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# The Effect of Three Different Mouthrinses on the Surface Hardness, Gloss and Colour Change of Bleached Nano Composite Resins

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**Abstract -** *This in vitro study evaluated the effects of three mouthrinses (Listerine - alcohol containing, Oral B - alcohol free and Rembrandt Plus - peroxide whitening rinse) on the surface hardness, gloss and colour of a nanofill (Filtek Supreme) and nanohybrid (Simile) composite resin that had been subjected to bleaching treatment. 30 specimens of each material were fabricated and randomly divided into three groups of 10. The hardness, gloss and CIE Lab colour parameters of each specimen were assessed prior to the experiments. Specimens were exposed to the 10% carbamide peroxide bleaching agent (Vivastyle) for 2 hours per day for 14 days. Following the bleaching treatment measurements were repeated. The specimens were then conditioned with mouthrinses for 12 hours which was equivalent in time to 1 year of two minutes daily use. The specimens were measured again for hardness, gloss and colour and data were subjected to the statistical analysis. The result of this study showed no statististical difference between the restorative materials after bleaching and the use of mouthrinses ($p > 0.05$). Bleaching treatment and the use of mouthrinses affected the hardness, gloss and colour of both resins. Significant differences were observed with the use of mouthrinses for all parameters ($p < 0.05$). Rembrandt Plus promoted the greatest changes, followed by Listerine and Oral B.*

KEY WORDS: Nanofill-nanohybrid composites, bleaching, mouthrinses

## INTRODUCTION

The use of patient administered peroxide containing bleaching products has become increasingly popular for whitening vital teeth, showing good clinical long term results and great patient satisfaction since their introduction by Haywood and Heymann[1]. As these products contact tooth structures for extended periods of time and possibly inadvertently come into contact with dental materials, the effects of bleaching products on dental hard tissues and dental materials have attracted much attention in the literature[2-4]. The influence of various bleaching agents on physical properties, surface morphology and colour of different restorative materials has been investigated in several *in vitro* studies simulating the clinical situation as closely as possible. Some studies report alterations in the surface morphology of the dental materials and also changes in their chemical and physical properties; whereas other studies have found no changes[5-8].

Whilst mouthrinses have been in use for centuries as breath fresheners, medicaments and antiseptics, it is only more recently that mouthrinses have been given much credence as preventive agents against dental disease. The role of dental plaque in caries and periodontal disease changed the perception of mouthrinses by the dental profession, and has led to an upsurge in the search for anti-plaque agents[9]. Although several *in vitro* and in vivo studies have evaluated the effects of mouthrinses on chemical plaque control[9], there have been a limited number of studies into their effects on restorative materials. Some clinicians have expressed concern about their effects on tooth coloured restorations[10,11].

Maintaining dental restorations in the mouth after bleaching is a major challenge in restorative and preventive dentistry. Adhesion of oral plaque bacteria may influence the restorative materials. Besides mechanical means, such as brushing and flossing, mounthrinses are commonly utilized, especially in those individuals who have already undergone extensive restorative treatment. Recently, composites with nanometer - size particles have been introduced to the dental market[12,13]. Although some work has already been conducted on the effects of mounthrinses on the composites or compomers[10,11], the effects of mouthrinses on the composites with nanofiller particles has not been investigated. Therefore, we hypothesize that the use of mouthrinses could affect these restorative materials that had bleaching treatment.

This *in vitro* study investigated first, the effect of bleaching with 10% carbamide peroxide on nanofill and nanohybrid composites and then the effects of three different mouthrinses on these bleached composites.

## MATERIALS & METHODS

A nanofill (Filtek Supreme) and a nanohybrid (Simile) composite resin were selected for the study. Table 1 shows the technical profiles of the restorative materials evaluated. Thirty specimens of each restorative material were fabricated using plexiglass moulds (30 x 30 x 2 mm) covered by polyethylene sheets and pressed flat with glass plates[14].

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**Table 1.** *Technical Profiles of the Restorative Materials Evaluated.*

| | *Manufacturer* | *Shade* | *Material type* | *Matrix* | *Filler Size* | *Filler Volume (%)* |
|---|---|---|---|---|---|---|
| *Filtek Supreme* | 3M, St Paul MN USA | A3 | Nanofill composite | TEGDMA, UDMA Bis- EMA, silica and glass zirconium silicate | Zirconia-silica 0.6-1.4 µ Silica 5-20nm | 59 |
| *Simile* | Pentron, Wallingford USA | A3 | Nanohybrid composite | PCBisGMA,UDMA HDDMA, Silica and barium-zirconium silicate | Barium- glass 0.6-0.7µ Silica 20-40nm | 66 |

