Is Dental Bleaching Affected by Factors of Agents, Concentrations and Time of Treatment? A Review Article

Muteb Masad Al-Mutairi* and Ahmed M Elmarakby

1General Practitioner Dentist, Head of Dental Department at Alkhasirah Hospital, Saudi Arabia
2Assistant Professor and Chairman of Restorative Dental Sciences, AlFarabi Colleges for Dentistry and Nursing, Riyadh, Kingdom of Saudi Arabia and Lecturer of Operative Dentistry, Faculty of Dental Medicine, Al-Azhar University, Assiute Branch, Egypt

*Corresponding Author: Muteb Masad Al-Mutairi, General Practitioner Dentist, Head of Dental Department at Alkhasirah Hospital, Saudi Arabia.

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Abstract

Introduction: Several factors can control the esthetics of a smile, including changes in the shape, texture, position and color of teeth. Currently, dental bleaching or tooth whitening is considered as one of the cosmetic dental procedures most frequently required by patients who seek a “perfect white smile”. The aim of this article was to review the techniques of dental bleaching including in-office, at-home and over-the-counter focusing on the agents applied, their concentrations and the time of treatment, and how these three factors can affect the success of dental bleaching.

Methodology: An internet search was done to review the articles published about the aim of our study. The search included different websites such as PubMed, Google Scholar, Web of Science, etc.

Keywords: Dental Bleaching; Techniques; Agents; Concentrations; Time; Laser; White Smile

Introduction

Many elements can affect the esthetic look of a smile, and these elements are related to the texture, shape, color and position of teeth. Complex phenomena are involved in the color and appearance of teeth and they are highly affected by the type of surrounding light, light scattering, translucency, opacity and brightness of the substrate [1,2]. Among the various esthetic treatments presented to improve the dental esthetics, dental bleaching comes as the most conservative and effective technique with great popularity [1,3]. It is, nowadays, the optimal choice for external discoloration pigmentation because of its fast execution, little cost and minimal invasiveness [4]. In other words, tooth bleaching is highly requested in the field of dental medicine for its super ability to improve the color of teeth without painful procedures such as crowns or laminated veneers. Three distinct approaches come to the surface for dental bleaching and they include dentist-supervised night guard bleaching, in-office or power bleaching and over-the-counter bleaching. The Dentist-supervised night guard bleaching (at home) depends upon the application of bleaching agent to the teeth with a relatively low concentration and through a custom fabricated tray put at night for at least two weeks. Hydrogen peroxide with concentrations ranging from 3% to 50%, and carbamide peroxide from 1% to 45% are the whitening agents currently used. High concentrations of bleaching agents (15% hydrogen peroxide) are used in in-office-bleaching and they are applied for a shorter period of time. On the other hand, low concentrations of the bleaching agent (6% hydrogen peroxide) are existed in over-the-counter products and they are self-applied to the teeth via strips; they are normally employed twice a day for up to two weeks [5]. The aim of this article was to review the techniques of dental bleaching including
in-office, at-home and over-the-counter focusing on the agents applied, their concentrations and the time of treatment, and how these three factors can affect the success of dental bleaching.

**Dental bleaching methods**

Tooth whitening nowadays is one of the dental procedures highly required by patients who want a “perfect white smile” [6]. Vital tooth bleaching can be conducted through three methods: in-office (professionally administered), at-home (professionally dispensed) or over-the-counter (self-administered). Among the different bleaching therapies, the at-home bleaching technique is seen as the gold standard treatment and it is due to its efficacy and biosafety [7]. Regarding the home-use technique, the main advantage is latent in being easy to use with less chair time and a low incidence of tooth sensitivity and gingival irritation [8-11]. On the other hand, what make the in-office dental bleaching gain high popularity compared to the at-home or over-the-counter bleaching techniques are the professional control, avoidance of soft tissue exposure and material ingestion, less total treatment time and the possibility of instant results [12,13]. Hydrogen peroxide or carbamide peroxide is involved in most bleaching solutions as the active ingredient which is applied with or without light activation; it is delivered through various carrier designs [14].

