Journal of the mechanical behavior of biomedical materials 71 (2017) 156–164

Contents lists available at ScienceDirect

Journal of the Mechanical Behavior of Biomedical Materials

journal homepage: www.elsevier.com/locate/jmbbm

Evaluating the effect of antioxidant agents on shear bond strength of tooth-colored restorative materials after bleaching: A systematic review

Atiyeh Feiz[a], Hamid Mosleh[b], Rahman Nazeri[c,*]

[a] Department of Restorative Dentistry, Torabinejad Dental Material Research Center, Dental School, Isfahan University of Medical Sciences, Isfahan, Iran
[b] Department of Pediatric Dentistry and Research Committee, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran
[c] General Dentist, Isfahan University of Medical Sciences, Isfahan, Iran

ARTICLE INFO

Keywords:
Antioxidant
Bleaching
Restorative material
Shear bond strength

ABSTRACT

Purpose: The main objective of the present study was to make a systematic review of how antioxidant agents affect shear bond strength of tooth-colored restorative materials after bleaching.
Data sources: Electronic search was used to extract the related articles on the targeted key words such as "antioxidant", "dental bleaching" and "shear bond strength" (SBS) from MeSH, PubMed, Medline, and Cochrane electronic data bases. These articles were all published before 2016.
Study selection: Inclusion criteria were restricted to English journal articles concerning humans, clinical trials, cohorts and case-control studies. Therefore, systematic reviews, case reports, letters to editors, editorials and congress abstracts were excluded from the analysis.
Conclusions: Most studies conducted on the issue have produced experimental data which are rather controversial, and there is no general agreement about the reported outcomes. As an illustration, most studies have not considered the relationship between the type of antioxidant materials and the shear bond strength. In point of fact, some researchers (e.g Kimyai et al.) have concluded that antioxidants like gel and solution leave similar effects on SBS. Alternatively, certain studies (e.g., Kunt et al.) have produced inconclusive data regarding the impact of one week postponement of the restorative process on SBS after the bleaching process. The results of the studies evaluating the role of various adhesive systems used after bleaching have demonstrated that regardless of the type of adhesive system used, applying antioxidants before restorative procedures can adversely affect the bleaching agents utilized for SBS. It has also been suggested that the type of the adhesive system used might be correlated with the magnitude of SBS. The results obtained from the systematic review of the articles under investigation reflected that the use of antioxidant agents, regardless of their type, form, concentration and duration of application, can improve SBS after bleaching.

1. Introduction

Different methods and materials can be used for tooth bleaching, which is the application of certain treatment methods for removing tooth pigmentation and stains (Zantner et al., 2007). Since the inception of the first bleaching treatment methods (Haywood and Heymann, 1989), various bleaching systems have been introduced using 10, 15–16 or 20–22% CP as the active bleaching agent (Kihn et al., 2000; Oltu and Gurgan, 2000). Notably, bleaching of vital teeth has been shown to be a safe and acceptable procedure for removing stains (Matis et al., 1998). The main reason is that bleaching is a suitable stimulus for patients who do not easily accept additional esthetic dental procedures. In point of fact, after bleaching they often show a greater interest in veneers, closure of diastemas and other esthetic procedures (Christensen, 1997).

Although bleaching has proved to be meritorious in different ways, it may present certain undesirable side effects such as pulp toxicity (de Lima et al., 2009; Dias Ribeiro et al., 2009; Lima et al., 2010; Lima et al., 2010), microleakage (Khoroushi and Fardashtaki, 2009; Khoroushi et al., 2009), external root resorption (Plotino et al., 2008), changes in the structure of tooth (Goldberg et al., 2010), and a decrease in microhardness (Zantner et al., 2007; Rodrigues et al., 2005) as well as the bond strength reduction of composite resin to tooth structures (Cavalli et al., 2005; Cavalli et al., 2001; da Silva et al., 2010; Sasaki et al., 2009). Alternatively, the residual oxygen remaining on tooth surfaces after bleaching can interfere with adhesion of the adhesive system applied for restorative procedures (Rueggeberg and Margeson, 1990). All in all, the decrease in bond strength may be

* Corresponding author.
E-mail address: rahman.nazeri@gmail.com (R. Nazeri).

http://dx.doi.org/10.1016/j.jmbbm.2017.03.010
Received 31 October 2016; Received in revised form 6 March 2017; Accepted 9 March 2017
Available online 10 March 2017

evoked by a number of factors including an increase in microleakage (Khoroushi and Fardashtaki, 2009; Khoroushi et al., 2009), tooth surface porosity (Titley et al., 1991), changes in fracture resistance (Khoroushi et al., 2010) and fracture resistance of the tooth (Tam and Noroozi, 2007).

After the bleaching treatment, patients usually require esthetic procedures such as laminate veneers for restoring deficiencies; however, several studies have shown that the bleaching process may result in residual peroxide (Titley et al., 1991), which has an immediate adverse effect on bond strength of adhesive restorations to tooth structures (Cvitko et al., 1991; Toko and Hisamitsu, 1993).

