

Effects of different desensitizing agents on bleaching treatments

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ABSTRACT

The objective of this paper was to bring together and summarize the available information on the effects of different desensitizing agents on bleaching treatments. Information from all scientific papers and reviews identified in the Institute for Scientific Information Web of Science and PubMed using the search terms: Bleaching, whitening, brightening or color and desensitizing, fluoride, potassium nitrate, or amorphous calcium phosphate was included in the data collected and synthesized to produce the summary of findings and recommendations. The use of desensitizing agents in bleaching treatments may limit or control sensitivity, promote remineralization, increase enamel microhardness, and enhance the efficacy of the bleaching treatment. The use of desensitizing agents may exert a positive influence on the outcome of bleaching treatments.

Key words

Bleaching treatments, desensitizing agents, enamel microhardness, remineralization, sensitivity

INTRODUCTION

Bleaching is widely used and accepted as means to lighten teeth [Figure 1].^[1] Bleaching materials include different concentrations of hydrogen peroxide. Side-effects are associated with bleaching treatments. These include tooth sensitivity, changes to the tooth structure and effects on bonding.

Tooth sensitivity is a common side-effect and it occurs as generalized hypersensitivity to cold stimuli or as spontaneous sharp, short duration pain, limited to one or more teeth. Such sensitivity is usually temporary. It typically occurs early in the treatment and decrease as treatment proceeds.^[2] Sensitivity associated with bleaching may be so severe that a significant minority of patients (<14%) may be unable to complete their bleaching treatment.^[3]

The application of carbamide peroxide, as required for dental bleaching, may reduce the calcium, phosphate, and fluoride content of enamel.^[4] Carbamide peroxide

may cause changes in the surface of enamel also, including the formation of porosities, pitting and areas of erosion, and decalcification of enamel prisms, possibly together with alterations in surface topography.^[5] The application of both carbamide peroxide and hydrogen peroxide to teeth may reduce the microhardness of enamel.^[6]

Bleaching agents may cause chemical softening, and reduce the durability of resin composite restorations.^[7] Bleaching prior to the placement of restorations of resin composites may reduce adhesive and resin to enamel bond strengths.^[8]



Figure 1: Shade improvement after home bleaching treatment with 10% carbamide peroxide

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10.4103/2278-9626.134829

POTASSIUM NITRATE

Tam compared the effects of 10% carbamide peroxide with and without the addition of potassium nitrate and fluoride. There was no difference in the bleaching effect of the two gels; however, the sensitivity associated with the use of the modified gel was significantly lower than that experienced with the unmodified gel.^[9] Browning showed that the addition of 0.5% potassium nitrate to 10% carbamide peroxide reduced postoperative sensitivity more than the addition of 3% potassium nitrate, without reducing the bleaching effect.^[10] Haywood showed that the addition of 5% potassium nitrate to bleaching gel applied in a bleaching tray was effective in reducing tooth sensitivity.^[11] If tooth sensitivity occurs, applying 5% potassium nitrate in a bleaching trays for 10-30 min, may be found to reduce sensitivity in >90% patients, allowing many patients to complete their bleaching regime.^[11]

Kose reported that pretreatment with 5% potassium nitrate and 2% sodium fluoride reduced the duration of sensitivity during bleaching treatment - the placebo group had sensitivity on 35% of the bleaching days, while the desensitizing agent group had sensitivity on 20% of the bleaching days.^[12] Browning investigated 10% carbamide peroxide, containing potassium nitrate (3%) and sodium fluoride (0.11%). This modified bleaching gel was found to be safe and effective, with patients experiencing minor sensitivity only.^[13]

In other studies, potassium nitrate had no effect on tooth sensitivity associated with bleaching.^[14] Kishore found that 10% strontium chloride solution, 2% sodium fluoride solution and 40% formalin solution significantly reduced dentin hypersensitivity, whereas 5% potassium nitrate solution did not.^[15] Gallo evaluated the use of 30% carbamide peroxide containing 5% potassium nitrate. The addition of the potassium nitrate has little effect on sensitivity, but the bleaching time was short duration (1 h a day for 10 days).^[16]

