

Effects of Different Whitening agents on the Mechanical Properties of Restorative Materials

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Abstract

Dental bleaching procedures are commonly performed to improve esthetics. It can be either in-office professional bleaching techniques or self-administered home-based bleaching agents. These bleaching agents contain variable concentrations of hydrogen or carbamide peroxide that initiates oxidation process mechanism which reduces the extrinsic tooth discoloration. The objective of this review was to discuss the influence of different whitening agents on the mechanical properties of restorative materials. Dentists should be aware of the mechanical properties of restorative materials and ideally prepare the patients free of carious lesions before performing the bleaching procedures. However, bleaching agents with new formulations are introduced that doesn't impact the surface integrity of existing restorations. Moreover, composite restorations on bleached enamel surfaces should be placed after at least 2 weeks. For those patients that require restorative treatment immediately, use of antioxidant agents before bonding procedures on bleached enamel neutralizes completely the deleterious effects of bleaching and increases the bond strength.

Key words: bleaching; composite restorations; whitening agents; whitening treatments, tooth bleaching.

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INTRODUCTION

Dental bleaching procedures are commonly performed to improve esthetics. It can be either in-office professional bleaching techniques or self-administered home-based bleaching agents. These bleaching agents contain variable concentrations of hydrogen or carbamide peroxide that initiates oxidation process mechanism which reduces the extrinsic tooth discoloration. Some studies have reported the repeatedly use of these whitening agents or if they are applied for longer periods might cause some adverse effects on the tooth structure and extra coronal restorations. These adverse effects include softening, roughness, cracks and invisible color changes. Some investigators have discussed that bleaching agents might induce increase surface roughness of composite and porcelain materials while others reported that low concentrations of home-based whitening gels don't cause any significant changes in the surface integrity of extra coronal restorations. Nevertheless, novel whitening formulations derived from the natural materials are introduced that might help in reducing the drawbacks associated with the existing formulas and can produce effective whitening without altering the tooth structures and restorative materials [1].

With the advancement in technology, new methods are invented to measure the mechanical properties of both dental tissues and restorative materials. Nanoindentation method is used to calculate the mechanical properties in extremely thin regions such as the tooth-restoration interface unlike conventional microhardness testing procedures such as scanning electron microscopy (SEM) analysis. Therefore, this method can be implemented to evaluate the effects of bleaching agents on the existing restorations [2].

The objective of this review was to discuss the influence of different whitening agents on the mechanical properties of restorative materials.

Overview

Numerous studies have discussed the effects of bleaching agents regardless of the techniques on the surface integrity and physical properties of dental restorative materials.

Novel Formulations in Bleaching Agents

A study by Firoozmand LM *et al.* investigated the in vitro bond strength of composite resins on enamel previously treated with the whitening strips. A total of

48 bovine incisors were divided into four experimental groups and treated with different whitening strips containing variable concentrations of hydrogen peroxides (9.5%, 10% and 7.5% with Fluorine, calcium, and potassium nitrate content) respectively. The specimens were subjected to a whitening procedure for over 2 weeks. Moreover, significant differences were evident among the groups ($p < 0.05$). Authors concluded that new whitening formulation containing a gel with 7.5 % hydrogen peroxide with added calcium and fluorine increases the bond strength of composite restorations as compared the other bleaching strips that decreased the bond strength following 14 days of treatment [3].

On the other hand, a study evaluated the effects of two different whitening strips on color, microstructure, and roughness of tea-stained porcelain and composite surfaces. 54 porcelain and 72 composite chins served as the specimen and treated with a novel (Crest® 3D White Whitestrips™ and Oral Essentials® Whitening Strips) or control dental whitening strips. The sample surfaces were examined by light microscopy, profilometry, and SEM. No discrete physical defects were seen in the light microscopy and SEM images whereas high-resolution SEM and profilometry showed an appearance of increased surface roughness in all composite samples. Hence, a novel whitening strip demonstrated a comparable whitening effect and didn't induce physical defects or roughening of the composite sample surfaces [1].

Influence of Bleaching Agents on the Mechanical Properties

In-office bleaching procedure has some benefits over the other home-based bleaching techniques. However, some studies have reported that laser-assisted and conventional in-office bleaching might interact with the single or double c-c bonds and can degrade the three-dimensional polymer network of dental composites. This would cause dimensional changes, influences the mechanical properties and affects the clinical durability of restorations. A study by Omarani *et al.* demonstrated the effects of In-office bleaching techniques on monomer release from microhybrid and nanohybrid composite. 2 samples of each composite type was subdivided into 4 groups and treated with 1: Conventional in-office bleaching (CIB) using Opalescence Boost PF 38% gel, 2: Laser-assisted bleaching (LBO) using Opalescence Boost PF 38% gel, 3: Laser-assisted bleaching (LBH) with the JW Power bleaching gel, 4: (CO) control without bleaching respectively. Hence, nanohybrid composites showed significantly more monomer release than microhybrid composites ($P < 0.05$). Bleaching by laser with JW Power Bleaching gel can significantly lead to more monomer release in nanohybrid composite [4]. While an in vitro study revealed bleaching with 35% hydrogen peroxide gel did not enhance the surface roughness of nanohybrid composite [5].

