

An Evaluation of the Effect of Bleaching Agent on Microhardness of a New Silorane-Based Restorative System and Methacrylate-Based Restorative Material

Shatha Abdul Kareem

Rasha Hameid Jehad

Baghdad University

Abstract

Background: The high reactivity of hydrogen peroxide used in bleaching agents have raised important questions on their potential adverse effects on physical properties of restorative materials. The purpose of this in vitro study was to evaluate the effect of in-office bleaching agents on the microhardness of a new Silorane-based restorative material in comparison to methacrylate-based restorative material.

Materials and method: Forty specimens of Filtek™ P90 (3M ESPE,USA) and Filtek™ Supreme XT (3M ESPE, USA) of (8mm diameter and 3m height) were prepared. All specimens were polished with Sof-Lex disks (3M ESPE, USA). All samples were rinsed and stored in incubator 37°C for 24 hours in DDW. Ten sample of each material were subjected to 37.5% hydrogen peroxide gel (Pola office +, SDI)for 8 minutes while exposed to light curing device, this step was repeated three times for 3 weeks. While the other ten samples for each material was served as control. All specimens were subjected to microhardness test using digital microhardness tester to determine the VHN (Vickers Hardness Number)

Results : The Filtek™ P90 exhibited higher microhardness value than Filtek™ Supreme XT. After hydrogen peroxide treatment, both types of composites exhibited low microhardness values but still Filtek™ P90 is harder than Filtek™ Supreme XT.

Conclusion : In-office hydrogen peroxide bleaching agent resulted in reduction in microhardness values for both composite materials. Silorane- based composite is more affected by the bleaching agent than methacrylate-based composite.

Keywords: hydrogen peroxide , Silorane, microhardness

Introduction

Tooth whitening either by the removal of extrinsic stains, or bleaching by the reduction of intrinsic coloration, is increasingly popular among patients. Many systems are available but those with proven efficacy share the common mechanism of peroxide. The form of the peroxide (hydrogen peroxide, carbamide peroxide , sodium percarbonate) and the method of delivery (gels in trays, strips, films, or paint-on gels) vary but all have been shown to be efficacious. There is a large research base supporting the use of these materials but little work has been undertaken on their possible deleterious effects within the oral cavity using appropriate in situ or in vivo models. Recently published studies have examined the effect of peroxide products on the susceptibility of enamel to demineralization and erosion and the soft tissue impact of peroxide placement. There is contradictory evidence that bleaching (of any type) effects dental material (Attin et al.,2004)

Cosmetic dentistry has become an integral part of contemporary dental practice. Bleaching when combined with advanced restorative techniques and materials can optimize esthetic results. Resin composites are one of the most common and widely used materials in dentistry. For this reason, these tooth-coloured polymeric restorative

materials have been extensively studied and improved throughout the last three decades (Furus et al., 2008)

Today's methacrylate-based composites still have shortcomings that limit their applications. Recently, a new Silorane based composite resin has been introduced with a distinctive polymerization characteristic to reduce polymerization shrinkage. The Silorane matrix is formed by the cationic ring-opening polymerization of the Silorane monomers . The Silorane molecule represents a hybrid that is made of both siloxane and oxirane structural moieties (Weinmann et al., 2005)

Microhardness is one of the most important physic-mechanical properties that must be evaluated because of its influences on aesthetic, oral health and clinical longevity. Maximum surface hardness of composite resin restoration mean more surface resistance to indentation and scratching, so the effect of in-office bleaching treatment on the composite resins is very important to evaluate if any alteration can be happen on microhardness of composite resin restoration (Turker and Biskin.,2003)

The purpose of the present study was to investigate the effect of In-office bleaching agent on microhardness of two different composite restorations: Silorane-based composite and methacrylate-based composite material.

Materials and Method

By utilizing a specially designed cylindrical mold (8mm diameter, and 3mm depth); forty specimens of Filtek™ P90 (3M ESPE,USA) which is Silorane based composite and Filtek™ Supreme XT (3M ESPE,USA) which is methacrylate based composite of (8mm internal diameter and 3mm height)shade A3 were fabricated.

