

# The Effect of Lase Peroxide Sense and Whitening Lase II radiation on Gingival Microleakage of Different Types of Composite Resin Filling Materials. (An in Vitro Study)



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## Abstract

**Aim:** This in vitro study was conducted to evaluate the effect of lase peroxide sense, and whitening lase II radiation on gingival microleakage of three types of composite filling materials (tartaric N Ceram, SDR, GC). **Materials and Methods:** This study was performed on thirty caries free upper first premolar teeth. The Standardized class V cavity preparation on buccal and lingual surfaces of each tooth was done, then the teeth were randomly divided into two major groups: group 1 unbleached and group 2 bleached composites, then each main group divided into three subgroups; ten cavities (5teeth) for each group. The cavities were cleaned, and acid etched with 37% phosphoric acid, then bonding agent (G-permio bond) was applied according to the manufacturer's instructions. Group I and II the cavities were filled with tetric N ceram composite(Vivadent), group III and IVthe cavities were filled with SDR composite (SDI), and group V and VI the cavities filled with GC Essentia composite(GC).

After filling the teeth in groups II, IV, VI were subjected to whitening lase II (DMC, USA) laser bleaching, according to manufacturer's instructions, then the teeth were thermo cycled for 500 cycles. After thermocycling all teeth were immersed in a freshly prepared solution of 2% methylene blue for 24 hours at 37Co then sectioned longitudinally. For gingival margins, dye penetration at the tooth/composite interfaces was analyzed using a stereomicroscope.

**Results:** Statistical analysis of data by using Mann-Whitney Test Revealed that there was a significant difference among the different groups in both bleached and unbleached composite, Kruskal-Wallis Test revealed that there is a significant difference between bleached and unbleached composite for every type of material.

**Conclusions:** All samples in this study showed microleakage with different levels. Hydrogen peroxide increased Microleakage in all tested materials.

**Keywords:** Laser bleaching, composite resin restoration, microleakage, Hydrogen peroxide.

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## Introduction

Discoloration of teeth, especially the interior is a cosmetic problem that is often significant enough to induce patients to seek corrective measures<sup>(1)</sup>.

The aesthetic appearance of anterior teeth has become a major concern for patients. Discolored vital anterior teeth have long been treated with different approaches, including composite resin restorations, direct and indirect veneers, crowns, and, most conservatively, bleaching. Both take-home and in-office bleaching techniques have proven effective in whitening teeth, with the latter having the advantage of producing immediate results<sup>(2, 3)</sup>. The typical in-office bleaching regimen involves the application of a high-percentage

hydrogen peroxide formulation to the tooth surfaces, which is activated either chemically or by a light source. The theoretical advantage of using lights is their ability to heat hydrogen peroxide, thereby enhancing the rate of hydrogen peroxide decomposition. The increased amount of oxygen-free radicals produced thus enhances the release of stain-containing molecules and, therefore, results in enhanced whitening<sup>(4)</sup>. The etiology of tooth discoloration may be extrinsic or intrinsic or both; it may affect enamel, dentin and pulp, or any such combination of these tissues. Iatrogenic discoloration is a consequence of dentist or physician therapy, or it is the result of dietary, environmental, habitual, or age-related factors. The condition may be recent, temporary or permanent, and of local or systemic origin. The cause of

the condition influences the potential outcome of the bleaching treatment and its lasting prognosis<sup>(5)</sup>.

Dental bleaching agents must have close contact with the tooth surface and penetrate the dental substrate, where the hydrogen peroxide is decomposed into oxygen (O<sup>+</sup>) and peroxy (HO<sub>2</sub><sup>-</sup> radicals).<sup>(6)</sup> These free radicals react with the dark pigments, organic macromolecules composed of aromatic rings that provide molecular stability<sup>(7)</sup>, breaking them into smaller molecules, which are less complex than the original macromolecule<sup>(8)</sup>. However, this reaction is nonspecific and may cause undesirable effects on teeth and restorative materials<sup>(9)</sup>.

When the bleaching agent contacts the resin composite, it will affect their organic matrix, especially, tend toward chemical alteration compared to ceramic restorations<sup>(10)</sup>. Bleaching agents may change the surface morphology, as well as the chemical and physical properties of composite resins. Chemical softening from bleaching may affect the clinical longevity of the composite restoration<sup>(11)</sup>.

