

Effects of commercially available toothpastes on the surface roughness of a universal nanohybrid composite resin: a profilometric study

 Cansu Yıkıcı Çöl^{*1},  Sema Yazıcı Akbıyık²

¹Department of Restorative Dentistry, Panorama Ankara Oral and Dental Health Clinic, Ankara, Türkiye

²Department of Restorative Dentistry, Faculty of Dentistry, Lokman Hekim University, Ankara, Türkiye

Cite this article: Yıkıcı Çöl C, Yazıcı Akbıyık S. Effects of commercially available toothpastes on the surface roughness of a universal nanohybrid composite resin: a profilometric study. *Ank Med J.* 2026;5(2):40-45. doi:10.51271/ANKMJ-0064

Received: 29/12/2025

Accepted: 21/01/2026

Published: 25/03/2026

ABSTRACT

Aims: The aim of this in vitro study was to evaluate the effects of different commercially available toothpastes on the surface roughness of a universal nanohybrid composite resin following simulated toothbrushing.

Methods: Eighty cylindrical specimens of a universal nanohybrid composite resin were prepared and randomly assigned to ten groups (n=8), including nine toothpaste groups and one control group brushed with distilled water. Surface roughness (Ra, μm) was measured before and after standardized simulated toothbrushing using a contact profilometer. Toothbrushing was performed with an electric toothbrush and toothpaste slurry prepared at a 1:1 ratio. Statistical analysis was conducted using the Wilcoxon Signed-Rank test, Kruskal–Wallis test, and Mann–Whitney U test with Holm–Bonferroni correction ($\alpha=0.05$).

Results: All groups demonstrated statistically significant changes in surface roughness after brushing ($p=0.0078$); however, the magnitude and direction of change varied among the toothpastes. Significant differences in ΔRa values were observed between certain groups ($p<0.05$). Among the tested toothpastes, the ROC group was the only group that exhibited a reduction in surface roughness following brushing.

Conclusion: Different toothpastes produced varying effects on the surface roughness of nanohybrid composite resin. Although some whitening and herbal toothpastes increased surface roughness, the changes generally remained within clinically acceptable limits. These findings highlight the importance of toothpaste selection for patients with composite resin restorations.

Keywords: Activated charcoal, dentifrice, resin composite, surface roughness, toothpaste, whitening

INTRODUCTION

Composite resin materials play a fundamental role in contemporary restorative dentistry by providing an optimal combination of esthetic appeal, functional performance, and clinical versatility.¹ However, the long-term clinical success of composite resin restorations is closely related to their ability to maintain surface smoothness.²

A smooth restorative surface is essential for achieving optimal esthetic outcomes while minimizing plaque accumulation.³ In contrast, increased surface irregularities may reduce surface gloss and promote discoloration, thereby compromising the overall esthetic appearance of the restoration.⁴ Surface roughness describes the finer irregularities present on a material's surface, which typically arise from its intrinsic properties or the manufacturing process.⁵

Daily oral hygiene procedures, particularly toothbrushing with toothpastes, represent one of the main extrinsic factors affecting the surface integrity of composite resin

materials.⁶ Toothpastes are composed of a variety of chemical and mechanical agents—including abrasive particles, surfactants, fluoride, and other therapeutic additives that have been reported to produce distinct effects on the surface characteristics of restorative materials.⁷ Among these components, abrasive particles play a central role in stain removal but may also contribute to increased surface roughness of composite restorations.⁸

The most commonly used abrasive agents in contemporary toothpastes include hydrated silica, calcium carbonate, dicalcium phosphate dihydrate, and sodium bicarbonate, each exhibiting different abrasive potentials depending on particle size, shape, and concentration. Whitening toothpastes, which have gained popularity due to increasing esthetic demands, primarily act by removing extrinsic stains through mechanical abrasion rather than chemical bleaching.⁸

*Corresponding Author: Cansu Yıkıcı Çöl, cansu.yikici@gmail.com



Several in vitro studies have reported that whitening, charcoal-based toothpastes may increase surface roughness of composite resin materials following simulated toothbrushing.⁹⁻¹¹ The abrasive nature of charcoal-containing dentifrices has raised concerns regarding their potential to increase surface roughness and compromise the integrity of composite restorations.² Systematic reviews have reported conflicting findings regarding the effects of toothpastes on the surface roughness of composite resins, highlighting the need for further standardized investigations.^{2,12}

Despite the growing number of commercially available toothpastes, limited data exist comparing their abrasive effects on modern universal nanohybrid composite resin materials under standardized brushing conditions. Therefore, the aim of this in vitro study was to evaluate the effect of different commercially available toothpastes on the surface roughness of a universal nanohybrid composite resin following simulated toothbrushing.

