ORIGINAL ARTICLE
DOI: 10.5152/EssentDent.2026.25133

Effects of In-Office Bleaching and Repolishing on the Color Stability and Surface Roughness of Nano-Hybrid Resin Composites

Selinsu Öztürk[1], Nazlı Zeynep Kuzu[2], Yağmur Görer[2], Aslı Kirikçi[3], Bengü Doğu Kaya[4], Ayşe Aslı Şenol[2], Pınar Yılmaz Atalı[2], Bilge Tarçın[2]

[1]Department of Restorative Dentistry, University of Health Sciences, Hamidiye Faculty of Dental Medicine, İstanbul, Türkiye
[2]Department of Restorative Dentistry, Marmara University Faculty of Dentistry, İstanbul, Türkiye
[3]Department of Restorative Dentistry, Marmara University Institute of Health Sciences, İstanbul, Türkiye
[4]Department of Restorative Dentistry, Çanakkale Onsekiz Mart University Faculty of Dentistry, Çanakkale, Türkiye

Cite this article as: Öztürk S, Kuzu NZ, Görer Y, *et al*. Effects of in-office bleaching and repolishing on the color stability and surface roughness of nano-hybrid resin composites. *Essent Dent.* 2026, 5, 0133, doi: 10.5152/EssentDent.2026.25133.

Abstract

Background: To evaluate the effects of in-office bleaching treatment on color and surface roughness of nano-hybrid resin composites (NH-RC) and the impact of different repolishing procedures following bleaching.

Methods: Sixty disc-shaped (8 × 2 mm, A2) specimens were prepared using 2 different NH-RC (Charisma Topaz One, Kulzer, Germany; Parion, Dentac, Türkiye). Initial finishing and polishing processes were completed with 4-stage discs (OptiDisc, Kerr). Excluding the control groups (n = 10), 40 specimens were subjected to 2 sessions of office bleaching (40% hydrogen peroxide, Opalescence Boost, Ultradent), each consisting of three 20-minute applications at 3-day intervals. After 24 hours, half of the bleached specimens from each composite group were repolished with a 4-step disc system (OptiDisc, Kerr), and the others with diamond-impregnated silicone rubbers (DiaComp Plus Twist, Eve). Surface roughness (Ra) was recorded with a profilometer (SJ-210, Mitutoyo, Japan) and color was analyzed with a spectrophotometer (Easyshade V, VITA, Germany) at baseline, after bleaching, and after repolishing, respectively. Color changes (ΔE) were calculated with the CIEDE2000 formula. The data were evaluated statistically by 2-way ANOVA and Bonferroni test ($P < .05$).

Results: In Parion, bleaching significantly increased surface roughness ($P < .05$) and ΔE_1-ΔE_2 values (>1.8; $P < .001$), exceeding the acceptability threshold, whereas the control remained below the 0.8 perceptibility limit. Repolishing reduced roughness ($P < .05$) and ΔE_3 values (0.8-1.8) regardless of the repolishing system used, indicating acceptable matches. In Charisma Topaz One , no group showed $\Delta E_{00} \geq 1.8$ or significant roughness changes ($P > .05$).

Conclusion: Bleaching affects resin composites differently depending on their composition, but repolishing enhances color and surface properties regardless of the system used.

Keywords: Color change, nano-hybrid resin composite, office bleaching, repolishing, surface roughness

What is already known on this topic?

- *Dental bleaching agents can interact with restorative materials, potentially altering their color stability and surface roughness.*
- *Repolishing is considered a minimally invasive approach to restore esthetics and surface smoothness after bleaching.*

What this study adds on this topic?

- *The study demonstrated that in-office bleaching affected color stability and surface roughness differently among the tested resin composites, suggesting that material composition plays a decisive role in these outcomes.*
- *Immediate repolishing following bleaching effectively improved surface smoothness and color stability, regardless of whether a multi-step or 2-step polishing system was used.*

INTRODUCTION

With the growing demand for esthetic dental treatments, the use of direct resin composites and bleaching agents has become increasingly prevalent.[1] Dental bleaching is

Corresponding author: Selinsu Öztürk
e-mail: selinsuozturk0@gmail.com, selinsu.ozturk@sbu.edu.tr

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Received: October 14, 2025
Revision Requested: December 2, 2025
Last Revision Received: December 16, 2025
Accepted: January 19, 2026
Publication Date: July 30, 2026

an effective and conservative approach for removing both intrinsic and extrinsic stains. Among bleaching methods, in-office procedures, which are performed by a dental professional, offer several advantages, including precise control over the bleaching process, a shorter treatment duration, and more immediate whitening results compared to at-home techniques.[2]

