

EFFECT OF DIFFERENT CONCENTRATIONS OF THE TEETH BLEACHING AGENTS ON THE QUALITY OF BOND BETWEEN COMPOSITE MATERIAL AND BLEACHED TOOTH

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Abstract: Introduction: Micro-morphological and organic-inorganic changes of dental structure as well as the effect of hydrogen peroxide on polymerisation of composite materials cause lower adhesion, i.e. poor bond quality between composite material and bleached tooth. The aim of this study was to determine the effect of different concentrations of carbamide (16%, 20% and 30%) and 35% hydrogen peroxide on bond strength of the composite materials and bleached endodontically treated teeth.

Methods: The current study included 40 extracted human endodontically treated teeth. Internal bleaching was done using the “Walking bleach technique” method. The teeth were bleached with 16%, 20%, 30% carbamide or 35% hydrogen peroxide. After internal teeth bleaching, a class V cavity was prepared and restored with Tetric EvoCeram nanocomposite material. Microleakage was determined using dye method (silver nitrate) and measured on the incisal and gingival walls using stereoloupes.

Results: The smallest dye penetration on the occlusal wall was found of teeth bleached with 20% carbamide peroxide (5,45 μm), and the largest dye penetration was on teeth bleached with 30% carbamide peroxide (7,25 μm). The smallest dye penetration on the gingival wall was found on teeth bleached with 16% carbamide peroxide (12,25 μm) and the largest dye penetration was on teeth bleached with 30% carbamide peroxide (20,00 μm). The difference was statistically significant ($p < 0.05$).

Conclusion: Microleakage was detected in all teeth restored with composite and bleached with the internal bleaching technique with 16%, 20%, 30% carbamide or 35% hydrogen peroxide.

Keywords: carbamide peroxide, hydrogen peroxide, composite, microcracks.

1. INTRODUCTION

Internal discolorations are the consequence of structural changes in composition and density of hard dental tissue causing changes in transmission of light through dental structure [1–4].

Etiology of internal discolorations is diverse while changes in colour of teeth can occur in a pre-eruptive and post-eruptive manner. Pre-eruptive discolorations include tooth damages following the application of medicaments (tetracycline), metabolic changes (fluorosis, dystrophic calcification), genetic disorders (alkaptonuria, hyperbilirubinaemia, amelogenesis imperfecta, dentinogenesis imperfecta, congenital erythropoietic porphyria, cystic fibrosis) as well as dental trauma [1–4]. Post-eruptive discolorations are caused by pulp necrosis,

intrapulpal haemorrhages, endodontic materials (medicaments, sealers), definitive fillings materials, root resorptions and aging [1–4].

Interaction of bleaching agents with dental structure is based on the process of diffusion of molecules, whereby dental tissue acts as a semipermeable membrane. Theoretically, this process can be considered as osmosis (Soanes, Catherine, 2008). Molecules of water migrate from the inside of tooth through dentin and enamel, and make contact with hydrogen peroxide on the tooth surface [2].

During teeth bleaching, bleaching agents can cause damaging effects on dental structure such as damages of dental pulp, cervical resorptions, damages of soft tissues, changes in structure and biomechanical characteristics of hard dental tissues [3–6].

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Micro-morphological and organic-inorganic changes of dental structure as well as the effect of hydrogen peroxide on polymerisation of composite materials cause lower adhesion, i.e. poor bond quality between composite material and bleached tooth [3-4, 6-9].

Ellias and Sajjan studied the effect of 30% of hydrogen peroxide on the quality of bond between teeth bleached for two, three, four i.e. seven days and the composite resin Z100 (3M, USA). In all experimental groups, they noticed microcrack enlargement when compared to unbleached teeth [10].

Observing the influence of 10% carbamide peroxide on marginal seal, Turkun and Turkun also found a poor bond quality between composite materials and teeth restored immediately after bleaching compared to teeth restored seven days after bleaching and teeth treated by desensitizer [11].

Carrasco et al. studied the effect of different bleaching agents on dental permeability (37% carbamide peroxide, mixture of sodium perborate and 20% hydrogen peroxide, and 27% of carbamide peroxide). The highest dental permeability was found in 37% carbamide peroxide followed by sodium perborate with 20% hydrogen peroxide, while teeth bleached with 27% carbamide peroxide demonstrated the lowest permeability [12].