Each specimen was light cured through a translucent matrix strip and a glass microscope slide for the duration 40 seconds using Astralis 5 light curing device (Vivadent, Liechtenstein) at 500 mW/cm².All specimens were polished using Al₂O₃ Sof-Lex abrasive discs from coarse to superfine (3M ESPE,USA) under dry conditions for 20 seconds using a slow speed handpiece with a circular movement in one direction only (Barbosa et al.,2005) . The polishing of the composite samples was done immediately after light polymerization to simulate the clinical situation (Sturdevant et al.,2006). All samples were rinsed thoroughly with deionized distilled water and stored in incubator 37°C for 24 hours in plastic containers containing deionized distilled water (Olga et al.,2006).

Ten specimens of each material were served as control , while the other ten specimens were subjected to bleaching agent and served as experimental group. Each experimental composite sample was wiped with a piece of sterile cotton. 37.5% hydrogen peroxide gel (Pola office+, SDI) was applied using a disposable brush to paint the surface of each sample (Nadia.,2005)

The time of application was 8 minutes, during this time samples were exposed to light cure device and the tip of the curing device was as near as possible to the bleached surface, this step was repeated for three times for each sample, and this procedure was done for 3 weeks as recommended by the manufacturer instructions.

At the end of the bleaching procedure , the treated specimens were cleaned with a piece of cotton and rinsed under running distilled water for 2 minutes to remove any remnants of the bleaching agent, then placed in fresh distilled water in incubator 37°C until the next application or until the end of the time period (Zahira.,2000)

Surface microhardness was measured for all samples using digital microhardness tester (TH-751), with applied load of 50g for 5 second via Vickers diamond pyramid in which three indentations were made for each specimen and converted into VHN digitally by the testing machine. The average of three measurements were calculated

digitally and obtained as one reading .After indentation was made on the composite sample surface, the length of the two diagonals of the resulting indentation was measured using a calibrated eyepiece that reads in microns and the average of the two diagonals was recorded. The VHN was determined automatically by the testing machine.

Results

The mean , standard deviation, minimum and maximum values of VHN for all groups are illustrated in table (1).

Statistical analysis of data using t-test showed that there was a highly significant difference between Silorane (A1) and methacrylate (B1) based composite without bleaching (control group) $p < 0.01$, also there was a highly significant difference between Silorane group without (A1) and with (A2) bleaching.

There was a highly significant difference between Silorane groups without bleaching (A1) and bleached methacrylate groups (B2) . Student t-test also showed that there was no significant difference between methacrylate groups before bleaching (B1) and bleached Silorane group (A2) $p > 0.05$. There was no significant difference between methacrylate group without (B1) and with (B2) bleaching , also a highly significant difference between bleached Silorane (A2) and methacrylate (B2) groups $p < 0.01$ table (2)

Table (1) : Descriptive statistics of microhardness values (VHN) for all groups

	Groups	N	Mean	SD	Min. value	Max. value
A	A1*	10	742.81	103.59	634.5	964.1
	A2	10	317.72	11.07	308.1	331.9
B	B1*	10	292.65	71.03	213.9	427.8
	B2	10	227.15	13.93	214.4	245.3

*Control

Table (3) : Student t-test among groups

Groups	Mean difference	t-value	p-value	Sig.
A1XB1	450.16	11.333	$P < 0.01$	HS
A1XA2	425.085	7.993	$P < 0.01$	HS
B1XB2	65.5	1.788	0.099	NS
A2XB2	90.575	10.18	$P < 0.01$	HS