**Light-activated bleaching**

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 [6,12,15]. 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 [16,17]. 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 [6,18-26]. One of the most common side effects associated with vital tooth bleaching is tooth sensitivity. The incidence of bleaching-induced tooth sensitivity is high and it ranges from 55% to 100% according to different reports and estimates [6,13,23,27,28]; the degree of tooth sensitivity in these reports ranges from very mild to intolerable. As per the existing literature, the pulp tissue may be badly affected by the heat or light applied for the activation of bleaching agents (halogen, light emitting diode [LED] or laser) [29,30]. It is already reported that the use of intense lights does lead to an increase in the bleach temperature, but it results in elevated intrapulpal temperatures [31] that may further affect the patient's sensitivity and pulpal health. As dental professionals, we have strong feeling of responsibility towards our patients and hence we seek scientific knowledge about the effective, true and safe bleaching methods and those that are targeting the market and promotional speculation [32].

**Precautions in dental bleaching**

It is known that the microhardness, surface roughness and enamel surface morphology are highly affected by the dental bleaching products which can increase the tooth porosity [33-36]. Thus, patients are recommended by many professionals and manufacturers to avoid eating pigment-rich foods during the stage of bleaching in order to reach the desired esthetic results [37-39]. Despite the occurrence of these alterations in the enamel, the increased risk of pigmentation during bleaching has not been confirmed considering that the challenging conditions of the oral environment have been ignored in most of these investigations [40]. *In situ* studies are considered as an intermediate step between laboratory experiments and clinical trials. They are effective in investigating the biological impacts and protective influences of saliva under experimental conditions [34,41]. Therefore, intraoral models provide a clinical reality approach while preserving the sensitivity of laboratory models since the analysis can be carried out outside the oral cavity, using sensitive and accurate methods [38]. Regarding the assessment of the effects of bleaching, three color dimensions have been considered by few studies: the value (DL), the amount of red and green (Da), and the amount of yellow and blue (Db) [3,39,42]. These color parameters are related to human eye color perception and they play an important role in getting the final result through calculating the overall change in tooth color (DE) [1,2].

Dental bleaching and factors of success

Because of the increasing request for brighter and whiter teeth by patients, various bleaching products have been developed by the industry. Tooth discolorations are varied in terms of appearance, severity, localization, etiology and adherence to tooth structure. They are categorized as intrinsic or extrinsic. Intrinsic discoloration comes as a result of the insertion of chromatogenic material into dentin and enamel during odontogenesis or after eruption. After the eruption of tooth, intrinsic discoloration is mainly caused by pulpal necrosis, aging and iatrogenesis.

Dyes of tea, coffee, orange, carrots, red wine and tobacco stand behind the extrinsic staining of teeth [43,44]. For removing the majority of extrinsic stains, scaling and professional cleaning of discolored teeth are highly recommended. For more tenacious extrinsic discolorations and intrinsic staining, the three distinct bleaching methods should be accompanied by certain bleaching agents and concentrations: dentist-supervised night guard bleaching (at home) typically uses a relatively low concentration of bleaching agent applied to the teeth via a custom fabricated tray put at night for at least two weeks. Hydrogen peroxide at concentrations ranging from 3% to 50% and carbamide peroxide at concentrations from 1% to 45% represent the bleaching agents currently used. In in-office bleaching, high concentrations of agents (15% hydrogen peroxide) are applied for a shorter period of time. On the other hand, the over-the-counter method used products with low concentrations of the bleaching agent (6% hydrogen peroxide), they are self-applied to the teeth twice a day for up to two weeks via strips [5]. In general, hydrogen peroxide-containing products and those containing carbamide peroxide appear with similar efficacy after being tested in vivo [5,45]. Treatment time, besides the bleaching agent and its concentration, also plays an important role in bleaching success. After comparing the in vitro tooth bleaching efficacy of gels containing 5%-35% hydrogen peroxide, Sulieman and others found that the concentration is reversely correlated with the number of gels applied; the higher the concentration, the lower the number of gel applications required to produce uniform bleaching [46]. Through comparing the in vitro tooth bleaching efficacy of 5%, 10% and 16% carbamide peroxide gels, Leonard., et al. gave similar results illustrating that bleaching by 16% and 10% carbamide peroxide was initially faster than that by the 5% concentration [47]. Matis., et al. showed that a 15% carbamide peroxide gel showed better results of tooth bleaching than a 10% carbamide peroxide gel after two weeks of application. However, the increasing of treatment time to six weeks does not significantly affect tooth color or brightness [48]. Hypersensitivity and gingival irritation are considered as common clinical adverse effects of bleaching. Dentinal hypersensitivity was noticed in 77% of subjects while soft tissue sensitivity was observed in 22% [49].

