ORIGINAL ARTICLE

Effects of Two Different Bleaching Agents on the Microhardness of Composite

Tahmeena Atiq[1], Mian Farrukh Imran[2], Maleeha Khurram[1], Fahmoona Irfan[3], Hina Barkaat[4], Sarosh Iqbal[5]

Department of Dental Materials, University Medical and Dental College, Department of Prosthodontics, University Medical and Dental College, Department of Dental Materials, University Medical and Dental College, Department of Operative Dentistry, University Medical and Dental College, Department of Community Dentistry, University Medical and Dental College, Department of Oral Biology, University Medical and Dental College, Faisalabad, Pakistan.

ABSTRACT

Background: Various bleaching agents are used in different concentrations to overcome discoloration of teeth. The oxidizing nature of these bleaching agents can cause replacement of composite due to their negative physical and mechanical properties. The objective of this study was to check the effects of 16% Carbamide Peroxide and 35% Hydrogen Peroxide on the microhardness of composites.

Methods: Nanofiller composite and micro hybrid composite was used to prepare 30-disc specimens. The specimens were randomly divided into 6 groups of n=05 specimens only and there was no subdivision. The initial and final surface microhardness test of both composites was carried out before and after treatment of specimens with bleaching agents using a Microhardness Testing Machine. The values were noted as the final Vickers Hardness number value of individual specimen. All data were collected and analyzed by using SPSS and p-value of < 0.05 was considered statistically significant. ANOVA was used to determine microhardness values in the groups for comparison.

Results: There was a significant reduction in microhardness of micro hybrid composite ($p< 0.001$) after bleaching with 35% Hydrogen peroxide, but a little reduction was found in nanofiller composite (p=0.001). The slight reduction in hardness was also observed with micro hybrid composite after treatment with 16% Carbamide Peroxide (p=0.003), but no reduction was found in nanofiller composite (p=0.110). There was significant difference (p=0.068) between Nanofiller 16% and micro hybrid 35%.

Conclusion: Hydrogen peroxide (35%) showed a greater reduction in microhardness of composites compared to 16% Carbamide peroxide.

Keywords: Resin Composite; Microhardness; Bleaching Agents; Discoloration; Concentrations; Tooth Colored Restorations.

Corresponding Author:
Dr. Tahmeena Atiq
Department of Dental Materials,
University Medical and Dental College,
Faisalabad, Pakistan.
Email: asfafz@gmail.com
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INTRODUCTION

Currently, the development of new restorative materials has increased the demand for composites, which has been used for the last 50 years as it overcomes the shortcoming of amalgam and preserves tooth structure by making a chemical bond with it[1,2]. In addition, it not only fulfills the aesthetic demand of the patient but also has optimum physical and mechanical properties[3]. The quality and durability of the restoration depend upon certain properties like fracture toughness, flexural strength, and microhardness[4,5].

Dental composites are composed of the combination of inorganic fillers, silane coupling agents and organic matrix[1]. TEGDMA, Bis-GMA and UDMA forms the organic portion of the composite with higher molecular weight which causes decrease in polymerization shrinkage, aging and produces softer resin matrix[6,7]. Depending upon the size of filler particles composites are usually classified in the form of hybrids, macro fillers and microfillers[4,8]. Hybrid composites have good features of higher mechanical properties and wear resistance in contrast to micro filler, but micro filler has superior polish as well as glossy surface[9,10]. Nowadays a new class of composite known as nanocomposites is most widely used with filler particles in the range of 0.1-100 nm [11]. Due to high filler content, nanofillers have increase polish retention, translucency, optimum physical characteristics, and wear resistance[8,12].

Patients having composite restorations may demand whiter teeth to enhance their aesthetic appearance[13,14]. Bleaching agents were introduced by Haywood and Heyman and are now gaining popularity in improving the aesthetic form of patients because of their efficacy as well as safety[14-16]. Bleaching comprises 30-38 % hydrogen peroxide in the form of gel for in-office bleaching technique and 10 to 22 % carbamide peroxide in gel form for at-home bleaching technique[14,17]. This peroxide is decomposed to release free radicals, which undergo oxidation/reduction reactions. These free radicals split the double bond of pigmented molecules to smaller sizes that either are diffused out of the tooth or appear lighter due to less absorption of light[5,16]. Organic matrix in composite resin is more susceptible to be chemically altered as compared to other aesthetic restorations including ceramic or metal[13,14]. The impact of bleaching agents on certain properties of composites like surface hardness, surface roughness, staining susceptibility, microleakage, etc. have been examined by a lot of scholars[3,15,18].