One study reported that 20% carbamide peroxide containing 3% potassium nitrate and 0.11% ion fluoride increased the microhardness of the substrate enamel.^[17]

Tay evaluated 5% potassium nitrate and 2% sodium fluoride use before in-office bleaching. The desensitizing agent did not affect the bleaching efficacy, but reduced tooth sensitivity. Few participants (47%) in the experimental group experienced sensitivity compared to the control group (87%), and the severity of the sensitivity was significantly lower.^[18]

Gamma investigated in-office bleaching using 35% hydrogen peroxide and 37% carbamide peroxide, combined with casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), which largely prevented surface roughening and reduction in hardness.^[19] Reis

assessed tooth sensitivity following the application of 5% potassium nitrate and 2% sodium fluoride prior to light-activated bleaching. Less severe sensitivity was experienced by 80% of those in the experimental group.^[20]

Gerlach compared whitening strips (6% hydrogen peroxide) with 5% carbamide peroxide, including 5% potassium nitrate, applied in a custom tray. The whitening strips group displayed greater tooth whitening, and less tooth sensitivity (13% subjects) compared to the custom tray group (22% subjects).^[21]

Grobler compared two different 10% carbamide peroxide bleaching products. One contains potassium nitrate and sodium fluoride, and the other contains potassium nitrate, ACP and fluoride. The patients using bleaching gel containing ACP experienced more "relapse of color" over a 6 months period.^[22]

Haywood performed a study in which one group of patients prebrushed with potassium nitrate toothpaste for 2 weeks before bleaching, while the other group of patients prebrushed with fluoride toothpaste. The group using the potassium nitrate toothpaste experienced less sensitivity and more sensitive-free days than the fluoride toothpaste group.^[23]

Basting compared the effectiveness and tooth sensitivity with 10% and 20% carbamide peroxide home bleaching, and office bleaching using 35% and 38% hydrogen peroxide, including potassium nitrate and fluoride. All bleaching treatments were effective in bleaching teeth. Overall, 43% of the patients experienced mild or moderate tooth sensitivity. The highest prevalence of sensitivity (71%) was found in patients who used 20% carbamide peroxide home bleaching.^[24] Only 15% of patients experienced tooth sensitivity in the group using 38% hydrogen peroxide.^[24]

Leonard suggested that applying 3% potassium nitrate and 0.11% fluoride for 30 min before whitening may reduce sensitivity for "at risk patients."^[25] Matis showed that when patients experienced tooth sensitivity during bleaching treatment, they were instructed to place the desensitizing gel (3% KNO₃ and 0.11% fluoride) into bleaching tray and wear it 4-5 h through the night, by doing this tooth sensitivity was reduced.^[26]

Miles found a reduction in bond strength in orthodontic bracket bonding after bleaching.^[27] Ray concluded that the use of a potassium oxalate-based desensitizing agent, possibly in combination with 10% carbamide peroxide limited the reduction in shear bond strength to a level above the recommended level for orthodontic bracket bonding (5.9-7.8 MPa). Bleaching with 10% carbamide peroxide containing a desensitizing agent was not considered to be contraindicating before fixed orthodontic appliance therapy.^[28]

UltraEZ (Ultradent Products Inc., South Jordan, Utah) contains 3% potassium nitrate and 0.11% fluoride. Smith concluded that the use of UltraEZ before bleaching reduced tooth sensitivity in patients, even those with preexisting sensitivity. UltraEZ was not found to have a statistically significant effect in reducing tooth sensitivity in patients representative of the general population.^[29]

FLUORIDE

Felipe reported that 5% sodium fluoride varnish reestablished the surface microhardness of bleached dentin.^[30] Attin reported that the application of either 2.23% fluoride varnish or 0.25% sodium fluoride significantly reduced loss of surface hardness loss in bleached enamel.^[31]

