temperatures. Dent Mater 2021;37(03):413–422
3 Zubrzycki J, Klepka T, Marchewka M, Zubrzycki R. Tests of dental properties of composite materials containing nanohybrid filler. Materials (Basel) 2022;16(01):348
4 Randolph LD, Palin WM, Leloup G, Leprince JG. Filler characteristics of modern dental resin composites and their influence on physico-mechanical properties. Dent Mater 2016;32(12):1586–1599
5 Pala K, Tekçe N, Tuncer S, Serim ME, Demirci M. Evaluation of the surface hardness, roughness, gloss and color of composites after different finishing/polishing treatments and thermocycling using a multitechnique approach. Dent Mater J 2016;35(02):278–289
6 Bansal K, Acharya SR, Saraswathi V. Effect of alcoholic and non-alcoholic beverages on color stability and surface roughness of resin composites: an in vitro study. J Conserv Dent 2012;15(03):283–288
7 Alkhadim YK, Hulbah MJ, Nassar HM. Color shift, color stability, and post-polishing surface roughness of esthetic resin composites. Materials (Basel) 2020;13(06):1376
8 Gaintantzopoulou M, Kakaboura A, Vougiouklakis G. Colour stability of tooth-coloured restorative materials. Eur J Prosthodont Restor Dent 2005;13(02):51–56
9 Hasani E, Baghban AA, Sheikh-Al-Eslamian SM, Sadr A. Effect of bleaching on color change of composite after immersion in chlorhexidine and coffee. J Conserv Dent 2019;22(06):529–532
10 Yu H, Zhang CY, Cheng SL, Cheng H. Effects of bleaching agents on dental restorative materials: a review of the literature and recommendation to dental practitioners and researchers. J Dent Sci 2015;10(04):345–351
11 Halacoglu DM, Yamanel K, Basaran S, Tuncer D, Celik C. Effects of staining and bleaching on a nanohybrid composite with or without surface sealant. Eur J Dent 2016;10(03):361–365
12 Popescu AD, Tuculina MJ, Diaconu OA, et al. Effects of dental bleaching agents on the surface roughness of dental restoration materials. Medicina (Kaunas) 2023;59(06):1067
13 Durner J, Obermaier J, Ilie N. Investigation of different bleaching conditions on the amount of elutable substances from nanohybrid composites. Dent Mater 2014;30(02):192–199
14 Tepe H, Erdılek AD, Sahın M, Efes BG, Yaman BC. Effect of different polishing systems and speeds on the surface roughness of resin composites. J Conserv Dent 2023;26(01):36–41
15 Çelik C, Yüzügüllü B, Erkut S, Yazici AR. Effect of bleaching on staining susceptibility of resin composite restorative materials. J Esthet Restor Dent 2009;21(06):407–414
16 Fernandes RA, Strazzi-Sahyon HB, Suzuki TYU, Briso ALF, Dos Santos PH. Effect of dental bleaching on the microhardness and surface roughness of sealed composite resins. Restor Dent Endod 2020;45(01):e12
17 ISO/TR28642. 2016. Technical Report (E): Dentistry – Guidance on Colour Measurements. Geneva: ISO; 2016
18 Sedrez-Porto JA, Münchow EA, Cenci MS, Pereira-Cenci T. Translucency and color stability of resin composite and dental

adhesives as modeling liquids - a one-year evaluation. Braz Oral Res 2017;31:e54
19 Faria-E-Silva AL, Piva E, Moraes RR. Time-dependent effect of refrigeration on viscosity and conversion kinetics of dental adhesive resins. Eur J Dent 2010;4(02):150–155
20 Araújo RM, Lemes EC, Pachito RF, Feitosa FA. The impact of at home and in-office bleaching agents on the color stability of bulk-fill composite resins. Braz Dent Sci 2019;22(01):94–102
21 Althaqafi KA, Alshabib A. Effect of bleaching agents on discoloured resin-based composites for direct restorations: a systematic review. J Pharm Bioallied Sci 2023;15(Suppl 1):S1–S10
22 Madhyastha PS, Naik DG, Kotian R, Srikant N, Bhat KMR. Effect of staining solutions on color stability of silorane & methacrylate restorative material. Int J Biomed Sci 2015;11(01):29–34
23 Zhang X, Zhang Q, Meng X, et al. Rheological and mechanical properties of resin-based materials applied in dental restorations. Polymers (Basel) 2021;13(17):2975
24 Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. Dent Mater 1997;13(04):258–269
25 Telang A, Narayana IH, Madhu KS, Kalasaiah D, Ramesh P, Nagaraja S. Effect of staining and bleaching on color stability and surface roughness of three resin composites: an *in vitro* study. Contemp Clin Dent 2018;9(03):452–456
26 Marghalani HY. Effect of filler particles on surface roughness of experimental composite series. J Appl Oral Sci 2010;18(01):59–67
27 Gurgan S, Koc Vural U, Miletic I. Comparison of mechanical and optical properties of a newly marketed universal composite resin with contemporary universal composite resins: an in vitro study. Microsc Res Tech 2022;85(03):1171–1179
28 Chakraborty A, Purayil T, Ginjupalli K, Pentapati KC, Shenoy N. Effect of in-office bleaching agent on the surface roughness and microhardness of nanofilled and nanohybrid composite resins. F1000 Res 2023;12:129
29 Vinagre A, Barros C, Gonçalves J, Messias A, Oliveira F, Ramos J. Surface roughness evaluation of resin composites after finishing and polishing using 3D-profilometry. Int J Dent 2023;2023:e4078788
30 Barry TN, Bailey CW, Ashcraft-Olmscheid D, Vandewalle KS. Effect of a new bleaching gel on tooth whitening. Oper Dent 2017;42(05):559–566
31 Erturk-Avunduk AT, Delikan E, Cengiz-Yanardag E, Karakaya I. Effect of whitening concepts on surface roughness and optical characteristics of resin-based composites: an AFM study. Microsc Res Tech 2024;87(02):214–228
32 Lee YK. Translucency changes of direct esthetic restorative materials after curing, aging and treatment. Restor Dent Endod 2016;41(04):239–245
33 Yu B, Lee YK. Translucency of varied brand and shade of resin composites. Am J Dent 2008;21(04):229–232

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