The null hypothesis of this study was that different commercially available toothpastes would not cause any significant change in the surface roughness of the universal nanohybrid composite resin.

METHODS

This study was conducted exclusively on in vitro materials; since no human or animal subjects were used, approval from an ethics committee is not required.

This in vitro research examined how nine different commercially available toothpastes influence the surface roughness of a universal nanohybrid composite resin material when exposed to standardized, simulated toothbrushing procedures. The surface roughness (Ra) of the samples was measured both before and after the brushing simulation using a profilometric analysis system. Their compositions and manufacturers are presented in **Table 1**.

The required sample size was determined using the G*Power software (version 3.1.9.4, Düsseldorf, Germany) with a desired power of 95% and $\alpha=0.05$, and at least eight samples were obtained for each group. A total of 80 samples were prepared for 10 study groups (n=8). Cylindrical samples (8 mm in diameter and 2 mm in thickness) were fabricated for each material using plastic molds. The materials were placed in a single layer and covered with Mylar strips and glass slides to achieve a uniform surface finish. They were cured for 20

Table 1. Composition and manufacturing details of the experimen materials

Toothpastes	Group code	Compositions	Manufacturers
Control group	C	Distilled water	-
Agarta	AGA	Sorbitol, <i>hydrated silica</i> , aqua, glycerin, <u>xylitol</u> , lauryl glucoside, cocamidopropyl betaine, zinc oxide, cocos nucifera oil, xantan gum, mentha piperita oil, menthol, eugenia caryophyllus leaf oil, citrus limon peel oil, phenylpropanol, caprylyl glycol, aloe barbadensis leaf extract, rebaudioside a, salvia officinalis oil, eucalyptus globulus leaf oil, melameuca alternifolia leaf oil.	Güneyce Chemistry, (Ankara Türkiye)
Biomed Charcoal	CHA	Aqua, hydrogenated starch hydrolysate, <i>dicalcium phosphate dihydrate</i> , <i>hydrated silica</i> , glycerin, sodium coco-sulfate, cellulose gum, aroma, calcium hydroxyapatite, zinc citrate, benzyl alcohol, <i>sodium bicarbonate</i> , tetrasodium glutamate diacetate, xanthan gum, menthol, l-lysine, <i>charcoal powder</i> , xylitol, carbon black, cymbopogon flexuosus herb oil, mentha piperita oil, cinnamomum camphora bark oil, sodium benzoate, ananas sativus fruit extract, maltodextrin, cedrus atlantica bark oil, betula alba leaf extract, plantago major leaf extract, potassium sorbate, arginine, sodium hydroxide, helianthus annuus seed oil, limonene, citral.	STS holoding, Gabrova, Bulgaria
LR Aloe.via sensitive protect tooth paste	ALO	Aloe barbadensis leaf juice, <i>calcium carbonate</i> , glycerin, sorbitol, potassium chloride, silica, <u>sodium monofluorophosphate (1440 ppm)</u> , cocamidopropyl betaine, hydroxyethylcellulose, flavor, sodium saccharin, sodium hydroxide, CI 42090 (blue 1), CI19140 (yellow 5)	LR Health & Beauty, Ahlen, Germany)
Meridol	MER	Glycerin, aqua, <i>hydrated silica</i> , hydroxyethylcellulose, olaflur*, sodium gluconate, propylene glycol, aroma, cocamidopropyl betaine, peg-3 tallow aminopropylamine, caprylyl glycol, stannous chloride, <u>1440 ppm f. sodium saccharin</u> , phenylpropanol, limonene, CI 74160.	Colgate Palomoliv, Świdnica, Poland
