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Effects of External Bleaching on Restorative Materials: A Review

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Abstract

With the increasingly commercial emphasis on dental esthetics, patients have become more interested in improving the appearance of their smile. For many, whiter teeth is their chief goal. However, when considering dental bleaching, practitioners need to take certain precautions. Over the past decade, multiple studies have evaluated the effects of bleaching agents on restorative materials. This article reviews their conclusions, focusing mainly on the clinical impact these agents can have on amalgam, porcelain, ormocer, glass ionomer, compomer and composite resin restorations.

As dental whitening has become more accessible, many patients select this treatment for esthetic reasons. In most cases, they want whiter teeth. Others want to eliminate the intrinsic discoloration caused by fluoride, pulpal necrosis, tetracycline, smoking, or drinking tea, coffee or red wine. Because of the popularity of bleaching and the addition of new bleaching products every year, many have studied the effects of these products on teeth and dental restorative materials. Authors have found that hydrogen peroxide (HP) and carbamide peroxide (CP), the 2 most popular bleaching products, can change the physical properties of dental restorations such as their colour, surface roughness, hardness and ion leakage. In this article, we put these changes in restorative materials into clinical perspective and provide practitioners with the evidence to properly answer patients' questions.

Effects of Bleaching Agents on the Properties of Restorative Materials

Amalgam

A number of studies have found that CP and HP change the properties of dental amalgam restorations, such as elution, microhardness and surface roughness. Al-Salehi and colleagues[1] reported no significant increase in the release of metal ions from dental amalgams treated with 10% CP. However, 2 other studies found a significant increase in the release of metal ions from dental amalgams exposed to 10% CP[2] or to 1%, 3%, 10% and 30% HP[3] concentrations. Because the release of mercury, silver, copper and tin from the dental amalgams did not exceed the limits defined by the World Health Organization, the authors[2,3] concluded

that bleaching teeth with amalgam restorations is not a health hazard. Another study[4] identified some factors involved in the bleaching treatment, such as the age of the dental amalgam, an unpolished amalgam surface and the acidity of the bleaching agent, as possible causes of increased release of mercury.

Concerned about the surface roughness and the microhardness of dental amalgams after bleaching procedures, some authors[1-3] studied the impact of bleaching agents on these 2 properties and found no significant changes. In a case report, Haywood[5] described a green discoloration around certain dental amalgam restorations of a patient who had an extended bleaching treatment with 10% CP. Removal of the dental amalgam revealed underlying carious lesions. In another case report,[6] intraoral bleaching with 10% CP caused some staining of the bleaching tray in areas where dental amalgam restorations presented with superficial chipping at the cavosurface margins. The causes of colour change found in these case reports could be linked to defective dental amalgam restorations, the composition of the bleaching agent and the dental amalgam, the presence of undiagnosed decay or a more complex interaction among these elements.

Overall, these studies revealed minor effects of bleaching on elution, surface roughness and microhardness of dental amalgam restorations that are within a clinically acceptable range. To avoid greening discoloration around dental amalgams, practitioners should meticulously examine the restorations before proceeding with bleaching and pay particular attention to the amalgams that have marginal discrepancies.

Porcelain

A number of recent articles have studied the impact of bleaching treatment on the physical properties of ceramic restorations. In a recent in vitro study,[7] feldspathic porcelain had a rougher surface after 21 days of exposure to 10% and 35% CP. According to the authors, the changes over the porcelain's surface may have been caused by a reduction of silicon dioxide (SiO_2) and potassium peroxide (K_2O_2) molecules. In their study, Zaki and Fahmy[8] distinguished between autoglazed and overglazed ceramic restorations. They showed that an in-office bleaching procedure with 35% CP followed by an at-home bleaching technique with 15% CP significantly increased the surface roughness and changed the whiteness of polished overglazed ceramic restorations, but did not affect autoglazed ceramic restorations. Because the increased ceramic roughness could lead to more plaque retention, bacterial adherence and gingival irritation, the authors suggested protecting these materials with a barrier before bleaching to preserve the integrity of the ceramic surface.[8]

Laboratory studies of in-office[9] (38% HP) and at-home[10] (15% CP) bleaching agents concluded that the microhardness of ceramic restorations was not affected 30 days after the end of the bleaching procedure. However, Turker and Biskin[11] found a significant decrease of 15% in the surface microhardness of feldspathic porcelain 30 days after bleaching with 10% and 16% CP.