Sadeghloo et al. studied the effect of different concentrations of carbamide peroxide (10%, 22% and 35%) on the marginal seal of composite restorations bonded with a self-etch adhesive (Clearfil SE Bond). The authors found that bleaching with different concentrations of CP can increase the microleakage between teeth and composite restorations bonded with self-etch adhesive [13].

The aim of this study was to determine the effect of different concentrations of carbamide peroxide (16%, 20% and 30%) and 35% hydrogen peroxide on bond strength of the composite materials and bleached endodontically treated teeth.

2. METHODS

The current study included 40 extracted human intact anterior teeth. All teeth were endodontically treated and obturated with gutta-percha points and sealer (AH Plus, Dentsply, UK). The teeth were divided into four groups. The first group was bleached with 16% carbamide peroxide (VivaStyle 16%, Ivoclar Vivadent, Liechtenstein), the second group with 20% carbamide peroxide (Opalescence 20%, Ultradent, USA), the third group

with 30% carbamide peroxide (VivaStyle 30%, Ivoclar Vivadent, Liechtenstein), and the fourth group with 35% hydrogen peroxide (Opalescence 35%, Ultradent, USA). The shade of all teeth was determined using Vita shade before the bleaching.

Internal bleaching was done using the "Walking bleach technique" method. Bleaching procedure included cavity access preparation on the lingual surface of teeth and removal of two millimeters canal filling. Gutta-percha was covered with glass ionomer cement Alfagal Base (Galenika, Serbia). Bleaching agent was applied in the cavity and temporarily closed with glass ionomer cement Fuji IX (GC Europe). Bleaching agent was reapplied three times every seven days. After the bleaching was done, calcium hydroxide Calxyl (OCO praeparo, GmbH) was placed in the cavity for additional seven days. After seven days, the shade for each tooth was checked again. A class V cavity preparation was performed on the buccal surface of all teeth and composite restoration (Tetric EvoCeram, Ivoclar, Vivadent, Liechtenstein) was placed using the standard technique. Following restoration, all surfaces were coated with two layers of nail varnish, except for the restoration and 1 mm around it. Microleakage was determined using dye solution of silver nitrate. The teeth were immersed in 50% AgNO₃ solution for six hours. After that, the teeth were washed under water for 60 seconds. The samples were then immersed in the photo-maker for 120 minutes to fix silver nitrate particles. After removing teeth from dye solution, varnish was removed and all samples were sectioned in the buccal-oral direction using a diamond disc of 6 mm, through the middle part of the filling. The cross sections are made with a diamond diameter of 6 mm, mounted on a technical micromotor. Measurements were done using stereoloupes with six times magnification on the incisal (occlusal) and gingival walls (μm). Values of linear color penetration on the joint of the tooth tissue and restoration material are expressed in micrometers.

3. RESULTS

Observing the linear color penetration on the occlusal and the gingival wall of bleached teeth, the largest dye penetration was on the gingival wall of all the teeth. The difference was statistically significant ($p < 0.05$) (Table 1).

Observing the linear color penetration on the occlusal wall of all teeth, the smallest dye penetration was found of teeth bleached with 20% carbamide peroxide (5,45 μm), and the largest dye

penetration was on teeth bleached with 30% carbamide peroxide (7,25 µm). The difference was not statistically significant (Table 1).

Observing the linear color penetration on the gingival wall of all teeth, the smallest dye

penetration was found of teeth bleached with 16% carbamide peroxide (12,25 µm) and the largest dye penetration was on teeth bleached with 30% carbamide peroxide (20,00 µm). The difference was statistically significant ($p < 0.05$) (Table 1).