Opalescence	OPA	Aqua, <i>silica</i> , glycerin, sorbitol, <u>xylitol</u> , aroma (flavor), poloxamer 407, sodium lauryl sulfate, carbomer, sodium benzoate, <u>sodium flüoride (1100 Ppm)</u> , sodium hydroxide, sucralose, xantan gum, FD&C, blue no.1(CI 42090), FD&C yellow no.5(CI 19140)	Opalescence (Ultradent Products, South Jordan USA)
Oral-B pro-3D white clinical	ORA	Sorbitol, <i>hydrated silica</i> , sodium hexametaphosphate, disodium pyrophosphate, sodium lauryl sulfate, carrageenan, aroma, sodium monofluorophosphate (1450 ppm), xanthan gum, sodium saccharin, cocamidopropyl betaine, phosphoric acid, sodium chloride, sucralose, cinnamal, benzyl alcohol, eugenol, sodium hydroxide, sodium benzoate, CI 74160, CI 74260, citric acid, sodium citrate, potassium sorbate	GmbH, Procter &Gamble, Germany
R.O.C.S Uno	ROC	Aqua, <i>silica</i> , glycerin, <u>xylitol (%2,2)</u> , xanthan gum, aroma (flavor), sodium glycerophosphate, magnesium chloride, calcium glycerophosphate, sodium lauryl sulfate (SLS), sodium saccharin, sodium silicate, methylparaben, propylparaben and limonene.	R.O.C.S. Laboratories AG (Switzerland)
Sensodyne Nourish	NOU	Aqua, sorbitol, <i>hydrated silica</i> , glycerin, potassium nitrate, sodium lauryl sulfate (SLS), flavour (natural mint and citrus oils), xanthan gum, cocamidopropyl betaine, <u>sodium flüoride (\approx 1450 ppm)</u> , sodium saccharin, <i>titanium dioxide</i> , limonene and benzyl alcohol	Haleon (Weybridge, United Kingdom)
Sensodyne Pronamel	PRO	Aqua, sorbitol, <i>hydrated silica</i> , glycerin, potassium nitrate, PEG-6, cocamidopropyl betaine, sodium lactate, glaxosmithkline aroma, xanthan gum, <u>sodium flüoride (1450ppm)</u> , sodium saccharin, <i>titanium dioxide</i> , <u>PVM/MA copolymer</u> , sodium hydroxide, limonene.	Haleon (Weybridge, United Kingdom)
Universal, nano-hybrid composite		<i>Barium aluminum borosilicate glass</i> , <i>silicon dioxide</i> , HEDMA, BisGMA, TCDDMA, <i>Fumed silica</i> , TEGDMA, BisEMA, initiator, stabilizer, pigment	Grandio SO (VOCO, Cuxhaven, Germany)

Abrasive components are indicated in *italics*, whereas remineralizing or auxiliary ingredients are underlined in the toothpaste group

seconds with an LED curing device (Woodpecker, Guilin Woodpecker Medical Instrument Co., China) operating at approximately 1200 mW/cm².

To ensure surface standardization, the specimens were sequentially polished with silicon carbide abrasive papers of 600, 800, and 1200 grit under continuous water cooling. Following polishing, the samples were ultrasonically cleaned for 10 minutes to eliminate surface residues and subsequently stored in distilled water at 37°C for 24 hours before surface roughness evaluation. All samples were randomly distributed into 10 groups. Group codes are shown in [Table 1](#).

Each specimen was brushed for a total duration of 4 minutes, simulating approximately one month of clinical toothbrushing, in accordance with the protocol described by Gömleksiz and Okumuş,¹³ using an electric toothbrush (Oral-B iO, Braun, Germany) equipped with medium-hardness bristles. The toothpaste slurry was prepared at a 1:1 toothpaste-water ratio, as this proportion has been widely adopted in previous in vitro toothbrushing studies^{14,15} to simulate the dilution of toothpaste by saliva during clinical brushing conditions. For the control group, brushing was performed using distilled water alone for the same brushing duration. Following the brushing procedure, all specimens were rinsed under running tap water and subsequently stored at 37°C for 24 hours prior to the final surface roughness measurements.

