

Review Article

Tooth Bleaching: An Aesthetic Consideration and Safety Controversies

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Abstract:

Aesthetics are of utmost importance including tooth colour to the people these days. Dentists are called upon to respond to requests from patients who wish to enhance their smiles. In this review of the literature, various causes of tooth discoloration, bleaching of vital and non vital teeth and biological hazards are discussed.

Keywords: Tooth whitening, Esthetics, Hydrogen peroxide, Peroxide toxicity

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Introduction

Today's dental patients are better educated than in the past. There has been an increase in the ability of patients to understand what dentistry has to offer because television and print media have provided our patients with insights on the latest advances and research in dentistry, including periodontal disease and its implications with heart disease, lasers, CAD-CAM, implants, white fillings, porcelain veneers, and tooth whitening, among others. Also, the Internet provides patients with access to information on the advances in dentistry. One major area that our patients are requesting more information on is aesthetic dentistry.¹

Aesthetics of the teeth is of great importance to patients, including tooth colour. The colour of the teeth is influenced by a combination of their intrinsic colour and the presence of any extrinsic stains that may form on the tooth surface, Intrinsic tooth colour is associated with the light scattering and adsorption properties of the enamel and dentine, with the properties of dentine playing a major

role in determining the overall tooth colour.²

Extrinsic stains tend to form in areas of the teeth that are less accessible to tooth brushing and the abrasive action of a toothpaste and is often promoted by smoking, dietary intake of tannin-rich foods (e.g. red wine) and the use of certain cationic agents such as chlorhexidine, or metal salts such as tin and iron.³

There are a number of methods and approaches that have been described in the literature for the bleaching of vital teeth. For examples, methods utilising different bleach agents, concentrations, times of application, product format, application mode and light activation.⁴

In-office tooth bleaching has been a dental procedure for more than a century; however, at-home tooth bleaching was not available until 1989, when it was introduced by Haywood and Heymann. With its demonstrated efficacy, lower cost than in-office bleaching, and the convenience of self-application, at-home bleaching quickly gained popularity and has now become an integrated procedure in aesthetic dentistry. Nowadays, in

addition to the bleaching products available from dental professionals, over-the-counter (OTC) and infomercial at-home bleaching products are available directly to consumers, and they can be applied with a custom or preformed tray, with a brush, or as a strip. In recent years, tooth bleaching similar to in-office procedures but performed under nondental settings, such as mall kiosks, spas, and cruise ships, has become available.⁵

Causes of Tooth Discoloration

The correct diagnosis of the cause of discoloration of teeth is of great importance because it has a profound effect on the treatment outcome. It is therefore necessary that dental practitioners have an understanding of the etiology of tooth discoloration to arrive at a correct diagnosis leading to an appropriate treatment plan.⁶

Tooth color is determined by a combination of phenomena associated with optical properties and light. Essentially, tooth color is determined by the color of dentin and by intrinsic and extrinsic colorations. Intrinsic color is determined by the optical properties of enamel and dentin and their interaction with light. Extrinsic color depends on material absorption on the enamel surface. Any change in enamel, dentin, or coronal pulp structure can cause a change of the light-transmitting properties of the tooth. Tooth discoloration varies in etiology, appearance, location, severity, and affinity to tooth structure.⁷ It can be classified as intrinsic, extrinsic, or a combination of both, according to its location and etiology.⁸

Extrinsic Causes are chromogens derived from habitual intake of dietary sources, such as wine, coffee, tea, carrots, oranges, licorice, chocolate, or from tobacco, mouth rinses, or plaque on the tooth surface.

Intrinsic Causes

Systemic causes are 1) drug-related (tetracycline); 2) metabolic: dystrophic calcification,

fluorosis; and 3) genetic: congenital erythropoietic porphyria, cystic fibrosis of the pancreas, hyperbilirubinemia, amelogenesis imperfecta, and dentinogenesis imperfecta.