Consequently, different treatment methods like compromised bond strength (24) have been suggested for solving clinical problems related to post-bleaching side effects. For example, Barghi and Godwin (Barghi and Godwin, 1994) have proposed removal of the superficial enamel layer, while Kalili et al. (1991) have suggested use of alcohol for treating bleached enamel. In this context, Sung et al. (1999) have similarly pointed to the use of adhesives which contain organic solvents. However, other researchers have offered other techniques for solving the problem including the application of antioxidant agents such as sodium ascorbate, ascorbic acid, catalase, acetone, butylated hydroxyanisole (Kaya and Turkun, 2003; Torres et al., 2006) or certain mouthrinses with an antioxidant activity like sodium fluoride, chlorhexidine and essential oils (Battino et al., 2002; Desmarchelier et al., 1997), as well as photopolymerization (Loretto et al., 2004) and water rinsing (Torneck et al., 1991).

It has been demonstrated that the decrease in adhesive bond strength of resin to enamel and dentin after bleaching process depends on concentration and application time of bleaching materials (Kaya et al., 2008; Freire et al., 2011). Reduction in bond strength caused by hydrogen peroxide or sodium hypochlorite can be reversed with sodium ascorbate as an antioxidant (Lai et al., 2001). Türkün and Kaya (Turkun and Kaya, 2004) in a study in 2004 showed that use of sodium ascorbate even for 10 min is enough to reverse the reduced bond strength, but in a study in 2008, Kaya et al. (2008) claimed that the antioxidant should be applied for at least 60 min for maximum effectiveness and an increase in the application time of sodium ascorbate (SA) can lead to a greater increase in SBS.

To mitigate the reduced bod strength, several studies have demonstrated that we should wait a certain amount of time before applying any restorative procedures (Cavalli et al., 2001; van der Vyver et al., 1997; Unlu et al., 2008). Since it has been shown that the decrease in bond strength is temporary, clinicians usually postpone bonding procedures for a while after bleaching procedures. This waiting period can differ from 24 h to 3 weeks (Cavalli et al., 2001; van der Vyver et al., 1997; Unlu et al., 2008). One study showed that delayed bonding also produces no significant differences in bond strength with the use of antioxidant (Freire et al., 2011). Fortunately, the results obtained from similar studies have revealed that simultaneous use of both forms of sodium ascorbate (e.g.,hydrogel and solution) can reverse the reduced bond strength caused by bleaching with carbamide peroxide (Kimyai and Valizadeh, 2008; Kimyai et al., 2010). Additionally, Turkun et al. (2009) showed that using the SA form of the gel in the clinical context may be more effective. Therefore, by utilizing a systematic review of carefully selected articles, the main objective of the present study was to determine how concerned practitioners addressed the effect of antioxidants on shear bond strength after the bleaching procedures.

2. Materials and methods

2.1. Search strategy

The corpora related to the targeted key words such as “antioxidant”, “dental bleaching” and “shear bond strength” were extracted from several electronic data bases by utilizing electronic search.

2.2. Electronic databases

Electronic search was carried out to specify the related articles comprising the corpora under investigation. Only those articles covering the predetermined key words and published prior to the year 2016 were selected for the review. The key words were searched both individually and in various combinations. The articles for the review were found in electronic data bases like PubMed, Medline (ISI Web of Science) and Cochrane.

2.3. Inclusion criteria

Inclusion criteria only allowed the selection of English journal articles concerning humans, clinical trials, cohorts and case-control studies. Consequently, systematic reviews, case reports, letters to editors, editorials and congress abstracts were excluded. Two authors were assigned to review the titles and abstracts of each article. The quality of the chosen articles was determined in terms of randomization, treatment allocation, drop-out rates and use of blind reviewers. As such, only articles meeting the inclusion criteria were selected. If there was a disagreement between the two reviewers on an article selection, a different reviewer was asked to compare the articles under investigation based on the prespecified inclusion criteria.

2.4. Data extraction

From the selected articles, the information matching inclusion criteria; namely, the first author, year of publication, study design and main results was extracted.

3. Results

From the target population of 496 articles, a sample of 41 studies was specified for the review. For the sake of clarity, the sample was divided into five distinct categories explained below:

3.1. Comparison of the effect of different times and different concentrations of antioxidants on bond strength of bleached surfaces

In this section, a total of 7 in vitro articles were investigated (Kaya et al., 2008; Freire et al., 2011; Kimyai et al., 2010; Turkun et al., 2009; Dabas et al., 2011; Lima et al., 2011; Thapa et al., 2013).

Kaya et al. (2008) compared the effects of different application times (10, 60, 120, 240 and 480 min) of 10% SA gel on SBS after bleaching. They reported that maximum effectiveness of the antioxidant was obtained after an application time of at least 60 minutes. As the application time increased, the SBS increased, too.

In a similar study, Freire et al. (2011) investigated the effect of different antioxidant application times on SBS (one 60 min, one 10 min, two 10 min, two 5 min, two one min and three one min). It was demonstrated that two applications of 35% SA for one min produced the same bond strength as no-bleached group and delayed bonding after 5 days.

Kimyai et al. (2010) studied the effect of application of 10% and 20% sodium ascorbate (hydrogel and solution forms) within two different time intervals (10 and 180 min) on bracket bond strength after bleaching. The results showed no significant differences between hydrogel and solution forms and the application time of the antioxidant. It was reported although bleaching can reduce bracket bond strength significantly, such adverse effect can be reversed utilizing 10 min application of both forms of SA.

In another study, Turkun et al. (2009) evaluated the effect of the hydrogel form of different concentrations (2.5%, 5% and 10%) of sodium ascorbate on the shear bond strength of composite resin after bleaching of the enamel with 10% carbamide peroxide gel. They found out that 10% hydrogel form of sodium ascorbate may be used in clinical