Surface roughness (Ra, µm) was evaluated both before and after the brushing procedure using a contact profilometer⁹ (Perthometer; Mahr GmbH, Ingolstadt, Germany). For each specimen, measurements were taken at three separate locations, and the average Ra value was calculated and used for statistical analysis. The difference between pre and post-brushing Ra values was determined to assess changes in surface roughness.

Statistical Analysis

The data analyses were performed using IBM SPSS Statistics software (version 26, IBM Corp., Armonk, NY, USA). Descriptive data were summarized as before, after, and delta median [interquartile range, (IQR)] values. The Shapiro-Wilk test was used to evaluate the normality of the data distribution. As the assumptions of normality were not met ($p < 0.05$), non-parametric statistical methods were applied. Within-group comparisons between before and after brushing measurements were conducted using the Wilcoxon Signed-Rank test. Intergroup comparisons were performed using the Kruskal-Wallis H test, and when significant differences were observed, post hoc pairwise comparisons were performed using the Mann-Whitney U test with Holm-Bonferroni correction. A significance level of $p < 0.05$ was adopted for all statistical evaluations.

RESULTS

All analyses were performed on the original assigned groups, with 8 specimens included in each group. [Table 2](#) presents descriptive statistics including the before, after brushing median surface roughness (Ra, µm (IQR)) and Δ Final-Initial [IQR], values of the test groups. Within-group comparisons revealed statistically significant differences between pre- and post-brushing surface roughness values for all groups according to the Wilcoxon signed-rank test ($p = 0.0078$)

([Table 2](#)). However, the magnitude and direction of surface roughness changes varied among the groups, as reflected by the Δ Ra values.

Table 2. Descriptive statistics of the study

	Initial (median (IQR))	After (median (IQR))	Δ Final-initial (IQR)	P
C	0.26 (0.013)	0.23 (0.054)	-0.019(0.050)	0.0078
AGA	0.24 (0.019)	0.28 (0.026)	0.050(0.031)	
CHA	0.23 (0.025)	0.29 (0.029)	0.058 (0.035)	
ALO	0.24 (0.017)	0.28 (0.026)	0.046 (0.028)	
MER	0.24 (0.023)	0.29 (0.032)	0.052 (0.034)	
OPA	0.24 (0.023)	0.29 (0.028)	0.045 (0.028)	
ORA	0.24 (0.022)	0.29 (0.030)	0.050 (0.029)	
ROC	0.24 (0.019)	0.22 (0.008)	-0.014 (0.017)	
NOU	0.23 (0.021)	0.28 (0.026)	0.010 (0.026)	
PRO	0.23 (0.020)	0.28 (0.025)	0.050 (0.025)	

C: Control, AGA: Agarta, CHA: Biomed Charcoal, ALO: LR Aloe.Via sensitive protect tooth paste, MER: Meridol, OPA: Opalescence, ORA: Oral-B pro-3D white clinical, ROC: R.O.C.S Uno, NOU: Sensodyne Nourish, PRO: Sensodyne Pronamel

The Kruskal-Wallis test revealed a statistically significant difference among the groups in terms of Δ Ra values ($H = 78.22$, $p < 0.001$, $df = 9$). Post hoc pairwise comparisons performed using the Mann-Whitney U test with Holm-Bonferroni correction demonstrated that statistically significant differences in Δ Ra values were observed in a limited number of group comparisons ($p < 0.05$) ([Table 3](#)). The ROC group differed significantly from several toothpaste groups, including AGA, ALO, MER, OPA, ORA, and PRO.

In addition, significant differences were detected between the control group and some toothpaste groups, such as ALO, MER, OPA, ORA, and PRO. Significant differences were observed between the PRO group and the AGA, ALO, MER, and NOU groups. Conversely, the majority of comparisons among conventional toothpaste groups did not reach statistical significance after Holm-Bonferroni correction ($p > 0.05$), suggesting similar effects on surface roughness change among these products ([Table 3](#)).

