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# DENTAL BLEACHING AND NEW POSSIBILITIES: LITERATURE REVIEW

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**ABSTRACT** **Dental bleaching is an initial step in the analysis and reproduction of smile aesthetics, so it is very important that the dentist knows how to diagnose the causes of color change and to indicate whitening before proposing the appropriate dental procedure. With the technological advance, dental bleaching techniques have emerged to facilitate its use and improve comfort, safety and time reduction in the execution of the technique. The conventional means of external dental whitening is with carbamate or hydrogen peroxide photoactivated or not. However, the home and office whitening procedure causes dental sensitivity. There is a new bleaching proposal on the market without the use of bleaching gels, thus reducing post-treatment sensitivity. Such a proposal elucidates ultraviolet light as a bleaching agent.**

**KEYWORDS** :Bleaching; Ultraviolet light; Peroxides.

## INTRODUCTION

Aligned white and well-contoured teeth are relevant to the majority of the population. This search for the "perfect smile" can be influenced by the media, by the professionals and among the patients themselves, reflecting as a synonym of health in the buccal cavity, besides the influence on the psychosocial state of the same ones [1,2].

The process of dental dimming occurs due to the formation of chemically stable structures, responsible for the progressive installation of spots on the dental crown. Knowledge of the etiology of dental blemishes by the dental surgeon is relevant to the choice of appropriate treatment [2].

Changes in tooth structure color may be due to extrinsic and intrinsic factors. The extrinsic stains usually come from the medium and are associated with dye pigments such as tobacco and coffee, the use of certain types of medications and the accumulation of bacterial plaque, being surface stains and that leave more easily after prophylaxis. Since intrinsic stains can be congenital, related to dentinogenesis and imperfect amelogenesis or can be acquired, from pulp necrosis, fluorosis, repairing dentin formation [1].

Since 1861, Noavais and Toledo [3] reported that the first whitening. The Dental Cosmos Journal, in an article that stressed the importance of this theme in the New Haven Convention. Where he recommended the importance of knowing the chemical characteristics of the substances in question, mentioning sulfur dioxide and Labarraque liqueur (2.5% sodium hypochlorite) as bleaching agents.

Nowadays, the essence of the whitening technique still belongs to the one who used 30% hydrogen peroxide and heat in vitalized teeth and for the pulped teeth the sodium perborate associated with hydrogen peroxide at 30% [4].

There are several bleaching techniques cited in the literature, with different types of substances such as carbamide peroxide and hydrogen peroxide and in different concentrations. In addition to the variety of the bleaching substance, light sources such as allogeneic, laser, LED and ultraviolet can be used to potentiate the bleaching action [5,6].

Bleaching is a technique that increases dentin permeability, increasing dental sensitivity especially when there is an increase in temperature. The lower the heat generation of the whitening system, the lower the sensitivity. In this sense the new techniques of bleaching should evolve, in addition to decreasing the irradiance of the light that should activate photochemically the bleaching gel [7].

The most common adverse effect associated with vital tooth whitening is tooth sensitivity. The incidence of hypersensitivity post bleaching is 10.0 to 90.0%, of mild or moderate intensity; however, it may become intense and result in discontinuation of treatment. The sensitivity is caused by the passage of the oxygen ion through the enamel and dentin, reaching the pulp tissues, which will result in sensitivity [8,9], being the treatment contraindicated for patients with dentin sensitivity [10].

In an attempt to neutralize dentin sensitivity, some manufacturers add potassium nitrate and fluoride to bleaching products, although it appears to result only in a limited reduction in the sensitivity experienced by patients. Low intensity laser therapies for desensitization have also been reported in the literature [11]. Sensitivity to the tooth remains a major concern, although there are many studies and techniques that combine desensitizing approaches and bleaching substances and it is important to explore alternative desensitization regimes that are able to reduce or eliminate sensitivity and discomfort [11].

In cases of non-carious or incisal cervical lesions, dentinal exposure leads to dentin sensitivity during tooth whitening, which is why restoration of these lesions is indicated for treatment to be performed [12].