Borges reported that the addition of fluoride and calcium to 35% hydrogen peroxide increased the microhardness of bleached enamel.^[32] Borges reported also that fluoride gel, and a combination of calcium and fluoride gel, significantly increased the microhardness of enamel bleached with 35% hydrogen peroxide.^[33] In a further study in which extracted molars were bleached with 10% carbamide peroxide, enamel microhardness was reduced. Two weeks later, following fluoride treatment, all the bleached teeth showed a significant increase in enamel microhardness.^[34]

Lewinstein reported that 0.05% fluoride restored the knoop hardness of enamel after in-office bleaching (35% hydrogen peroxide and 35% carbamide peroxide) and home bleaching (10% and 15% carbamide peroxide).^[35] Basting showed no difference in the change in enamel microhardness after treatment with 35% hydrogen peroxide photo activated using diode laser with or without acidulated phosphate fluoride (APF).^[17]

Costa studied the knoop microhardness of bleached enamel treated with 1.23% APF. Fluoridated 10% carbamide peroxide enabled “re-hardening” of bleached enamel faster than unfluoridated gels.^[34] On the contrary, Oliveira reported that calcium and fluoride in bleaching gels did not restore the microhardness of the surface enamel.^[36]

X-ray photoelectron spectroscopy investigations showed that sodium fluoride in hydrogen peroxide gel induced the formation of fluoridated hydroxyapatite and calcium fluoride crystals on the tooth surface, aiding enamel remineralization.^[37] Cavalli concluded that mineral loss was minimized by the addition of fluoride and calcium to 10% carbamide peroxide.^[38] Leandro showed that both the professional application of sodium fluoride and the self-administration of sodium fluoride mouthwash remineralized enamel bleached using 10% carbamide

peroxide.^[39]

Attin found that 0.5% fluoridated carbamide peroxide gel with pH-7.0, reduced surface softening compared to unfluoridated bleaching gel. Fluoride therapy during supervised bleaching was advised.^[40] Attin reported also that 10% carbamide peroxide, fluoridated with 0.5% fluoride, facilitated “re-hardening” of bleached enamel faster than unfluoridated gels.^[41] Hellwig found that fluoride concentration decreased from the enamel surface down to the enamel-dentinal junction in bleached enamel. The highest fluoride concentration was found on the enamel surface, following high dosed fluoride application.^[42]

Remineralization of bleached enamel was accelerated by the application of sodium fluoride. Fluoride uptake by demineralized enamel is more than normal enamel. Mineral crystals containing fluoride were precipitated within the demineralized layer.^[35] Professional application of 1.23% APF gel and the use of sodium fluoride mouthwash (0.02% or 0.5%) were recommended after bleaching to aid enamel remineralization.^[37] Attin showed that fluoride facilitated remineralization of enamel softened by bleaching.^[31] Attin reported that pretreatment of enamel with carbamide peroxide, before fluoride application, did not induce higher uptake of fluoride, nor increased erosion resistance.^[43]

Chen reported that fluoridated bleaching gel resulted in less marked demineralization changes, without affecting whitening efficiency.^[44] The application of 0.05% fluoride following bleaching restored the hardness of softened dental tissues. Fluoride forms a calcium fluoride layer on the enamel surface, inhibiting further demineralization.^[45] Acidulated fluoride gel results in more fluoride deposition in bleached enamel than neutral gel. Frequent use of low concentration fluoride gel during bleaching may benefit patients with a high risk of demineralization.^[43] A study, which evaluated the effects of fluoride after bleaching with 10% carbamide peroxide, found that enamel did not have an increased resistance to demineralization.^[46] Attin reported that both fluoridated and nonfluoridated 10% carbamide peroxide gels caused enamel more susceptible to demineralization when neutral or acidic.^[40] Bizhang showed that application of fluoride following bleaching reduced the demineralization of enamel.^[47]