Bleaching agents may result in a softening and reduction in microhardness and free radicals induced by peroxides may affect the resin-filler interface and cause filler-matrix de-bonding may cause microscopic cracks<sup>(12)</sup>. The bleaching agent can contain products that can promote degradation of the adhesive interface, which may reduce the longevity of the restoration.<sup>(13)</sup>

Scientific evidence shows that bleaching can reduce the concentration of calcium and phosphorus, microhardness and fracture resistance of dental structures<sup>(14, 15)</sup>. Moreover the roughness of enamel surface increases<sup>(16)</sup>. The microleakage test is a very useful method to measure the quality of adhesion in dental restorations<sup>(17)</sup>.

The purpose of this study was to determine the effect of lase peroxide sense, and whitening lase II radiation on gingival microleakage of different types of composite resin restoration.

## MATERIALS AND METHODS

This study was performed on 30 extracted human premolar teeth. The teeth after polishing with a rubber cup and pumice were checked under 20X magnification for caries and crack to exclude them from the study.

The teeth were stored in normal saline before cavity preparation, and then standardized class V cavity preparation on buccal and lingual surfaces was done. The cavities were 5mm in length, 2mm in width and 2mm in depth 1.0 mm above the cement-enamel junction. The cavities were prepared using a diamond straight fissure burs (TG England) using a high-speed turbine under constant water cooling, which was adapted to the horizontal arm of a surveyor in such a way that the long axis of the bur will be perpendicular to that of the tooth. For standardization and accurate positioning of the two

cavities, two vertical lines were drawn from the tips of the buccal and lingual cusps to the lowest points of the cervical lines, and the mid distance of these lines represent the center of each cavity this guidance will aid in perfect sectioning through the two opposite cavities. The outline of the cavity was drawn on the tooth surface with a 0.5 mechanical pencil using a matrix band with a pre-cut hole of 5 x 2 mm which was fixed on the tooth with a retainer (each one bur was used to prepare five cavities) (figure 1). The cavities were conditioned with 37% phosphoric acid (Vivadent, Liechtenstein) for 30 seconds on the enamel and 15 seconds on the dentin, and then rinsed with a spray of water and air for 60 seconds. Excess water was removed from the dentin using a cotton pellet, which remained in position during the drying of the enamel to keep the dentin moisture<sup>(18, 19)</sup>.

The adhesive system G-permio bond (GC, Japan) was applied according to the manufacturer's instructions using a disposable applicator. The solvent was evaporated with a gentle air-blast for five seconds, and the adhesive was light-cured using a halogen light (Vivadent, Schaan, Liechtenstein) for 20 seconds with a standard light at 480 mW/cm<sup>2</sup> assessed with a radiometer every five restorations. Then the specimens were divided into two major groups; the control group (unbleached group; group I, III and V) and bleached group (group II, IV and VI) according to the restorative material ten cavities for each group.



(Figure 1): class V cavity in the buccal surface of premolar.

Groups I and II the cavities were filled with Tetric N ceram composite (Vivadent, Liechtenstein) 2mm, one increment and light cured for 40 seconds.

Groups III and IV the cavities filled with flowable composite SDR (SDI) (Dentsply, Australia) 2mm and light cured for 40 seconds.

Groups V and VI cavities filled with GC Essentia composite (GC, Japan) 2mm, one increment universal tube and light cured for 40 seconds.

For all the restoration celluloid strip will be applied to the restoration and light-cured with a distance 1mm between the tip of light cure and restoration. The restored teeth were stored in distilled water at 37 oC for 24 hours. After storage, the restorations were finished

and polished using Sof-Lex discs (3M, USA) without water cooling.

The specimens in groups II, IV and VI was subjected to bleaching agents (Lase peroxide sense, DMC, USA) which consist of two containers ,one contain 35%hydrogen peroxide while the other contain thickening gel, for each 3 drops of hydrogen peroxide 1 drop of the thickening gel were used (according to the manufacturer instructions). Bleaching material applied over the tooth surface and covering the composite filling and then applicate the whitening lase II radiation. The whitening lase II radiation has visible emitters with a wavelength: 470 nm and laser type: InGaN and infrared emitters with a wavelength: 830nm and laser type: AsGaAl. (Figure 2,3).

The application of DMC Laser was made according to the manufacturer instruction (apply radiation for 3minutes then rest (without radiation) for 2 minutes this procedure is repeated for three times, then the bleaching materials were washed with distilled water and air for 1 minute and apply new material and repeat the same procedure). After bleaching after one week, the specimens were subjected to 500 cycles of thermal baths at temperatures of  $5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  to  $55\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ , with 30 seconds dwell time and a 3 seconds transfer<sup>(20)</sup>.



Figure (2): Bleaching material.



Figure (3): DMC whitening lase II bleaching device.