During application, bleaching agents come into contact not only with natural teeth but also with the surfaces of dental restorations, potentially affecting their mechanical, physical, and esthetic properties.[3,4] Chemical interactions between restorative materials and bleaching agents may lead to discoloration, reduced brightness, alterations in surface topography, and increased surface roughness, potentially promoting bacterial plaque accumulation.[5,6] As a result of these physical and mechanical alterations, restorations are often replaced following bleaching treatment.[1] Previous research has also highlighted the impact of bleaching agents on the surfaces of restorative materials, indicating that restorations exposed to bleaching gel during treatment might benefit from repolishing.[1,7]

Repolishing offers a minimally invasive solution to enhance esthetics by eliminating surface stains. This approach can contribute to the long-term durability of restorations by improving their visual appearance without replacing the material.[8] Selection of the appropriate finishing and polishing techniques is essential to achieve optimal quality and durability of resin composite restorations while preserving the natural tooth anatomy. Various finishing and polishing methods are employed in dental practice, including polishing pastes and discs, rotary tools, and polyester strips. Each of these techniques has its benefits and drawbacks.[9] Traditionally, multi-step systems, such as discs and diamond paste, are commonly used by clinicians, and their effectiveness has been well documented.[10] More recently, various manufacturers have introduced single- and 2-step polishing instruments and protocols. Ideally, these systems aim to be more cost-effective and less time-consuming while maintaining comparable esthetic results.[11]

This *in vitro* study aimed to assess the effects of in-office bleaching treatment on the color and surface roughness of nano-hybrid resin composites, and to compare the effectiveness of different refinishing and polishing procedures following bleaching. The null hypotheses were that:

1. Bleaching does not affect the color stability or surface roughness of resin composites.
2. Repolishing after bleaching does not affect the color stability or surface roughness of resin composites.
3. The use of different repolishing systems does not affect the color stability or surface roughness of resin composites.

MATERIAL AND METHODS

The compositions of the nano-hybrid resin composites used in the study are presented in Table 1.

Specimen Preparation

Sample size determination was performed using G* Power v3.1.9.5 software (Franz Faul, Universität Kiel, Germany), aiming for a statistical power of 85% (1-β=0.85), with 6 treatment groups and 10 specimens per group. Sixty disc-shaped specimens (8 mm in diameter with a thickness of 2 mm) were prepared using a silicone mold, a transparent Mylar strip (Kerr Hawe, Bioggio, Switzerland), and a Teflon matrix. Two different nano-hybrid resin composites were used: Parion (PR, Dentac, İstanbul, Türkiye) and Charisma Topaz One (CTO, Kulzer, Hanau, Germany), as listed in Table 1 (n=30 for each material).

Composite resin was placed in a single increment into a silicone mold positioned on a glass slide and covered with a Mylar strip to ensure a smooth surface. Polymerization was carried out for 20 seconds using a Valo Cordless light-curing unit (Ultradent, South Jordan, UT, USA) in standard mode at an intensity of 1000 mW/cm^2, in accordance with the manufacturer's instructions. All specimens underwent a standardized initial finishing and polishing procedure using 4-step aluminum-oxide coated discs (OptiDisc, Kerr Corporation, USA). The procedure was performed by a single operator at conventional rotational speeds, in accordance with the manufacturer's instructions. Following this step, the specimens were stored in distilled water at 37 ± 1 °C for 24 hours under dark conditions, in line with ISO/TR 28642:2016 guidelines (ISO, 2016). The initial measurements of surface roughness and color values were recorded, and the specimens were randomly and blindly allocated into subgroups. The overall workflow of the study protocol and experimental groups is illustrated in Figure 1.

Bleaching Procedures

In-office bleaching procedure was carried out following the manufacturer's instructions, with Opalescence Boost

Table 1. The Composition of the Resin Composites Used in the Study

Materials	Manufacturers	Filler Content (% w/v)	Type	Filler Composition	Organic Matrix
Parion (PR)	Dentac, Istanbul, Türkiye	77-78/66	Nano-hybrid	SiO_2, quartz	Bis-GMA, UDMA, Bis-EMA, TEGDMA
Charisma Topaz One (CTO)	Kulzer, Hanau, Germany	81/64	Nano-hybrid	Barium aluminum fluoride glass, pyrogenic SiO_2	TCD-DI-HEA, TEGDMA, UDMA

Bis-EMA, ethoxylated bisphenol-A dimethacrylate; Bis-GMA, bisphenol A glycidyl methacrylate; SiO_2, silicon dioxide; TCD-DI-HEA, 2-propenoic acid; (octahydro-4,7-methano-1H-indene-5-diyl) bis(methyleneiminocarbonyloxy-2,1-ethanediyl) ester; TEGDMA, triethylene glycol dimethacrylate; UDMA, urethane dimethacrylate.

