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# Effect of Nano Filled Protective Coating and Dentin Bonding Agent on the Microleakage Resistance of A Hybrid Composite During Bleaching Treatment- An In Vitro Study

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**ABSTRACT**

Activation of bleaching agents containing hydrogen peroxide or carbamide peroxide results in their transformation into low molecular weight reactive free radicals which infiltrate dental hard tissues. These, in turn, remove the discolouration in the dental tissue. However, they may have undesired consequences on the dental tissues, restoration materials, and tooth restoration interfaces. Microleakage at restoration margins is a significant consequence which can lead to numerous clinical issues. Some of these are pulpal damage, secondary caries, surgical sensitivity, marginal discolouration, and bacterial buildup. Surface coating agents or protective coating materials can be considered as an alternative for minimizing microleakage, to prevent these clinical adverse effects. The materials are applied to the cavosurface margins of completed restorations, where they penetrate into structural microdefects and marginal gaps formed during the finishing and polishing operations via capillary action. This study examined the effects of a nanoparticle-loaded covering material on the hybrid composite resin's marginal integrity after bleaching. Class V cavities were created in the middle third of human premolar buccal surfaces and were restored with hybrid composite resin for three groups (n = 30). Group A-restored and coated with G coat plus and bleached using 35% $H_2O_2$ Group B-restored and coated with dentin bonding agent & bleached using 35% $H_2O_2$. Group C-restored with hybrid composite resin, without any coating & was bleached using $H_2O_2$. All specimens were dyed with 0.5% fuschin stain & observed under the stereomicroscope for assessing the marginal gap and microleakage. Group A showed maximum resistance to microleakage in this study.

**KEYWORDS**

Hydrogen peroxide; Coating material; Composite resin; Office bleaching; Microleakage

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## 1 | INTRODUCTION

Patient desires for healthy and aesthetically pleasing smiles have led to vital bleaching becoming one of the most popular dental procedures.[1] Numerous strategies, including various chemicals, concentrations, application times, and activation modalities, have been employed since the bleaching treatment was established.[2] However, the literature has essentially defined three strategies for vital bleaching. "Power bleaching" or "in-office bleaching" was the first technique, whereas, others are referred to as "night guard bleaching" or "home bleaching." A new class of bleaching process has been documented known as "over-the-counter" bleaching agents.[1,3]

Vital bleaching is not regarded as creating macroscopically visible defects. However, there are numerous studies which have proved otherwise. They have exhibited that bleaching agents induce micro-structural changes of dental hard tissue. The effect is more pronounced when peroxides are applied in high concentrations.[4] As compared to the alternative methods of treatment for tooth discolourations, bleaching is more widely accepted as it is safer, less intrusive and less damaging.[1]

The two primary components in modern teeth-whitening products are hydrogen peroxide (HP) and carbamide peroxide (CP). When CP comes into touch with saliva or tissues, it quickly breaks down into roughly two thirds urea and one third HP due to its high instability. HP is a powerful oxidizing agent that generates free radicals, reactive oxygen molecules, and anions.[1] The fact that the bleaching chemical comes into close contact with the teeth and possibly any related restorations raise the likelihood that the agent will produce unwanted changes, such as softening and degeneration of the teeth and restorative materials. As a result, questions concerning the bleaching effects on dental restorative materials have been raised.[5,6] The marginal integrity of restorations following bleaching treatment has not been extensively studied. Enhanced microleakage is one of the most significant outcome of bleaching over a restoration that causes a clinical issue.[5]

Bleaching substances may permeate the dental tissues through open margins at the restoration interface, potentially causing microleakage and hypersensitivity, according to some researchers.[3] Many strategies have been put forth to lessen microleakage at the tooth-restoration interface such as protective coating materials or surface coating agents can help reduce microleakage.[1] Protective coatings are applied to the cavosurface margins of composite resin restorations so that the structural micro-defects and gaps caused by finishing and polishing are filled in. Although there have been some concerns expressed regarding the detrimental effects of bleaching agents on dental tissues and dental materials, surface protection prior to bleaching procedures is undervalued.[1] Coating materials may protect the restoration and tooth-restoration interfaces from bleaching chemicals.[7,8] This study aimed to investigate how a nano-filled protective covering affects a nano-hybrid composite resin restorations marginal integrity when bleached using 35% hydrogen peroxide.

