Effects of bleaching agents on the micro hardness of composite materials; a tooth colored restorative material

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Abstract

Over the last several decades, tooth bleaching has been considered as one of the most popular cosmetic dentistry procedures which have been linked to changes in the surface and subsurface micro-hardness, color, surface topography and surface roughness, of restorative substances. The aim of the study is to evaluate the effects of bleaching agents on the micro-hardness of tooth colored restorative materials. This study was carried out from 1st July, 2021 to 31st December, 2021 at the Department of Dental Materials, Sardar Begum Dental College, Gandhara University, Peshawa. Nanofill composite and micro hybrid composite, were used in our study to prepare 30 disc samples. Power bleaching material Pola Office (with 35% hydrogen peroxide) and night guard vital bleaching material Pola Night (with 16% carbamide peroxide concentration) were used as bleaching agent in our study. After the bleaching procedure the final micro hardness values were quantified. SPSS version 23 was used to analyze all of the results. The mean (±SD) difference in micro hardness of microhybrid composite materials after bleaching with 35% hydrogen peroxide and 16% carbamide peroxide was 8.88 (0.95) and 7.38 (2.0) respectively. While the mean (±SD) difference in micro hardness of nanofill composite material after bleaching with 35% hydrogen peroxide and 16% carbamide peroxide was 7.90 (2.09) and 4.25 (1.10) respectively. Only microhybrid composite materials shows statistically significant reduction in micro hardness after treatment with 35% hydrogen peroxide (p=0.021). In our study, significant micro hardness reduction occurs in micro hybrid composites by using 35% hydrogen peroxide. No or little affect was observed on micro hardness of nanocomposites and micro hybrid with 16% carbamide peroxide bleaching agent.

Keywords: *Mmicro-hardness; Composite restorative materials; Bleaching agents.*

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Introduction

Over the last several decades, tooth bleaching has been considered as one of the most popular material in cosmetic dentistry procedures. Although there are various options for treating discolored teeth but bleaching of teeth is found to be the most effective treatment among the individuals who wants to enhance their dental aesthetics (Tin-Oo, Saddki, & Hassan, 2011). Furthermore, as reported by Clinical Research Associates, 97% of dentists offer bleaching of teeth in their clinics, and the success rate of tooth bleaching therapy is 79 % (Thejeswar, 2018). In 1877, bleaching of teeth was described in the research as a cosmetic therapeutic approach (Feinman, GOLDSTEIN, & and GARBER, 1987). In-office bleaching (power bleaching), at-home bleaching (night guard vital bleaching), and over-the-counter (OTC) bleaching chemicals are the three primary kinds of teeth bleaching options available today. Majority of in-office and at-home bleaching treatments have been demonstrated to be successful, while outcomes may change based on variables such as stain type, bleaching chemical, and treatment regimen (Burrows, 2009; Matis, Cochran, & Eckert, 2009; Sulieman, 2008). Furthermore, over-the-counter bleaching treatments are readily available around the globe as a low-cost substitute for conventional bleaching chemicals. But, there is limited clinical evidence on the safety and efficacy of OTC products (Demarco, Meireles, & Masotti, 2009).

Nowadays, teeth bleaching agents are mostly composed of hydrogen peroxide (HP) or carbamide peroxide (CP). When CP is in contact with tissues or saliva, it degrades quickly into roughly one-third HP and two-thirds urea. HP produces reactive oxygen molecules, free radicals and anions, all of which function as potent oxidizing agents (Joiner, 2006). Potentially harmful alterations to the teeth and restorative substances may occur when the bleaching chemical comes into direct contact with teeth and their related restorations. Thus, worries concerning bleaching implications on tooth restoration substances have been reported in numerous studies (El-Murr, Ruel, & St-Georges, 2011; Li, 2011; Yu, Li, Wang, & Cheng, 2013). Bleaching agents have been linked to changes in the surface and subsurface micro hardness, color, surface topography and surface roughness, of restorative substances. Other research, on the other hand, implies that the bleaching impact on restoration materials is clinically insignificant (Attin, Hannig, Wiegand, & Attin, 2004; El-Murr et al., 2011). Based on literature and to best of our knowledge there is no such study has been conducted in Khyber Pakhtoonkwa, Pakistan. As a result, this study was undertaken with the goal of finding the impact of bleaching materials on tooth restorative materials and providing dental researchers and practitioners with evidence-based suggestions.

