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Review Article

Teeth Bleaching: A Closer View

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Abstract

Background: Tooth bleaching is a popular cosmetic procedure that can give someone a brighter smile and the appearance of youth by reducing discoloration on stained teeth. These stains occur due to the consumption of certain foods, drinks, and the use of certain medications. Discoloration may also results from traumatic injury or pulpal death. There are a variety of bleaching techniques which include: in-office procedures and home treatments. The results of both are generally successful, although a common side effect is an increase in tooth sensitivity.

Objectives: The main objective of this review article was to highlight the great benefits of different teeth whitening methods without forgetting the possibility of some side effects that can now be avoided or even if they occur can be given appropriate treatment

Methodology: Collecting data was by collecting the related articles between the years 2004 to 2019 that have been published in PubMed indexed journals.

Conclusion: It is very important that the dentist is fully aware of the methods of teeth whitening before starting treatment for patients. This also includes knowledge of the chemical components of these substances as well as the expected side effects and how to deal with such situations.

Keywords: *Bleaching Devices; Tooth Whitening; Reactive Oxygen Species; Tooth Sensitivity*

Effect of light activating devices

Tooth whitening nowadays is one of the most frequently requested cosmetic dental procedures by patients who want a "perfect white smile" [1]. Usually, vital tooth bleaching can be categorized generally as in-office (professionally administered), at-home (professionally dispensed) or over-the-counter (self-administered). Advantages of in-office dental bleaching over at home or over-the-counter bleaching techniques include professional control, avoidance of soft tissue exposure and material ingestion, reduced total treatment time, and the possibility of immediate results [2,3]. Most bleaching solutions contain hydrogen peroxide or carbamide peroxide as the active ingredient delivered through various carrier designs [4] that are applied with or without light activation. Proponents of light-activated bleaching claim that this procedure reduces total in-office bleaching time by energizing hydrogen peroxide through the use of various light sources [1,2,5]. The theoretical advantage is the ability of the light source to heat the hydrogen peroxide, thereby increasing the rate of decomposition of oxygen and accelerating the release of free radicals with higher kinetic energy, thus enhancing the rupture of stain-containing molecules

[6,7]. Despite the fact that many curing lights have been introduced onto the dental market for the purpose of accelerating the bleaching process, the effectiveness of such an approach has been controversial [1,8-16]. One of the most common side effects associated with vital tooth bleaching is tooth sensitivity. Reports and estimates of bleaching-induced tooth sensitivity incidence range from 55% to 100% [1,3,13,17,18] and the degree of tooth sensitivity in these reports ranges from very mild to intolerable. Some existing literature reveals that activation of bleaching agents by heat or light (halogen, light-emitting diode [LED], or laser) may have an adverse effect on pulpal tissue [19,20]. It was already reported that the use of intense lights does elevate bleach temperature, but it results in increased intra-pulpal temperatures [21]. which may further impact patient sensitivity and pulpal health. As dental professionals, we have an obligation to pursue scientific knowledge about what is available to treat our patients' teeth, so that we can differentiate between effective and safe bleaching methods and those that are marketed on the basis of promotional speculation [22].

Effect of reactive oxygen species (ROS)