**Table 2.** *Chemical Composition of the Bleaching Agent and Mouthrinses.*

| | | |
|---|---|---|
| *Bleaching Agent* | | |
| VIVASTYLE (10%Carbamide peroxide) | Vivadent,Schaan LIECHTENSTEIN | Glycerine, buffered polycarboxylic acid, peppermint oil |
| *Mouthrinses* | | |
| ORAL B (alcohol free) | Oral B Laboratories Belmont, CA, USA | Purified water, glycerin, polysorbote 20, flavor methyl paraben, cetylpyridinium chloride, sodium fluoride, sodium saccharin, sodium benzoate propylparaben, c142051, c147005 |
| LISTERINE (alcohol containing) | Warner-Lambert Co Morrisplains, NJ, USA | Water, ethanol, thymol, eucalyptol, metil salicyalate, menthol, benzoic acid, poloxamer 407, caramel |
| REMBRANDT PLUS (peroxide whitening rinse-alcohol free) | Denmat Corp Santa Maria, CA, USA | Hydrogen peroxide solution, sodium hydroxide, saccharine,cocamido propyl betaineglycerin,sodium citrate,PEG40 hydrogenated castor oil |

Materials were placed incrementally in three stages and cured for 40 seconds after each increment with a curing light (Hilux Expert) through the glass and polyethylene sheets on the top and bottom of the specimens. The intensity of the light curing unit was checked before each sample run, using a curing light meter (Hilux Dental curing meter). Immediately after polymerization, the polyethylene sheets were discarded and the specimens were stored in distilled water for 24 hours at 37°C.

Finishing and polishing of the specimens were performed using a sequential series of Sof-Lex discs always keeping the restoration surface wet. The specimens were randomly divided into three groups of ten.

Surface hardness number, CIE Lab and gloss values of each specimen were evaluated prior to experiments. The surface hardness of the specimens was assessed using a Tukon tester. A 500g load was applied through the Knoop Indentor with a dwell time of 17 seconds. Four indentations were made and measured at different points on each specimen and an average value was determined from each specimen.

The gloss values were measured with a gloss meter. The gloss meter was calibrated before each recording session with a standard specimen supplied by the manufacturer. To calibrate the instrument, a highly polished black glass with a refractive index of 1.567 was used. The glass had an assigned specular gloss value of 100 for each geometry.

Colour measurements were made with an ultraviolet visible recording spectrophotometer against a white background using CIE Lab colour space relative to CIE standard illuminant. The colour difference (ΔE) was calculated as follows: [15, 16]

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Where L* is lightness, a* is green-red (-a* = green, + a* =red), and b* is blue-yellow (-b*= blue, +b* =yellow). A perceptible discolouration that is $\Delta E > 1.0$ will be referred to as acceptable up to the value $\Delta E = 3.3$ in subjective visual evaluations made *in vitro* under optimal lighting conditions [17].

The specimens were then treated with 10 % carbamide peroxide (Vivastyle) for 2 hours per day for 14 days according to the manufacturer's recommendations. During the test period the specimens were kept in a humidor at 37°C and 100 % relative humidity. At the end of this treatment period, the specimens were rinsed with distilled water to remove the bleaching agent and hardness, gloss and colour measurements were recorded again. The specimens were then immersed in 20 ml of three mouthrinses (Listerine - alcohol containing; Oral B - alcohol free and Rembrandt Plus - peroxide whitening rinse (Table 2) for a total of 12 hours, which is equivalent in time to one year of two minutes daily use[10,18,19]. Mouthrinses were changed every hour and the specimens immersed in the mouth rinses were shaken to prevent chemical equilibrium around the restoration surface, and kept at 37°C throughout the experiments. At the end of the specified time period, the specimens were removed and rinsed with distilled water. They were subjected again to hardness, gloss and colour testing.

The data were analyzed statistically. Repeated measures of Anova test was used to compare the effects of bleaching and mouthrinses on hardness and gloss of each material. Paired t-tests were performed to determine any significant change in colour.

## RESULTS

Table 3 shows the mean hardness (KHN) values and SDs of restorative materials. The bleaching agent, Vivastyle and all the mouthrinses tested decreased the hardness values of both composites ($p< 0.05$). Rembrandt Plus (peroxide whitening mouthrinse) showed the smallest KHN value (47.7 for Filtek Supreme and 47.5 for Simile). No significant difference was observed between the Filtek Supreme and Simile in the KHN values ($p> 0.05$).

Table 4 shows the mean gloss values and SDs of the tested composite resins. The gloss values of materials were also affected by the bleaching agent and mouth rinses. The bleaching agent, Vivastyle and the mouthrinses decreased the gloss values ($p<0.05$). No significant difference was seen between the two composite resins ($p>0.05$). Rembrandt Plus showed the smallest gloss values (88.2) for both of the composite resins.