Table 1. Linear dye penetration depending on the concentration of the solution

Concentration (%)		N	Mean value (µm)	Standard deviation (µm)
16%	Incisal	10	6.85	7.39
	Gingival	10	12.25	8.45
20%	Incisal	10	5.45	4.19
	Gingival	10	18.75	8.99
30%	Incisal	10	7.25	7.12
	Gingival	10	20.00	6.12
35%	Incisal	10	6.50	4.12
	Gingival	10	16.75	9.06

4. DISCUSSION

The quality of bond between composite material and bleached teeth was tested by linear dye penetration at their contact. Solution of silver nitrate was used as a marker because its contrast enables good visualisation and provides accurate results [14].

Poor bond quality on gingival wall of all teeth can be found by observing the size of microcrack on occlusal and gingival wall of all teeth. The cause of this is an extremely mineralised tissue in occlusal area of the cavity which ends in enamel creating a better micromechanical bond with composite material. Cavity margins on the gingival wall are found in a less mineralised tissue, cement and dentin, and they create a poorer bond with the restorative material [15, 16].

The results of this study showed that the largest dye penetration, on the occlusal and the gingival wall of teeth, was detected in teeth bleached with 30% carbamide peroxide. This agent has led to the greatest micromorphological changes in enamel and dentin structure, and therefore also the poorer quality of bond between composite material and bleached tooth, due to better penetration of carbamide peroxide through dentin tubules and high pH carbamide peroxide. Urea, released during the decomposition of carbamide peroxide, has the ability to penetrate deeply into the structure of the enamel and affect the interprismatic region, denature the enamel and dentin proteins and allow greater

permeability to the hydrogen peroxide and free radicals [4, 17].

Wang et al. examined the effect of different concentrations of carbamide peroxide on development of microcracks in Class V cavities restored with the composite resin Filtek Z250 (3M, USA). Measuring linear penetration of silver nitrate, the authors also found that there was a better dye penetration along gingival wall than along incisal wall of the cavity. There was no statistically significant difference here. According to their results, there was no statistically significant difference between the teeth of the control group and teeth bleached with 10%, i.e. 20% carbamide peroxide. This could be down to the non-composite material Z250 (3M, USA) as well as to the adhesive system that secure a good quality of bond between the composite material and teeth, whereby blocking the penetration of bleaching agents and reducing the influence of carbamide peroxide on enlargement of microcracks between the resin and teeth [18].

Teixiera et al. also examined the effect of different bleaching agents on the quality of marginal seal between composite filling and a bleached tooth. Teeth were bleached by 'walking bleach technique' with the mixture of sodium perborate and 30% hydrogen peroxide, mixture of sodium perborate and distilled water, as well as with 37% carbamide peroxide. The teeth were restored with the composite resin Z100 (3M, USA) immediately after bleaching, and then 7, 14 and 21 days after bleaching. Results of this study have shown that the teeth restored immediately after bleaching, i.e. after

seven days, had a higher linear dye penetration compared to the teeth of the control group. The teeth restored 14 and 21 days after bleaching did not show a difference in the size of microcracks compared to the group of unbleached teeth. This research confirmed that it is necessary to postpone the restorative process for two to three weeks after bleaching in order to reduce the amount of residual hydrogen peroxide and create better conditions for the quality of bond between the composite resin and bleached teeth. High concentration of hydrogen peroxide (30%) mixed with sodium perborate has shown more damaging effects on hard dental tissue compared to 37% carbamide peroxide, or sodium perborate with water. Higher concentrations have caused development of larger microcracks in the teeth restored immediately after bleaching [19].

Machado et al. examined the quality of bond between a bleached tooth and composite material subject to bleaching agents, bleaching technique and period of restoration. Samples were bleached by 'home bleaching technique' with 16% solution of carbamide peroxide Clarigel Gold (Dentsply, USA), i.e. in office bleaching technique with 38% solution of hydrogen peroxide Opalescence Xtra Boost (Ultradent, USA). The teeth were restored with the composite resin Esthet X (Dentsply Batch, USA) immediately after bleaching, and then 7, 14 and 30 days after bleaching. The quality of bond was determined by measuring the depth of penetration of adhesive into enamel. According to their results, there was no statistically significant difference between different bleaching agents, i.e. between the bleaching techniques themselves. The authors have observed a statistically significant difference between the quality of marginal seal and the time of restorative filling application. Lower penetration of adhesive was found in the teeth restored immediately after bleaching and the authors explain this by structural and mineral change of enamel under the influence of bleaching agents. Time intervals of 7, 14 and 30 days after bleaching enabled better average penetration of adhesive into enamel. Following bleaching and awaiting restorative procedure, the teeth were stored in artificial saliva. Saliva enabled remineralisation of the tissue and better penetration of adhesive as well as reduction of residual hydrogen peroxide in postponed restorations [20].