Overall, these studies show that bleaching could affect the microhardness and surface roughness of porcelain. Since it is difficult for dentists to distinguish between overglazed and autoglazed ceramic restorations in the clinic, practitioners would be wise to advise patients to avoid bleaching ceramic restorations, especially those of anterior teeth.

Ormocer (Organically Modified Ceramic)

Two studies[12,13] investigated the impact of bleaching agents on the stability of the colour of ormocer restorations. Ormocers, or organically modified ceramics, are a combination of organic and inorganic copolymers developed to improve the results of dental restorations. Using a colorimeter, Yalcin and Gurgan[12] found a significant change in the colour of samples of ormocer exposed to 10% CP. Another study[13] that used a high (35%) concentration of HP demonstrated a significant change in colour that could necessitate the replacement of the restoration. The authors of these studies suggested that these restorations might have to be replaced after bleaching because the colour changes might be perceptible by the human eye, even though the colour changes were within a clinically acceptable range.

In another study,[14] ormocers showed no significant change in microhardness with the use of a high concentration of peroxide, such as 35% HP. The authors associated these results with the high weight percentage of filler particles and the matrix of the ormocer, which contains inorganic-organic copolymers. Similar results were described for the 38% HP and 15% CP concentrations used in 2 other studies.[9,10] Because the microhardness of the ormocers remained unchanged, the authors considered bleaching a safe option that required no replacement of the restorations.

A recent article[15] reported the effect of bleaching on the elution of monomers from different dental materials. The authors found a decrease in the quantity of released bisphenol A from the bleached ormocer samples compared to the unbleached samples and concluded that bleaching ormocer restorations is not a health hazard.

Consequently, since bleaching does not adversely affect the microhardness or monomer elution of ormocer restorations, it presents no health hazards. However, studies show that although bleaching can perceptibly affect the colour of these restorations, this effect is clinically acceptable.

Glass Ionomer Cement and Resin-Modified Glass Ionomer Cement

Some studies have evaluated the effects of bleaching agents on glass ionomer and resin-modified glass ionomer cements. A recent in situ study by Li and colleagues[16] found a significant difference in the colour of a conventional glass ionomer cement restoration after 4 weeks of bleaching with 15% CP, over that noted before the treatment. However, 2 weeks after the whitening treatment ceased, the colour returned to that noted before the treatment, showing that bleaching did not affect the colour of the glass ionomer cement. Additionally, scanning electron microscopy (SEM) revealed a slight surface dissolution. Similarly, another study[17] found alterations, such as cracks and pits, in the surface of the glass ionomer cement, which were explained by the ability of the bleaching agent to alter the surface properties of the material. The authors also found that bleached glass ionomer restorations were more susceptible to different staining solutions with a pH from 3.73 to 6.25, such as red wine, herbal tea, Coca Cola and coffee.

When using 15% CP and 35% HP on resin-modified glass ionomer cement restorations, Taher[14] found a softening effect and a significant decrease in their surface hardness. The change in hardness after at-home bleaching with 15% CP was 2.6% over that for the control group. For in-office bleaching with 35% HP, the percentage decrease was 23.1%. The author attributed these results to multiple air bubbles mixed into the material that can affect the final properties of the restorations.

Consequently, because glass ionomer and resin-modified glass ionomer cement restorations are changed when bleached, they may need to be replaced.

Compomer (Polyacid-Modified Composite Resin)

Researchers have demonstrated the effect of bleaching on the colour, roughness and hardness of compomer. Also known as polyacid-modified composite resin, compomer is a composite resin with fluoroaluminosilicate glass, an addition that confers similar properties to those of glass ionomer such as fluoride release. Clinical studies showed that surface roughness of compomers was clinically significantly increased when exposed to bleaching procedures. SEM showed cracks,[17-19] and chemical alterations and surface dissolution[16] in the restorations after their exposure to 10% and 15% CP. One study[18] related these results to filler-matrix debonding at the surface of the compomer, caused by free radicals from the peroxide.

Researchers[16,17,19] studying the effect of bleaching on the colour of compomer restorations concluded that bleaching with 10% to 15% CP causes a significant change that could be related to surface alterations, as Li and colleagues[16] showed with SEM. A recent study[17] of compomer restorations reported their increased susceptibility to staining with red wine, coffee and Coca Cola after bleaching with 15% CP. The authors related these results to the higher degree of porosity that resulted after bleaching the compomer material.