Thus, many techniques are described in the literature to minimize the adverse effects of the bleaching treatment and also to potentiate the effect of the bleaching substances, in view of this circumstance, this work had the objective of carrying out a literature review on the current bleaching techniques.

### Literature Review and Discussion

Mechanisms of color perception cannot exist without light, i.e., the shape and color of the dental element can only be perceived if the tooth emits a light frequency sensitive to human eyes through a beam of light. The variation of electromagnetic waves between 380-760 nm can be perfectly discernible with the naked eye. The short wavelength of 400 nm corresponds to the bluish colors, the average wavelengths 540 nm to the green ones and the long wavelengths to the reddish ones. Thus, color is nothing more than a wave of energy of specific length; is the visual perception of a given wavelength that determines the colors that the eyes detect [13].

The color has 3 dimensions: hue, chroma and value. Hue is used to set the color, for example, red, yellow, and blue. The value is related to the variation of the brightness and reflection of the light, and the chroma or saturation determines the intensity of the hue or its degree of saturation. In bleaching the teeth may undergo changes in saturation or chroma, but not in hue, for example a person presenting C3 color may, after treatment, present color C1,

but not change the hue for B1 or A2 [14].

Dental dimming occurs through pigments impregnated in the dental structure for a variety of reasons, such as food colorings, trauma, intracanal medication, dental internal bleeding, among other causes. When these pigments form molecules capable of reflecting light at a wavelength visible by the human eye and whose intensity is greater than the light reflected by the tooth structure, then the color of the pigment predominates and the darkened tooth is observed [15].

The extrinsic pigmentation is acquired from the medium after the dental eruption, is the result of the precipitation of food dyes on the plaque and acquired film coating the dental enamel and by chromogenic bacteria. The foods with the greatest potential dye are: coffee, soft drinks, black tea, food colorings, red wine and smoke. This type of pigmentation is usually removed after prophylaxis; however, extrinsic pigments that remain for a long time in contact with enamel and dentin may become intrinsic by penetration of the enamel defects and exposed permeable dentin. Intrinsic pigmentation may involve enamel and/or dentin, being of congenital origin (dentinogenesis or imperfect or amelogenesis) or acquired (fluorosis, tetracycline staining, pulp necrosis, metal impregnation, aging) [16,17].

The pigmenting molecules are formed by long and complex macromolecular carbon chains, which are housed inside the dental structure. These long chains inside the teeth cause the light to be more absorbed than reflected, making the dental structure darker [18].

Dental whitening can be indicated in practically all situations in which tooth darkening occurs, such as: decomposition of the pulp tissue, internal hemorrhage, trauma, use of medicines, restorative materials and systemic conditions such as: fluorosis, jaundice and fetal erythroblastosis, among others [19]. Among its main contraindications are: application in pregnant women, infants, children under 10 years of age, patients who have teeth with exposed dentinal tubules and individuals who cannot quit smoking during the treatment period [19].

Bonifacio et al. [20] explain that the contraindications of the dental bleaching treatment occur for children under 10 years, because in these children there is a possibility of dental blackening after the trauma and then return to their normal color without treatment is greater than in the young and adults. The dentinal canaliculi are wider, allowing the reabsorption of the hemoglobin that has penetrated the tubules as a result of the trauma, thus making the bleaching treatment unnecessary.

The basic bleaching process involves oxidation, which consists of a chemical process where the organic materials are converted to carbon dioxide and water. The pigments are complex compounds, with large amounts of carbon molecules, which are broken and converted into intermediate compounds (smaller carbon chains), resulting in lighter teeth [20].

Regardless of the technique or product used, the mechanism of action of bleaching agents is based on the release of reactive forms of oxygen, as a function of the interaction of hydrogen peroxide with tooth structure. Hydrogen peroxide is an oxidizing agent capable of producing free radicals, releasing oxygen (O2), reducing the complex carbonic chain of the pigment (which absorbs the blue spectrum of light), into smaller molecules with free hydroxyls (which do not absorb blue light) and thus reflect the blue light along with the green and red spectra; the color mixture gives the H2 whitening effect [7,21,22].

