Vital tooth bleaching with Hydrogen peroxide and laser – A review

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Abstract: Bleaching is the technique which is meant to change the coloured substances (internal or intrinsic stains) within the structure of tooth using reactive oxygen species (ROS).The three commonly used methods are at-home (professionally dispensed), in-office (professionally administered), and over-the-counter (self-administered).Among a wide variety of bleaching agents available for vital teeth, hydrogen-peroxide and carbamide-peroxide based agents are the most commonly used.Laser-assisted bleaching is the procedure that uses laser beam to speed up the release of free radicals present within the bleaching gel, thus decreasing the time of procedure. Efficacy of laser bleaching is compared with power bleaching by various researchers but still results remained controversial. Thus the present review was conducted to assess the efficacy of conventional bleaching using hydrogen peroxide and laser bleaching technique for a vital tooth.

Key words: Hydrogen peroxide; Laser; Power bleaching; Vital tooth bleaching;

1. Introduction:

According to the US Food and Drug Administration (FDA), bleaching is the technique that makes teeth lighter in colour than their natural shade.[1] Lightening of tooth color can be effectivelydone by using a wide range of methods of bleaching. The three commonly used methods are at-home (professionally dispensed), in-office (professionally administered), and over-the-counter (self-administered).[2] Bleaching is the technique which is meant to change the coloured substances (internal or intrinsic stains) within the structure of tooth using reactive oxygen species (ROS).[1]

Among a wide variety of bleaching agents available for vital teeth, hydrogen-peroxide and carbamide-peroxide based agents are the most commonly used. These products have varied concentration of bleaching agents, used for different whitening procedures and vary in format. High concentrations of agents are used for in-office use and low concentrations for home bleaching.[3] Minouxet al. were first to mention that procedure of tooth whitening is a complex techniqueas it is based on various factors: 1) thickness of bleaching agent and

method of its application 2) pH of bleaching agent, 3) tooth size, 4)fluctuation of irradiation, 5) duration of photoactivation,6) absorption of irradiation.[4]

Various studies have advocated that heating of hydrogen peroxide (HP) leads tohastening of its decomposition and formation of oxidant-free radicals. Thus by heat activation, the process of dental bleaching can be activated. One of the commonly used methods of activation that increase the temperature of the bleaching gel is power bleaching using high-intensity light.[5-6]In case of in-office bleaching, as compared to ambulatory technique, photo-activation using Laser Light Emitting Diodes (LED), lasers and halogen lamps is found to be more advantageous.[7-8]

Laser-assisted bleaching is the procedure that uses laser beam to speed upthe release of free radicals present within the bleaching gel, thus decreasing the time of procedure. Laser bleaching also reduces the chances of hypersensitivity after bleaching, decreases loss of microhardness of enamel and reduces the irritation of gingival because of lack of using hydrogen peroxide.[9]Although efficacy of laser bleaching is compared with power bleaching by various researchersbut still results remained controversial. Thus the present review was conducted to assess the efficacy of conventional bleaching using hydrogen peroxide and laser bleaching technique for a vital tooth.

2. **History**:

In 1867, M'Quillengave the first description on professional bleaching of discoloured teeth,[10]which led to the advent of first commercial bleaching productpyrozone (5:1 ratio of 25% hydrogen peroxide (HP) and diethyl ether), in 1895.[11]In 1937, Ames used electromagnetic radiationson 35% HP to raise the efficacy of bleaching.[12]Since 1980s, this approach is being used with help of infrared lamps as a heat source, but it was accompanied by disadvantages of thermal stress that causes pulp irritation. High (35%) concentration of HP reported to cause caustic effects.[13]In year 1989, the field of dental bleaching was revolutionized with the beginning of nightguard vital bleaching. This technique uses a custom-made mouthguard which is worn at home using a low strength product (10% carbamide peroxide), that allows a sustained release of HP and also covers multiple teeth.[14]

Presently there are two most commonly used bleaching techniques; home-based bleaching which uses bleaching gels with low concentrations of HP and in-office bleaching which use a high concentration of HP. For reducing the time of in-office bleaching, different methods have been used forfastening the disintegration of HP;physicochemical or photooxidation,

chemical (alkaline pH), and physical (heat) techniques. The method using heat is usually termed as "power bleaching".[15]Both incoherent and coherent sources of radiation are being used to catalyse the process of bleaching . These includeplasma arc, quartz tungsten halogen and mercury vapour lamps; light emitting diodes (LEDs); and lasers of different wavelengths.[16]Some authors stated that addition of different colourants to bleaching gels of power bleaching can cause better light absorption by bleaching gels, that helps in reducing the heat to dental pulp.They also mentioned that colourants can also activate other photochemical or photodynamic reactions.[17]

3. **Mechanism of action**:

