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Research Article

Effect of Commonly Used Whitening Toothpastes and Bleaching Agents on the Microhardness of Composite Resins

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Abstract

Background: The popularity of whitening toothpastes and bleaching agents has increased with rising esthetic demands. Although effective for tooth whitening, these agents may adversely influence the surface properties of restorative materials such as composite resins. Microhardness is a key factor that determines resistance to wear and long-term performance of restorations.

Aim: To assess the effect of commonly used whitening toothpastes and bleaching agents on the microhardness of composite resins in a clinical cross-sectional setting.

Materials and Methods: This cross-sectional study was conducted over six months.. A total of 100 patients (aged 18–40 years) with existing composite resin restorations were selected using a stratified random sampling technique. Data on the type of whitening toothpaste, exposure time, and bleaching agent usage were collected using a structured questionnaire and clinical examination form. Composite resin restorations from enrolled patients were evaluated using a Vickers microhardness tester under standardized conditions. Collected data were analyzed using SPSS version 26, with ANOVA and chi-square tests applied to determine associations.

Results: Patients using whitening toothpastes exhibited a mild but significant reduction in the microhardness of composite restorations compared with those using non-whitening toothpastes. Among whitening agents, abrasive-containing formulations showed greater reduction. In patients who claimed regular bleaching agent containing high concentration hydrogen peroxide, microhardness showed decreased.. Statistically significant ($p < 0.05$) were the discrepancies across the groups. **Conclusion**: Both whitening toothpastes and bleaching solutions reduce the microhardness of composite resin restorations; bleaching agents show a greater detrimental effect.Dental professionals should provide thorough guidance to patients with composite restorations who employ these whitening solutions so that they can keep the endurance of their restorations.

Keywords: Composite Resins, Whitening Toothpastes, Bleaching Agents, Microhardness, Crosssectional Study, Restorative Dentistry.

INTRODUCTION

One of the most sought-after cosmetic dentistry treatments, tooth whitening is becoming increasingly popular in both homeuse and inoffice products. Whitening toothpastes and bleaching agents usually hydrogen peroxide (H_2O_2) and carbamide peroxide (CP) offer easy and effective solutions to enhance dental appearance. These chemicals, meanwhile, might have negative consequences on restorative materials like composite resins, frequently employed for their adhesive properties and aesthetic appeal. Composite restorations are particularly vulnerable to loss of surface properties such microhardness, which is crucial for wear resistance and long-lasting restoration effectiveness. Understanding these interactions helps practitioners to properly advise whitening patients with composite restorations (Mohammadi, 2020; Popescu, 2023).

Comprising organic polymer matrix, silane coupling agent, and inorganic filler, composite resins. Microhardness and surface integrity determine their resilience; both of these can be harmed by environmental chemical contact (Popescu, 2023).

One crucial in vitro investigation revealed that prolonged use of bleaching chemicals (athome CP and inoffice H_2O_2, for instance) greatly decreased composite microhardness. Notably, longer curing times mitigated this damage, and in-office treatments showed greater adverse effects (Mohammadi,2020).

Another investigation reported that bleaching protocols significantly increased surface roughness and decreased microhardness across microhybrid and nanohybrid composites, suggesting that decreased hardness may lead to increased wear (MDPI, 2022) . High-concentration CP or HP further demonstrated a dose-dependent decrease in hardness (e.g., CP at 15% vs. 45%) in giomer materials (kimyai, 2017).

Dental materials also exhibit variable susceptibility; hybrid composites generally show greater hardness than nanofilled ones, yet bleaching agents may still adversely affect specific brands or filler compositions (Hatanaka, 2013).

Clinical timing is also significant: many clinicians suggest waiting at least two weeks post-bleaching before placing or restoring composite to avoid the oxygen-inhibition layer, which prevents proper polymerization (Reddit, 2024).