The current challenge of bleaching treatments is to define a technique that provides good cosmetic results without damaging the dental tissues, promotes high levels of satisfaction for patients who want an affordable and fast treatment, and produces minimal side effects. The bleaching process is believed to occur because of the low molecular weight of hydrogen peroxide (HP), which diffuses through the enamel and dentin [23], releasing reactive oxygen species (ROS) that react with other free or weakly bound substances, and there after regains molecular stability. This oxidant phenomenon may explain the complex mechanism of dental bleaching [23]. Despite the esthetic improvement obtained from most of the bleaching procedures currently available, the penetration of HP and its toxic byproducts in the pulp-dentin complex [20-26] is responsible for pulpal damage ranging from a transient inflammatory response to the occurrence of local necrosis [20,25,27]. The intensity of these negative effects is thought to be closely related to the amount of ROS that come into contact with the pulp cells; thus, the resulting damage increases as the concentration and exposure time to the bleaching product increase [20,27-31]. Most of the in-office bleaching products are 35 to 38% HP based; however, new products based on 20% HP were placed on the market, but there are few studies comparing the efficacy and the effects on pulp of this new concentration to traditional products. Within this context, although the literature questions whether the use of bleaching agents with a high concentration of HP is necessary or even safe, these products are being indicated, applied, and reapplied multiple times in the same clinical session in order to increase the speed of changing the color of the teeth. Although the whitening effect is known to be related to the diffusion of peroxide through the dental tissues, studies suggest that this diffusion is not related to the constant reapplication of the gel because good results have been obtained with the technique of a single clinical application [32,33]. The continuous exchanges have been justified by the rapid degradation of the peroxide after its application in trays in the at home technique [34,35]. However, recent studies show that the rate of decomposition is relatively small for the products used by the "in-office" technique [36,37], and this finding might support the adoption of a new dosage that is based on a single application of the bleaching product. Thus, given that high concentrations of peroxide are potentially harmful to the pulp cells [20,27,32-31] the study of posologies that are guided by the adoption of milder protocols is both appealing and justifiable in an effort to find safe alternatives to bleaching.

Tooth sensitivity

Applying hydrogen peroxide or carbamide peroxide are established methods for teeth bleaching [38,39]. There are two established methods for vital tooth bleaching: in-office and at-home bleaching. Respectively, 35% hydrogen peroxide for in-office or 10%–20% carbamide peroxide (which equals 3.5% - 6.5% hydrogen peroxide) or 3%–6% hydrogen peroxide for at-home bleaching [40]. However, the potential side effects should not be ignored. 80% of patients bleaching their teeth showed negative effects according to a report including input from more than 7000 dentists [38]. Tooth sensitivity, rebound of stain, enamel surface change, and soft tissue irritation are generally regarded. Among them, tooth sensitivity is the most commonly reported side effect [41]. Dentin sensitivity is generally referring to patients experiencing a sharp pain due to exposed dentin tubules [42]. The exposure of tubules may be initialized by the use of bleaching products, which can result in surface changes and increased roughness. Surface changes and roughness can be caused by carbamide peroxide with or without the addition of carbopol and glycerin [39]. The use of 10% carbamide peroxide has been found to

cause mild, reversible histological changes in some patients [26]. To minimize tooth sensitivity, lowering the concentration of peroxide in the paste has been recommended [43]. Some strategies have been used to reduce tooth sensitivity caused by peroxide bleaching [44,45]. For example, Prospec MI paste (GC America) containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) have been found effective in reducing sensitivity [44]. The paste is recommended to be applied immediately after bleaching. In addition, some specific agents can be mixed into bleaching paste to obtain less sensitivity (e.g., 5% potassium nitrate as a desensitizer [46] and amorphous calcium phosphate (ACP)-containing bleaching gel. Tooth remineralization is another good strategy to relieve the sensitivity. Previous studies have proven that calcium phosphate can improve tooth remineralization [47,48].

Effect of enamel and dentin thickness

Randomized clinical trials have detected that tooth hypersensitivity following bleaching therapies is limited to anterior teeth, with the intensity of this adverse effect being directly related to the thickness of enamel and dentin [30,49]. Rodrigues., *et al.* [50] demonstrated that the permeability of canines and incisors was significantly increased after bleaching with a 38% hydrogen peroxide (H_2O_2) gel, whereas premolars showed no or slight alteration. Indeed, histopathological studies in human teeth have shown that in-office bleaching with 35–38% H2O2 gels causes intense damage to pulp tissue of mandibular incisors, characterized by tissue disorganization, disturbance of the odontoblastic layer, areas of necrosis, and intense inflammatory reaction [51,52]. Conversely, premolars subjected to the same bleaching therapy did not exhibit such remarkable histological pulp alterations [28,53]. The intensity of pulp cells damage mediated by bleaching gels has been correlated with the amount of residual H_2O_2 capable of diffusing through enamel and dentin to reach the pulp chamber [54]. It is believed that the amount of H_2O_2 that reaches the pulp chamber is proportional to the enamel/dentin thickness of bleached teeth; therefore, small teeth, such as mandibular incisors, are more susceptible to the adverse effects of H_2O_2 released from bleaching gels. In view of this, it seems reckless to apply the same current professional bleaching protocols for different teeth disregarding their enamel and dentin thicknesses. Recent studies have demonstrated that 8 and 10% H_2O_2 bleaching gels resulted in limited trans-enamel and trans-dentinal cytotoxicity to human dental pulp cells *in vitro*, especially when the products were applied for 15 minutes to enamel/dentin disks simulating the thickness of maxillary central incisors [55].