After thermocycling the apices of teeth were blocked with cold cure acrylic and the teeth were coated with two layers of nail varnish except 1mm around the gingival margin. The teeth were then immersed in buffered 2% methylene blue solution at  $37\text{ }^{\circ}\text{C}$  for 24 hours, thoroughly rinsed with running water, then each tooth was longitudinally sectioned with a slow speed diamond sectioning disks (KG Sorensen SP, Brazil) in a buccolingual direction through the middle of the restoration, the sections were evaluated by two independent calibrated examiners on the stereomicroscope (Hamilton by A Italy international Italy) at a magnification level of x 40 to determine the extents of dye penetration on the gingival walls and the mean between two reading was depended.<sup>(9, 21)</sup>. (Figure 4).

The following criteria were used to score the extent of the leakage at both enamel and dentin margins.<sup>(19)</sup>

0 - No dye penetration

1- Dye penetration up to half of the cavity depth.

2- Dye penetration more than half of the cavity depth.

3- Dye penetration is arriving at the cavity floor.

The data were subjected to statistical analysis to compare the microleakage between bleached and unbleached teeth.

## Results

The mean values and standard deviation frequency of microleakage scores of all groups are presented in table(1). Statistical analysis of data by using Mann-Whitney Test revealed that there was a significant difference among the different groups in both bleached and unbleached composite  $P \leq 0.05$  (table 2) between bleached and unbleached composite for every type of material.(table 3). Further investigation was done using Kruskal-Wallis Test revealed that there is a significant difference

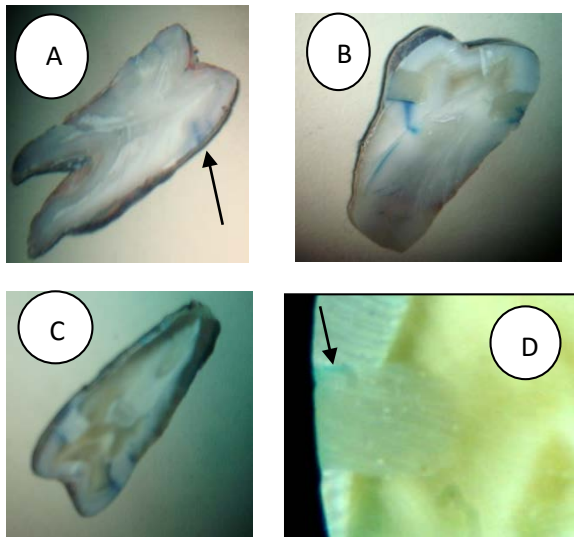


Figure (4): Microleakage between tooth-restoration interfaces:(A) tetric N ceram with bleaching, (B) SDR with bleaching,(C) GC essentia with bleaching,(D) magnified view of microleakage

#### Discussion:

Bleaching is a conservative procedure to restore the aesthetic appearance of either stained or darkened teeth, but it may exert some negative effects on existing composite resin restorations. Although bleaching could change the surface hardness and roughness and color susceptibility of composite resin restorations<sup>(22, 23)</sup>.

Under the condition of this study on microleakage test of different types of composite filling materials exposed to bleaching lase revealed that differences in chemical composition of the resin of different types of composite filling material and adhesive failure between the tooth and restoration will cause microleakage after bleaching.

The majority of dental composite resins is composed of a resin matrix, primarily Bis-GMA (bisphenol-A di glycidyl ether di-methacrylate), blended with TEGDMA (tri-ethylene glycol di-methacrylate) as a diluent. TEGDMA has a lower molecular weight than Bis-GMA and due to the higher number of double bonds per unit, more covalent cross-links are created during polymerization, resulting in a relatively higher shrinkage rate<sup>(24)</sup>. Polymerization shrinkage and subsequent dimensional change can cause internal stress at tooth\_adhesive interface, which in turn causes

debonding, microleakage and secondary caries or enamel fractures<sup>(25)</sup>.

Accordingly, some manufacturers have replaced the majority of TEGDMA with UDMA (urethane di-methacrylate) and Bis-EMA (bisphenol-A polyethylene glycoldiether di-methacrylate), which results in less shrinkage and less moisture sensitivity<sup>(24)</sup>.

Tetric N Ceram represents the medium viscosity type nanohybrid composite Bis-GMA Dimethacrylates, TEGDMA monomer; The stiffer composites help in restoring good contacts in posterior teeth; however, they may not adequately adapt to internal areas and cavosurface margins at the cervical joint<sup>(26)</sup>. In this study comparing to another group tetric N ceram record high leakage after exposed to lase bleaching. SDR (Smart Dentin Replacement) was introduced to the market as flowable nano hybrid composite UDMA monomer, which incorporates a new stress decreasing resin technology<sup>(27)</sup>. The low viscosity of SDR, which facilitates plastic flow during the early phases of polymerization could be responsible for the better adaptation exhibited by these restorative materials<sup>(28)</sup>. They serve as a stress-absorbing layer during polymerization shrinkage of the subsequent increment and act by reducing the effect of the C-factor<sup>(29, 30)</sup>. However, the benefit of using flowable composites as gingival increment for reducing polymerization contraction stress is still a matter of controversy<sup>(25)</sup>. In this study comparing to other group SDR composite record less leakage after exposing to lase bleaching.