## 2 | METHOD

### 2.1 | Tooth Selection

This study was conducted in the Department of Conservative Dentistry and Endodontics over the period of 6 months. The study was approved by the Institutional Ethical Committee (PCDS/IEC/3/2023/75. Dtd: 08.05.2023). 60 intact, human maxillary premolars of similar dimensions, which were extracted for orthodontic or periodontal reasons and which were free of restorations, caries, fractures and abrasions were collected from the Department of Oral and Maxillofacial Surgery. The teeth were debrided with scalers to remove any remaining soft tissue and calculus. The teeth were stored in saline at +4°C to maintain the physiologic integrity.

### 2.2 | Specimen preparation

Cavity preparation was performed on the middle third of the buccal surface of each tooth. [Fig. 1] (n = 60). Class V cavities were standardized as box-shaped (2.5 mm width, 4 mm height, 2 mm depth), with all cavo-surface margins located in enamel, and bevels were not prepared. Diamond burs were used for cavity preparation (Mani,SF-12, BR-41) using a high-speed airotor handpiece cooled with an air-water spray. Each bur was used for only 10 cavity preparations.

## 2.3 | Experimental Design

The specimens were randomly divided into three groups (20 teeth in each group) based on restoration material. Each 20 teeth were restored with either nano-filled resin coating agent (GCG Coat Plus, GC, Tokyo, Japan) (Group A) or dentin bonding agent (Te econom Bond, IVOCLAR, Schaan, Liechtenstein)(Group B), or not coated (no surface coating/protective material) (Group C).

## 2.4 | Microleakage measurement

After finishing and polishing, composite resin was used to seal the apical foramen to avoid any leakage. Two layers of nail varnish were uniformly applied to the teeth surfaces except for a 1 mm zone around the restoration margins. This was performed to block all the microcracks from bleach and dye penetration. All specimens were then bleached using 35% hydrogen peroxide (Maarc Blitz White) for 8 minutes, and then soaked in 0.5% carbol fuschin dye (Allways $^{TM}$) for 36 hours.

All specimens were cut longitudinally using diamond disc and observed under stereomicroscope at 40x magnification present and scored according to the scoring scale given by Manhart et al.[1] Microleakage was scored as follows: Score 0: Dye penetration - None, Score 1: Dye penetration - up to one-half of the extension of the incisal/gingival cavity wall, Score 2: Dye penetration - more than one-half of the extension of the cavity wall, not including the axial wall, Score 3: Dye penetration - more than one-half of the extension of the cavity wall, including the axial wall.

## 2.5 | Statistical Analysis

The data obtained was statistically analysed using Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA). Data comparison was performed by applying specific statistical tests to assess the statistical significance of the comparisons. Kolmogorov-Smirnov test was performed to determine the normality of the data for assessing the microleakage between groups. The test showed no significant difference and hence confirmed that the data obtained were normally distributed. Variables were compared by using mean values and standard deviation. The mean for different readings for microleakage between the groups was assessed by one way Analysis of variance (ANOVA). Tukey's post hoc was applied to find differences between groups. P value lesser than 0.05 was considered to be statistically significant.

# 3 | RESULT

60 intact, human maxillary premolars of similar dimensions, which were extracted for orthodontic or periodontal reasons and which free of restorations, caries, fractures and abrasions were collected for the study and were randomly divided into three groups. There was no specific predilection between male and female for collection of tooth specimen.

**TABLE 1** Microleakage among different groups

| Groups | N | Mean | Std. Deviation | P value |
|---|---|---|---|---|
| Group A | 20 | .6000 | .21082 | |
| Group B | 20 | 1.1000 | .39441 | .001* |
| Group C | 20 | 1.3000 | .48305 | |

*=Significant; NS=Not Significant

**TABLE 2** Pairwise comparison of microleakage

| Pairs | Mean Difference | Std. Error | Significance |
|---|---|---|---|
| A vs B | -.50000* | .16997 | .018* |
| A vs C | -.70000* | .16997 | .001* |
| B vs C | -.20000 | .16997 | .477 (NS) |

*=Significant; NS=Not Significant

When assessed for the extent of microleakage, it was seen that Group C displayed the most pronounced microleakage (Fig. 2(C)), reflecting a mean value of 1.3000 ± 0.48305. Following closely, Group B exhibited an intermediate level (Fig. 2(B)), while the least microleakage was observed in Group A (Fig. 2(A)). This discernible variation in microleakage among the groups was found to hold statistical significance (p= 0.001) (Table 1). The greatest difference in mean values was identified between Group A and Group C exhibiting a notable difference of 0.7000, a finding that attained statistical significance at p=0.001 (Table 2 ). Conversely, the microleakage comparison between Group B and Group C revealed a marginal difference implying that both groups yielded nearly similar results.

