EXTRINSIC TOOTH BLEACHING AND ITS EFFECT ON AESTHETIC DENTAL RESTORATIVE MATERIALS: A REVIEW

Lotfeia M. Khamas

Department of Dental Materials Science, Faculty of Dentistry, Sabratha University, Libya
lot.1983@yahoo.com

Abstract

Recently, aesthetic dentistry has been greatly focused on, and tooth bleaching has gradually been a considerable portion of this field. Concerns about the increasing use of peroxide products have driven the research to investigate their impact on oral and tooth tissue, and dental restorative materials.

In this research, the Focus has been on the effect of the extrinsic tooth bleaching on commonly used dental restorative materials including restorative glass-ionomer cements and resin composites.

From reviewing previous studies, it has been found that bleaching materials, even in low concentrations, can cause changes in the properties of these aesthetic restorative materials such as colour, hardness, surface texture, and fluoride release.

Keywords: bleaching; carbamide peroxide; hydrogen peroxide; aesthetic dentistry.

Introduction

Demand for improving appearance by having white teeth has increased with the increase in human population and their life expectancy. Recently, there has been a great inclination towards the use of dental bleaching agents as they have provided a conservative way of removing tooth discoloration and reduced the need for other invasive treatment measures.

Tooth lightening agents are commonly available in the market in a form of either hydrogen peroxide (HP) or carbamide peroxide (CP). The latter represents the most widely used tooth whitening formula (Ourigue et al., 2011) which during interaction with the tooth surface, it decomposes to produce hydrogen peroxide (powerful oxidizing agent) and free radicals (Leonard et al., 2002). These elements perform the bleaching function of the teeth (Leonard et al., 2002).

Dental bleaching can be non-vital or vital, which also referred to as extrinsic tooth bleaching. This type can be further classified into three categories; in-office bleaching, which is performed by the dentist and contains a high percentage of the active element

(HP), ranging from 25-40% (Algahtani, 2014). The second type is at-home or dentist supervised tooth bleaching which uses lower amounts of the active component (~10-20% CP, decomposes producing ~3.5-6.5% HP) (Algahtani, 2014). This type is referred to as an uncomplicated, biologically safe, and aesthetically efficient procedure **(**Carlos et al., 2017). The third category represents the products that can be used by the patient independently, without supervision from the dentist, and these are known as over the counter products (OTC) and also have low active agent content (Kihn, 2007).

Because of the significant increase of such products popularity, monitoring their effects is of a great importance, as they are chemicals and never be without side effects. Several studies examined the effect of tooth bleaching treatment on oral soft tissue, tooth structure, and dental restorations. This research discusses the effect of extrinsic tooth bleaching on the most widely used dental restorative materials, including restorative glass-ionomer cements and resin composites.

Methodology

This paper reviewed previous studies concerned with the impact of dental bleaching materials on two aesthetic restorative materials (GICs and resin composites). Studies that examine other types of aesthetic restorative materials are excluded from the review.

The research included original and reviewed papers retrieved mainly from PubMed and web of science using different keywords (mentioned above) while searching. The following themes were focused on:

- Type and concentration of the bleaching materials used in each study.
- The properties tested including colour, hardness, surface texture and fluoride release and any other properties are excluded from this work.
- Assessment methods and type of tests chosen for each property in each study.

Eventually, the results of the reviewed studies were compared and analysed and a conclusion was conducted.

Tables that summarize the data of the reviewed studies were organized to simplify information access to the reader.

Effects of Tooth Bleaching Treatment on Glass-Ionomer Cements (GICs)

Glass-ionomer cement and its modified forms such as resin modified glass-ionomer cements are frequently used for restoring teeth, particularly in both carious and non-carious lesions in the gingival third of the teeth. Therefore, it is highly susceptible to exposure to dental bleaching materials.

Table (1) summarizes a range of studies which examined the impact of tooth bleaching agents on the properties of these cements, including colour change, surface morphology, and surface hardness. Of these studies, Li, Yu, and Wang (2009) examined the effect of 15% CP and found that although the colour difference was initially considerable, clinically it became acceptable when the bleaching process was withdrawn. In addition, an increase in surface roughness represented by pitting and cracking of the cement surface was detected by scanning electron microscopy (SEM). The actual percentage of carbamide peroxide in the bleaching product was measured before testing. Such a step can insure reliable results, as depending on what has been reported by manufacturers might be a factor in the variability of the results.

Similarly, Turker and Biskin (2003) reported an increase in the surface discontinuity of resin modified glass-ionomer cement as more pits and cracks were seen by SEM after exposure to 10%, 16% CP.