Using of laser with in-office bleaching

Since patients need to use a bleaching tray daily and wait at least 2 weeks to see the result of at-home bleaching treatments, they usually tend to ask for another option that offers more immediate results. In-office bleaching is more popular, as it has the advantages of dentist control, protection of the soft tissues, avoidance of material ingestion, and prompt color change even after one appointment, which enhance patient satisfaction and motivation for maintenance [2,5]. Most of the in-office bleaching gels contain hydrogen peroxide and these agents are frequently used with an activator such as heat or light [10,56]. Light sources accelerate the bleaching procedure by heating the bleaching gels to increase the decomposition rate of oxygen to oxygen-free radicals and raise the release of stained molecules [10,56]. Currently, several types of light sources are recommended for in-office bleaching procedures such as halogen lamps, light emitting diodes (LEDs), plasma arc lamps (PACs), ultraviolet (UV) light sources, and several types of lasers. Among those, LEDs are one of the most common light sources with the advantage of easy availability, low cost, and promoting low-temperature variation in the pulp chamber [57,58]. Diode lasers are also highly favored for accelerating the bleaching gels as they provide a controlled heating on the gel and eliminate the risk of pulpal overheating due to their monochromatic nature. They additionally offer benefit of reversing the negative side effects of the bleaching procedure through their low-level laser therapy effect by inducing analgesia, anti-inflammation, and bio-modulation [59-61]. On the other hand, lasers are very popular topics for researchers, since there are numerous types of different wavelengths, which might be potentially used as bleaching activator and require to be evaluated individually to reveal their advantages and disadvantages in bleaching procedures [62]. The history of laser-activated bleaching started in 1996when the argon and carbon dioxide lasers were approved by the Food and Drug Administration (FDA), and continued with approval of diode lasers in 2007 [62]. Since then, several wavelengths, such as Nd:YAG and KTP lasers, have been evaluated for this purpose. The use of a 2940-nm-wavelength Er:YAG

laser in bleaching procedure is the most recent topic of attention for the last few years [63]. The action mechanism of this wavelength for bleaching activation depends on its high absorption potential in water, which is contained in an amount ranging from 40 to 65% by weight in the bleaching agents. Since this wavelength can be highly absorbed by the first 10 - 50-µm-thick superficial part of the aqueous bleaching agent [62], the laser energy is almost totally used to heat the gel by which the pulpal temperature rise side effect observed with the previous systems can also be avoided. Due to this mechanism, the Er:YAG laser activated bleaching was reported to be a fast, effective, safe, and non-invasive method for tooth whitening [62-66]. Beside the growing popularity of this method, there are only a few studies concerning the effect of Er:YAG laser-activated bleaching on pulpal temperature increase [62,64,67]. To the extent of authors' knowledge, there are still no available data about its potential and possible negative effects on enamel structure and on possible additional future esthetic resin-bonded restorations.

Conclusion

The role of teeth whitening cannot be overlooked in giving the smile and confidence to those patients who suffer from external or internal reasons for teeth discoloration, but this does not prevent the detection of what these patients might suffer from during or after finish their treatment. These frequently limited to moderate side effects in most cases but in some cases lead to very dangerous effect on their teeth. It is useful that the dentist has different solutions if faced with such conditions and this comes very frequently to see everything new in this area while maintaining the proper practice of the teeth whitening treatment.

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