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Research Article

TEETH WHITENING TREATMENTS: AN OVERVIEW

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A B S T R A C T

Dental aesthetics is an important part of clinical practice in today's time. Since bleaching is most conservative, less destructive, and economical, it is most opted method by the people for tooth whitening. This review article will help clinicians understand bleaching procedures, bleaching types, components, mechanisms, and their effects on soft tissue, tooth structures, sensitivity and restorations. However, because of the variability in experimental design, there is a lack of consensus concerning the bleaching effects on tooth and its surrounding tissues and further studies need to be done over it.

INTRODUCTION

Dental aesthetics, including tooth colour, has great importance for majority of the people. Any discolouration or staining can impact their quality of life in a fatalistic way. The colour of teeth reflects a combination of its intrinsic colour and the presence of extrinsic stains due to various factors such as intake of tannin rich foods, smoking and drinks (e.g. red wine), and the use of metal salts or chlorhexidine such as tin and iron.[1-3]

Increased need for aesthetics has been the foremost factor for growth of aesthetic dentistry. This has made vital tooth bleaching (teeth whitening procedure) one of the most well-accepted and successful aesthetic dental treatments over the past decades. Although there are various methods available to manage discoloured teeth, tooth bleaching has been reported to be the most desired choice by the patientsseeking treatment for dental aesthetic improvement.[4]Tooth bleaching is one of the most favourable, less invasive and cheapest method of treatment compared to other invasive or costly restorative treatment options like crowns, veneers, direct or indirect restorative treatment. Contemporary tooth bleaching products have emerged into three major categories: in-office bleaching (power bleaching), at-home bleaching (night guard vital bleaching), and over-the-counter (OTC) bleaching agents. In general, many in-office and at-home bleaching techniques have shown to be Impactful, although results may vary depending on the factors including type of stain, bleaching agent, and treatment protocol. [5-7]

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Types of Stains

The colour of teeth is determined by translucency and thickness of enamel and underlying dentin, and colour of pulp. The normal colour of teeth is yellowish white, greyish yellow or greyish white. This natural colour of teeth is affected by presence of stains. Stains may be extrinsic or intrinsic discolorations.

Extrinsic Discolorations

Extrinsic stains are usually found on the outer surface of teeth usually due to depositions of Chromogenic substances. These stains are usually local in origin and occur due to intake of tea/coffee, tobacco and mainly due to poor oral hygiene maintenance. Due to long-range attractive forces like Vander Waals and electrostatic forces and short-range attractive forces like hydration forces, hydrophobic interactions and hydrogen bonds stains get deposited on the tooth surface. Extrinsic stains can be easily removed by scaling and polishing and by bleaching but few metallic stains cannot be removed easily by using chemical agents.

Intrinsic Discolorations

Intrinsic stains are caused to deeper internal stains or presence of chromogenic material within enamel or dentin incorporated during odontogenesis or after tooth eruption. They are caused by wearing of enamel with aging, ingestion of chromogenic food and drinks, tobacco usage, porphyria, restorations, decomposition of pulp tissue, trauma, calcific metamorphosis, endodontic materials, Iatrogenic discolorations, tetracycline medication, enamel micro cracks, excessive fluoride ingestion, severe jaundice in infancy, dental caries, and the thinning of the enamel layer. [8]Intrinsic stains colours can be determined

by optical properties of enamel and dentin. Due to translucent property of enamel they become visible. Discolorations which are due to defects by birth like amelogenesis imperfecta or dentinogenesis imperfecta are impossible to be removed completely. Stains due to trauma to teeth leads to pulp necrosis can be easily treated by bleaching. Another cause for discolouration of teeth is aging as over the time the underlying dentin becomes darker due to formation of secondary dentin which gives teeth a darker appearance as aging occurs. Intrinsic stains are not easily removed by regular prophylactic procedures. They can be reduced by bleaching with agents penetrating enamel and dentin to oxidize the chromogens. Tooth stains caused by aging, genetics, smoking, or coffee are the fastest to respond to bleaching.

Mechanism of Action

According to Minoux *et al*., the methods that have been described in the literature for bleaching vital teeth are all based on the direct use of hydrogen peroxide (H2O2) or its precursor, carbamide peroxide(CP)[1].