Local causes are 1) pulp necrosis, 2) intrapulpal hemorrhage, 3) pulp tissue remnants after endodontic therapy, 4) endodontic materials, 5) coronal filling materials, 6) root resorption, and 7) aging.⁷

MECHANISMS OF TOOTH BLEACHING

The generally accepted mechanism involved in tooth bleaching is similar to that in textile and paper bleaching: free radicals, produced by H_2O_2 , interact with pigment molecules to produce a whitening effect. It is hypothesized that H_2O_2 in bleaching gel produces free radicals while diffusing through enamel and dentine, breaking double bonds of pigment molecules and changing the pigment molecule configuration and/or size. Such changes alter the optical properties of tooth structure, creating the perception of a whiter tooth colour. This theory is also plausible in explaining the commonly observed shade rebounding shortly after the bleaching treatment, probably due to the reformation of the double bonds.

Besides the bleaching effect by free radicals, it is possible that there are non-bleaching effects during the bleaching process that help enhance the whitening effect, including the cleansing of the tooth surface. Enamel dehydration during the bleaching process may also result in a temporary whitening effect since enamel dehydration alone is capable of producing a significant, visible tooth shade reduction. Such whitening effect dissipates upon the rehydration of the enamel.⁹

Vital tooth bleaching

The key factors that have an affect on the final result after bleaching should be considered include concentration of the bleaching agent, duration of use of the bleaching agent, type of tooth discoloration, color of the teeth, and

patient's age. It has been reported that tooth discolorations with the best prognosis for whitening are

1. yellowing of the teeth without any systemic or developmental cause (food, smoking, aging, staining)
2. mild flourousis staining
3. mild tooth darkening due to trauma
4. mild tetracycline staining¹⁰

Patients are using OTC whitening products in greater numbers. In recent years, manufacturers have developed novel, trayless methods of bleaching teeth. The first product introduced professionally was Crest Whitestrips (Procter and Gamble) for in-office dispensing. One problem with OTC whitening products, especially bleaching products, is that there has been no diagnosis of the condition for which the patient is bleaching.

Whitening is a catchall phrase used with many OTC dental products that are not bleaching products per se, but will remove extrinsic stains from the tooth structure. Toothpastes, mouth rinses, gums, and paint-on products tout the benefits of whitening on their labels. Also, a mouth rinse has been introduced recently that contains 2% hydrogen peroxide for whitening. Over a 6-week clinical trial, the 2% hydrogen peroxide pre-rinse showed no significant color improvement to regular tooth brushing.¹

Patients are always looking for convenience in self-provided dental treatment. With this in mind, a number of "whitening gums" have been introduced. In clinical trials, these gums have been shown to reduce extrinsic tooth staining and inhibit additional tooth staining.¹¹ The first bleaching of teeth to change color was an in office procedure. Currently, the most popular systems for in-office bleaching use high concentration hydrogen peroxides and are often referred to as "one-hour bleaching." These high concentration hydrogen peroxides range from 25% to 35%. In-office bleaching can be provided to patients as either a one-

visit 1–1.5 hour treatment or a multiple visit procedure. One can use one of the light enhanced bleaching techniques, a laser-activated bleach or merely a paint-on bleaching gel or solution. One light system is based on a plasma arc high-intensity photopolymerization device (Sapphire PAC Light, Den-Mat) that can be used for in-office whitening and for resin photopolymerization. In-office professional whitening can be a perfect complement to the at-home whitening system.¹

Nonvital Tooth Bleaching

Bleaching of endodontically treated teeth that present with chromatic alterations is a conservative alternative to a more invasive esthetic treatment such as placement of crowns or veneers. The most commonly used procedure to treat extrinsic stains is by a professional hygiene treatment and by polishing tooth surfaces with prophylactic cups and more or less aggressive abrasive pastes.

Intrinsic stains from systemic causes are difficult to treat without a prosthetic rehabilitation.

The microabrasion technique can be successfully used to treat superficial discolored enamel defects. At the present time, enamel microabrasion is considered a conservative technique to improve the esthetic appearance of teeth with surface defects. Because this technique removes superficial external enamel, a correct diagnosis is of utmost importance.