A study was conducted to evaluate the influence of three different whitening systems (opalescence 10%, whiteness perfect 16%, and whiteness HP 35%) on the microtensile bond strength (μ TBS) of resin composite to bleached enamel at different time intervals after the bleaching procedure was performed. Authors suggested that adhesive restorations should not be placed immediately after 1 week irrespective of the type or concentration of the whitening system used. Composite restorations on bleached enamel surfaces should be placed after at least 2 weeks [6]. On the other hand; bleaching agents (15% carbamide peroxide, 35% hydrogen peroxide and light-activated 35% hydrogen peroxide) significantly decreased the microhardness of a silorane-based composite resin [7].

Another study supported that all carbamide peroxide bleaching agent with variable concentrations (10%, 16%, or 22%) significantly decreased the microhardness of the methacrylate-based composite resin groups, while microhardness was significantly increased in the silorane-based composite resin groups [8]. The surface microhardness of the composite restorative materials mainly depends on the composition. The use of Er, Cr: YSGG laser during in-office tooth whitening procedure did not affect the surface microhardness and roughness of the composite restorative materials. Using a high concentrated in-office bleaching agent with 40% hydrogen peroxide decreased the surface microhardness of the viscous or flowable composite restorative materials [9].

Moreover, office-based bleaching agent containing 45% carbamide peroxide was observed to be more secure for composite resin than 38% hydrogen peroxide. Home bleaching agents despite the low concentrations can cause a significant decrease in the surface hardness of composite resins as their application time is longer [10]. A study by Esra *et al.* also suggested that home bleaching agents increased the surface roughness of all composite resins [11].

On the other hand, a study reported that application of different whitening systems does not have any adverse effect on the Flexure strength (FS) of hybrid composite resins. Moreover, in-office bleaching agents with hydrogen peroxide might have a lesser impact on the FS.12

A study supported that no remarkable difference was observed between the bleaching agents either Opalescence Boost or Whiteness Hydrogen peroxide Blue for the surface roughness of composite and porcelain crowns. The whitening agents can be applied without affecting the ceramic, nano filled or nanohybrid resin restorations. Moreover, bleaching might damage the surface finish of the microhybrid or microfilled composite restorations [13] Nevertheless,

tooth bleaching does not damage the tooth-restoration interface of composite restorations [14].

Moreover, the stability of bonded resin composite restorations to enamel with the use of different dental adhesives could be compromised after the bleaching procedure. Therefore, replacement of bonded resin composite restorations might be considered especially if these restorations were bonded previously with self-etch adhesives [15].

Additional Clinical Interventions

Some studies have suggested that the negative effects of whitening agents on composite bonding can be neutralized by applying 35 % sodium ascorbate for two minutes before placing composite restorations. This technique is clinically relevant and applicable for those patients that require restorative treatment immediately after in-office bleaching techniques [16]. Moreover, use of antioxidant (10% sodium ascorbate gel or 5% proanthocyanidin agent) before bonding procedures on bleached enamel neutralizes completely the deleterious effects of bleaching and significantly increases the bond strength [17].

Another study suggested that the use of anti-oxidant agents irrespective of their type, form, concentration and the duration of application use can improve the surface bond strength (SBS) of bleached enamel. Therefore, antioxidant treatment can be considered an appropriate technique for enhancing the SBS of bleached teeth [18].

Whitening procedure is known to decrease biofilm formation. A study by Mahmoud Bahari *et al.* discussed that lowest biofilm formation was reported in the group subjected to light-activated group with 35% hydrogen peroxide relative to other bleaching agents [19].

CONCLUSION

Dentists should be aware of the mechanical properties of restorative materials and ideally prepare the patients free of carious lesions before performing the bleaching procedures. However, bleaching agents with new formulations are introduced that doesn't impact the surface integrity of existing restorations. Moreover, composite restorations on bleached enamel surfaces should be placed after at least 2 weeks. For those patients that require restorative treatment immediately, use of antioxidant agents before bonding procedures on bleached enamel neutralizes completely the deleterious effects of bleaching and increases the bond strength.

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