Although numerous in vitro studies have demonstrated that bleaching agents and whitening toothpastes can reduce composite microhardness and increase surface roughness (e.g., high-concentration CP or H_2O_2 decreased hardness; longer curing times mitigated effects; higher-concentration bleaching caused more significant softening), real-world clinical evidence remains limited (kimyai, 2017). There is a lack of cross-sectional clinical studies assessing how patients' actual use of these whitening products affects composite microhardness in vivo. This gap hinders the formulation of evidence-based recommendations regarding whitening practices for patients with existing composite restorations.

Objectives

1. To assess the clinical effect of commonly used whitening toothpastes on the microhardness of composite resin restorations in patients aged 18–40.
2. To evaluate the influence of bleaching agents (home versus in-office) on the microhardness of these restorations.
3. To investigate any combined impact of whitening toothpaste use and bleaching agent exposure on composite microhardness.
4. To provide evidence-based clinical guidance on safe whitening practices in the presence of composite restorations.

Hypotheses

H_1: Whitening toothpastes, especially those with higher abrasivity, significantly reduce microhardness of composite restorations compared to non-whitening toothpaste.

H_2: High-concentration bleaching agents (e.g., in-office H_2O_2) cause a greater reduction in composite microhardness than low-concentration (home-use) agents.

H_3: Concurrent use of whitening toothpastes and bleaching agents produces an additive or synergistic negative impact on composite microhardness.

Research Questions

1. Does clinical use of whitening toothpastes alter the microhardness of composite restorations?
2. How do concentration and regime (home vs. in-office) of bleaching agents affect composite microhardness?
3. Is the combined use of whitening toothpaste and bleaching agents associated with greater microhardness reduction than either practice alone?

LITERATURE REVIEW

Recent experimental studies show dose–response behavior: 35–40% HP (in-office) typically causes greater microhardness loss than 10–16% CP (home). A 2023–2025 stream reports that 15% and 35% CP both decrease hardness (more so at higher levels) and that 35–40% HP produces the greatest reduction among tested protocols. Time under exposure and surface finish (polished vs unpolished) further modulate outcomes; unpolished surfaces are more vulnerable, and longer contact times accentuate softening (Alamoush, 2025).

Not all composites respond equally. Differences in filler load/type, matrix chemistry (e.g., Bis-GMA content), and flowability influence resilience to bleaching and staining. Recent evaluations show brand-specific variability: some "next-generation" or hybrid materials retain hardness better, while others exhibit pronounced degradation after bleaching challenges. These between-material differences are large enough to affect clinical recommendations (Ahmed,2025).

Through abrasive systems (RDA, particle size/shape) and additives (e.g., activated charcoal, blue covarine), whitening toothpastes mostly impact restorations. Newer data show that particle morphology in particular drive surface roughening beyond RDA's abrasive parameters; rougher surfaces might promote staining and biofilm retention. Some compositions (charcoal, blue covarine) are linked to increases in roughness on composites as well as to declines in microhardness (Farreira, 2025 ; Colak, 2023). Studies indicate additive negative effects on surface features when whitening toothpastes are used in conjunction with athome CP, even when the toothpaste on its own has minimal effect. This study reveals the total oxidative (chemical) and mechanical (abrasive) stressors on the resin matrix (Barbosa, 2023). Beyond hardness, a number of 2023–2025 studies discovered rising surface roughness following bleach or discoloration bleach cycles; roughness variations are material dependent and might increase plaque/biofilm accumulation and Staining sensitivity that might impact restorative lifespans. Some inoffice 35% HP procedures decrease hardness without always raising roughness, therefore highlighting how results vary on material and protocol information (Aksoy, 2025). Recent research investigates laser-assisted bleaching, notes protocol-specific variations in hardness/roughness results across flowable composites, and emphasizes the significance of protocol tweaking. Clinically, repolishing after bleaching can help to reduce surface changes; formulations with enhanced wear resistance and so on also do. Still, modern research supports restraint when patients with many composites are scheduled for frequent/high-concentration bleaching (Mierzejewska, 2025).