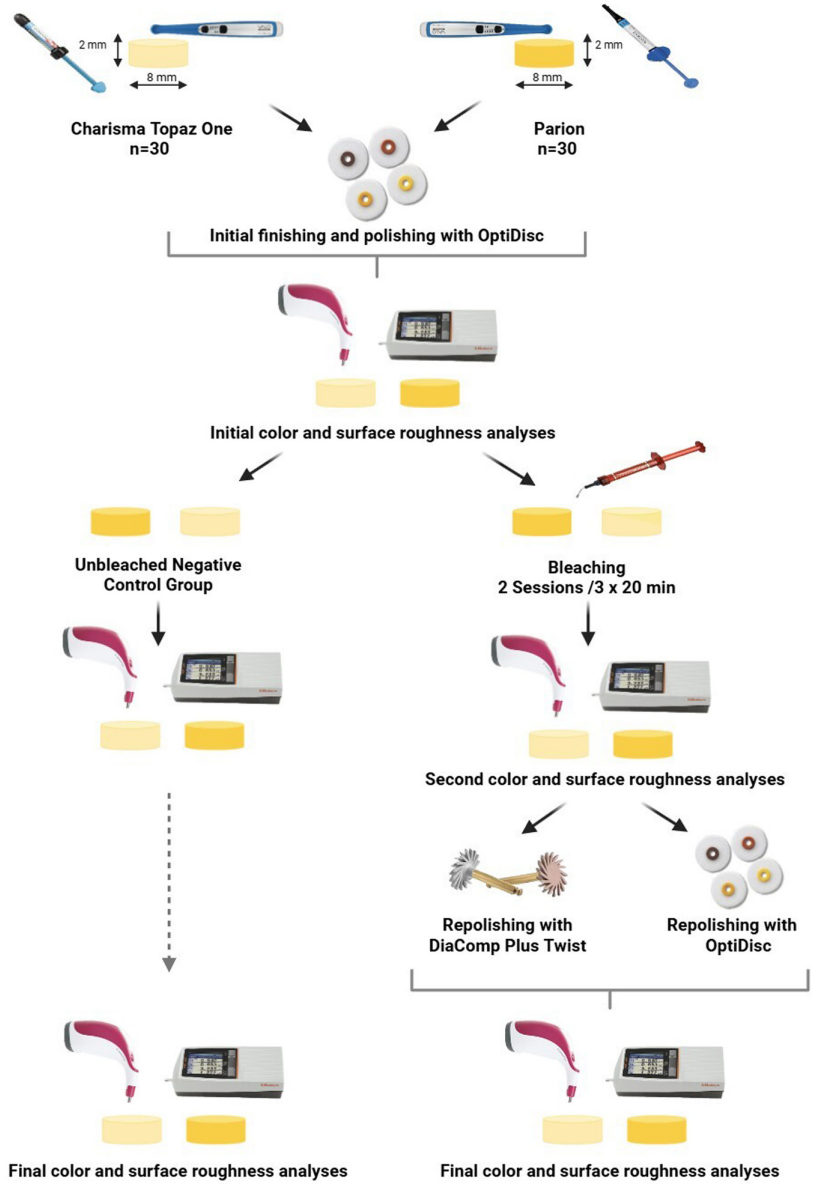


Figure 1. Flowchart of the study protocol and experimental groups.

containing 40% hydrogen peroxide (Ultradent, South Jordan, UT, USA). The agent was applied to 40 specimens, excluding the control groups, over 2 sessions, each consisting of three 20-minute applications, with a 3-day interval between the sessions. The bleaching gel was refreshed after each application. Following the bleaching process, all specimens were rinsed with distilled water and then kept in distilled water at 37± 1 °C for 24 hours.

Color Measurement

Color measurements were performed with the Easyshade V spectrophotometer (VITA Zahnfabrik, Bad Säckingen, Germany) on a neutral gray background under the D65 standard illuminant at 3 time points: 24 hours after specimen fabrication and hydration in distilled water (initial), 24 hours followingbleaching, and after repolishing.