In respect of the surface micro-hardness, it seems that treatment with tooth bleaching products is likely to increase this property; this was attributed to the complex erosion mechanism of glass-ionomer cement by Fukazawa, Matsuya, and Yamane (1990). This suggested that the surface hardness increases because of the exposure of silica core of the cement to the surface after cement top layer erosion. Turker and Biskin (2002) found that after exposure to 10% and 16% CP, resin modified glass-ionomer cement exhibited elevation in the values of the surface micro-hardness of the tested samples compared with the control group. These findings agree with Yu et al. (2008). The latter showed that exposure to 15% CP caused a significant increase in the surface micro-hardness of glass-ionomer cement (conventional type).

Regarding the two aforementioned studies, although there was an agreement on that bleaching agents increase the cement micro-hardness, the actual concentration of the bleaching agents was investigated only in the latter study. This can be considered a drawback of the former study, and probably question its results.

Besides the abovementioned properties, effects on fluoride release as a result of bleaching treatment is also worth examining. Baroudi, Mahmoud, and Tarakji (2013) evaluated the amount of fluoride release from conventional and resin modified glass-ionomer cements after treatment with 35% CP and 38% HP. The values of fluoride release were measured using a specific ion electrode and expressed in ppm (parts per million). Although both bleaching products caused changes in the release of fluoride from the cement, 38% HP induced higher values of release, which decreased over time, and 35% CP caused no significant effect.

From the above data, there appears an agreement that bleaching agents can induce changes in the properties of glass-ionomer restorations and might require replacement in some cases of sever cement dissolution and surface cracking. However, data about

the effect of whitening on fluoride release of GICs are rare; more studies are needed about this concern. Determining the actual content of the active agent in bleaching products was not tackled by some studies, which can affect their findings reliability.

Table (1): Studies that Show the Effect of Bleaching on GICs.

Study	Subject	Assessment Methods	Findings
Li, Yu, and Wang (2009)	Examining the effect of 15%CP on colour of GIC	A spectrophotometer	Change in the colour, but improved with treatment withdrawal
Turker and Biskin (2003)	Effect of 10%, 16% CP on surface roughness and topography of GIC	SEM and a profilometer	Considerable increase in the surface roughness
Turker and Biskin (2002)	Effect of 10% and 16% CP on resin modified GIC micro-hardness.	A Tukon tester	Increase in surface micro-hardness
Yu et al. (2008).	Effect of 15% CP on conventional GIC micro-hardness	A Vickers micro-hardness tester	Significant increase in the surface micro-hardness
Baroudi, Mahmoud, and Tarakji (2013)	Effect of 35% CP and 38% HP on fluoride release from conventional and resin modified GIC	A specific ion electrode	38% HP induced higher values of release while 35% CP caused no significant effect

Effects of Bleaching Treatment on Resin Composite Restorations

Resin composite is one of the most common dental aesthetic materials, that is used for restoring both anterior and posterior teeth. Matching the appearance of the natural teeth can be a result of combined simulation of both colour and translucency, as the reaction to the light can give a different appearance even if the colour is the same. Since the success of the aesthetic restorations is highly dependent on their appearance, several studies have examined the changes that may occur when these restorations are exposed to tooth bleaching agents. Table (2) shows the key findings of the studies covered below.

The colour and translucency of five types of resin composites were examined after exposure to 10% HP and 10% CP in an *in vitro* study (Kurtulmus-Yilmaz et al., 2013). Both bleaching agents caused significant changes in the colour of all resin composite

types whereas translucencies were not affected. Although there was a difference in hydrogen peroxide concentration in the lightening materials used, as 10% CP is reported by Haywood and Heymann (1989) to produce 3.5% HP, the effect on the colour of the resin composites was similar in this study. This can be linked to the difference in the application time; HP was applied only one hour per day compared with eight hours a day for CP. Another *in vitro* study by Canay and Cehreli (2003) examined the effect of 10% CP and 10% HP on the colour of three types of composites, namely: hybrid, macro-filled, and polyacid modified composites. They found that significant changes in all samples' colour occurred only after bleaching with 10% HP as the other bleaching agent considerably affected the colour of poly acid modified composite but not the other types. However, the evaluation policy followed in this study can be questioned as they used samples from hybrid composites to act as a control group for all the composite types tested. This may affect the validity of the findings since the difference in materials is likely to result in a different response under the same conditions.

In addition, since the lower concentrations of bleaching agents in the previous studies produced changes in colour of resin composites, the effect may be confirmed when higher concentrations are used. Hubbezoglu et al. (2008) found that 35% HP caused significant colour changes in resin composites. Similar findings were reported when a higher percentage of HP (40%) was used; this also increased susceptibility to discoloration of the tested resin composite samples (Peng et al., 2021). Although the studies followed a convincing evaluation technique, it would be more valid if the peroxide product was pre assessed in terms of the active agent real figure.

