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Original Research

Erosive potential of mouthwashes on composite resins: A microhardness perspective in-vitro study

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Abstract

Aim: The aim of this in vitro study was to evaluate the effect of different commercially available mouthwashes on the surface microhardness of a bulk-fill composite resin.

Materials and Methods: Forty-five disc-shaped specimens (8 × 4 mm) were prepared using a bulk-fill composite resin and randomly divided into three groups (n = 15): Group I—Listerine, Group II—Colgate Plax, and Group III—artificial saliva (control). Baseline surface microhardness values were recorded using a Vickers microhardness tester and specimens were immersed in 20 ml of the respective solutions for 24 hours at 37°C to simulate one year of daily mouthwash use. Post-immersion microhardness was measured under identical testing conditions.

Results: Data were statistically analyzed using one-way ANOVA and Tukey's post hoc test ($p < 0.05$). Following immersion, the artificial saliva group demonstrated a statistically significant increase in surface microhardness ($P < 0.05$). In contrast, specimens immersed in the alcohol-containing mouthwash (Listerine) demonstrated a statistically significant reduction in microhardness ($P < 0.05$). These findings indicate that immersion media significantly influence the surface microhardness of bulk-fill composite resin.

Conclusion: Within the limitations of this in vitro study, artificial saliva exhibited a protective effect on the surface microhardness of bulk-fill composite resin, whereas alcohol-containing mouthwash adversely affected its surface integrity.

Keywords: Green dentistry, Eco-dentistry, Sustainability, Dental practitioners, Waste management, Environmental awareness.

***Message**: The routine use of alcohol-containing mouthwashes may compromise the longevity of bulk-fill composite restorations.*

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Introduction

In modern oral healthcare, mouthwashes are a valuable adjunct to toothbrushing and flossing, helping reduce microbial load, limit plaque accumulation in hard-to-reach areas, and improve oral freshness.[1] Despite their clinical benefits, mouthwashes contain diverse active components such as alcohol, chlorhexidine, and essential oils, which may interact differently with restorative dental materials.[2] Prolonged or repeated exposure to these chemical agents has raised concerns regarding their potential influence on surface characteristics, particularly surface roughness and microhardness, which are critical determinants of restoration durability.[3]

Concurrently, bulk-fill composite resins have gained popularity as posterior restorative materials owing to their capacity for bulk placement and curing up to 4 mm, thereby reducing chair time and improving clinical efficiency.[4] Wizdent Master Design Packable Composite Resin represents a newer generation bulk-fill material engineered with an advanced formulation to meet the functional and esthetic demands of modern dentistry. Despite these advantages, the long-term behavior of bulk-fill composites in the oral environment remains a subject of ongoing investigation.

Surface microhardness is a critical property that reflects a material's resistance to surface wear, deformation, and chemical degradation.[5] A reduction in microhardness may compromise the structural integrity of restorations, leading to increased surface roughness, plaque retention, and eventual restoration failure.[3,5] Although mouthwashes are routinely prescribed for patients with dental restorations, emerging evidence suggests that certain formulations may adversely affect composite resin properties.[5,6] While numerous studies have evaluated the effects of mouthwashes on conventional composites, literature addressing their influence on bulk-fill composites remains limited.[6]

Since microhardness reflects resistance to wear and surface degradation, evaluating the effect of commonly used mouthwashes on bulk-fill composites is essential, especially in view of limited existing evidence . Hence, the present in vitro study was designed to evaluate the effect of different mouthwashes on the surface microhardness of bulk-fill composite resin, with the aim of assessing whether routine exposure to these commonly used oral rinses could alter the material's mechanical properties and potentially influence its clinical performance.

Materials and method

Study Design

The present study was designed as an in vitro experimental study to evaluate the effect of different commercially available mouthwashes on the surface microhardness of a bulk-fill composite resin. Ethical approval for the study was obtained from the Institutional Review Board of Dayananda Sagar college of dental Bengaluru (Approval No: 313-IRB-2025).