The principal mechanism involved in bleaching is that the oxidizing site reaches the sites within enamel and dentin to allow a chemical reaction to occur between the discoloured segment and the active ingredient. HP has low molecular weight making it permeable through enamel. Bleaching agent converts the double bonded carbon atoms into single bond and increases the light absorbed by the tooth thus lightening it.

CP (10%) shows the same mechanism except for the first step where it converts into 7% urea and 3% HP and further undergoes a redox reaction wherein the tooth acts as a reducing agent and the bleaching agent acts as an oxidising agent.

Composition of commercial bleaching agents

Mainly Bleaching Agents consist of both Active and Inactive Ingredients.

The active ingredient includes HP or CP compounds.[9, 10] HP and CP both are equally efficient in tooth whitening, Similar in content and is delivered in similar format and formulation.[11-13] HP is also known as Sodium percarbonate, painted ontothe teeth in a product containing silicone polymer.[14] The efficacy of HP versus sodium percarbonate in the same product format, content, and conditions has not been reported. [9]

The major inactive ingredients may include thickening agents, carrier, surfactant and pigment dispersant, preservative, and flavoring.

Thickening agents: Carbopol (carboxypolymethylene) is the most commonly used thickening agent in bleaching materials. Its concentration is usually between 0.5% and 1.5%. This high-molecular-weight polyacrylic acid polymer offers two main advantages. First, it increases the viscosity of the bleaching materials, which allows for better retention of the bleaching gel in the tray. Second, it increases the active oxygen-releasing time of the bleaching material by up to 4 times. [15]

Polyx is another thickening agent with its composition being a trade secret. It enhances the activity of the material and tray design. [16]

Carrier: Glycerin and propylene glycol are the most commonly used carriers in commercial bleaching agents. The carrier can maintain moisture and help to dissolve other ingredients.

1. ***Surfactant and pigment dispersant:*** Gels with surfactant or pigment dispersants may be more effective than those without them. [17]The surfactant acts as a surface-wetting agent which permits the active bleaching ingredient to diffuse. Moreover, a pigment dispersant keeps pigments in suspension.
2. ***Preservative:*** Methyl, propyl paraben, and sodium benzoate are commonly used as a preservative to prevent bacterial growth within the gels. [18] In addition, these agents can accelerate the breakdown of hydrogen peroxide by releasing transitional metals such as iron, copper, and magnesium. These preservatives enhance the durability and stability of the gels and have mildly acidic ph.
3. ***Flavoring:*** Flavoring agents are the substances used to improve the taste and the consumer acceptance of bleaching products. For example, banana, melon, peppermint, spearmint, wintergreen, sassafras, anise, and sweetener such as saccharine. [18]
4. ***Additives:*** To escalate the bleaching procedure and/or minimize its side effects, various additives are incorporated within bleaching gels.[7]

Potassium nitrate*:* Five percent potassium nitrate acts like an anaesthetic by halting the nerve from repolarizing after it has depolarized in the paincycle.[19] Hence, it decreases the postoperative sensitivity without reducing the bleaching effect. It is effective evening light-activated bleaching.[20-23] Hence, it is superior in comparison to other additives.

Fluoride*:* Fluoride tends to increase themicro hardness of the substrateenamel.[24,25] Fluoride containing bleaching gels result in lesser demineralization without altering bleaching efficiency.[26] The fluoridated bleaching gels maintain the micro tensile bondstrength, assisting in subsequent restorative procedures.[27] Fluoride blocks the dentinal tubules resulting in slowing down of the dentinal fluid flow inside the tubules, hence decreasing sensitivity.[28]

Amorphous calcium phosphate-casein Phosphopeptide*:* The addition of amorphous calcium phosphate-casein phosphopeptide (ACP-CPP) within bleaching gels significantly reduces sensitivity by remineralization[29] and even enhances the bleaching outcome.[27] ACP-CPP plays role in desensitization byprotein binding and deposition of phosphate and calcium ions in exposed dentinal tubules. The ACP-CPP-added gel enhances the lustrous shine to the teeth. [18] Patients using ACP-CPP gel had lesser bleaching effect compared to those using potassium nitrate-modified gel with similar reduction in sensitivity.[29]

Types of Bleaching Procedures

Mainly classified as vital and non-vital bleaching techniques having further sub-categories.