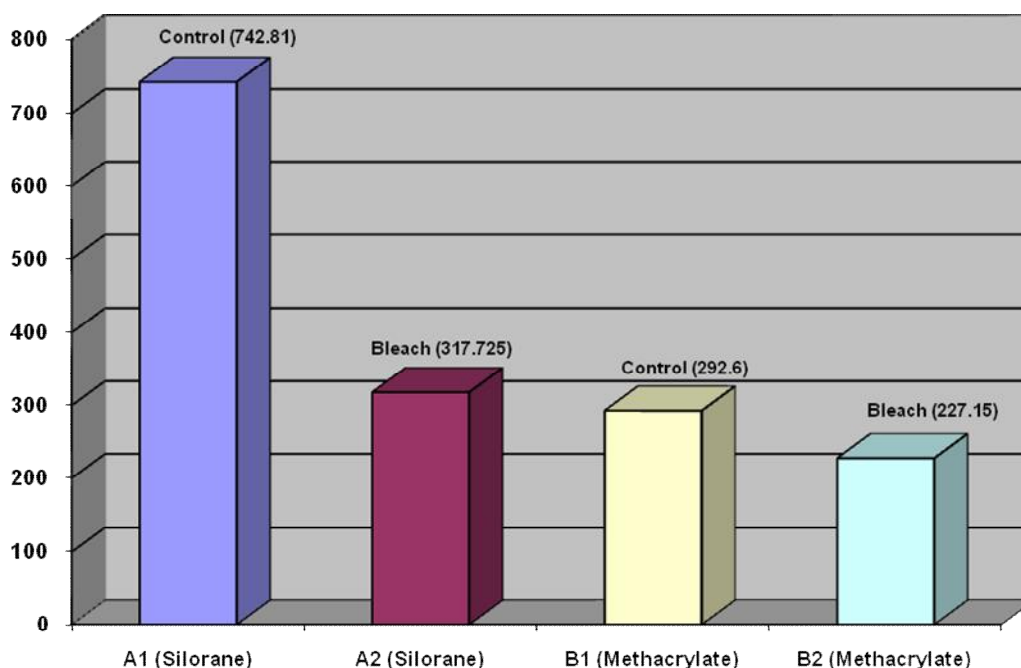


Fig. 1: Bar chart showing mean of microhardness values among different groups

Discussion

Composite-related factors affecting strongly surface hardness of the material include filler particle size , type, morphology , distribution , volume fraction. A positive correlation has been established between the hardness and inorganic filler content of resin composites (Kim et al.,2002)

Results of the present study reported that after bleaching treatment, there was a significant reduction in VHN values for both P90 and Supreme XT composite resins.

This reduction could be related to oxidation and degradation of the resinous matrix of the composite resin (Attin et al.,2004). Bleaching agents have a great effect on the resinous matrix of composite , hydrogen peroxide could diffuse through the organic matrix of the composite resin and because it is an oxidizing agent, it has the ability to produce free radicals, HO_2^- and O^- , the perhydroxyl free radicals (HO_2^-) are very reactive because these radicals have unpaired electrons and they are extremely electrophilic and unstable and will attack most other organic molecules to achieve stability (Haywood,2003). In another hand, the oxygen free radicals can break the bond between the polymer chain and the molecule of TEGDMA by combining to form molecular oxygen and water , these chemical processes might accelerate the degradation of composite resins (Attin et al.,2004).

The data of this study showed that Filtek™ P90 which is Silorane-based composite have higher microhardness than Supreme XT which is methacrylate-based composite , this may be attributed to the large filler particle size , filler type and high filler loading. Filtek™ P90 exhibited an average particle size of 0.04-1.7 μ m while Filtek™ Supreme XT have nano-particles of 20-70 nm which causes more light scattering and thus decreasing the effectiveness of the curing light causing lower degree of polymerization and conversion , resulting in softer resin matrix (Beun et al., 2007). Furthermore, the inorganic contents of Silorane-based composite are quartz particles, whose spatial orientation can be described as the crystalline solid of interconnected

SiO₄ tetrahedra and classified as tectosilicate . Conversely, methacrylate composite predominately consisted of glass, whose silica (SiO₂) structures have an amorphous (non-crystalline) orientation. The crystalline form is harder than non-crystalline form and it diffuses light more readily as it penetrate the composite resin (Lien and Vandewalle.,2010)

The VHN of Filtek™ P90 is higher than Filtek™ Supreme XT because of the cationic polymerization reaction. It is characterized by continuous ring-opening expansion initiated at the time of curing and promoted further cross-linking and hardening of the entire matrix. This cationic reaction is initiated by an acidic cation that allows stress relaxation , thereby, reducing polymerization contraction of the composite . This new monomer is capable of being polymerized and continuing the cationic reaction in dark which is called self or dark polymerization . The dark reaction usually is time dependent and may attribute to the strength and hardness of the material (Palin et al.,2005)

The difference in hardness between Silorane-based composite and methacrylate-based composite could be chiefly due to the uptake of water by the polymers. The methacrylate-based composite had resin matrices composed of Bis-GMA, Bis-EMA, and UDMA. Except for Bis-EMA, which is an ethoxylated version of Bis-GMA, other molecules (Bis-GMA and UDMA) have hydroxyl groups which promote water sorption. As for Filtek Silorane , it had 3,4 epoxy cyclohexyl cyclopolymethylsiloxane, the cyclosiloxane backbone imported hydrophobicity ,thereby curtailing water sorption therefore , the difference in chemical composition among the materials might have also contributed to the differences in hardness (Weinmann et al., 2005).

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