Color evaluations were performed using the CIE Lab* system recommended by the International Commission on Illumination. The overall color variation was expressed as ΔE_{00}, which was calculated according to the CIEDE2000 formula. The $\Delta L'$, $\Delta C'$, and $\Delta H'$ differences in lightness, chroma, and hue for a pair of specimens are given, and parametric factors (K_C, K_L, and K_H), which were set at a ratio of 1:1:1, are correction terms for experimental conditions; the weighting functions (S_L, S_C, S_H) adjust the total color difference, and

the rotation term (R_T) accounts for the interaction between chroma and hue differences, particularly in the blue region. The CIEDE2000 color-difference formula is presented in Equation (1).

$$E_{00} = \sqrt[2]{\left(\frac{L'}{K_L S_L}\right)^2 + \left(\frac{C'}{K_C S_C}\right)^2 + \left(\frac{H'}{K_H S_H}\right)^2 + R_T\left(\frac{C'}{K_C S_C}\right)^2\left(\frac{H'}{K_H S_H}\right)^2} \quad (1)$$

The calculated ΔE_{00} values were interpreted according to the established perceptibility (PT; $\Delta E_{00}=0.8$) and acceptability (AT; $\Delta E_{00}=1.8$) thresholds defined by Paravina et al, where values ≤ 0.8 were classified as an excellent match, values between 0.8 and 1.8 as an acceptable match, and values exceeding 1.8 as clinically unacceptable.Mismatch type a (moderately unacceptable) corresponds to ΔE_{00} values >1.8 and ≤3.6, whereas mismatch type b (clearly unacceptable) corresponds to ΔE_{00} values >3.6 and ≤5.4.[12]

Surface Roughness Measurement

A contact profilometer (Surftest SJ-210, Mitutoyo, Kanagawa, Japan) was employed to evaluate surface roughness at the same time points as the color measurements: baseline, after bleaching, and after repolishing. The Ra parameter (average surface roughness, µm) was measured with a cutoff value of 0.8 mm, at a speed of 0.25 mm/s, and a resolution of 0.01 µm.[13] For each specimen, 3 consecutive measurements were taken in the same direction from the central area of the top surface, and the mean value was subsequently calculated. Calibration of the profilometer was performed prior to each measurement session to ensure accuracy.

Refinishing and Polishing Procedure

Repolishing was carried out using 2 different polishing systems, following bleaching and 24 hours storage in distilled water at 37± 1 °C (Table 2).

Within each group, half of the specimens were repolished using a 4-step disc system (OptiDisc, Kerr Corporation, Orange, CA USA), while the remaining specimens were treated with a 2-step diamond-impregnated silicone disc system (DiaComp Plus Twist, EVE, Keltern, Germany). Both repolishing protocols were performed according to the manufacturers' instructions and to ensure standardization, each step of the respective systems was applied for 30 seconds.

Statistical Evaluation

Data were analyzed using IBM SPSS v23 (IBM Corp., Armonk, NY, USA). For repeated measures, two-way analysis of variance (ANOVA) was conducted, and for pairwise comparisons, Bonferroni post-hoc tests were employed. Statistical significance was set at $P < .05$.

RESULTS

The mean ΔE_{00} values with their corresponding standard deviations, as well as the intergroup differences observed following the bleaching and repolishing procedures, are presented in Table 3.

For PR, evaluation of the ΔE_1 and ΔE_2 values revealed a statistically significant difference among the groups ($P < .001$). The control group exhibited values below the 0.8 perceptibility threshold, whereas the bleached groups demonstrated unacceptable alterations exceeding the 1.8 acceptability threshold. These color changes corresponded to mismatch types a (>1.8, ≤3.6) and b (>3.6, ≤5.4). The ΔE_3 values between baseline and the repolishing were within the range of 0.8 to 1.8, indicating an acceptable match. In CTO, none of the groups exhibited clinically unacceptable alterations ($\Delta E_{00} < 1.8$). PR demonstrated significantly higher ΔE_1 and ΔE_2 values than CTO ($P < .05$) (Table 4).

The mean Ra values with their respective standard deviations, along with the intergroup differences for each experimental phase, are presented in Table 5.

In PR, repolishing after bleaching resulted in a statistically significant reduction in surface roughness ($P < .05$). However, no statistically significant differences were detected with respect to the polishing system used.

In CTO, bleaching and repolishing procedures did not yield statistically significant differences in surface roughness ($P > .05$).

Although PR showed higher initial and post-bleaching surface roughness values compared with CTO ($P < .05$), no significant differences were found between the composites following repolishing (Table 4).