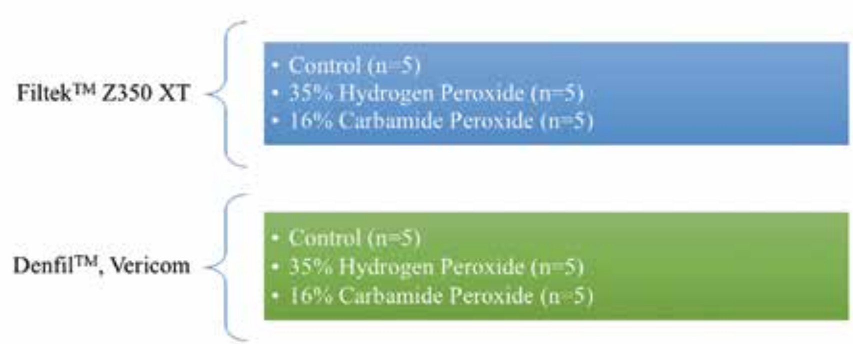
One of the most crucial physical properties of dental materials is their surface hardness, which describes the strength of the material and its ability to resist abrasion from opposing structures[13,16]. Bleaching results in chemical softening of organic portion of restoration, which raises objections on the clinical durability of composite[13]. Hence, it proves the aim of this research study, which states that, the microhardness of a nanofilled composite and a micro hybrid composite is reduced after the use of bleaching agents (16% carbamide peroxide and 35% hydrogen peroxide).

METHODS

Two different resin composite materials with A3 shade were selected in this study which include nanofill composite (Filtek™ Z350 XT, 3M ESPE, USA) and micro hybrid composite (Denfil™, Vericom, Korea). The research study also used the following bleaching materials; in office bleaching material Pola Office with 35% hydrogen peroxide, and at home bleaching material Pola Night with 16% carbamide peroxide concentration. The study was conducted in 2019; the ethical approval was obtained from the ethical review committee of the University of Faisalabad with reference number TUF/Dean/2019/08.

In total 30-disc specimens were prepared from micro hybrid and nanofiller composite using brass mold of 10 mm diameter and 2mm thickness. Firstly, the mold was covered with the very first transparent matrix strip and the glass slide underneath. Secondly, the mold was filled with the composite material following the manufacturer's instructions. Composite as a single component was syringed into the mold. Following the second step, the filled mold was covered using a second transparent matrix strip and glass slide from the above side that helped to remove access material from the mold and providing a smooth surface of the specimen. Light curing of material was done continuously through the top and bottom of the glass slide for 40 seconds using LED-curing light with a light intensity of 450mW/cm^2. After removal of strip, the specimens were polished using 800, 1200, 1500, 2000, grit silicon carbide papers and immersed in distilled water and ultrasonic bath for 3 min for the removal of debris and cleaning. Discs were then stored in distilled water for complete polymerization for 1 day. Thirty discs were divided into 6 groups each (05 discs /treatment group). All discs were kept in distilled water until the test was performed[13].

Sampling of the composite groups



An initial microhardness test for the composite was performed after the completion of polymerization. The discs were stabilized and placed in the Vickers microhardness-testing machine (Sinowon. TM- HVS 1000, China).

The indenter on the discs using 100g load for 20 seconds marked three indentations. There was a distance of 1mm between indentations. The average value was converted into Vickers hardness number (VHN) which was expressed in kg/mm^2. Thirty discs were divided randomly into 6 groups of n=05 specimens only and there was no subdivision. The 1 and 4 group were considered as control group and immersed in distilled water and the remaining were treated with bleaching agents. Specimens from group 2 and 5 were immersed in 16% carbamide peroxide once a day for 6 hours for the total duration of two weeks. Specimens from group 3 and 6 were immersed in 35% hydrogen peroxide once in a day for 45 min for two weeks.

After treatment, the specimens were washed with distilled water and a soft toothbrush for 1 min. During the hiatus period, the specimens were stored in screw top vials having distilled water. The distilled water was replaced on daily basis. After 15 days when the bleaching process was completed a quantitative evaluation of final microhardness values was taken. The values were inserted in the table as the final Vickers Hardness number value of individual specimen. The baseline and final obtained VHN for every specimen were statistically analyzed. The analysis of all the data was performed using SPSS. Mean±SD was calculated for quantitative assessment. ANOVA was used to determine microhardness values in the groups for comparison. Repeated measurements were applied to check differences in microhardness before and after the bleaching period. A *p*-value ≤ 0.05 was considered statistically significant.