## 4 | DISCUSSION

Microleakage is responsible for many clinical problems such as marginal discoloration, postoperative sensitivity, bacterial accumulation, pulpal damage, and secondary caries. Various techniques have been proposed to reduce microleakage at the tooth restoration interface. Re-bonding with a bonding agent at the cavosurface margins can prevent microleakage of composite resin restorations. A Mariani et al.[12] conducted studies on class V cavities of caries-free third molars, wherein a control group was compared with a group that had bonding agents applied after finishing and polishing. They concluded that re-bonding with a bonding agent may decrease marginal leakage of composite resin restorations.[12]

In present study, re-bonding with bonding agent did reduce the microleakage to certain extent but the reduction was significantly less as compared to the group coated with nano-filled resin agent. However, it's crucial to note that this observation did not reach statistical significance, emphasizing the nuanced variations in microleakage outcomes between the two groups. Elevated levels of reactive oxygen radicals produced during the bleaching process could potentially impact tooth tissues, restorative materials, and the link between the restored teeth. Peroxide radicals have been shown to be able to modify tooth components like dentin and enamel.[9] Oxygen radicals may accelerate deterioration of adhesive interfaces by attaching to unpolymerized monomer double bonds or reacting with ester groups, comparable to composite polymer matrix.[10] When a composite resin restoration is finished and polished, structural micro-defects and marginal gaps occur. Materials called protective coating materials or surface coating agents penetrate these defects by capillary action when applied over the cavosurface margins. This is a means for minimizing the microleakage. These materials may also increase wear resistance.[1] The use of nanotechnology in recent years has led to several improvements and innovations in various fields of science and technology. One of these areas is in the development of nano-filled resin-based coatings.[11] Recently, resin coatings have been considered to decrease discoloration and improve marginal integrity.[13]

## 5 | CONCLUSION

The tooth bleaching procedure may increase the microleakage scores in cavities restored with hybrid composite resin. Covering the composite resin restoration with a protective nano-filled resin coating material may decrease this undesired effect of the peroxide agent. However, further studies are required that simulate the clinical conditions and also assess the different types and concentrations of peroxide agents and adhesives. These would help us to further understand the adverse effects of bleaching on restorative materials.

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## Conflict of interest

The authors have no conflicts of interest to declare.

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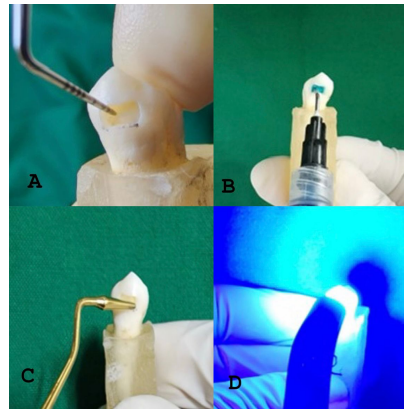


**FIGURE 1** A) Class V cavities prepared in middle third of buccal surface of tooth. B & C) Image showing application of Etchant and Adhesive. D) Each restored tooth is coated with different agents.

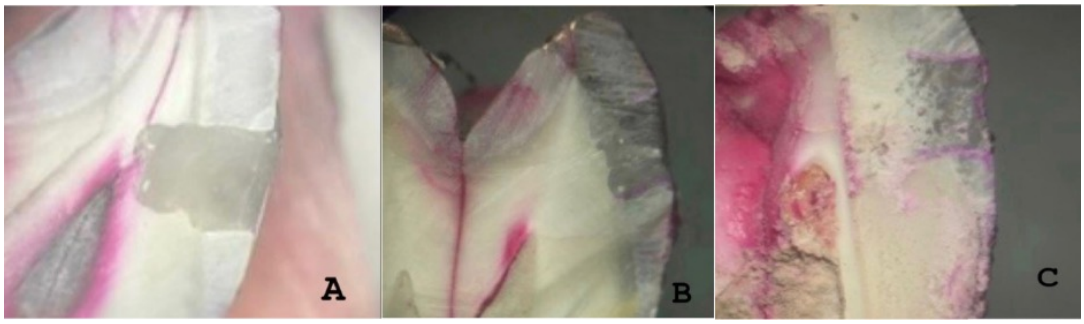


**FIGURE 2** Tooth visualised under stereomicroscope to see the extent of microleakage. A) Least micro-leakage seen in Group A where tooth was coated with Nano-filled resin. B) Intermediate micro-leakage seen in Group B where tooth was coated with Dentin bonding agent. C) Pronounced microleakage seen in Group C where tooth was not coated.