Table 2. Description of Polishing and Finishing Materials Used in the Present Study

Finishing and Polishing Systems	Manufacturer	Tools Description
DiaComp Plus Twist	EVE Ernst Vetter GmbH, Keltern, Germany	2-stage diamond-impregnated silicone polishing rubber Pre-polishing, medium (20-35 µm) High-shine polishing, fine (4-8 µm)
OptiDisc	Kerr Corporation, Orange, CA, USA	4-stage aluminum oxide coated polyethylene synthetic polymer disc Contouring (80 µm, Extra-Coarse) Finishing (40 µm, Coarse/Medium) Polishing (20 µm, Fine) High gloss polishing (10 µm, Extra-Fine)

Table 3. Means ± Standard Deviations of ΔE_{00} Values of Groups

	Charisma Topaz One			Parion		
Repolishing Groups	**ΔE_1**	**ΔE_2**	**ΔE_3**	**ΔE_1**	**ΔE_2**	**ΔE_3**
UB	1.604 ± 1.367	0.719 ± 0.941^{A}	1.578 ± 1.709	0.753 ± 0.405^{A}	0.197 ± 0.223^{A}	0.815 ± 0.363
BE	1.634 ± 0.527	1.746 ± 0.439^{AB}	1.025 ± 0.623	4.084 ± 1.607^{B}	4.363 ± 1.566^{B}	1.038 ± 0.212
BO	1.681 ± 0.462	1.823 ± 0.624^{B}	1.029 ± 0.587	3.430 ± 1.275^{B}	4.398 ± 1.238^{B}	1.436 ± 0.837
P	.987	**.021**	.270	**<.001**	**<.001**	.278

Different uppercase letters within the same column indicate statistically significant differences among the polishing groups. Two-way ANOVA with Bonferroni post hoc test.Bold values indicate statistically significant differences ($P < 0.05$)
ΔE_1, after bleaching- initial; ΔE_2, after repolishing- after bleaching; ΔE_3, after repolishing-initial color differences; UB, unbleached; BE, bleached and repolished with Eve; BO, bleached and repolished with OptiDisc;.

Table 4. Comparison of Charisma Topaz One and Parion Composites (*P*-values)

	ΔE_{00} p*			Ra p*		
Repolishing Groups	**ΔE_1**	**ΔE_2**	**ΔE_3**	**P0**	**P1**	**P2**
UB	0.078	0.229	0.055	0.148	0.089	**0.012**
BE	**<0.001**	**<0.001**	0.974	**0.005**	**0.002**	0.929
BO	**0.001**	**<0.001**	0.299	**0.013**	**0.007**	0.987

*Bonferroni test; Bold values indicate statistically significant differences ($P < 0.05$) ΔE_1, after bleaching- initial; ΔE_2, after repolishing- after bleaching; ΔE_3, after repolishing- initial color differences; P0, initial; P1, after bleaching; P2, after repolishing; BE, bleached and repolished with Eve; BO, bleached and repolished with OptiDisc; UB, unbleached.

Table 5. Means ± Standard Deviations of Ra Values of Groups

Repolishing Groups	Charisma Topaz One				Parion			
	P0	**P1**	**P2**	***P***	**P0**	**P1**	**P2**	***P***
UB	0.270 ± 0.073	0.25 ± 0.056	0.253 ± 0.07	.727	0.385 ± 0.248	0.378 ± 0.256	0.534 ± 0.569^{B}	.165
BE	0.273 ± 0.066	0.286 ± 0.067	0.318 ± 0.077	.791	0.504 ± 0.268^{ab}	0.531 ± 0.218^{b}	0.308 ± 0.095^{aAB}	**.021**
BO	0.236 ± 0.07	0.262 ± 0.044	0.231 ± 0.054	.536	0.436 ± 0.189^{b}	0.469 ± 0.196^{b}	0.232 ± 0.047^{aA}	**.012**
P	.187	.886	.707		.318	.119	**.020**	

P0, initial; P1: after bleaching; P2: after repolishing; BE, bleached and repolished with Eve; BO, bleached and repolished with OptiDisc; UB, Unbleached.Bold values indicate statistically significant differences ($P < 0.05$)
Different lowercase letters within the same row indicate statistically significant differences among the time points. Different uppercase letters within the same column indicate statistically significant differences among the polishing groups.

DISCUSSION

Numerous studies have investigated the impact of hydrogen peroxide (HP) on restorative materials.[14] While some have reported that bleaching agents can readily affect the resin matrix, leading to alterations in color, microhardness, and surface roughness, others have found these effects to be minimal or negligible.[15,16]

Multiple factors determine the impact of bleaching on resin composites, including the structural and compositional properties of the composite material, the bleaching agent, and the treatment procedure performed.[1]

The first null hypothesis, stating that bleaching does not affect the color stability or surface roughness of resin composites, was rejected, as bleaching significantly affected the color stability of PR, resulting in an unacceptable color match ($\Delta E_{00} > 1.8$).

In CTO, bleached groups exhibited an acceptable color match. ($\Delta E_{00} > 0.8, \leq 1.8$). Both resin composites exhibited an increase in surface roughness following bleaching; however, this change did not reach statistical significance.