Bleaching done by using ROS (HP or derived from HP) is a chemical process occurring because of oxidative reduction of chromophores, which is the breaking down of light absorbing organic molecules. Target molecules or chromophoresabsorbe photons due to their elaborated π-π conjugated system consisting of delocalized electrons. The difference of energy between the highest occupied and lowest unoccupied molecular orbital (HOMO, LUMO) is called "band gap." Light of same wavelength as of band gap is absorbed by the molecule, leading to excitement of the π-electron.[18]

Bleaching is the process that causes disruption of π-π conjugated systems by oxidation and other chemical reactions. Molecules with such ring structures opened up into linear forms, causing loss of light absorbing properties, thus leading to discolouration of molecules.[18]

Besides HP, various other oxidizing agents like ozone can be used in bleaching reactions, with varying bleaching potential. With high potential, effectivity of bleaching agent will be more to bleach chromophores.[19] The targets of bleaching agents are the chromophores or coloured stains that are present either inside or on the surface of tooth. On surface stains can be removed by professional cleaning, prior to an in-office bleaching procedure. They can also be decolourized by using paint-on gels, low strength (0.5%) HP rinses, and oxygen releasing products like denture cleansers. For stains inside the tooth structure, a penetrating action is required. This can be done using light being transmitted internally, causing photooxidation and producing ROS. This generates radicals which readily infiltrate via the crystallized enamel and dentine structure. Thus agents being used in tooth bleaching should (i) have a high redox potential, (ii) release ROS that diffuse readily into dentine, (iii) be nontoxic and noncorrosive.[20]

4. **Bleaching with Lasers**

Various essential elements of laser light determining its effect on the target are 1) power density of beam (W/cm²), wavelength of radiant energy (nm) of laser, and temporal features of beam energy (pulse rate (Hz), continuous or pulsed delivery, pulse duration, energy density (J/cm²) and fluence (amount of energy per unit area). Other parameters of laser delivery are mode of delivery (contact or noncontact), focused or unfocused beams, and diameter of beam. The mechanism of action of laser is influenced by its wavelength, power and mode of operation. The operating mode affects the dynamics of heating of target. The accumulated heating using continuous wave mode is more than pulsed mode. At low energies, interactions between laser and tissue are recognized to create photobiostimulation, photochemical effects and purely optical or a combination of optical effects. On increasingpower of laser or pulse energy, the photothermal interactions alsoincrease. Pulsed lasers usuallyproduce high power densities in a short time interval, causing photoablation, which is not desirable in a bleaching gel.

While choosing a desired wavelength of laser, it is required to consider the extent of light "absorption" for a better bleaching efficacy. The amount of photon absorption effects the rise in temperature occurring within the dental hard tissues, pulp and bleaching product. It is required to properly understand the features of bleaching gel and its additives, so that they can be wisely used with laser, affecting the colour and absorption spectrum. The pH and thickness of gel have to be considered as it effects the patterns of radicals which are produced.[21]

5. Comparative studies

Fekrazad R et al.[2]compared both laser-assisted and power bleaching techniques and found that both were able to alter the tooth color, but laser bleaching was found to be a more effective. Both techniques increased whiteness and decreased degree of yellowness in tooth samples. The decrease in ΔE for laser bleaching and power bleaching groups was 3.05 and 1.67 respectively. Change in tooth colorwas 1.88 times more in laser bleaching than power bleaching (p<0.001).**Papathanasiou A et al.**[22]revealed that activation of bleaching gel with different light sources like infrared (2000-4000nm), halogen (400-500nm), and plasma lamp (400-550nm) can cause a considerable success in tooth whitening as compared with different laser systems likediode laser (830nm), argon ion laser(488nm), and CO2 laser (10600nm). **Gurgan S et al.**[23]found that diode laser-activated bleaching gels were observed to perform significantly better than power bleaching, as found in spectrophotometry. **Torrez CR et al.**[24]**,**

described that bleaching of a vital tooth with photo-activation using diode lasers of low intensity is intense and fast but weakening of colorchange was seen before 1yr.

In the past 20yrs, dentists are being exposed to various dental bleaching materials and techniques, and even the devices for light activation of the peroxides have also increased extensively. Based on varied light sources, the technique is undergoing several changes for activation of peroxide. Laser light is different from conventional light as it needs a laser-target interaction, which occurs in the bleaching gel, followed by a second interaction in the tooth, mainly dentine. It has been found that professional bleaching treatment using HP- and CP-based agents is safe and effective when manufacturers' instructions are properly followed. For getting safe and successful results of bleaching, a careful monitoring and supervision is required. The common risks of bleachingsuch as tooth sensitivity and gingival irritationare temporaryin nature and can be managed with professional help.Home bleaching is a safe and cost-effective option, whereas In-office bleach is a viable option for getting immediate results. Future work is required to determine the uses of light-activated bleach.

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