DISCUSSION

The null hypothesis of the present study, which stated that different commercially available toothpastes would not affect the surface roughness of a universal nanohybrid composite resin, was rejected. The results demonstrated statistically significant differences in surface roughness changes among the toothpaste groups, as revealed by the Kruskal-Wallis test ($H = 78.22$, $p < 0.001$). These findings indicate that the type of toothpaste used can significantly influence the surface characteristics of composite resin restorations.

The Ra value is the main parameter to describe the surface roughness of a flattened surface. Surface roughness is clinically significant because roughened surfaces promote bacterial adhesion, staining, and reduced gloss, affecting both esthetics and restoration longevity. A threshold of approximately 0.2 µm has been identified as critical for plaque retention, meaning even small increases in surface irregularity can contribute to biofilm accumulation and degradation of restorative margins. This threshold is well-documented, as “an average roughness greater than 0.2

Table 3. Pairwise comparisons using the Mann–Whitney U test with Holm–Bonferroni correction

Comparison	Holm-adjusted p-value	Comparison	Holm-adjusted p-value	Comparison	Holm-adjusted p-value
C & AGA	0.076768	AGA & NOU	0.310023	MER & OPA	1.000000
C & CHA	0.798135	AGA & PRO	0.006993	MER & ORA	0.506294
C & ALO	0.031546	CHA & ALO	1.000000	MER & ROC	0.006993
C & MER	0.018648	CHA & MER	0.909402	MER & NOU	0.052214
C & OPA	0.011189	CHA & OPA	0.413364	MER & PRO	0.011189
C & ORA	0.011189	CHA & ORA	0.413364	OPA & ORA	1.000000
C & ROC	1.000000	CHA & ROC	0.909402	OPA & ROC	0.006993
C & NOU	1.000000	CHA & NOU	1.000000	OPA & NOU	0.011189
C & PRO	0.006993	CHA & PRO	0.076768	OPA & PRO	0.644600
AGA & CHA	1.000000	ALO & MER	1.000000	ORA & ROC	0.006993
AGA & ALO	1.000000	ALO & OPA	0.798135	ORA & NOU	0.011189
AGA & MER	0.909402	ALO & ORA	0.153846	ORA & PRO	1.000000
AGA & OPA	0.076768	ALO & ROC	0.006993	ROC & NOU	1.000000
AGA & ORA	0.107226	ALO & NOU	0.052214	ROC & PRO	0.006993
AGA & ROC	0.006993	ALO & PRO	0.011189	NOU & PRO	0.006993

Statistically significant (p<0.05) comparisons are indicated in bold. C: Control, AGA: Agarta, CHA: Biomed Charcoal, ALO: LR Aloe.Via sensitive protect tooth paste, MER: Meridol, OPA: Opalescence, ORA: Oral-B pro-3D white clinical, ROC: R.O.C.S Uno, NOU: Sensodyne Nourish, PRO: Sensodyne Pronamel

μm is associated with a substantial increase in bacterial retention".^{16,17} In the present study, although statistically significant changes in surface roughness were observed, all ΔRa values remained below the 0.2 μm plaque-retention threshold, indicating that the observed changes may have limited clinical relevance in terms of plaque accumulation.

The nanohybrid composite used in the study contains a resin matrix in which BisGMA-based formulations are characterized by high viscosity due to strong hydrogen bonding, leading to reduced polymerization shrinkage and improved wear resistance and mechanical strength; however, this high viscosity often necessitates the incorporation of diluent monomers. BisEMA, with its ethoxylated structure and lower viscosity compared with BisGMA, improves handling and flow while maintaining acceptable mechanical durability, though its lower hydrogen bonding may slightly compromise wear resistance when used alone. TEGDMA, a low-molecular-weight diluent monomer, significantly reduces viscosity and enhances degree of conversion, but its flexible structure increases polymer network mobility, which has been associated with higher wear rates and reduced long-term mechanical stability, especially under cyclic loading. In contrast, TCDDMA and HEDMA are more rigid aliphatic dimethacrylates that increase cross-link density, leading to improved hardness, wear resistance, and resistance to mechanical degradation, while maintaining lower viscosity than BisGMA-dominant systems. Overall, the balance between these monomers strongly influences clinical performance: formulations richer in BisGMA, TCDDMA, or HEDMA tend to show superior wear resistance and durability, whereas increased TEGDMA or BisEMA content enhances handling and viscosity at the expense of long-term mechanical stability, underscoring the importance of optimized monomer combinations rather than reliance on a single resin component.¹⁸