This chemical reaction changes the type, number and relative position of the atoms that make up these molecules. During the bleaching the carbon chains are transformed into CO2 and H2O, being gradually released together with the nascent oxygen. The point of saturation is the moment in which the maximum bleaching occurs, from that stage the pigments are no longer bleached. This fact is of high clinical relevance because the indiscriminate use of high concentrations and prolonged times can cause undesirable damages to the dental structure. This may range from a simple transient pulp hyperemia, as is commonly observed in most cases of bleaching [8], to pulp necrosis or degradation of the crystalline structure of the enamel, which occurs when the bleaching agent begins to act on other carbon compounds, such as enamel matrix proteins [4,23]. The factors that interfere in the decomposition of hydrogen peroxide in the oral cavity, forming ions and free radicals are temperature, pH, light, coenzymes and the interaction with metals such as Fe, Cu, Ti.

External bleaching techniques are aimed at clarifying the polished teeth and can be carried out both at home by the patient and in the practice with products based on carbamide peroxide, hydrogen peroxide and sodium perborate in different concentrations [23,24,25].

Bleaching by the home-made technique uses products with lower concentrations, from 10% to 22% of carbamide peroxide. In dental whitening performed in the office, greater concentrations of whitening substances are used and laser, LED, ultraviolet and allogene light can be used to intensify the whitening processor [26].

From a physical/chemical point of view, the efficiency of a bleaching agent is directly proportional to the resulting chemical reaction rate, that is, its efficiency is limited by the concentration of the bleaching agent, the time of contact with the tooth structure, its reactivity and by the number of complex molecules present. The use of methods that increase the rate of chemical reactions allows the development of faster, efficient and clinically convenient techniques [27-29].

In this way, several methods have been developed in order to potentiate the chemical reactions such as chemical catalysis by Fenton reactions, thermo catalysis with heat units, lasers and high intensity lamps (plasma arc, xenon and halogen), photo thermal conversion (low intensity lights - LED and LED/ Laser) and ultraviolet light [11].

Due to the constitution and reaction form of hydrogen peroxide, it can be chemically classified according to the type of oxidative process, which can be homogenous (POAHo) or advanced heterogenous oxidative process (POAHe). Due to its high instability and reactivity characteristics, POAHo can have its reactions catalyzed by the temperature increase, the difference between the ambient temperature and the oral cavity, in this way, whitening will be catalyzed by the blending gel components and will not depend on no light source [30]. This is the beginning of the action of the home bleaching gels and some office bleaching agents that do not rely on irradiation for the bleaching process to occur. However, the bleaching gel can receive a source of energy to have its process accelerated.

The group of POAHe has its bleaching action dependent on a previous chemical reaction, called the process Fenton (Fe2+/H2O2) or Photo / Fenton (Fe2+/H2O2/UV), where the bleaching action depends on both the mixture and the action of a UV light [30].

In cases where the lightening gel does not require activation by light, the final aesthetic result using light will be the same as that obtained without using it, however, the time required to achieve it will be lower in the groups submitted to irradiation. The use of LED/ Laser

conjugated light is a Brazilian technology [28] based on the conversion of light energy into thermal energy in the bleaching gel applied on the dental surface. This increases molecular vibrations, providing a higher rate of free radical formation, accelerating the whitening process without the risks of heating the dental structure. However, the use of these methods is controversial. There are reports that some bleaching agents are more effective when photocatalysed, while others are not affected by the application of this electromagnetic energy [31] and that the use of light sources is inefficient, dispensable and potentially damaging to dental structure, sensitivity and discomfort to patients [32-34].

The persistent bleaching process for a few days after the end of the applications and authors demonstrated that the final aesthetic result is similar regardless of the use or not of the photo catalysis [29].