GC essentia is a micro-hybrid composite have soft viscosity and is new material there is a little study on it, the least leakage due to soft viscosity and good adaptation to the cavity wall.

In this study, the results showed that whitening lase II bleaching significantly increases microleakage at the restoration interface this could be related to the fact that bleaching agents hydrogen peroxide can cause the loss of calcium and phosphorus<sup>(5)</sup> from the dental structure. Thus, microstructural changes occur in enamel up to a depth of 50  $\mu\text{m}$ .<sup>(6, 7)</sup>

It is possible that these structural changes in enamel may cause degradation at the adhesive interface of pre-existing restorations.

**Table (1): Descriptive Analysis Of Micro-Leakage For composites With And Without Bleaching.**

Group	Type of Composite	N	Min.	Max.	Mean	SD.	Frequency of Scores (%)				
							0	1	2	3	4
<b>Group I</b>	Tetric N ceram without bleaching	10	1.00	3.00	1.5	0.7	–	60	30	10	–
<b>Group II</b>	Tetric N ceram with bleaching	10	3.00	4.00	3.2	0.42	–	–	–	80	20
<b>Group III</b>	SDRwithout bleaching	10	0.00	1.00	0.6	0.51	40	60	–	–	–
<b>Group IV</b>	SDRwith bleaching	10	2.00	3.00	2.4	0.51	–	–	60	40	–
<b>Group V</b>	GC essential without bleaching	10	0.00	1.00	0.4	0.51	60	40	–	–	–
<b>Group VI</b>	GC essential with bleaching	10	1.00	3.00	1.7	0.67	–	40	50	10	–

**Table (2): comparison of Micro-Leakage of each type of composite restoration versus the same type after bleaching.**

Type of Composite	N	Z-values	Significance
<b>Group I</b>	<b>10</b>	<b>3.70</b>	<b>.000</b>
<b>Group II</b>	<b>10</b>		
<b>Group III</b>	<b>10</b>	<b>3.91</b>	<b>.000</b>
<b>Group IV</b>	<b>10</b>		
<b>Group V</b>	<b>10</b>	<b>3.35</b>	<b>.001</b>
<b>Group VI</b>	<b>10</b>		

Significant Difference at P≤0.05.

**Table (3): Comparison of Micro-Leakage Among Different Types Of Composites.**

Type of Composite	N	Chi-Square	Significance
Group I	10	12.23	.002
Group III	10		
Group V	10		
Group II	10	17.51	.000
Group IV	10		
Group VI	10		

Significant Difference at  $P \leq 0.05$ .

In addition, when in contact with resin composite, bleaching agents may cause an increase in surface roughness and porosity in addition to surface changes<sup>(21, 31)</sup>.

Ellias and Sajjanthey concluded that the bleaching agent definitely affects the seal at the tooth resin interphase and microleakage increase with increased bleaching time<sup>(32)</sup>.

Although adhesive systems have a higher amount of matrix than resin composites, these changes would be greater and the interfaces more susceptible to adhesive failure<sup>(33, 34)</sup>.

Crim found that bleaching agents (35% hydrogen peroxide and 10% or 16% carbamide peroxide) caused adverse effects to the tooth/restoration interface with increased microleakage<sup>(15)</sup>.

Examination of the enamel surface of the specimen treated with hydrogen peroxide for longer period revealed an increase in the size and number of non-attachment areas between the resin and the enamel. The presence of peroxide in this area may result from its transportation along interprismatic enamel pathways after exposure<sup>(9)</sup>.

The results of Noor and Ali 2014 showed that A significant increase in surface roughness of different types of composite after Bleaching with Hydrogen peroxide this might be due to the oxidation process that occurs in the organic matrix which can facilitate water absorption and lead to loss of particles and soften of the resinous matrix this will effect on the restoration-tooth interface and cause increase in microleakage<sup>(35)</sup>.

#### Conclusions

Within the limitations of this *in-vitro* study the following conclusions could be withdrawn:

1. All samples in this study showed microleakage with different levels.
2. Hydrogen peroxide lase and whitening lase II cause increase Microleakage of all tested materials.

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