The variations in color change detected in this study could be related to the differences in the chemical composition of the composites tested. Although both materials are classified as nano-hybrid resin composites, their compositional characteristics vary. CTO is a monoshade nano-hybrid resin composite developed on the principle of 'adaptive light matching,' which allows the restorative material to harmonize with the surrounding tooth structure by absorbing and reflecting ambient light wavelengths. It contains barium aluminum fluoride glass and pyrogenic silicon dioxide fillers (81 wt%, 64 vol%) incorporated into a TCD-DI-HEA, TEGDMA, and UDMA resin matrix.[17,18] On the other hand, PR is a multishade nano-hybrid resin composite incorporating silicon dioxide and quartz fillers (77-78 wt%, 66 vol%) within a UDMA, TEGDMA, Bis-EMA, and Bis-GMA resin matrix.[19] In CTO, the presence of TCD-urethaneacrylate, a low-shrinkage monomer with hydrophobic properties and high cross-linking potential, likely contributed to the improved color stability by reducing water sorption and limiting pigment penetration when compared to the more hydrophilic Bis-GMA-containing resin-based composite PR.[20] Several authors, including Karanasiou,[21] Mendes,[22] and Melo,[14] have reported that greater color change was observed after bleaching treatment in composites with a Bis-GMA-based matrix compared to

those without Bis-GMA, which is consistent with the present study. Filler particles are known to influence the performance and surface morphology of composite resins, as their type, size, and amount can affect surface properties.[23] Higher filler content may provide greater protection to the resin matrix against wear, facilitating smoother surfaces.[24] However, given that the volumetric filler content of the 2 composites is relatively similar (CTO: 64 vol% vs. PR: 66 vol%), this factor alone is unlikely to be the primary determinant of the differences in surface roughness and color stability observed in this study. The resin matrix composition appears to play a more decisive role in the present comparison.

There is limited research in the literature on the effect of immediate repolishing following bleaching. Barakah *et al.*[25] investigated the influence of different polishing procedures on the color stability of resin composites and demonstrated that polishing enhances resistance to discoloration. Similarly, Güler et al [26] reported that polishing with discs comparable to those used in the present study reduced color changes in composite materials. Rodrigues et al[1] concluded that repolishing significantly improves the color stability of composites. In line with previous studies, the ΔE_3 (repolishing–initial color difference) values of bleached composite resins, regardless of the repolishing material used, showed no statistically significant difference compared with those of the unbleached group, indicating that repolishing may help restore the color to baseline levels. In the same study by Rodrigues et al.[1] roughness analysis did not reveal any statistically significant differences between bleached–repolished and bleached–unrepolished groups. No significant difference was found between these groups for CTO, whereas a statistically significant decrease in surface roughness was observed for PR in the present study. This difference may be explained by the higher initial roughness values of PR. Consequently, the second null hypothesis (Repolishing after bleaching does not affect the color stability or surface roughness of resin composites) is rejected.

Aluminum oxide particles exhibit greater hardness compared to most resin composite fillers. This property enables them to abrade both the resin matrix and inorganic fillers, resulting in smoother surfaces without causing filler displacement.[27] Conversely, diamond particles have been shown to be harder than aluminum oxide and silicon carbide, and their use in finishing and polishing procedures often leads to comparatively rougher composite surfaces.[23] Several studies have examined the comparative effectiveness of multi-step and single-step polishing systems, with findings varying among studies, some reporting that multi-step discs produce smoother surfaces,[23,28] whereas others suggest that single- or 2-step spiral systems yield superior results.[29,30] In this context, the present study compared the aluminum oxide–impregnated OptiDisc, as a multi-step polishing system, and the diamond–impregnated 2-stage spiral polishing system, DiaComp Plus, to evaluate their effects on the repolishing of bleached resin composites.

Regarding the third null hypothesis, which stated that different repolishing systems do not affect the color stability or surface roughness of resin composites, the results supported this assumption, as no statistically significant differences were detected among the repolishing systems for either resin composite in terms of color stability or roughness. The overall significant difference observed in roughness was due to the inclusion of the control group, which did not undergo repolishing. In line with the results, Ozan and Berkman[31] reported no statistically significant differences in Ra values between 1- and multi-step systems when polishing various types of composite resins. Similarly, Altınışık and Özyurt[32] found that multi-step alumina discs and the 2-step Twist Dia system achieved comparable surface roughness levels on Charisma Diamond One.