Focus on dental bleaching agents and their concentrations

Carbamide peroxide (CP) is a highly recommended agent in the home-use bleaching supervised by a dentist; using a customized tray, the gel can be applied to the external surfaces of the teeth [50]. In the past, a 10% CP was seen as the optimal choice for the home-use bleaching technique [51]. To raise the efficacy of bleaching agents, different concentrations of hydrogen peroxide (HP) ranging from 3% to 10% were recommended [55,57], with higher concentrations of CP [52-56]. Also, fluoride and/or other desensitizing products, such as potassium nitrate, in formulations fall under the home-use agents that may reduce tooth sensitivity [10]. However, the in-office technique has gained more popularity than the home-use one and it is due to the ability of the highly concentrated products to achieve faster tooth whitening (the higher the bleaching solution concentration, the more quickly a shade change will occur). In the in-office systems, a high concentration of HP (15% to 38%) can be applied with the possibility of using light-activation devices (e.g. light emitting diodes, plasma arc, diode laser and xenon halogen lamps) that can hasten the whitening process. However, using the light sources for the purpose of in-office tooth whitening is still debatable [58-60]. The dentist has full control on the process with the merit of ending the treatment at any time. Usually the results of color change can be noticed after one visit. Despite the in-office method enjoys the advantage of quick tooth whitening, tooth sensitivity is usually reported [58-64]. Similarly to the home-use agents, some manufacturers have added fluoride or desensitize products into the in-office gel formulas with the aim of relieving tooth sensitivity.
Some clinical trials have compared the agents used for home-use or in-office tooth bleaching with high and low concentration, and similar whitening effect was observed regardless of the concentrations of agents and the techniques used [8,11,65,66]. Nevertheless, when the agent concentration [64,66,67] or bleaching time [54,68,69] is increased, the occurrence of tooth sensitivity or irritation gingival is highly observed. However, because of the different techniques of dental bleaching (home use or in office), the several concentrations of bleaching agents, and the incorporation of fluoride or desensitizing products in bleaching agents, it becomes hard for dentists to put their hands on the optimal choice that can be most effective for and least sensitive to patients. However bleaching gels are proven to be equal with no observed differences in efficacy and dental sensitivity regardless of their concentration, the technique used (home use or in office), or the presence of desensitizing agents. [70]. Recently, several studies have encouraged the use of bleaching gels with low concentrations reporting their effectiveness [71] and observing lower cell damage at these low concentrations of peroxide [72]. Some researches have been conducted regarding the bleaching gels catalyzed by agents such as titanium dioxide nanoparticles activated by hybrid light (laser/LED) with different concentrations (15%) [73], which present similar effectiveness, and in some cases, much lower adverse post procedure effects [73]. The As per literature, the longevity of bleaching is somewhat questionable. Some studies have indicated an observed jump in color; others show only a slight difference [74-76]. Moreover, retreatment can be witnessed with the passage of time. All of these reports are associated with concentrations higher than 10% hydrogen peroxide, with only one report at 6% [77]. This report by Vano and others showed that no change was achieved in at least five units of DE initially and observed a color rebound at nine months [77].

**Conclusion**

In conclusion, it is important for clinicians to know about the new in-office concentrations and to correlate these with patients. It is important to shed light upon patients’ expectations regarding tooth whitening. However, they are poorly described in the literature. Tooth whitening plays an important role in esthetic perception psychosocial status. Martin and others has conducted a study indicating the positive effect on esthetic look and psychosocial comfort [78]. It would be interesting for clinicians to assure the stable existence of this effect over time.

**Bibliography**


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