Colour values of the restorative materials are presented at Table 5. No significant difference was seen between the colour changes ($\Delta E$) of the restorative materials ($p> 0.05$). Both restorative materials demonstrated significantly higher colour change with Vivastyle and mouthrinses ($p< 0.05$). However, after the materials were treated with mouth rinses, Filtek Supreme, treated with Listerine (3.42) and Rembrandt Plus (4.15) showed colour values greater than clinically accepted $\Delta E$ ($\Delta E >3.3$). Simile, treated only with Rembrandt Plus (4.08) showed colour values greater than 3.3. Among the tested mouth rinses, Rembrandt Plus showed the highest colour change followed by Listerine and Oral B ($p<0.05$).

**Table 3.** *Hardness Values (KHN) of Restorative Materials ( $\overline{X}$: mean, SD: Standard Deviation, n: number of specimens).*

| | *Before Bleaching* | *After Bleaching with 10% carbamide peroxide* | *After treatment with mouth rinse* | |
|---|---|---|---|---|
| n=10 | $\overline{X}$ (SD) | $\overline{X}$ (SD) | $\overline{X}$ (SD) | p |
| FILTEK SUPREME | 53.2 (1.72) | 51.2 (1.80) | Oral-B 49.1 (1.85) | < 0.05 |
| | 53.4 (1.84) | 51.3 (1.84) | Listerine 48.3 (1.83) | < 0.05 |
| | 53.8 (2.54) | 51.7 (2.54) | Rembrandt Plus 47.7 (2.56) | < 0.05 |
| SIMILE | 53.2 (1.93) | 51.2 (2.01) | Oral-B 49.1 (1.97) | < 0.05 |
| | 53.7 (2.25) | 51.3 (2.58) | Listerine 48.3 (2.68) | < 0.05 |
| | 53.8 (2.23) | 51.7 (2.16) | Rembrandt Plus 47.5 (2.16) | < 0.05 |

**Table 4.** *Gloss Values of Restorative Materials ( $\overline{X}$: mean, SD: Standard Deviation, n: number of specimens).*

| | *Before Bleaching* | *After Bleaching with 10% carbamide peroxide* | *After treatment with mouth rinse* | |
|---|---|---|---|---|
| n=10 | $\overline{X}$ (SD) | $\overline{X}$ (SD) | $\overline{X}$ (SD) | p |
| FILTEK SUPREME | 95.0 (0.84) | 92.9 (0.86) | Oral-B 90.9 (0.86) | < 0.05 |
| | 94.7 (1.02) | 92.6 (1.02) | Listerine 89.5 (1.01) | < 0.05 |
| | 94.4 (0.88) | 92.3 (0.90) | Rembrandt Plus 88.2 (0.94) | < 0.05 |
| SIMILE | 94.7 (1.25) | 92.8 (1.32) | Oral-B 90.7 (1.31) | < 0.05 |
| | 94.6 (1.04) | 92.6 (1.03) | Listerine 89.5 (0.98) | < 0.05 |
| | 94.5 (1.06) | 92.4 (1.08) | Rembrandt Plus 88.2 (1.04) | < 0.05 |

**Table 5.** *Colour Change (ΔE) of the Restorative Materials. ( $\overline{X}$: mean, SD: Standard Deviation, n: number of specimens).*

| | $\Delta E_B$ $\overline{X}$ (SD) | $\Delta E_M$ $\overline{X}$ (SD) | p |
|---|---|---|---|
| FILTEK SUPREME | *2.41 (0.13)* | $\Delta E_{OB}$ 2.89 (0.39) | < 0.05 |
| | *2.41 (0.19)* | $\Delta E_L$ 3.42 (0.30)* | < 0.05 |
| | *2.78 (0.48)* | $\Delta E_R$ 4.15 (0.04)* | < 0.05 |
| SIMILE | *2.38 (0.31)* | $\Delta E_{OB}$ 2.96 (0.43) | < 0.05 |
| | *2.51 (0.44)* | $\Delta E_L$ 3.14 (0.80) | < 0.05 |
| | *2.69 (0.44)* | $\Delta E_R$ 4.08(0.50)* | < 0.05 |

$\Delta E_B$ :Colour change after bleaching, $\Delta E_M$: Colour change after Mount rinses, $\Delta E_{OB}$: Colour change after Oral B, $\Delta E_L$ : Colour change after Listerine, $\Delta E_R$ : Colour change after Rembrandt Plus
*indicates clinically unacceptable value (ΔE > 3.3)

## DISCUSSION

The fact that the bleaching agent is held in intimate contact with the teeth and potentially associated restorations, the possibility could exist that the agents may cause physical alterations of the teeth and the restorative materials. Studies investigating the effects on restorative materials after long-term exposure to carbamide peroxide solutions have reported somewhat conflicting results. Cooley and Burger[20] reported a significant change in hardness of microfill and hybrid composite resins subjected to 10% carbamide peroxide bleaching agents. In a similar study, Bailey and Swift[6] found that hardness of hybrid and microfilled composites had decreased. Blackwell et al.[21] observed little changes of micro, macro and hybrid composites after exposure to bleaching gels whereas Gurgan and Yalcin[22] reported decreased hardness of a flowable composite with 10% carbamide peroxide.