While this study offers clinical insights regarding the surface and color alterations of nano-hybrid resin composites following office bleaching and the effects of different repolishing procedures, certain limitations should be acknowledged. The initially higher surface roughness of the PR may have contributed to its greater susceptibility to discoloration. In fact, its Ra values exceeded 0.2 µm, which is generally regarded as the clinical threshold for surface roughness.[33] Moreover, bleaching was assessed only with an in-office protocol using a single concentration of hydrogen peroxide; future studies should investigate the effects of different HP concentrations, as well as at-home bleaching protocols, to provide more comprehensive data. The investigation was restricted to the use of 1 monoshade and 1 multishade resin composite, thereby limiting the diversity of materials evaluated; assessing a wider spectrum of composite types and shades would strengthen the generalizability of the results. Additionally, incorporating aging procedures into future studies would enable the assessment of the long-term effects on both surface roughness and color stability after bleaching and repolishing. Employing the Whiteness Index for Dentistry (WID) alongside ΔE_{00} in future research may enhance the clinical relevance of color measurements, enabling a more comprehensive assessment of bleaching-induced changes and the visual perception of whitening effects.

CONCLUSION

Within the limitations of this *in vitro* study, resin composites with different chemical compositions may exhibit varying responses to bleaching procedures with respect to color stability and surface roughness. Repolishing immediately after bleaching appears to enhance both the color stability and surface smoothness of resin composites. However, the choice of repolishing system may not be a decisive factor in re-establishing these properties.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: The authors declared that no Artificial Intelligence Tool was used in the preparation of the manuscript.

Ethics Committee Approval: Ethical approval and informed consent were not required for this study, as no human participants, human data, or animal subjects were involved.

Informed Consent: Ethical approval and informed consent were not required for this study, as no human participants, human data, or animal subjects were involved.

Peer-review: Externally peer-reviewed.

Acknowledgements: The authors would like to thank Dentac (Öncü Dental) and Kulzer for their kind donation of materials for this study.

Author Contributions: Concept – P.Y.A., B.T.; Design – S.Ö., P.Y.A., B.T.; Supervision – P.Y.A., B.T.; Resources – P.Y.A., A.A.Ş.; Materials – S.Ö., Y.G., A.K.; Data Collection and/or Processing – S.Ö., N.Z.K., Y.G., A.K.; Analysis and/or Interpretation – S.Ö., N.Z.K., B.D.K.; Literature Search – S.Ö., N.Z.K., B.D.K.; Writing – S.Ö., N.Z.K., B.D.K.; Critical Review – A.A.Ş., P.Y.A., B.T.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