Sartori et al. have also examined the post-restorative effect of bleaching on development of microcracks in Class V restorations. Teeth were restored with the composite resin Filtek Z 250 (3M, USA) and bleached with 10% carbamide peroxide and 25% hydrogen peroxide. The quality of bond

was tested by linear penetration of 0.5% basic fuchsin. The authors' results have also shown that dye penetration was higher along gingival wall than along incisal wall in all teeth. These results were explained by the fact that the gingival wall of the cavity ends in dentin, a less mineralised tissue, which consequently enables poorer quality of bond between the teeth and restorative material. However, compared to the control group, in this study there was no statistically significant difference between the teeth bleached with 10% carbamide peroxide and the teeth bleached with 25% hydrogen peroxide. This confirms the findings of the previous research. Bleaching agents did not affect the quality of the existing bond, i.e. there was no enlargement of microcrack at the contact of the teeth and composite material [21].

Oliviera et al. studied development of microcrack at the contact of composite material and a bleached beef tooth. Teeth were bleached with 15% carbamide peroxide Opalescence (Ultradent, USA), and then restored with the composite resin Filtek Z250 (3M, USA). The authors' results have also shown a larger microcrack in the bleached teeth compared to the teeth of the control group. The authors measured the quantity of released oxygen and found that the highest volume is released within the first 24 hours after bleaching. Results of this study have also shown that the interaction between adhesive and remaining oxygen affects the polymerisation and creates changes in the strength of bonding between the material and enamel [22].

Using different antioxidant agents, Mosavi et al. examined the quality of bond between restorative material and teeth bleached with 10% carbamide peroxide. The highest dye penetration was found in teeth restored after bleaching. The lowest dye penetration was in teeth treated by antioxidant with non-ionic surfactant. The authors explain these results by the effect of non-ionic surfactant, which reduces surface voltage, bonding angle and cohesive power between the molecules, therefore affecting the reduction of microcrack [23].

Yusri et al. examined the effect of different antioxidant agents (sodium ascorbate, sodium ascorbate with Tween 80 and catalase) on development of microcrack after restoration of composite material and a bleached tooth. The largest microcrack was found in teeth restored immediately after bleaching. Research results show that there is a significant reduction in microcrack following the application of any type of antioxidant to the teeth 24 hours, i.e. 48 hours after bleaching. Antioxidants neutralise the free radicals and residual hydrogen peroxide from dental structure whereby making an

impact on better adhesion between the composite resin and bleached tooth [24].

Khoroushi and Aghelinejad examined the bond strength of teeth bleached with 20% carbamide peroxide and restored with composite material by application of the total-etch technique in three steps (Optibond FL, Kerr, USA), two steps (Opti Bond Solo Plus, Kerr, USA), i.e. in one step (Optibond All in One, self-etch technique, Kerr, USA). Application of the two steps technique demonstrated a stronger bond in comparison to the technique with the self-etch primer due to the tendency of carbamide peroxide to inhibit the self-etch adhesive. Moreover, remainder of the residual oxygen additionally hinders penetration and polymerisation of the resin, which significantly reduces the bond strength [25].

Khoroushi and Ghazalgoo examined the bond strength of a bleached tooth and composite material after application of amorphous calcium phosphate (ACP), an agent for desensitisation of dentin. A superior bond strength was found in teeth with restoration postponed for two weeks after bleaching, but treated by desensitizers. The authors point out the importance of postponement of the restorative process due to residual hydrogen peroxide [26].

Sgura et al. also studied the quality of bond between the composite material Opallis (Joinville, Brazil) and a bleached tooth, and found a smaller microcrack in teeth treated by ascorbic acid and sodium ascorbate, i.e. in teeth with restoration postponed for 14 days. The authors indicate that the antioxidant caused a partial neutralisation of residual oxygen after bleaching [27].