For standardized and reproducible evaluation of colour changes of restorative materials, colourimeters are used according to the CIE Lab System[15,16]. It has been claimed that under clinical conditions in the mouth, colour differences have been reported to be relevant and perceptible only when higher than 3.3[17] or 3.6[23]. Application of 10% carbamide peroxide led to colour changes of composites less than ΔE 2 and these were comparable to colour changes of unbleached samples [24, 25]. In another study by Yalcin and Gurgan [14], the gloss of flowable and packable composites was shown to be changed by 10% carbamide peroxide.

In this study, the two new composite resin materials with finer inorganic particles produced by means of nanotechnology were used. The objective of these materials was to be used in all areas of the mouth with high initial polish and superior polish retention (typical of microfills), as well as excellent mechanical properties suitable for high stress-bearing restorations (typical of hybrid composites)[26]. Ten percent carbamide peroxide bleaching agent, Vivastyle, decreased the hardness and gloss of the nanofill and nanohybrid composites but the colour change was lower than ΔE 3.3 for both restoratives.

Characteristics of the restorations, such as modification in the filler technology, filler distribution and the filler loading and the alterations in the matrices of the resins appear to be related with these changes. Despite such wide variations in the characteristics of the restoratives, carbamide peroxide gel was more likely to cause these changes by its oxidation effect[27,28].

The use of mouthrinses is highly recommended for oral health and also for the clinical durability of restorations[10,11]. The mouthrinses tested were selected to represent the range of commercially available products: Alcohol-containing (Listerine), alcohol-free (Oral-B) and peroxide whitening rinse, Rembrandt Plus (with hydrogen peroxide). Rembrandt Plus was claimed by the manufacturer to ensure the longevity of the bleaching treatment. All tested mouthrinses affected the hardness, gloss and colour of the bleached materials but there was not any difference between the composites.

Yap et al.[11] demonstrated that the effect of mouthrinses on composite and compomers was material dependent and the materials were softened by the alcohol containing mouthrinse. Weiner et al.[29] and Penugonda et al.[30] also found that high alcohol containing mouthrinses could soften composites. Both BIS GMA and UDMA-based polymers are susceptible to chemical softening by ethanol [24]. In addition to the effect on the resin matrix, the chemical component of the mouthrinses could also degrade the inorganic fillers and filler resin interface.

In the present study, Rembrandt Plus, seemed to be more effective than the alcohol containing Listerine. This could explain that alcohol was not the only factor that has a softening effect on composite materials. The effect of Rembrandt Plus on the restorative material may be attributed to oxidation of the surface pigments and amine compounds which have also been indicated as responsible for colour instability of restorative materials over time[5].

It is important to remember that this is an *in vitro* study and clinically, the effects of mouthrinses on restoratives may be modified by many factors in the mouth that could not be replicated in an *in vitro* study. However, the relation-

ship between mouthrinses and dental restorative materials requires further investigation in vivo.

## CONCLUSION

1. 10 % carbamide peroxide and mouthrinses affected the hardness, gloss and colour of the nanofill and nanohybrid composites.
2. The effects of bleaching and mouthrinses were not material dependent.
3. The peroxide whitening rinse Rembrandt Plus showed smaller hardness and gloss values and higher colour change than the alcohol containing mouth rinse Listerine and followed by alcohol-free Oral B.

## MANUFACTURERS' DETAILS

- Filtek Supreme/3M Dental Products, St Paul, MN, USA.
- Simile/ Pentron, Wallingford, USA.
- Hilux Expert/ Benlioğlu Dental Inc, Ankara, Turkey.
- Hilux Dental curing meter/ Benlioğlu Dental Inc, Ankara, Turkey.
- Sof-Lex discs/3M Dental Products, St Paul, MN, USA.
- Tukon tester/ Wilson Mechanical Instrument Division, Model LL, American Chain and Cable Co. Inc, New York, USA.
- Gloss meter/ Sheen Instruments, Middlesex, England.
- Ultraviolet visible recording spectrophotometer/ Cary 500 Win UV- VIS- NIR, Varian Optical Spectroscopy Instruments, Mulgrove, Victoria, Australia.
- Vivastyle/ Vivadent, Schaan, Liechtenstein.
- Listerine - alcohol containing/ Warner-Lambert Co, Morrisplains, NJ, USA.
- Oral B - alcohol free / Oral B Laboratories, Belmont, CA, USA.
- Rembrandt Plus - peroxide whitening rinse / Denmat Corp, Santa Maria, CA, USA.

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