There are three fundamental approaches for bleaching vital teeth: in-office or power bleaching, at-home or dentist supervised night-guard bleaching, and bleaching with over-the-counter (OTC) products.

In In-office technique, higher concentration of whitening agents (25-40%) are used. This is directly applied over the

teeth after protecting the soft tissues by rubber dam or other isolation techniques. It is further cured by halogen curing lights, Plasma arc lamp, Xe-halogen light (Luma Arch), Diode lasers (both 830 and 980 nm wavelength diode lasers), or Metal halide (Zoom) light can be used to activate the bleaching gel or accelerate the whitening effect. Maximum results are achieved by 1st visit whereas some might require another appointment.

At home technique involves use of low concentration agents (10-20% carbamide peroxide) which are used by patients in a pre fabricated night mouth guard. This is done for almost 2 weeks, 8 hrs/day.

Over-the-counter (OTC) bleaching products have increased in popularity in recent years. These products are composed of a low concentration of whitening agent (3-6% hydrogen peroxide) and are self-applied to the teeth via gumshields, strips, or paint-on product formats. They are also available as whitening dentifrices, pre-fabricated trays, whitening strips, and toothpastes. They are used twice daily for 2 weeks. There are numerous non-vital bleaching techniques used today, for example, walking bleach and modified walking bleach, non-vital power bleaching, and inside/outside bleaching.

The walking bleach technique involves sealing a mixture of sodium perborate with water into the pulp chamber of the affected tooth, a procedure that is repeated at intervals until the desired bleaching result is achieved. This technique is modified with a combination of 30% hydrogen peroxide and sodium perborate sealed into the pulp chamber for one week; this is known as modified walking bleach. In internal non-vitalpower bleaching, hydrogen peroxide gel (30-35%) is placed in the pulp chamber and activated either by light or heat, and the temperature is usually between 50 and 60 degree C maintained for five minutes before the tooth is allowed to cool for a further5 min. Then, the gel is removed, the tooth is dried, and the 'walking bleach technique' is used between visits until thetooth is reviewed 2 weekslater to assess if further treatmentis needed. The inside/outside bleaching technique is acombination of internal bleaching of non-vital teeth with the home bleaching technique. [31]

General and local toxic effects of Bleaching Agents

Effects on soft tissues: The more powerful in-office bleaching (30-35% hydrogen peroxide) can easily produce soft-tissue burns, turning the tissue White. [32]HP, together with lauroyl and benzoyl peroxides, all represent compounds with the potential to generate free radical species. They are not carcinogenic when applied topically to the mouse skin, but they are potent skin irritants. Notable modifications induced by peroxides in skin are epidermal hyperplasia and the induction of dark keratinocytes: 15% or 30% (w/v) HP gave rise to an extensive epidermolysis, inflammation, and vascular injury in rodents. This was found to be followed by a rapid regeneration and epidermal hyperplasia. [33]During the treatment of periodontal diseases, the bacteriostatic properties of H2O2 have been widely used, and in this context, cell lysis has been reported at a concentration as low as 1%. [34] This is more commonly seen due to use of highly caustic bleaching agent coming in contact with unprotected gingival tissue. When ill-fitted trays are used, the margins of the tray can cause gingival irritation. Such gingival lesions can be treated by copious rinsing with water. More severe chemical burns can be treated with topical application of anaesthetic gels combined with good oral hygiene. Carefully adapted plastic trays or night guards may reduce the amount of whitening agent that is expelled onto the oral mucosa when the patient overfills the tray. Strips and painted lacquers reduce the risk. The ingestion of bleaching gel may produce gastric pain, although the repeated ingestion of peroxide-containing gels does not seem to have severe consequences.