Many studies have evaluated how whitening toothpastes influence the surface roughness of restorative materials. Roopa et al.¹⁹ as well as Dayı and Öcal,²⁰ reported that

whitening toothpastes resulted in a statistically significant increase in the surface roughness of composite materials. Yılmaz et al.²¹ concluded that the observed whitening effect is mainly attributable to the brushing process itself rather than the specific composition of the toothpaste. In line with this finding, da Rosa et al.²² showed that the use of whitening toothpastes did not cause a significant increase in the surface roughness of nanohybrid composite resin after a one-month simulated brushing period. Manis et al.²³ observed a decrease in Ra values in simulated toothbrushing using nanohybrid composite resin, regardless of the toothpaste used.

The results showed that among the groups marketed as whitening toothpastes (CHA, OPA, ORA, ROC, and NOU), only the OPA and ORA groups exhibited statistically significantly higher surface roughness values compared with the control group. The ROC group was the only group, apart from the control group, that demonstrated lower median surface roughness values after brushing than before brushing. The ROC group also showed the most pronounced difference among the AGA, ALO, MER, OPA, ORA, and PRO groups, presenting a distinct surface roughness pattern with statistically significantly lower values. The findings of this study indicate that whitening toothpastes did not produce a consistent surface roughness pattern on nanohybrid composite resins, although variations in surface roughness among the groups were observed depending on the toothpaste used.

Polan and Gürkan¹¹ (2-week brushing period), Koç Vural et al.²⁴ (12-week brushing period) investigated the effects of activated charcoal-containing whitening toothpastes on the surface roughness of composite resins and showed that it caused a statistically significant increase in surface roughness, similar to the findings of the present study (CHA ΔRa 0.058, $p=0.0078$). In contrast, no significant change in surface roughness was observed in the control group brushed only with distilled water. The study also showed that the increase in surface roughness was not solely attributable to the presence of activated charcoal but was also influenced by

other abrasive components in the toothpaste formulations, such as hydrated silica, silica, mica, as well as particle characteristics including size, shape, and hardness. In the present study, no statistically significant differences were observed among any of the toothpaste groups, including the activated charcoal-containing toothpaste and the control group.

Herbal and non-herbal toothpastes demonstrated an increase in enamel surface roughness within clinically acceptable limits.²⁵ Following six months of simulated toothbrushing, two different herbal toothpastes produced a statistically significant increase in surface roughness on nanofilled composite surfaces. This finding has been attributed to the detachment of filler particles from the composite matrix during the abrasion process. The results of the study indicate that herbal toothpastes may adversely affect the surface texture of restorative materials and that their long-term use may lead to increased plaque accumulation and aesthetic deterioration as a consequence of elevated surface roughness.²⁶ In the present study, the groups classified under the herbal toothpaste category, AGA and ALO, exhibited significantly higher post-brushing surface roughness values compared with their baseline measurements (AGA $\Delta Ra=0.050$, $p=0.0078 <0.05$; ALO $\Delta Ra=0.046$, $p=0.0078 <0.05$). Intergroup comparisons revealed statistically significant differences only between the ROC and PRO groups ($p<0.05$).

Limitations

This study has several limitations that should be considered when interpreting the results. First, the investigation was conducted under in vitro conditions, which may not fully replicate the complex oral environment, where factors such as saliva composition, temperature fluctuations, pH changes, dietary habits, and masticatory forces can influence the wear behavior of restorative materials. Second, artificial aging procedures, such as thermocycling or long-term water storage, were not applied prior to or during the brushing simulation; therefore, the potential effects of material aging on surface roughness could not be assessed. Additionally, only one universal nanohybrid composite resin with a specific resin matrix composition was evaluated, which limits the generalizability of the findings to other composite types with different filler sizes, filler loadings, or resin formulations. Furthermore, the RDA values of the tested toothpastes could not be considered, as these data are not consistently disclosed by manufacturers, limiting direct correlation between surface roughness changes and standardized abrasivity indices. Finally, the brushing protocol was standardized using a single electric toothbrush type and a fixed brushing duration, which may not fully represent the variability in brushing techniques, forces, and durations observed in daily clinical practice.