Han et al. studied the quality of bond between a bleached tooth and the composite material Filtek Z350 (3M, USA) immediately after bleaching, with postponed restoration and following application of different antioxidants. The best marginal seal was found in teeth treated by ascorbate with the surface active agent (Tween 80), as well as in teeth treated by catalase [28].

Al-Hassani and Al-Shamma examined the bond strength of teeth bleached with 35% hydrogen peroxide (Opalescence Endo, Ultradent) and restored with composite materials (Filtek Bulk, 3M): immediately after bleaching, two weeks after bleaching and treated with three different antioxidants (10% sodium ascorbate solution, 10% green tea extract solution, and 10% pine bark extract solution) and then restored immediately. Microleakage was determined using dye solution 2% methylene blue. Their results show that the highest dye penetration was found in teeth restored immediately after bleaching. This may be due to the presence of residual peroxide and oxygen in the

enamel and dentine, which can interfere with resin attachment and inhibit resin polymerization. No significant difference was found between control group, group that bonded after 14 days after bleaching and group that bonded after treatment with antioxidant materials. The use of antioxidants effectively reversed the compromised sealing ability of composite filling to bleached dental tissue. All the antioxidants were equally effective to neutralize the adverse effects of hydrogen peroxide on microleakage of immediately restored teeth. Antioxidants intercept radical chain and break the oxidizing reaction by trapping peroxy and other reactive oxygen free radicals [9].

5. CONCLUSION

Microleakage was detected in all the teeth bleached with the internal bleaching technique with 16, 20, 30% carbamide peroxide, or 35% hydrogen peroxide. The smallest dye penetration was detected on the occlusal wall of teeth bleached with 20% carbamide peroxide. The largest dye penetration was detected on the gingival wall of teeth bleached with 30% carbamide peroxide.

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УТИЦАЈ РАЗЛИЧИТИХ КОНЦЕНТРАЦИЈА СРЕДСТАВА ЗА БИЈЕЉЕЊЕ НА КВАЛИТЕТ ВЕЗЕ КОМПОЗИТНОГ МАТЕРИЈАЛА И ИЗБИЈЕЉЕНОГ ЗУБА

Сажетак: Увод: Микроморфолошке и органско-неорганске промјене зубне структуре настале током процеса бијељења, али и сам утицај резидуалног водоник-пероксида на полимеризацију композитних материјала доводе до слабијег квалитета везе композитног материјала и избијељеног зуба.

Циљ овог рада је био да се провјери утицај различитих концентрација карбамид и водоник-пероксида на квалитет везе композитних материјала за избијељене зубе.

Методе рада: Испитивања су урађена на 40 екстрахованих ендодонтски третираних зуба. Зуби су бијељени „шетајућом“ техником бијељења са 16, 20, 30% карбамид, односно, 35% водоник-пероксидом. Након процеса бијељења, на свим зубима је урађена препарација кавитета V класе и зуби су рестаурисани композитним материјалом Tetric EvoCeram. Испитивање микропропустљивости вршено је методом бојених раствора у сребро-нитрату. Помоћу стереолупе са увећањем од шест пута вршено је читавање резултата на инцизалном (оклузалном) и гингивалном дијелу испуна.

Резултати: Најмањи продор боје на оклузалном зиду уочен је код зуба третираних са 20% карбамид пероксидом (5,45 μm), док је највећи продор боје био код зуба третираних са 30% карбамид-пероксидом (7,25 μm). Најмањи продор боје на гингивалном зиду је био код зуба третираних са 16% карбамид пероксидом (12,25 μm), док је највећи продор боје био код зуба третираних са 30% карбамид-пероксидом (20,00 μm). Разлика је била статистички значајна ($p < 0,05$).

Закључак: Микропукотина је уочена код свих зуба рестаурисаних композитним материјалом и избијељених унутрашњом техником бијељења са 16, 20, 30% раствором карбамид, односно, 35% водоник-пероксида.

Кључне ријечи: карбамид-пероксид, водоник-пероксид, микропукотина, композитни материјали, бијељење.



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