METHODOLOGY

Study Design and Setting

This study was designed as a cross-sectional investigation conducted over six months in the Department of Restorative Dentistry. The aim was to assess the effect of commonly used whitening toothpastes and bleaching agents on the surface microhardness of composite resin restorations. Clinical assessments were performed in the restorative dentistry clinics, while laboratory testing of microhardness was conducted in the biomaterials research laboratory under standardized protocols. Informed consent was taken from all participants.

Sample Size and Sampling Technique

A total of 100 patients aged 18–40 years were included. Stratified random sampling was adopted to ensure balanced representation across gender and age groups, enhancing the reliability of comparisons between study variables.

Inclusion Criteria

The inclusion criteria comprised patients between 18 and 40 years with at least one intact composite resin restoration that had been in place for 6 to 24 months. Only restorations with smooth surfaces and no secondary caries, fractures, discoloration, or marginal defects were considered eligible. Patients who regularly used whitening or non-whitening toothpaste for at least six months and who reported consistent oral hygiene practices were included. Additionally, only systemically healthy individuals with no conditions affecting dental hard tissues were selected, and all participants were required to provide informed consent and willingness to disclose their oral hygiene practices honestly.

Exclusion Criteria

Patients were excluded if their restorations were fractured, dislodged, heavily worn, or placed within the last six months (due to incomplete polymerization) or more than two years ago (to minimize natural wear bias). Individuals with parafunctional habits such as bruxism and clenching, or those undergoing orthodontic treatment, were excluded to avoid confounding effects on microhardness. Patients with poor oral hygiene, rampant caries, or periodontal disease were also excluded. In addition, individuals who had undergone whitening procedures beyond toothpaste and bleaching agents, such as whitening strips or laser-assisted bleaching, were not included. Pregnant or lactating women were excluded for ethical considerations, and those unwilling to provide consent or comply with study protocols were not enrolled.

Data Collection Tools

Two instruments were employed for data collection: a structured questionnaire and a clinical examination form. The questionnaire recorded demographic details such as age, gender, and socioeconomic status, along with oral hygiene practices including toothpaste type, frequency, exposure time, and bleaching agent usage. The clinical form was used to record restoration type, location, and condition, with examinations conducted by calibrated dental practitioners to ensure reliability.

Grouping of Participants and Exposure Assessment

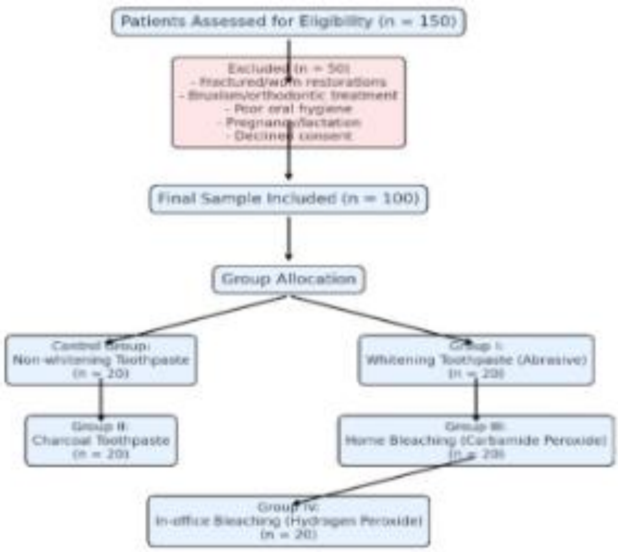
Participants were categorized into five groups: a control group of non-whitening fluoride toothpaste users, Group I comprising patients using whitening toothpastes containing abrasive silica, Group II including charcoal-based whitening toothpaste users, Group III consisting of patients using home bleaching products with carbamide peroxide (10–16%), and Group IV consisting of patients undergoing in-office bleaching with hydrogen peroxide (35–40%). Exposure time and frequency of use (once daily, twice daily, or more) were recorded to assess the intensity of exposure to whitening agents.