Sample Size Estimation

Sample size estimation was performed using G*Power software version 3.1.9.7 (Heinrich Heine University, Düsseldorf, Germany) based on one-way ANOVA (fixed effects, omnibus test). Considering an effect size of 0.47, alpha error probability of 0.05, statistical power of 80% ($1-\beta = 0.80$), and three study groups, the total sample size was calculated to be 45 specimens, with 15 specimens allocated to each group. The materials used in this study. (Chart 1 and Figure 1)

Preparation of Samples

A total of forty-five composite resin disc specimens (Figure-2) were fabricated using a standardized protocol. Plastic molds measuring 8 mm in diameter and 4 mm in thickness were used to ensure dimensional uniformity. The bulk-fill composite resin was packed into the molds and covered with a transparent Mylar strip to obtain a smooth, oxygen-inhibited surface. A glass slide was gently placed over the strip to remove excess material and achieve a flat surface. Polymerization was carried out using a Ivoclar Vivadent Bluephase N MC Light cure unit with a wavelength of 430-490 nm for 20 seconds in accordance with the manufacturer's instructions. The specimens were carefully removed from the molds and randomly allocated into three groups ($n = 15$ per group). Baseline surface microhardness values were recorded prior to immersion.[5,6]

Immersion Protocol

Each specimen was individually immersed in 20 ml of the assigned solution and stored in an incubator at 37°C for 24 hours. This immersion period was selected to simulate approximately one year of daily mouthwash use, assuming an average exposure of four minutes per day.

Group Allocation

The 45 specimens were randomly divided into three experimental groups ($n = 15$ per group) according to the immersion solution used:

Group I – Artificial Saliva (Control Group):
Specimens were immersed in artificial saliva to simulate the normal oral environment and served as the control group.

Materials	Composition	Manufacturer Details
Wizdent Master Design	Fluoroboroalumino-silicate glass Aluminium Oxide BisGMA TEGDMA Neostann Dibutylin dilaurate Titanium dioxide Red Iron oxide	Pidilite Wizdent Kuraray Pvt Ltd, Pidilite Industries limited, Mumbai, Maharashtra
Artificial Saliva	Carboxymethylcellulose (CMC) (for lubrication/ viscosity), Electrolytes (sodium, potassium, calcium, phosphates for mineral balance) Glycerin/Sorbitol (moisturizing) Preservatives, flavourings, enzymes or mucins	Dextrose Technology Pvt Limited, Bangalore, Karnataka
Listerine®	Active Ingredient: Eucalyptol, Menthol, Methyl Salicylate, Thymol Inactive Ingredients: Water, Alcohol, Sorbitol Solution, Flavoring, Poloxamer 407, Benzoic Acid, Sodium Saccharin, Sodium Benzoate, FD&C Green 3	Johnson & Johnson Ltd. Mumbai, Maharashtra
Colgate® Plax	Active Ingredient: Cetylpyridinium Chloride Inactive Ingredient: Aqua (Dissolves substances or ingredients.) Glycerin, Propylene glycol, Sorbitol, Poloxamer 407, Aroma, Potassium sorbate	Colgate Palmolive, Colgate Palmolive (India) Ltd. Sri City, Andhra Pradhesh

Chart-1

Figure 1- Materials used in the study

Group II – Colgate® Plax: Specimens were immersed in Colgate® Plax mouthwash, a cetylpyridinium chloride-containing non-alcoholic mouthwash.

Group III – Listerine®: Specimens were immersed in Listerine® mouthwash, an alcohol-containing mouthwash with essential oils.

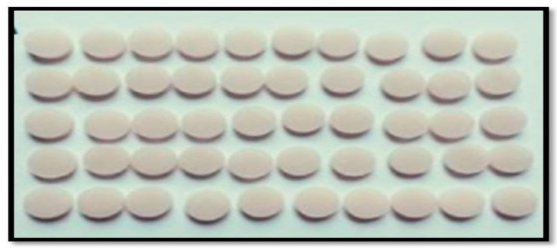

Figure2: 45 samples of Composite resin

Following immersion, the specimens were removed from their respective solutions, rinsed with distilled water, and allowed to air-dry at room temperature prior to testing.[5.6] (Figure 3)

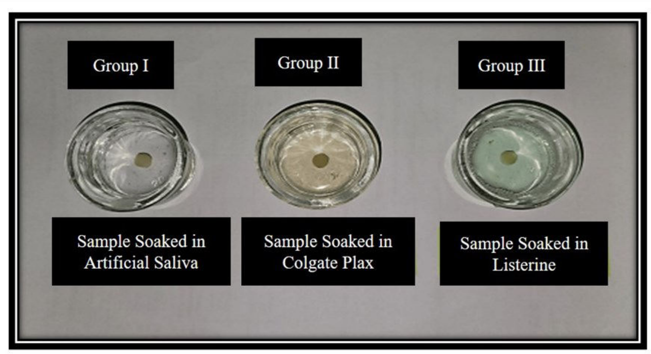

Figure 3 Pre and Post Immersion test

Microhardness Testing

Surface microhardness was evaluated using a Vickers microhardness tester (LECO Corporation model LM-100). A load of 30 N (300 gf) was applied to the specimen surface with a dwell time of 20 seconds. Three indent-