Surface roughness and topography of the resin composites have also been frequently tested; any change in the surface features is expected to alter the appearance of the restoration in the patient's mouth. Turker and Biskin (2003) reported that bleaching with 10% and 16% CP could create mild increases in the surface roughness of a microfilled composite. Nevertheless, by using SEM, they found that the surfaces of the samples were largely affected by shallow pits that were located more in the central areas of the surfaces. These findings are in consistency with a study by Wattanapayungkul et al. (2004) who used 10% and 15% CP for bleaching different composite materials, including microfill, minifill, and polyacid modified composites. Changes were noticed earlier in the study when bleaching with the higher concentration (15%). Although the overall effect was insignificant, SEM showed cracking of the samples' surfaces because of the bleaching procedure. Peng et al. (2021), similarly, found that surface changes and roughness of different resin composite samples resulted after whitening with high concentration of HP (40%).

The effect on resin composites surface micro-hardness has been investigated by several studies and there seem to be controversies in the findings. For instance, low concentrations of bleaching agents such as 10% CP (Turker and Biskin, 2002) and

16% CP (Lima et al., 2008) were shown to decrease the micro-hardness of microfilled and mini-filled hybrid composites respectively. These studies are in agreement with a recent study, which also used low (10% CP) concentration (Alqahtani, 2013). However, 16% CP was also tested by Turker and Biskin (2002) and increased the micro-hardness of the composite material. Using high concentrations, variability in the impact of the tooth whiteners on dental composites has also been reported. Lima et al. (2008) found that 35% HP did not decrease the surface micro-hardness of minifilled hybrid composites. Differently, 40% HP was found to reduce the micro-hardness of methacrylate-based with no significant effect on silorane-based composites (Kamangar et al., 2014).

Although the impact of bleaching treatment on resin composite restorations may vary depending on the type of the composite, and concentration of the bleachers used, neither of the above *in vitro* studies assessed the percentage of the active agents in the products before use. This can also be considered as another factor in the effect variation.

Table (2): Studies that Show the Effect of Bleaching on Resin Composites.

Study	Subject	Assessment Methods	Findings
Kurtulmus-Yilmaz et al., (2013)	Effect of 10% HP and 10% CP on colour and translucency of resin composites	A spectrophotometer and translucency parameters	Significant changes in the colour while translucency was not affected
Canay and Cehreli (2003)	Effect of 10% CP and 10% HP on the colour of three types of composites (hybrid, macro-filled, and polyacid modified (PAM)	A spectrophotometer	10% HP caused significant changes in all samples' colour while 10% CP affects only PAM composite
Hubbezoglu et al. (2008)	Effect on colour change of resin composites using 35% HP	A colorimeter	Significant colour changes
Wattanapayungkul et al. (2004)	Effect of 10% and 16% CP on surface roughness and topography	Examination by profilometer and SEM	Mild increases in the surface roughness with appearance of shallow pits.

Turker and Biskin, (2002)	Effect of 10% and 16% CP on surface roughness and topography	SEM	No significant changes in the roughness but cracks appeared
Lima et al. (2008)	Effect of 10%, 16% CP on composite surface micro-hardness	Knoop hardness test	10% CP decreased surface micro-hardness while 16%CP increased it.
Alqahtani (2013)	10% CP on surface micro-hardness	Vickers hardness test	Decreases in micro-hardness
Kamangar et al. (2014)	40% HP on micro-hardness of methacrylate-based and silorane-based composites	Vickers hardness test	Reduction in micro-hardness of methacrylate-based with no significant effect on silorane-based composites
Peng et al. (2021)	Effect of 40% HP on colour and surface texture of 5 types of resin composites	A spectrophotometer	Significant changes in colour with increased surface roughness.

Conclusions

From the available data, there seems that peroxide products have the potential to affect the properties of the existing restorations negatively. Changes in colour, hardness, and increasing surface roughness of restorative GICs, and resin composites have been found, which calls for the need to protect those restorations before bleaching.

Fluoride release from GICs showed an increase under the effect of a high concentration of HP, even though the effect was not permanent. However, most of the time, there was inconsistency in the findings of the studies, which can be attributed to a range of factors. Firstly, there was no standardization in the assessment methods (as shown in Tables (1) and (2)) as different techniques and application times were adopted. Moreover, measuring the actual concentration of the bleacher and its pH was neglected by the majority of the studies which can compromise the reliability of their results. Finally, there is a gap between the *in vitro* studies and the real clinical situations as the exposure time appeared to be longer in most of the covered studies. Consequently, more *in vivo* studies are highly recommended.

References

- AlQahtani, M. Q. (2013). The Effect of a 10% Carbamide Peroxide Bleaching Agent on the Microhardness of Four Types of Direct Resin-based Restorative Materials. Operative Dentistry. 38(3), 316-323.