Materials and methods

This study was carried at the Department of Dental Materials, Sardar Begum Dental College, Gandhara University, Peshawar. The study duration was six months from 1st July, 2021 to 31st December, 2021. In our study, two different composite materials, nanofill composite (FiltekTM Z350 XT, 3M ESPE, USA) and micro hybrid composite (DenfilTM, Vericom, Korea), were used. Two different bleaching agent were used in our study. These includes, power bleaching material Pola Office (with 35% hydrogen peroxide) and night guard vital bleaching material Pola Night (with 16% carbamide peroxide concentration). Study approval was taken from the ethical and research committee of the hospital. Brass mold with a diameter of 10mm and thickness of 2mm was used to divide the nanofiller composite and micro hybrid composite materials into 30 discs samples. Transparent matrix strip was initially used to cover the mold with underneath glass slide. Then following the instructions of manufacturing company, composite materials were put into the mold. With the help of syringe, the composite was put into the mold as a single component. A second transparent matrix strip and a glass slide from the upper side were used to cover the filled mold after the second stage, which assisted in removing accessibility of material from the mold and giving the specimen a smooth surface. For 40 seconds, LED-curing light with a light intensity of 450mW/cm2 was used to light cure the material constantly through the top and bottom of the glass slide.

After removing the strip, the samples were treated with 800, 1200, 1500, and 2000 grit silicon carbide papers before being submerged in distilled water and cleaned in an ultrasonic bath for 3 minutes. After that, the discs were placed in distilled water for one day to complete polymerization but avoid into contact with composite during polymerization. Six groups were made from the thirty discs. These six groups includes Micro hybrid (16%), Micro hybrid (35%), Nanofiller (16%), Nanofiller (35%), Micro hybrid Control and Nanofiller Control. Until the test, all of the discs were retained in distilled water (Aleem, Amin, Ahmed, & Tariq, 2017a). After the polymerization process was completed, the composite was subjected to an initial microhardness test. Stabilized discs were inserted in the Vickers micro hardness testing equipment (Sinowon. TM- HVS 1000, China) and tested for hardness.

Three indentations were made on the discs using a 100g load for 20 seconds. Between indentations, there was a 1mm gap. After converting the average result to a Vickers hardness number (VHN), they were reported in kg/mm2. The control groups (1 and 4) were submerged in distilled water, while the others were bleached. For a total of two weeks, specimens from groups 2 and 5 were engrossed in 16 % carbamide peroxide for 6 hours once a day. For two weeks, specimens from groups 3 and 6 were engrossed in % hydrogen peroxide for 45 minutes once a day.

The samples were then cleaned for 1 minute with distilled water and a gentle toothbrush after treatment. Samples were kept in screw-top vials filled with distilled water for the duration of the break. Every day, the distilled water was changed. After the bleaching procedure had been finished for 15 days, the final micro hardness values were quantified. The data were entered into the table as the individual specimen's final Vickers Hardness number value. Every specimen's baseline and final acquired VHN were statistically evaluated. SPSS version 23 was used to analyze all of the results. For quantitative evaluation, the mean (SD) was determined. The ANOVA test was used to calculate the micro hardness values in the comparative groups. Micro hardness was measured repeatedly before and after the bleaching phase to see whether there were any variations. Statistical significance was defined as a *p*-value of less than 0.05.

Results

In this study two composites material (microhybrid composite and nanofill composite) were used. The micro hardness was recorded before and after treatment of composites materials with bleaching agent. The mean (SD) micro hardness for the microhybrid composite and nanofill composite material before bleaching was 72.99 (4.16) and 93.81 (5.21) respectively. The mean (SD) micro hardness for the microhybrid composite and nanofill composite material after bleaching with 16% carbamide peroxide was 65.61 (2.16) and 89.56 (4.11) respectively.