-ations were made on the top surface of each specimen, equidistantly positioned along a circular path, ensuring a minimum distance of 1 mm from adjacent indentations and specimen margins. The mean of the three readings was calculated to obtain the Vickers microhardness value (kg/mm^2). Post-immersion microhardness measurements were performed using the same testing parameters and equipment to maintain consistency and reliability. [1,5,6]

Statistical Analysis

Data were analysed using Statistical Package Social Sciences (Version 23; IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± SD or median (IQR) based on normality. Intragroup comparisons were performed using the paired t-test, while intergroup comparisons were carried out using one-way ANOVA or the Kruskal–Wallis test, followed by appropriate post-hoc analysis. A P value ≤ 0.05 was considered statistically significant.

Results

The surface microhardness values of bulk-fill composite resin before and after immersion in different solutions are presented in Table 1. Each group consisted of 15 specimens, and intragroup comparisons were performed to assess changes in microhardness following 24 hour immersion.

Group	N	Pre-immersion Mean± SD	Post-immersion Mean± SD	p-Value
Group 1	15	50.45± 0.82	51.40± 0.88	0.015 *
Group 2	15	50.40± 0.79	50.36± 0.85	0.022 *
Group 3	15	50.40± 0.84	50.01± 0.91	0.039 *

Table 1: Microhardness before and after Immersion

The type of immersion medium significantly influences the surface microhardness of bulk-fill composite resin. While artificial saliva exhibited a protective or enhancing effect, exposure to an alcohol-containing mouthwash resulted in measurable surface deterioration, highlighting the clinical relevance of mouthwash selection in patients with composite restorations. (Table-1)

Groups	Difference in Pre-Post Immersion Mean	Median	Test groups	p-Value
Group 1	0.95	0.72	Group 2 Group 3	0.021 0.206
Group 2	-0.31	-0.08	Group 3	0.993
Group 3	-0.39	-0.70		

Table 2: Inter- group comparison of difference in microhardness of composite material after immersion in each mouthwash

As per the present study result, intergroup comparison (Table 2) of the differences in pre- and post-immersion microhardness highlighted variations such as Group 1 exhibited the highest positive mean difference (0.95; median: 0.72), indicating an overall enhancement in surface hardness. This increase was found to be statistically significant when compared to Group 2 (mean difference: −0.31; median: −0.08) (P = 0.021), suggesting a distinctly different effect between these two immersion conditions. However, although Group 3 (mean difference: −0.39; median: −0.70) demonstrated a greater reduction in microhardness than Group 2, the difference between Group 1 and Group 3 did not reach statistical significance (P = 0.206). Additionally, the comparison between Groups 2 and 3 revealed no statistically significant difference (P = 0.993), indicating that both immersion media exerted a comparable influence in reducing surface microhardness.

Intragroup analysis (Table 1) revealed that immersion produced statistically significant changes in the surface microhardness of bulk-fill composite resin across all groups (P < 0.05). Group 1 demonstrated a clear increase in mean microhardness from 50.45 to 51.40 (P = 0.015), reflecting a positive alteration in surface properties following exposure to the respective medium. In contrast, Groups 2 and 3 exhibited reductions in microhardness, with Group 2 showing a slight but statistically significant decrease from 50.40 to 50.36 (P = 0.022), and Group 3 demonstrating a more pronounced decline from 50.40 to 50.01 (P = 0.039). These findings suggest that while all immersion media influenced the composite surface, the direction and magnitude of change varied depending on the solution.

Discussion

The present in vitro study evaluated the effect of different mouthwashes on the surface microhardness of a bulk-fill composite resin. The results demonstrated a statistically significant increase in microhardness following immersion in artificial saliva, whereas exposure to an alcohol-containing mouthwash (Listerine) resulted in a significant reduction. These findings indicate that the chemical nature of the immersion medium plays a crucial role in determining the surface integrity of bulk fill composite restorations.