Burgmaier reported that pretreatment with 2000 ppm sodium fluoride before bleaching did not improve erosive resistance; bleaching reduced the fluoride concentration in enamel despite the fluoride application.^[46] Attin concluded that treatment with carbamide peroxide and amine fluoride caused less fluoride uptake in enamel than amine fluoride alone. Carbamide peroxide can influence enamel fluoride uptake.^[48] Burgmaier reported that fluoride treatment could not compensate for the loss of fluoride from enamel during bleaching.^[46]

Ferreira studied the morphology of enamel treated with 35% hydrogen peroxide, followed by 1.23% acidulated fluoride gel. Changes in enamel morphology were greater after the fluoride application. The changes included porosities, depressions, and surface irregularities.^[49] Martin evaluated the effect of fluoride on enamel exposed to bleaching gels (16% carbamide peroxide or 35% hydrogen peroxide). The application of 2% topical fluoride reduced the increase in the enamel surface roughness after bleaching.^[50]

Chuang showed that 0.37% fluoride in 10% carbamide peroxide reduced enamel demineralization and maintained the microtensile bond strength, aiding any subsequent restorative procedure.^[51] Chuang also reported that 0.11% fluoridated 10% carbamide peroxide reduced microtensile bond strength, the bond strength was regained after 7 days.^[51] Another study reported that fluoride treatment after bleaching did not reverse a reduction in enamel-resin shear bond strengths.^[52]

Marcelo showed the ultimate tensile strength of enamel was not decreased after treatment of carbamide-peroxide containing fluoride or calcium.^[53]

The effect of fluoride on tooth sensitivity, however, remains controversial. Armenio investigated the effect on tooth sensitivity of applying 1.23% fluoride gel in a bleaching tray for 4 min, following the use of 16% bleaching agent. It was concluded that the fluoride treatment did not reduce the occurrence of bleaching related tooth sensitivity, however it decreased the intensity of the sensitivity.^[54] If the patient had sensitive teeth, the concomitant use of fluoride reduced tooth sensitivity and allowed patients to continue their bleaching regimen.^[54] Jorgensen reported that the application of fluoride had no benefit in the management of bleaching related tooth sensitivity. The use of a “whitening solution” with 0.11% fluoride resulted in 68% of the participants experiencing tooth sensitivity. This percentage of participating patients experiencing sensitivity was comparable to that found in other studies, using carbamide peroxide without any desensitizing agents.^[55]

Betke demonstrated fluoride varnish reduced dentine dehydration and decreased tooth sensitivity in bleaching treatment.^[56] Furthermore, mineral loss could be significantly reduced by topical fluoride application following bleaching.^[47]

AMORPHOUS CALCIUM PHOSPHATE

Ginger compared the effects of 16% carbamide peroxide with and without the addition of ACP. The addition of ACP significantly reduced sensitivity and enhanced the bleaching outcome.^[57] ACP resulted in a rapid desensitizing effect through protein binding and the

deposition of phosphate and calcium ions in exposed dentinal tubules.^[58]

Borges investigated the effect of MI paste (GC Corporation, Tokyo, Japan), containing CPP-ACP and 22% carbamide peroxide. The MI paste did not affect the bleaching, but reduced tooth sensitivity.^[59] Grobler assessed the whitening efficacy of 10% Nite White (Discus Dental, Victoria, Australia) containing ACP, potassium nitrate and fluoride over a 6 months period. Nite White and ACP demonstrated significant tooth whitening with relatively little tooth sensitivity.^[60]

Matis compared the effects of additions of potassium nitrate and ACP to carbamide peroxide. The reduction in sensitivity was similar. Subjects using the potassium nitrate modified gel had a greater bleaching effect than those using the ACP gel.^[61] Bayrak found that CPP-ACP significantly increased enamel microhardness following bleaching with 38% hydrogen peroxide, while fluoride gel had no effect on enamel microhardness.^[62]