The mean (SD) micro hardness for the microhybrid composite and nanofill composite material after bleaching with 35% hydrogen peroxide was 64.11 (3.21) and 85.91 (3.12) respectively. (Figure 1) The mean (SD) difference in micro hardness of microhybrid composite materials after bleaching with 35% hydrogen peroxide and 16% carbamide peroxide was 8.88 (0.95) and 7.38 (2.0) respectively while the mean (SD) difference in micro hardness of nanofill composite material after bleaching with 35% hydrogen peroxide and 16% carbamide peroxide was 7.90 (2.09) and 4.25 (1.10) respectively. Only microhybrid composite materials showed statistically significant reduction in micro hardness after treatment with 35% hydrogen peroxide (p=0.021) (Table

1).

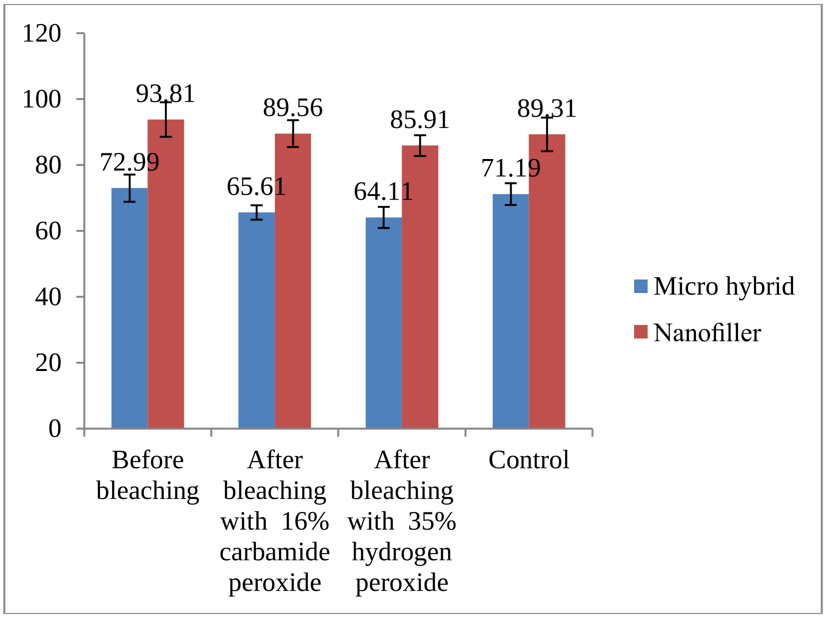

Figure 1: Micro hardness of composites materials before and after bleaching agent

Table 1:
Reduction in micro hardness of composites material after bleaching agents

Group name	Post treatment Mean difference	P value
Micro hybrid (16%)	7.38 (2.0)	0.831
Micro hybrid (35%)	8.88 (0.95)	0.021
Nanofiller(16%)	4.25 (1.10)	0.072
Nanofiller(35%)	7.90 (2.09)	0.061
Micro hybrid Control	1.80 (0.89)	0.091
Nanofiller Control	4.50 (0.11)	0.079

Discussion

The substance utilized for aesthetic purpose should be ideally of tooth color material. The enamel surface, which is difficult to detect with the naked eye, is reflected by a composite repair (Aleem, Amin, Ahmed, & Tariq, 2017b). Growing need for composite resins in hospitals has resulted from the introduction of novel aesthetic materials and patient aesthetic expectations (Al-Angari, Eckert, & Sabrah, 2021).