Microhardness Testing

The microhardness of composite restorations was assessed using a Vickers microhardness tester (Model XYZ). Each restoration was subjected to three indentations using a 200 g load applied for 15 seconds, and the mean of the three readings was recorded as the final microhardness value. All testing was performed by a blinded examiner, and the device was calibrated before each testing session to ensure accuracy and reproducibility.

Data Management and Statistical Analysis

All collected data were entered and analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were computed. Intergroup differences in microhardness were evaluated using one-way ANOVA, and Tukey's post-hoc test was applied for pairwise group comparisons. Associations between categorical variables such as toothpaste type and bleaching frequency were assessed using the chi-square test. A p-value of less than 0.05 was considered statistically significant.



RESULTS

A total of 100 patients with existing composite resin restorations were included in the study. The demographic characteristics, distribution of whitening product use, and comparative effects on microhardness are presented in the following tables

Table 1: Demographic Characteristics of Study Participants (N = 100)

Variable	**Frequency (n)**	**Percentage (%)**
Gender		
Male	48	48.0
Female	52	52.0
Age Group (years)		
18–25	30	30.0
26–32	40	40.0
33–40	30	30.0
Mean Age ± SD	28.9 ± 6.2	–
Educational Status		
Primary	12	12.0
Secondary	30	30.0
Graduate	40	40.0
Postgraduate	18	18.0
Socio-economic Status		
Low	28	28.0
Middle	50	50.0
High	22	22.0

Table 1 presents the demographic distribution of participants. Slightly more females (52%) than males (48%) were included in the study. The mean age of participants was 28.9 years (SD = 6.2), with most patients belonging to the 26–32 years group (40%). In terms of education, the largest group were graduates (40%), followed by secondary education (30%), while only 12% had primary education. Socio-economic distribution revealed that half of the participants (50%) belonged to the middle class, while 28% were from low and 22% from high socio-economic groups.

Table 2: Distribution of Patients Based on Whitening Toothpaste Usage

Toothpaste Type	**Frequency (n)**	**Percentage (%)**
Non-whitening toothpaste	30	30.0
Low-abrasive whitening	25	25.0
Medium-abrasive whitening	28	28.0
High-abrasive whitening	17	17.0

As shown in Table 2, almost one-third of participants (30%) reported using non-whitening toothpaste, while 70% used whitening formulations. Among whitening users, medium-abrasive toothpaste was the most common (28%), followed by low-abrasive (25%) and high-abrasive types (17%). This indicates that abrasive formulations are commonly selected by patients seeking whitening effects.

Table 3: Distribution of Patients Based on Bleaching Agent Use

Bleaching Agent Type	**Frequency (n)**	**Percentage (%)**
No bleaching agent	40	40.0
Low-concentration hydrogen peroxide	25	25.0
High-concentration hydrogen peroxide	20	20.0
Carbamide peroxide-based	15	15.0

Table 3 shows that 40% of participants did not use bleaching agents, whereas 60% reported bleaching practices. Low-concentration hydrogen peroxide agents were the most commonly used (25%), followed by high-concentration hydrogen peroxide (20%) and carbamide peroxide-based products (15%). These findings suggest that both professional and at-home bleaching agents are widely adopted by patients.

Table 4: Effect of Whitening Toothpaste Type on Composite Resin Microhardness

Toothpaste Type	Mean Microhardness (VHN)	Standard Deviation	p-value
Non-whitening toothpaste	78.4	3.2	
Low-abrasive whitening	75.1	3.5	
Medium-abrasive whitening	72.6	4.1	
High-abrasive whitening	70.3	4.4	<0.05

Table 4 highlights that non-whitening toothpaste users exhibited the highest mean microhardness values (M = 78.4 VHN, SD = 3.2). A progressive reduction in microhardness was observed with increasing abrasivity of whitening toothpaste, with high-abrasive users showing the lowest values (M = 70.3 VHN, SD = 4.4). Statistical analysis confirmed significant differences across the groups ($p < .05$), indicating that toothpaste abrasivity adversely affects the surface microhardness of composite resins.