Remineralization induced by ACP was found to be much more effective than that produced by potassium nitrate or fluoride alone.^[63] Giniger showed that ACP in whitening gels could reduce tooth sensitivity by remineralization.^[64] Another study reported that ACP caused ACP compounds to crystallize, forming hydroxyapatite.^[65]

Singh concluded that bleached enamel surfaces showed more color stability when treated with CPP-ACP.^[66] Vasconcelos investigated bleaching with 7.5% hydrogen peroxide and 16% carbamide peroxide in association with a CPP-ACP paste (MI paste, GC Corporation). CPP-ACP did not affect tooth whitening efficacy.^[67] Manton suggested that Tooth Mousse (GC Corporation) might be applied concurrently with bleaching, and not reduce bleaching effectiveness.^[68] Giniger concluded that the gel containing ACP offered 10% better longterm whitening efficacy. There were no adverse gingival or other negative effects observed.^[57]

Borges evaluated 10% and 16% carbamide peroxide modified by CPP-ACP. The CPP-ACP increased the enamel microhardness without compromising whitening efficacy.^[69] Khoroushi reported that CCP-ACP could compensate for any loss of flexural strength of the enamel and dentine complex during bleaching.^[70]

VARNISHES

Ziebolz conducted a study on the effects of VivaSens (Ivoclar Vivadent, New York, United States) on a paint-on bleaching agent (VivaStyle Paint On Plus, Ivoclar Vivadent). Similar color changes were observed for the control and VivaSens groups. Tooth sensitivity was lower in the Vivasens group; however, the difference was not significant.^[71]

The application of varnishes (VivaSens, Bilfluorid and Seal and Protect) (Dentsply, New York, United States) before bleaching may reduce dentine dehydration.^[56] Hannig studied the diffusion of peroxides through dentine after the application of the desensitizing varnish VivaSens. The VivaSens reduced peroxide diffusion significantly during bleaching.^[72]

A study on the impact of fluoride and Nano-P (FGM, Joinville, Brazil) - A nanohydroxyapatite-based remineralizing agent, on enamel microhardness after in-office tooth bleaching indicated that a high mineral content deposit was formed on the bleached enamel surface. Neither the fluoride nor Nano-P were capable of preventing some reduction in the microhardness of enamel during bleaching.^[73]

NOVAMIN

Gjorgievska conducted a study on the prevention of enamel demineralization after tooth bleaching using Novamin (GlaxoSmithKline) incorporated into toothpaste. The use of the Novamin containing toothpaste resulted in the formation of a protective layer on the enamel surface, consisting of a bioactive glass deposits. There was also an increase in calcium and phosphate content of the enamel layer.^[74]

SENSODYNE

de Oliveira investigated the effect of Sensodyne toothpaste (GlaxoSmithKline) and 10% carbamide peroxide on enamel microhardness. The use of the Sensodyne toothpaste significantly increased the enamel microhardness values. After the posttreatment period, the use of Sensodyne toothpaste was able to maintain the baseline Knoop microhardness of the enamel.^[75]

CONCLUSIONS

Most desensitizing agents may help to reduce the duration and intensity of tooth sensitivity caused by dental bleaching. Desensitizing agents may also limit changes in enamel morphology and surface hardness caused by bleaching and promotes the remineralization of bleached enamel and dentine.

The inclusion of desensitizing agents in bleaching agents may allow a patient to continue and complete a bleaching treatment with relatively little sensitivity and other side-effects. Of the desensitizing agents tested to date, potassium nitrate would appear to offer the greatest advantage. It is suggested that further research is required to investigate the inclusion of different desensitizing agents in bleaching materials and regimens.

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How to cite this article: Po LH, Wilson NW. Effects of different desensitizing agents on bleaching treatments. *Eur J Gen Dent* 2014;3:93-9.

Source of Support: Nil, **Conflict of Interest:** None declared.

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