The increase in surface microhardness observed in the artificial saliva group can be attributed to continued post-polymerization and maturation of the resin matrix, facilitated by a neutral, non-reactive environment that does not disrupt the filler–matrix interface. In contrast, although polymerization may continue in all groups, the presence of alcohol, acids, or other active agents in mouthwashes can promote water sorption, plasticization, and hydrolytic degradation, thereby counteracting or masking the beneficial effects of post-curing.[7,8]

Similar findings have been reported by Yilmaz et al., who observed stabilization and enhancement of mechanical properties of composite materials stored in artificial saliva, attributing this effect to water-mediated polymer network maturation.[9] Sati et.al, Dionysoupulous et.al and Kelic et al, in their study upon evaluating bulk-fill composites have also demonstrated that their microhardness values may increase over time under favorable storage conditions due to delayed polymerization reactions.[10,11,12] This explains the protective or enhancing effect noted in the present study.

In contrast, specimens immersed in Listerine exhibited a statistically significant reduction in surface microhardness. Alcohol-containing mouthwashes are known to penetrate the resin matrix, acting as plasticizers that soften the polymer network and promote elution of unreacted monomers.[6,13] Mallick et al. reported significant deterioration of surface properties of composite resins following exposure to commercial mouthwashes, particularly those containing alcohol.1 Similar reductions in microhardness have been consistently documented in studies evaluating both conventional and bulk-fill composites exposed to mouth rinses.[2,5,6,8,14] The essential oils and low pH (Listrine ph- 4.3-5 and Colgate plax ph 6.2) associated with such formulations further contribute to hydrolytic degradation of the filler resin interface, leading to surface softening and reduced hardness.[3]

Bulk-fill composites, despite their favorable curing depth and clinical efficiency, are still susceptible to chemical degradation of the resin matrix when exposed to aggressive oral solutions.[4,7] Since surface microhardness is directly related to wear resistance and surface durability, a reduction in hardness may predispose restorations to increased roughness, plaque retention, and premature failure.[9,10,11]

An in vitro study by Sonali Taneja et al. reported a decrease in bond strength with increasing depth, indicating limitations in polymerization at deeper regions. This may influence mechanical properties such as surface microhardness.[15] Similarly, Nidhi Aggarwal et al. found that while flowable bulk-fill composites achieved adequate cure at 4 mm, high-viscosity materials did not reach the optimal hardness threshold. Such variations in degree of conversion may account for the differences in microhardness observed after immersion in the present study.[16]

The compilation by Nawaz Mubashir and Rafiq Ahmad Mir highlights current advances in restorative materials and their interaction with oral environments. This correlates with the present study, where different mouthwashes influenced the surface microhardness of bulk-fill composites, emphasizing the role of chemical exposure on material performance.[17] The in vitro study by Nishmitha Hegde et al. demonstrated a significant reduction in microhardness following high-dose radiation, attributed to structural degradation. This parallels the present study, where exposure to certain mouthwashes led to decreased microhardness of bulk-fill composites, highlighting how external chemical or physical agents can adversely affect dental material properties.[18]

The in-vitro study by Jyothi et.al, showed that all five commercial mouth rinses significantly reduced the Vickers microhardness of a nanofilled resin composite, with alcohol-based rinses (especially Listerine) causing the greatest decrease which aligns with the present study.[19]
The present study is limited by its in vitro design, which does not fully replicate the dynamic oral environment, as factors such as thermal cycling, masticatory forces, salivary enzymes, pH fluctuations, and mechanical abrasion from tooth brushing were not simulated. Additionally, the evaluation was restricted to a single bulk-fill composite resin and a limited selection of mouthwashes over a fixed

immersion period. Future research should incorporate long-term aging protocols, thermocycling, and brushing simulations, along with a broader range of restorative materials and mouthwash formulations. Well-designed clinical studies are further required to validate these findings under actual intraoral conditions

Conclusion

Within the limitations of this in vitro study, it can be concluded that the surface microhardness of bulk -fill composite resin is influenced by the immersion medium. Artificial saliva demonstrated a protective effect by significantly enhancing surface microhardness, whereas exposure to an alcohol-containing mouthwash resulted in a statistically significant reduction. These findings suggest that mouthwash composition plays a critical role in maintaining the mechanical integrity of bulk-fill composite restorations.

Clinical relevance

Given the widespread use of mouthwashes as an adjunct to oral hygiene, clinicians should consider the potential impact of mouthwash composition on composite restorations. Alcohol-containing mouthwashes may adversely affect the surface microhardness of bulk-fill composites, potentially compromising restoration longevity. Therefore, the use of alcohol-free or neutral formulations may be preferable for patients with extensive composite restorations to preserve surface integrity and enhance clinical performance.

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