CONCLUSION

Future studies should incorporate artificial aging protocols, such as thermocycling and prolonged water storage, to better simulate long-term clinical conditions and evaluate their combined effects of toothbrushing on composite resin surface roughness. The use of composite resins with different resin matrices, filler morphologies, and filler loadings—including

microhybrid, nanofilled, bulk-fill, and flowable composites—would provide a broader understanding of material-dependent surface changes. Moreover, extending the brushing duration to simulate longer periods of clinical use may help clarify cumulative abrasive effects over time. Comparative evaluations using both electric and manual toothbrushes, as well as varying brushing forces and techniques, would further enhance the clinical relevance of future investigations. In addition, in vivo or long-term clinical studies are warranted to confirm the in vitro findings and to assess the impact of toothpaste-induced surface roughness changes on plaque accumulation, discoloration, and restoration longevity.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study was conducted exclusively on in vitro materials; since no human or animal subjects were used, approval from an ethics committee is not required.

Informed Consent

This study was conducted exclusively on in vitro materials; since no human or animal subjects were used, informed consent is not required.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: CYÇ; Design: CYÇ; Control: CYÇ, SYA; Resources: CYÇ, SYA; Materials: CYÇ, SYA; Data Collection and/or Processing: CYÇ, SYA; Analysis and/or Interpretation: CYÇ, SYA; Literature Review: CYÇ, SYA; Writing the Article: CYÇ, SYA; Critical Review: CYÇ, SYA.

REFERENCES

1. Raghu R, Srinivasan R. Optimizing tooth form with direct posterior composite restorations. *J Conserv Dent*. 2011;14(4):330-336. doi:10.4103/0972-0707.87192
2. Wiktorski CA, Michelogiannakis D, Rossouw PE, Javed F. The effect of charcoal-based dentifrice and conventional whitening toothpaste on the color stability and surface roughness of composite resin: a systematic review of in vitro studies. *Dent J*. 2024;12(3):58. doi:10.3390/dj12030058
3. Hotta M, Hirukawa H, Aono M. The effect of glaze on restorative glass-ionomer cements. *J Oral Rehabil*. 1995;22(3):197-201. doi:10.1111/j.1365-2842.1995.tb01564.x
4. Sakaguchi R, Douglas WH, DeLong R, Pintado M. The wear of a posterior composite in an artificial mouth: a clinical correlation. *Dent Mater*. 1986;2(6):235-240. doi:10.1016/s0109-5641(86)80034-3
5. Paravina RD, Powers JM. *Eesthetic color training in dentistry*. St. Louis, MO: Elsevier Mosby; 2004.
6. Roselino LdMR, Chinelatti MA, Alandia-Román CC, Pires-de-Souza FdCP. Effect of brushing time and dentifrice abrasiveness on color change and surface roughness of resin composites. *Braz Dent J*. 2015; 26(5):507-513. doi:10.1590/0103-6440201300399