There are a variety of bleaching techniques accessible for the therapy, with hydrogen peroxide and carbamide peroxide bleaching chemicals playing a key role (Karatas, Ilday, Bayindir, Duzyol, & Seven, 2020). The concentration variation between these two substances may have a variety of consequences, including a reduction in hardness (Aleem et al., 2017b). Previous research has shown that bleaching compounds have both good and negative impact on composite resins hardness (Al-Angari et al., 2021). Bleaching may soften the organic matrix, reducing the micro hardness of restorative materials and reducing the clinical durability of restorations (Aleem et al., 2017b). Thus, evaluation of effectiveness of bleaching agents on the composites is needed

In our study, the mean (SD) micro hardness for the microhybrid composite and nanofill composite material before bleaching was 72.99 (4.16) and 93.81 (5.21) respectively. The mean (SD) micro hardness for the microhybrid composite and nanofill composite material after bleaching with 16% carbamide peroxide was 65.61 (2.16) and 89.56 (4.11) respectively. The mean (SD) micro hardness for the microhybrid composite and nanofill composite material after bleaching with 35% hydrogen peroxide was 64.11 (3.21) and 85.91 (3.12) respectively. In accordance with our study, Hatanaka et al. reported that 16% carbamide peroxide had a negative effect on microhybrid composites by comparing with hybrid and nanofill composites (Hatanaka, Abi-Rached, Almeida-Junior, & Cruz, 2013). Same findings were reported by Kamangar et al. who highlighted that after using 15% carbamide peroxide and 40% hydrogen peroxide, a noticeable decrease in the micro hardness of micro hybrid and nanofiller composites was observed (Kamangar, Kiakojoori, Mirzaii, & Fard, 2014). The micro hardness of micro hybrid composites was not significantly affected by bleaching with 10% carbamide in another study (Solomon, Byragoni, Jain, Juvvadi, & Babu, 2016).

In our study, the mean (SD) difference in micro hardness of microhybrid composite materials after bleaching with 35% hydrogen peroxide was 8.88 (0.95) ($p=0.021$). Youn-Soo also looked into the impact of 25% hydrogen peroxide on the hardness of micro hybrid composite and found that it had no influence (Youn-Soo, 2015). Furthermore, researcher Aleem et al. demonstrated that when nanofilled and hybrid composites are subjected with 38 % hydrogen peroxide and 36 % carbamide peroxide, the hardness of the composites is significantly reduced (Aleem et al., 2017a).

In our study, the mean (SD) difference in microhardness of nanofill composite material after bleaching 16% carbamide peroxide was 4.25 (1.10) ($p=0.072$). In accordance with our findings the micro hardness of nanofiller composites was not significantly reduced by 16% carbamide peroxide in a research conducted by Hatanaka et al. (Hatanaka et al., 2013). Bleaching with 16% carbamide peroxide and 30% hydrogen peroxide had no effect on the studied nanocomposites' micro hardness, according to Bicer et al. (Bicer, Oz, & Attar, 2017). When 10% carbamide peroxide is used to treat nanocomposites, Mona D et al. found that the micro hardness decreases (Mona & Rismayansari, 2019).

According to our findings, the mean (SD) difference in micro hardness of nanofill composite material after bleaching with 35% hydrogen peroxide was 90 (2.09) (p=0.061). This finding is in line with the previous study, who found that the micro hardness of nanofilled composites was lowered by 35% and 38% hydrogen peroxide and 35% carbamide peroxide (Atali & Buuml, 2011). Another research by Aleem et al. found that using 36 % carbamide peroxide and 38 % hydrogen peroxide reduced the micro hardness of nanocomposites and hybrid composites significantly (Aleem et al., 2017a). Yet, Leal et al. showed that when 10% carbamide peroxide and 35% hydrogen peroxide were examined, they had no effect on the micro hardness of the nanocomposites (Leal et al., 2015).

Conclusion

In our study, significant micro hardness reduction occurs in micro hybrid composites by using 35% hydrogen peroxide. Either no or little affect was observed on micro hardness of nanocomposites and micro hybrid with 16% carbamide peroxide bleaching agent. As a result, for clinical management, nanofilled composites are more appropriate for cosmetic restoration in bleaching patients, whereas 16% carbamide peroxide has less impact than 35% hydrogen peroxide.

Recommendations

Our study recommends that various concentrations of bleaching agents should be tested in the oral cavity to assess composite micro hardness. To compare this research, controlled clinical trials should be conducted. The dentist should be aware of the potential changes that might be caused by the application of bleaching agents on composites. After utilizing bleaching chemicals, a patient should be advised that the present restoration may need to be replaced.

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