REFERENCES

1. Rodrigues CS, Nora BD, Mallmann A, et al. Repolishing resin composites after bleaching treatments: effects on color stability and smoothness. *Oper Dent*. 2019;44(1):54-64. [CrossRef]
2. Vidal ML, Pecho OE, Collares K, et al. Color change of resin-based composites after in vitro bleaching protocols: a systematic review and meta-analysis. *Oper Dent*. 2022;47(2):149-162. [CrossRef]
3. 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(6):1067. [CrossRef]
4. Irawan BA, Irawan SN, Masudi SM, et al. 3D surface profile and color stability of tooth colored filling materials after bleaching. *BioMed Res Int*. 2015;2015:327289. [CrossRef]
5. Pruthi G, Jain V, Kandpal HC, et al. Effect of bleaching on color change and surface topography of composite restorations. *Int J Dent*. 2010;2010:695748. [CrossRef]
6. Atali PY, Topbaşi FB. The effect of different bleaching methods on the surface roughness and hardness of resin composites. *J Dent Oral Hyg*. 2011;3(2):10-17.
7. Yu H, Li Q, Wang Y-N, et al. Effects of temperature and in-office bleaching agents on surface and subsurface properties of aesthetic restorative materials. *J Dent*. 2013;41(12):1290-1296. [CrossRef]
8. Ugurlu M. Effect of repolishing on the discoloration of indirect composite block, nanohybrid, and microhybrid resin composites. *Eur Oral Res*. 2022;56(3):158-163. [CrossRef]
9. Mierzejewska ŻA, Łukaszuk K, Choromańska M, et al. Influence of different polishing methods on surface roughness and microhardness of dental composites. *Adv Sci Technol Res J*. 2024;18(1):268-279. [CrossRef]
10. Janus J, Fauxpoint G, Arntz Y, et al. Surface roughness and morphology of three nanocomposites after two different polishing treatments by a multitechnique approach. *Dent Mater*. 2010;26(5):416-425. [CrossRef]
11. Dennis T, Zoltie T, Wood D, et al. Reduced-step composite polishing systems - a new gold standard? *J Dent*. 2021/09/01/ 2021;112:103769. [CrossRef]
12. Paravina RD, Pérez MM, Ghinea R. Acceptability and perceptibility thresholds in dentistry: A comprehensive review of clinical and research applications. *J Esthet Restor Dent*. 2019;31(2):103-112. [CrossRef]
13. Doğu Kaya B, Yılmaz Atalı P, Özmen S, et al. Effect of an effervescent multivitamin on color and surface roughness of microhybrid dental resin composites. *Materials (Basel)*. 2024;17(5):1040. [CrossRef]
14. Melo M, Dumitrache B, Ghilotti J, et al. Effect of bleaching agents on composite resins with and without bis-GMA: an in vitro study. *J Funct Biomater*. 2024;15(6):144. [CrossRef]
15. Vieira I, Ferraz LN, Vieira Junior WF, et al. Effect of at-home bleaching gels with different thickeners on the physical properties of a composite resin without bisphenol A. *J Esthet Restor Dent*. 2022;34(6):969-977. [CrossRef]
16. Yu H, Li Q, Hussain M, et al. Effects of bleaching gels on the surface microhardness of tooth-colored restorative materials in situ. *J Dent*. 2008;36(4):261-267. [CrossRef]
17. Lucena C, Ruiz-López J, Pulgar R, et al. Optical behavior of one-shaded resin-based composites. *Dent Mater*. 2021;37(5):840-848. [CrossRef]
18. Yılmaz Atalı P, Doğu Kaya B, Manav Özen A, et al. Assessment of micro-hardness, degree of conversion, and flexural strength for single-shade universal resin composites. *Polymers*. 2022;14(22):4987. [CrossRef]
19. Öztürk S, Kaya B, Şenol A, et al. Comparison of flexural strength and degree of conversion of novel resin composites used in clinical practice. *Clin Dent Res*. 2024;48(3):116-124.
20. Durner J, Obermaier J, Draenert M, et al. Correlation of the degree of conversion with the amount of elutable substances in nano-hybrid dental composites. *Dent Mater*. 2012;28(11):1146-1153. [CrossRef]
21. Karanasiou C, Dionysopoulos D, Naka O, et al. Effects of tooth bleaching protocols assisted by Er, Cr: YSGG and diode (980 nm) lasers on color change of resin-based restoratives. *J Esthet Restor Dent*. 2021;33(8):1210-1220. [CrossRef]
22. Mendes APKF, Barceleiro MdO, dos Reis RSA, et al. Changes in surface roughness and color stability of two composites caused by different bleaching agents. *Braz Dent J*. 2012;23(6):659-666. [CrossRef]
23. Kılıç V, Gök A. Effect of different polishing systems on the surface roughness of various bulk-fill and nano-filled resin-based composites: an atomic force microscopy and scanning electron microscopy study. *Microsc Res Tech*. 2021;84(9):2058-2067. [CrossRef]
24. Meniawi M, Şirinsükan N, Can E. Color stability, surface roughness, and surface morphology of universal composites. *Odontology*. 2025;114(1):149-160. [CrossRef]

25. Barakah HM, Taher NM. Effect of polishing systems on stain susceptibility and surface roughness of nanocomposite resin material. *J Prosthet Dent*. 2014;112(3):625-631. [CrossRef]
26. Güler AU, Güler E, Yücel AC, et al. Effects of polishing procedures on color stability of composite resins. *J Appl Oral Sci*. 2009;17(2):108-112. [CrossRef]
27. Kemaloglu H, Karacolak G, Turkun LS. Can reduced-step polishers be as effective as multiple-step polishers in enhancing surface smoothness? *J Esthet Restor Dent*. 2017;29(1):31-40. [CrossRef]
28. Arisu HD, Üçtaşli MB, Ömürlü H, et al. The effect of different finishing and polishing systems on the surface roughness of different composite restorative materials. *J Contemp Dent Pract*. 2008;8:89-96.
29. Alharbi G, Al Nahedh HNA, Al-Saud LM, et al. Effect of different finishing and polishing systems on surface properties of universal single shade resin-based composites. *BMC Oral Health*. 2024/02/07;24(1):197. [CrossRef]
30. Ekici MA, Egilmez F, Cekic-Nagas I, et al. Physical characteristics of ceramic/glass-polymer based CAD/CAM materials: effect of finishing and polishing techniques. *J Adv Prosthodont*. 2019;11(2):128-137. [CrossRef]
31. Ozan G, Berkman M. Surface roughness evaluation of composite materials polished with one- or multi-step systems. *Int Dent Res*. 2022;12(3):165-170. [CrossRef]
32. Altınışık H, Özyurt E. Effect of different polishing systems on surface roughness and gloss values of single-shade resin composites. *BMC Oral Health*. 2024;24(1):1391. [CrossRef]
33. 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(4):258-269. [CrossRef]