- Alqahtani, M.Q. (2014). Tooth-bleaching procedures and their controversial effects: A literature review. *The Saudi dental journal.* 26(2), 33–46.

- Baroudi, K., Mahmoud, R. S. and Tarakji, B. (2013). Fluoride release of glass ionomer restorations after bleaching with two different bleaching materials. *European journal of dentistry*. *7*(2), 196-200.

- Canay, S., Cehreli, M. C. (2003). The effect of current bleaching agents on the color of light-polymerized composites in vitro. *Journal of prosthetic dentistry.* 89(5), 474-8.

- Carlos, N.R., Bridi E.C., Amaral, F., França, F., Turssi, C.P., Basting, R.T. (2017). Efficacy of home-use bleaching agents delivered in customized or prefilled disposable trays: a randomized clinical trial. *Operative dentistry*. 42(1), 30-40.

- Fukazawa, M., Matsuya, S. and Yamane, M. (1990). The mechanism for erosion of glass-ionomer cements in organic-acid buffer solutions. *Journal of dental research. 69*(5), 1175-1179.

- Haywood, V.B. and Heymann, H.O. (1989). Nightguard vital bleaching. Quintessence Int. 20(3), 173–6.

- Hubbezoglu, I., Akaoglu, B., Dogan, A., Keskin, S., Bolayir, G., Ozcelik, S. and Dogan, O. M. (2008). Effect of bleaching on color change and refractive index of dental composite resins. *Dental materials journal. 27*(1), 105-116.

- Kamangar, S. S. H., Kiakojoori, K., Mirzaii, M. and Fard, M. J. K. (2014). Effects of 15% Carbamide Peroxide and 40% Hydrogen Peroxide on the Microhardness and Color Change of Composite Resins. *Journal of dentistry. 11*(2), 196.

- Kihn, P. W. (2007). Vital tooth whitening. *Dental Clinics of North America*. *51*(2), 319-331.

- Kurtulmus-Yilmaz, S., Cengiz, E., Ulusoy, N., Ozak, S. T. and Yuksel, E. (2013). The effect of home-bleaching application on the color and translucency of five resin composites. *Journal of dentistry*, 41(5), e70–e75.

- Leonard, R. H., Garland, G. K., Eagle, J. C. and Caiman, D. J. (2002). Safety issues when using a 16% carbamide peroxide whitening solution. *Journal of Aesthetics and Restorative Dentistry. 14* (6), 358-367.

- Li, Q., Yu, H. and Wang, Y. (2009). Colour and surface analysis of carbamide peroxide bleaching effects on the dental restorative materials in situ. *Journal of dentistry*. 37(5), 348–56.

- Lima, D. A. N. L., De Alexandre, R. S., Martins, A. C. M., Aguiar, F. H. B., Ambrosano, G., Bovi, M. and Lovadino, J. R. (2008). Effect of curing lights and bleaching agents on physical properties of a hybrid composite resin. *Journal of Esthetic and Restorative Dentistry*. *20*(4), 266-273.

- Ourique, S. A., Arrais, C. A., Cassoni, A., Ota-Tsuzuki, C., Rodrigues, J. A. (2011). Effects of different concentrations of carbamide peroxide and bleaching periods on the roughness of dental ceramics. *Brazilian Oral Research*. 25(5), 453-458.

- Peng, P. W., Huang, C. F., Hsu, C. Y., Chen, A., Ng, H. H., Cheng, M. S., Tsay, S., Lai, J. Y., Yang, T. S., Lee, W. F. (2021). Color Stability and Staining Susceptibility of Direct Resin-Based Composites after Light-Activated In-Office Bleaching. *Polymers.* 13(17), 29-41.

- Türker, S. B. and Biskin, T. (2002). The effect of bleaching agents on the microhardness of dentalaesthetic restorative materials. *Journal of oral rehabilitation*. *29*(7), 657-661.

- Turker, Ş. B. and Biskin, T. (2003). Effect of three bleaching agents on the surface properties of three different esthetic restorative materials. *The Journal of prosthetic dentistry. 89*(5), 466-473.

- Wattanapayungkul, P., Yap, A. U. J., Chooi, K. W., Lee, M. F. L. A., Selamat, R. S. and Zhou, R. D. (2004). The effect of home bleaching agents on the surface roughness of tooth-colored restoratives with time. *Operative Dentistry-University of Washington*. *29*(4), 398-403.

- Yu, H., Li, Q., Hussain, M. and Wang, Y. (2008). Effects of bleaching gels on the surface microhardness of tooth-colored restorative materials in situ. *Journal of dentistry*. 36(4), 261–267.