RESULTS

The hardness was recorded pre and post treatment for various groups and difference in hardness along the percent of pretreatment was calculated as shown in Table 1.

Table 1: The hardness recorded pre and post treatment for various groups and difference in hardness along with percent of pretreatment.

Group	Hardness Pre	Hardness Post	Difference	*p* - Value
	Mean±SD	Mean±SD	Mean±SD	
Micro hybrid Control	72.09±5.72	69.63±3.67	2.466.39	0.158
Nanofiller Control	85.99±6.79	80.87±3.17	5.1 2±7.71	0.022
Micro hybrid (16%)	73.49±6.35	66.65±3.11	6.83±7.53	0.003
Nanofiller (16%)	94.25±7.03	90.34±5.54	3.91±8.88	0.11
Micro hybrid (35%)	77.63±7.02	65.88±4.54	11.75±8.57	< 0.001
Nanofiller (35%)	93.44±6.25	86.01±4.61	7.42±6.70	0.001

**p-value is calculated by using paired t-test between pre and post treatment for each group.*

Thus, only microhybrid composites, when treated with 35% hydrogen peroxide showed significant reduction in hardness with a *p*-value <0.001. The comparison among six groups was made by using One-way ANOVA. The pretreatment comparison was significant with *p*-value <0.001. It was the case for post treatment with *p*-value <0.001. As the pretreatment difference was significant so post treatment differences were not directly comparable. For this reason, the difference was calculated and compared among groups; the *p*-value was 0.026. As the base line, value also had a role in the post treatment hardness so the difference was calculated as percent of base line. The difference then again was highly significant with *p*-value 0.007. The post hoc analysis was performed for all four scenarios though the most important one was for the difference in percent as shown in Table 2.

Table 2: Comparison of mean hardness among six groups measured, pre-treatment, post treatment, difference between two readings and percent difference between two readings.

Comparison of Mean Hardness		Sum of Squares	Mean Square	*p*-Value
Hardness pre	Between Groups	7237.6	1447.5	< 0.001
	Within Groups	3598.4	42.8	
	Total	10836.0		
Hardness post	Between Groups	8368.9	1673.8	< 0.001
	Within Groups	1479.2	17.6	
	Total	9848.1		
Difference	Between Groups	796.2	159.2	0.026
	Within Groups	4959.7	59.0	
	Total	5755.9		
Difference %	Between Groups	1340.9	268.2	0.007
	Within Groups	6553.2	78.0	
	Total	7894.1		

The only significant difference was observed between Micro hybrid control and 35% groups with *p*-value 0.017. The difference between nanofiller 16% and micro hybrid 35% had a *p*-value 0.068. All other differences were non-significant as shown in Table 3.

Table 3: Group wise comparison of mean difference and mean percent difference in hardness among six groups.

Group (I)	Group (J)	Mean Difference (I-J)	*p*-Value	Mean % Difference (I-J)	*p*-Value
Micro hybrid Control	Nanofiller Control	-2.66	0.933	-2.52	0.970
	Micro hybrid (16%)	-4.37	0.628	-5.76	0.481
	Nanofiller (16%)	-1.45	0.995	-0.76	1.000
	Micro hybrid (35%)	-9.29*	0.017	-11.57*	0.007
	Nanofiller (35%)	-4.96	0.492	-4.76	0.681
Nanofiller Control	Micro hybrid (16%)	-1.71	0.990	-3.24	0.915
	Nanofiller (16%)	1.21	0.998	1.76	0.994
	Micro hybrid (35%)	-6.63	0.181	-9.05	0.066
	Nanofiller (35%)	-2.30	0.963	-2.24	0.982
Micro hybrid (16%)	Nanofiller (16%)	2.92	0.903	5.00	0.633
	Micro hybrid (35%)	-4.92	0.501	-5.81	0.470
	Nanofiller (35%)	-.59	1.000	1.00	1.000
Nanofiller (16%)	Micro hybrid (35%)	-7.84	0.068	-10.82*	0.015
	Nanofiller (35%)	-3.51	0.811	-4.00	0.816
Micro hybrid (35%)	Nanofiller (35%)	4.33	0.638	6.81	0.291

** Significant p-values*

DISCUSSION

In aesthetics dentistry, the material used for restoration should resemble close to natural tooth. A composite restoration reflects the enamel surface, which is hard to be seen by the naked eye[13]. The development of new aesthetic materials and expectations of patient aesthetics have led towards increased demand for composite resins in clinics[19].