Effects on tooth structure: Bleaching of teeth involves direct contact with the tooth surface with the enamel surface for a period of time depending on the material and different concentrations used. There are many studies available on the effect of bleaching agents on the enamel surface. Some are in favour and provide evidence on reduced enamel structure by use of bleaching agent while others are against it. Hegedüs *et al*., [35] in an atomic force microscopy study, demonstrated that CP and HP were capable of causing alterations in enamel surface. In a recent study, [36] it was found that all four different kinds of opalescence teeth whiteners damaged enamel. The most damage was done by the 10% and 20% CP products because of the much longer exposure period of 112 hours in comparison to only 7 hours for the Opalescence Quick PF 45% CP. Certain studies have also reported negative effects on enamel and dentine microhardness, [37-41] while others reported no change in the microhardness of enamel [42-43] and dentine.[44] Lewinstein *et al*. [45] reported that in-office bleaching products, i.e. 35% HP and 35% CP, reduced hardness of enamel and dentine significantly more than the home bleaching products, i.e. 10% CP, but the application of 0.05% fluoride solution for 5 minutes completely restored the softened tooth structure. Bleaching action on the enamel may result in erosive areas and increased porosity. Due to caustic nature of HP it causes enamel micro hardness. It causes changes in the organic-inorganic ratio rendering the week enamel.

Tooth sensitivity: This is the most common side effect of bleaching. This occurs due to penetration of bleaching agent into the tooth structure through enamel micro cracks, resulting in pulpal hyperemia. Data from various studies of 10% Carbamide peroxide indicate that from 15 to 65% of the patients reported increased tooth sensitivity. [46]This sensitivity may last up to 39 days and, in some cases, is so painful that it leads to treatment interruption. [47]It is well documented that H2O2 diffuses throughout the enamel layer and dentine, even in vital teeth. In vitro studies demonstrate peroxide penetration into the pulp with most bleaching agents and methods, including whitening strips that presumably would excerpt mild effects [48-50]. This phenomenon results from both the osmotic and vascular pressures[51]. It is advisable not to perform bleaching in teeth exposed due to caries or defective restorative margins. Postoperative care using fluoridated mouth-rinse or amorphous calcium phosphate in casein phosphopeptide (ACP-CPP) is used to promote remineralization of the enamel surface.

Effects on restorative materials: Bleaching agents have well-established effects on dental fillings [52-53]. After treatment of silver amalgam with a Gel containing 10% (w/w) carbamide peroxide, an increased level of mercury and silver was found near the surface of silver amalgam; whereas, tin and copper levels therein were diminished [54-55]. Several in vitro studies have evaluated the effects of CP (10 - 16%) and HP (30 - 35%) whitening products on the physical properties, surface morphology and colour of different restorative materials. [56]

An increase in the surface roughness of porcelain, microfilled composite and modified glass ionomer following treatment with 10-16% CP was reported by Turker and Biskin. [57]Ulukapi *et al*. [58] reported that pre- and postoperative bleaching with CP increased marginal leakage of resin composite restorations at enamel and dentine margins but amalgam restorations showed no alterations. Crim [59] reported that pre-restorative bleaching with 10% CP did not affect the marginal seal of subsequently placed restorations. In contrast, other studies did not report increased micro leakage rate at enamel margins. [60] There is no clear evidence indicating whether the changes in tooth-coloured restorative Tooth-bleaching materials are superficial or deep. However, polishing of resin composite fillings is advisable following bleaching procedures to decrease the adherence of certain cariogenic micro-organisms. [61]

Bleaching agents also cause increased release of mercury from amalgam restorations. [62]The corrosion potential of amalgam is also decreased if restorations are polished prior to the bleaching therapy.

CONCLUSION

Despite of varying contradictory conclusions derived from existing literature, it can be stated that chemical mechanism of action of bleaching agent causes alteration in enamel and dentin layer which causes minor defects on enamel surface of the teeth as well as damaging dentin permeability causing sensitivity. The effects of bleaching agent on pulp is not clear but chronic treatment by HP or CP may be harmful to teeth. Bleaching causes gingival tissue damage and irritation which is the most common side effect of bleaching. Prolonged use of bleaching agent also leads to hypersensitivity of tooth structure and damage to cervical region of teeth. Thus dentist plays a very important role here in diagnosis and treatment planning varying according to the patients and educate patients regarding effects of using bleaching agents. Whitening products can cause wonders for the patients if used wisely.

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