Table 5: Effect of Bleaching Agents and Frequency of Use on Composite Resin Microhardness

Bleaching Agent Type	Frequency of Use	Mean Microhardness (VHN)	Standard Deviation / p-value
No bleaching	–	77.9	3.1
Low-conc. H_2O_2 (≤2×/week)	2×/week	74.5	3.7
Low-conc. H_2O_2 (≥3×/week)	≥3×/week	71.8	4.0
High-conc. H_2O_2 (≤2×/week)	2×/week	70.6	4.2
High-conc. H_2O_2 (≥3×/week)	≥3×/week	68.2	4.5 / <0.05
Carbamide peroxide-based (any freq)	–	72.4	3.9 / <0.05

As illustrated in Table 5, composite restorations of patients who did not use bleaching agents demonstrated the highest microhardness (M = 77.9 VHN, SD = 3.1). In contrast, restorations exposed to high-concentration hydrogen peroxide, especially with frequent use (≥3 times/week), exhibited the lowest values (M = 68.2 VHN, SD = 4.5). Carbamide peroxide-based agents also reduced microhardness (M = 72.4 VHN, SD = 3.9). The differences among bleaching agent groups were statistically significant ($p < .05$), suggesting that both concentration and frequency of bleaching agent use strongly influence the microhardness of composite resins.

DISCUSSION

The results showed that while high-concentration bleaching products showed a significant decrease in composite microhardness, whitening toothpastes had a discernible effect. This result fits invitro studies showing more surface roughness and little hardness reduction following brushing with whitening solutions including abrasive particles or activated charcoal (Elgendy et al., 2023; Farooq et al., 2023). As a cause of resin damage the role of abrasivity over RDA Emphasized as well have been values such particle form and distribution (Delgado et al., 2024).

On the other hand, bleaching agents, particularly those in office hydrogen peroxide (35–40%), exhibited more notable microhardness reduction, hence confirming earlier studies demonstrating higher oxidative stress. greater peroxide concentrations on the resin matrix (Arjmand et al., 2023; Baciu et al., 2023). Similarly, carbamide peroxide at 15–16% caused significant but less severe reductions notably in unpolished or long exposures (Amri et al., 2024).

These findings match with previous systematic analyses and metaanalyses showing whitening toothpaste has less consistent effect whereas bleaching agents normally reduce composite resin hardness. Effects (Mese et al., 2022; Mosallam et al., 2022). But some recent research have emphasized that surface coatings, nanofilled materials, or protective sealants may aid Reducing (Yadav et al., 202) defines this degradation. From a clinical standpoint, the observed drop in microhardness may indicate higher vulnerability to wear, discoloration, and shortened lifespan of restorations (Alqahtani et al., 2020). This emphasizes the importance of patient education on excessive usage of bleaching products as well as the need of surface or restorative material reinforcement. Finishing after bleaching (Tavangar et al., 2021).

Future Suggestions

Building on the growing body of evidence, the current study compares commonly used whitening toothpastes and bleaching compounds within the same experimental setting. Doing so highlights the damage potential gradient, ranging from little abrasivity-related hardness loss to more significant oxidative deterioration. Longitudinal clinical outcomes, effects of many bleaching cycles, and generation of composites with improved resilience to peroxide and abrasive challenges ought to In future studies, everything will have top priority**.**

CONCLUSION

According to this crosssectional study, whitening toothpastes and bleaching chemicals reduced the microhardness of composite resins, with bleaching agents especially high-concentration hydrogen peroxide having the biggest effect. Particularly those with abrasive ingredients, bleaching toothpastes showed a smaller but yet significant effect. Little link between patient demographics like age, education, and economic level and hardness changes suggests that the composition of the item was the most significant impact. Clinically, dentists should carefully consider whitening choices for patients with composite restorations to strike a balance between esthetic results and long-term restorative stability.

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