Rosentritt and colleagues[19] found that compomers deteriorated and decreased in hardness after they were bleached. In another study,[20] subsurface analysis of bleached compomers showed that layers up to 2 mm deep were affected because of significantly reduced hardness and that the filling materials appeared softened. Because these results were clinically significant, the authors suggested that it might be necessary to replace or polish compomer restorations after bleaching.

Overall, these studies showed that the roughness, microhardness, colour stability and stain susceptibility of compomer restorations can be clinically affected by bleaching agents.

Composite Resins

Many studies have examined the changes bleaching causes in the characteristics of composite resins, a material commonly used for esthetic dental treatments, such as colour, surface hardness and roughness, staining susceptibility, microleakage and elution. Using a spectrophotometer, Li and colleagues[16] found significant changes in the colour of nanohybrid and packable composite resins after bleaching with 15% CP. Another study[13] found that this difference was especially noticeable when a high peroxide concentration (35% HP) was used on low-density resins such as microfilled composite resin. The authors attributed these results to the volume of resin matrices and filler type. In both studies, the colour change was clinically acceptable.

Using the Knoop hardness test, Hannig and colleagues[20] reported a significant decrease in the surface hardness of bleached composite resins, not only on superficial surfaces, but in the deeper layers of the filling materials as well. Similarly, another research study[14] concluded that bleaching with different peroxide concentrations significantly decreased the surface microhardness of a microfilled composite resin. These results were related to the high oxidation and degradation of the resinous matrix in the composites. Other investigations of microhardness reported different results. One study[21] reported that bleaching with 16% CP decreased the microhardness of a hybrid composite resin, whereas bleaching with 35% HP had no effect on it. Two other studies found that doing an at-home[10] and an in-office bleaching[9] on different composite resins did not reduce their microhardness, making replacing fillings after bleaching unnecessary. Although several authors reported a change in the surface hardness of composite resin restorations after bleaching, most concluded that further clinical research was necessary to reveal the clinical relevance of bleaching on these restorations.

A recent study by Wattanapayungkul and colleagues[18] demonstrated that treating composite resins with a low peroxide concentration significantly increased their surface roughness. However, because the surface roughness values did not exceed 0.2 µm, which is the critical limit for plaque retention and accumulation, the results were not clinically significant. Another study[7] that evaluated the effect of low and high peroxide concentrations on hybrid and microfilled composite resins came to a similar conclusion.

Yu and colleagues[17] found that bleached composite resins stain more easily than unbleached ones. The authors suggested that this staining could be caused by alterations in the surface of the bleached restorations. However, one study[22] found that bleaching can remove stains from the external surface of a composite restoration, and another[23] found that bleaching with 15% HP is more effective than polishing for removing stains and restoring the original colour of the composite resin. Unlike enamel, composite restorations do not change colour when bleached. Therefore, they may not require replacing to match the colour of bleached enamel after teeth whitening.[22]

Bleaching teeth with Class I composite restorations with 20% CP does not affect the occlusal margins of the restorations and, therefore, does not cause microleakage.[24] Similar results were found at the occlusal and gingival margins of Class V restorations after they were bleached with 20% CP and 38% HP.[25] Although the findings of these studies suggest that the margins of restorations are not affected after bleaching procedures, more clinical studies are needed to show the impact of bleaching on more extensive Class II composite resin restorations.

Polydorou and colleagues,[15] in their study of the amount of monomer released from a bleached

composite resin, found that less Bis-GMA (bisphenol A-glycidyl dimethacrylate) and less UDMA-2 (urethane dimethacrylate) were released from composite resin restorations than from unbleached control samples. The released concentration of TEGDMA (triethylene glycoldimethacrylate) molecules was similar to that of the control group.[15]

Overall, although many studies found potential changes in the physical properties of composite-resin restorations after bleaching, they could not demonstrate the clinical relevance of these changes and recommended further clinical research.

Conclusion

Given the availability of 2 types of peroxide in multiple concentrations, the lack of consensus about the effects of bleaching agents on restorative materials among the authors of the laboratory studies reviewed in this article is not surprising. Dentists should be aware that the physical properties of some dental restorations may be altered after bleaching. They should also make sure that their patients with dental restorations are aware of the changes that may occur during whitening, as well as the possibility that their bleached restorations may need to be polished or replaced at the end of the treatment.

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