7. Carvalho LF, Alves LMM, Bergamo ET, et al. Influence of abrasive dentifrices on polymeric reconstructive material properties after simulated toothbrushing. *Biomater Investig Dent*. 2023;10(1):2268670. doi:10.1080/26415275.2023.2268670
8. Joiner A. Whitening toothpastes: a review of the literature. *J Dent*. 2010; 38(Suppl 2):e17-e24. doi:10.1016/j.jdent.2010.05.017
9. Ferreira NMR, Lippert VF, Heck ABdS, et al. Surface roughness of composite resins subjected to brushing with whitening toothpastes: an in vitro study. *Braz Oral Res*. 2025;39:e006. doi:10.1590/1807-3107bor-2025.vol39.006
10. Uppal M, Ganesh A, Balagopal S, Kaur G. Profilometric analysis of two composite resins' surface repolished after tooth brush abrasion with three polishing systems. *J Conserv Dent*. 2013;16(4):309-313. doi:10.4103/0972-0707.114356
11. Polan MN, Gurgan S. Effects of different charcoal-containing whitening toothpastes on color and surface roughness of a supra-nanofilled composite resin. *BMC Oral Health*. 2025;25(1):1083. doi:10.1186/s12903-025-06401-8
12. Jamwal N, Rao A, Shenoy R, Pai M, Ks A, Br A. Effect of whitening toothpaste on surface roughness and microhardness of human teeth: a systematic review and meta-analysis. *F1000Res*. 2022;11:22. doi:10.12688/f1000research.76180.3
13. Gömleksiz S, Okumuş ÖF. The effect of whitening toothpastes on the color stability and surface roughness of stained resin composite. *BMC Oral Health*. 2024;24(1):860. doi:10.1186/s12903-024-04654-3
14. Aydın N, Karaoglanoglu S, Oktay EA. Investigation the effects of whitening toothpastes on color change of resin-based CAD/CAM blocks. *J Esthet Restor Dent*. 2021;33(6):884-890. doi:10.1111/jerd.12627
15. Enax J, Fandrich P, Schulze zur Wiesche E, Amaechi BT. The whitening efficacy of a hydroxyapatite toothpaste and a blue covarine toothpaste: a comparative in vitro study. *Dent J (Basel)*. 2025;13(4):143. doi:10.3390/dj13040143
16. 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. doi:10.1016/s0109-5641(97)80038-3
17. Zhang K, Zhang N, Weir MD, Reynolds MA, Bai Y, Xu HH. Bioactive dental composites and bonding agents having remineralizing and antibacterial characteristics. *Dent Clin North Am*. 2017;61(4):669-687. doi:10.1016/j.cden.2017.05.002
18. Dantagnan C-A, Babajko S, Nassif A, et al. Analysis of resin-based dental materials' composition depending on their clinical applications. *Polymers*. 2024;16(8):1022. doi:10.3390/polym16081022
19. Roopa K, Basappa N, Prabhakar A, Raju O, Lamba G. Effect of whitening dentifrice on micro hardness, colour stability and surface roughness of aesthetic restorative materials. *J Clin Diagn Res*. 2016;10(3):ZC06-ZC11. doi:10.7860/JCDR/2016/15700.7350
20. Dayi B, Ocal F. The effect of whitening toothpastes on colour change and surface roughness of restorative materials. *Odovtos Int J Dent Sci*. 2023;25(2):40-52. doi:10.15517/ijds.2022.52728
21. Yılmaz MN, Gul P, Unal M, Turgut G. Effects of whitening toothpastes on the esthetic properties and surface roughness of a composite resin. *J Oral Sci*. 2021;63(4):320-325. doi:10.2334/josnusd.21-0044
22. da Rosa GM, da Silva LM, de Menezes M, do Vale HF, Regalado DF, Pontes DG. Effect of whitening dentifrices on the surface roughness of a nanohybrid composite resin. *Eur J Dent*. 2016;10(02):170-175. doi:10.4103/1305-7456.178305
23. Manis RB, Da Silva TM, Franco TT, Dantas DCB, Franco LT, Huhtala MFRL. Influence of whitening toothpaste on color, roughness, and microhardness of composite resins. *Eur J Gen Dent*. 2017;6(2):92-98. doi:10.4103/ejgd.ejgd_53_17
24. Koc Vural U, Bagdatli Z, Yılmaz AE, Yalçın Çakır F, Altundaşar E, Gurgan S. Effects of charcoal-based whitening toothpastes on human enamel in terms of color, surface roughness, and microhardness: an in vitro study. *Clin Oral Investig*. 2021;25(10):5977-5985. doi:10.1007/s00784-021-03903-x
25. Kaur R, Dodamani A, Patil S, et al. Comparative analysis of enamel surface roughness between herbal and non-herbal dentifrices: an in vitro study. *Cureus*. 2025;17(3):e80436. doi:10.7759/cureus.80436
26. Hazra Y, Rao A, Natarajan S, Srikrishna SB. Effect of herbal toothpaste on the colour stability, surface roughness, and microhardness of aesthetic restorative materials—an in vitro study. *BDJ Open*. 2024;10(1): 95. doi:10.1038/s41405-024-00280-x