The decomposition of hydrogen peroxide and the release of free radicals responsible for bleaching can be accelerated by the supply of electromagnetic energy through an external source of light. The major difference in photoactivated lightening techniques is light emitting diodes (LEDs) that emit light in a narrow band, with electromagnetic energy of highly selective spectral purity, which increases the absorption of light by the dye, accelerating the peroxide decomposition and the whitening process. The advantage of photochemical activation is that light acts on the product and very little heats the dental structure [35].

Commonly, patients submitted to vital teeth whitening report sensitivity or discomfort during treatment, and can reach rates of up to 87.0%. Dental sensitivity during bleaching is caused by the harmful effect of hydrogen peroxide on pulp tissues as well as by stimulation of neural receptors [36].

The cytotoxic effects of chemical agents used for tooth whitening associated with its ability to trigger a significant inflammatory response in the pulp would impair the maintenance of the dentin structure. Pulp inflammation can also be explained by the fact that hydrogen peroxide, even at low concentrations, has the ability to penetrate easily into the enamel and to diffuse deep into the dentin reaching the pulp, especially in regions where the dentin is exposed in areas of gingival recession, abrasion, erosion, wear, defects in the enamel, defects in the dentinal junction, or in marginal areas between the tooth and the restoration. Oxidative stress, generated by bleaching agents, causes apoptosis and damage to periodontal DNA (genotoxicity) and cellular cytotoxicity [37].

Armenio [2] reported that sensitivity occurs in approximately 2/3 of the patients, and can be explained by the low molecular weight of this agent and the free passage through the enamel and dentin, which can reach the pulp.

In this aspect the literature is also controversial, it is stated that office whitening causes more sensitivity due to the high concentration of hydrogen peroxide used, especially if it is catalyzed by light or laser sources, usually associated with excessive heating of the dental structure due to the use of high intensity irradiation [28,38]. On the other hand, they affirm that home bleaching provokes dental sensitivity in all clinical articles selected for systematic review on this topic, which demonstrates that, even in small concentrations, peroxide can cause pain and discomfort to patients.

A new generation of bleaching agents with a low concentration of hydrogen peroxide (3.5% and 15%) was introduced in the market to perform dental office whitening, aiming to achieve greater safety and efficiency in tooth whitening. These are substances that have reactions dependent on heterogeneous advanced oxidative processes (POAHe) in which the action of hydrogen peroxide is catalyzed and potentiated by a semiconductor agent, usually titanium dioxide. According to Maetani et al. [39] and Suemori et al. [40], this new generation of bleaches containing nanoparticles of TiO2, is safer and more effective than traditional formulations because they promote bleaching without the presence of hydroxyl, which minimizes damage to dental structure.

Clinically it is observed that some patients feel a lot of pain while another simply has no relevant discomfort, even when submitted to the same technique of whitening, regardless of whether it is performed by the office or nursing home technique. The reason for this type of occurrence remains uncertain. It is believed that this is due to structural defects of dental tissues and individual predisposition, although there are no objective data for this statement [11].

The LEDs present numerous advantages, one of them being the decrease of the dentin sensitivity when associated to the therapeutic laser. It is affordable equipment, less use of electricity and does not cause increase in the temperature of the dental structure [41].

Nowadays we find several ways to perform dental whitening, recently ultraviolet light has been used for dental whitening, and propose to exclude the use of bleaching chemicals such as hydrogen peroxide or carbamide [42-45]. Bleaching using ultraviolet light is indicated by the manufacturer for patients with dentin hypersensitivity, gingival retractions, enamel micro fractures, dentin exposures and restorations with extensive restorative/enamel interface materials [46]. However, we did not find any literature on the action of this light on tooth whitening, only the manufacturer's information. This would be the resolution for the problems of dentin sensitivity after bleaching treatment and other adverse effects related to hydrogen peroxide [47-50].

## CONCLUSION

In view of the above, we concluded that the techniques of whitening are very contradictory; however, they present positive results regarding tooth whitening, although sensitivity after treatment is a frequent adverse effect.

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