In order to enhance aesthetics, patient demands bleaching. There are numerous bleaching systems available for the treatment and there is an active role of hydrogen peroxide and carbamide peroxide bleaching agents[20]. The difference of these two agents and their concentration can result in different effects including a decrease in hardness[13]. The previous studies have revealed both positive and negative effects of bleaching materials on the hardness of composite resins[19]. Softening of organic matrix from bleaching can have an effect on the microhardness of restorative materials and on the clinical durability of restorations[13]. Therefore, a need was identified for assessment of the effects of bleaching agents on composites.

The results for pre and post treatments to check the hardness for micro hybrid 16% carbamide peroxide the mean values pre and post treatments were 73.49±6.35 and 66.65±3.11 respectively with *p*-value 0.003. The *p*-value showed non-significant difference among pre-treatment and post treatment groups.

The study of Hatanaka et al. reported that 16% carbamide peroxide adversely affected microhybrid composites as compared to hybrid and nanofill composites[21]. The same Kamangar et al. discussed in their research study that there is visible reduction seen in the micro hardness of micro hybrid and nanofiller composite after the use of 15% carbamide peroxide and 40% hydrogen peroxide[2]. However, in another study by Solomon RV it was observed that bleaching with 10% carbamide did not significantly altered the microhardness of micro hybrid composite[22].

In addition, the results for pre and post treatments to check the hardness for microhybrid group with 35% hydrogen peroxidewere77.63±7.02 and 65.88±4.54 with *p*-value <0.001. The p-value showed significant difference among pre and post treatment groups. Youn-Soo also studied the effect of 25% hydrogen peroxide and revealed no effect on hardness for micro hybrid composite[23]. In addition to it, scholar Aleem et al. showed that there is significant reduction in hardness of nanofilled and hybrid composites when treated with 38% hydrogen peroxide and 36% carbamide peroxide[13].

Furthermore, the results for pre and post treatments to check the hardness for nanofiller group with 16% carbamide peroxide shows non-significant difference among pre-treatment and post treatment groups with *p*-value of 0.110 with a mean hardness of 94.25±7.03 and 90.34±5.54 for both groups, respectively. Hatanaka et al. observed similar findings in a study in which 16% carbamide peroxide showed no significant reduction in microhardness of nanofiller composites[21]. Bicer et al. also found that microhardness of tested nanocomposites was not affected by bleaching with 16% carbamide peroxide and 30% hydrogen peroxide[16]. On the other hand, Mona D revealed that there is a decrease in microhardness of nanocomposites when treated with 10% carbamide peroxide[24].

In addition, the results for pre and post treatments to check the hardness for nanofiller group with 35% hydrogen peroxide show significant difference pre-treatment and post treatment groups with *p*-value of 0.001 with a mean hardness of 93.44±6.25 and 86.01±4.61 for both groups, respectively. This result is consistent with the study of Atali and Topbasi who argued that 35% and 38% hydrogen peroxide and 35% carbamide peroxide had reduced the microhardness of nanohybrid, hybrid, nanosuper filled and silo Rane based composites[25]. Another study by Aleem et al. revealed that there is significant reduction in hardness of nanocomposites and hybrid composite after the use of 36% carbamide peroxide and 38% hydrogen peroxide[13]. However, study by Leal et al. reported that the 10% carbamide peroxide and 35% hydrogen peroxide did not affect the microhardness of the nanocomposites when evaluated[26].

Considering the limitations of this study different concentration of bleaching agents should be checked under the conditions of the oral cavity to evaluate the microhardness of composites. Controlled clinical studies should be performed to compare this study. The dentist should have some knowledge about the possible alterations that can be produced by the use of bleaching agents on composites. A patient should be informed that after using bleaching agents there are chances of replacement of existing restoration.

CONCLUSION

The micro hybrid composites showed a significant reduction in microhardness than nanofillers. Thus, 16% carbamide peroxide bleaching agent has little or no effect on microhardness of nanocomposites and micro hybrid. Thus, 35% hydrogen peroxide bleaching agent affected adversely on microhardness of nanocomposites and micro hybrid. Hence, for clinical decision-making, nanofilled composites are more appropriate for aesthetic restoration in patients desirous of bleaching while 16% carbamide peroxide has less effect as compared to 35% hydrogen peroxide.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS APPROVAL

The ethical approval was obtained from the ethical review committee of University of Faisalabad with reference number: TUF/Dean/2019/08.

AUTHORS' CONTRIBUTION

TA designed the study, analyzed the data and wrote manuscript. MFI suggested the topic, supervised the research. MK did literature review and done critical revision of whole manuscript.FI interpreted all the data for the manuscript. HB helped in specimen preparation.SI helped in designing the manuscript.

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