For intrinsic stains to be removed, chemicals such as hydrogen peroxide are required because they penetrate enamel and dentin and decolorize or solubilize the chromogens. Internal discoloration of teeth represents the primary indication for whitening of root-filled teeth.⁷

Walking Bleach Technique

Internal bleaching procedures such as the walking bleach technique can be used for whitening of discoloured root-filled teeth. The walking bleach technique is performed by application of a paste consisting of sodium perborate-

(tetrahydrate) and distilled water (3% H₂O₂), respectively, in the pulp chamber.¹²

In this procedure, the mixture was left in the pulp cavity for a few days, and the access cavity was sealed with provisional cement. This procedure starts with intentional devitalization and root canal treatment of the tooth to enable application of the bleaching agent into the pulp chamber. Because the methods of intentional devitalization and root canal treatment have risks, the advantages and disadvantages of this therapy should be assessed. Restorative treatment options such as ceramic veneers should be considered as an alternative procedure. Before preparation of the access cavity, rubber dam should be applied to protect the adjacent structures. In case of severe discoloration, 3% hydrogen peroxide can be applied in lieu of water. The bleaching agent can be applied with an amalgam carrier or plugger and should be changed every 3–7 days. Successful bleaching becomes apparent after 2–4 visits, depending on the severity of the discoloration. The patients should be instructed to evaluate the tooth color on a daily basis and return when the bleaching is acceptable to avoid “over-bleaching”.⁷

Thermocatalytic Technique

Thermocatalytic technique was used to bleach nonvital teeth as the application of heat increases the bleaching properties of hydrogen peroxide by accelerating the bleaching reaction.¹³ This technique involves placement of 30%–35% hydrogen peroxide in the pulp chamber followed by heat application by electric heating devices or specially designed lamps. Heat might be applied by using a heated metal instrument or other commercial heat applicators. Heat application is repeated 3 or 4 times at every appointment, changing the pellet with “fresh” bleaching agent at each visit. When heat is applied, a reaction produces foam and releases the oxygen present in the preparation. At the

end of each appointment the bleaching agent is sealed into the pulp chamber for additional bleaching between appointments.⁷

Safety Controversies

With the available data on the toxicity of H₂O₂ as well as the research on bleaching materials and the assessment of their exposure in bleaching, concerns with potential systemic health risks have largely diminished, including the acute, subacute, and chronic toxicities associated with the use of materials containing 10% carbamide peroxide. This reduction is mainly because H₂O₂ exposure from bleaching is limited to the oral cavity and is incapable of reaching a systemic level. The possible exposure dose of H₂O₂ has been estimated at approximately 3.5 mg for a treatment of both arches with a whitener containing 10% carbamide peroxide, whereas the oral cavity is capable of decomposing more than 29 mg H₂O₂ within 1 minute.¹⁴

While many OTC products have demonstrated safety and efficacy for consumers, other unregulated and unresearched materials and methods may potentially cause irreversible damage if used on a long-term basis. The products in cruise ships and beauty spas commonly use chlorine dioxide as the active ingredient positioned as a ‘safer’ alternative to hydrogen peroxide while avoiding local and state legislations regarding the use of hydrogen peroxide. In truth, these chlorine dioxide products are more harmful, having little if any safety studies and commonly coming with a pH of 2 to 3. The chlorine dioxide at 0.5% concentration applied to the teeth for 20 minutes in a chair side procedure with gingival protection applied by a beauty therapist has been shown to strip the enamel off the teeth, reduce the enamel lustre and cause sensitivity.⁹

Potential Adverse Effects on Gingiva

The most common side-effects of tooth bleaching techniques are transient thermal sensitivity and oral irritation or ulceration.

A few reported cases have shown severe reactions to vital tooth bleaching. The greater concern for safety relates to the subtle biological reactions that take place rather than the clinically observable reactions.¹⁵

H₂O₂ at high concentrations is an irritant and also cytotoxic. In cell culture experiments,

H₂O₂ is cytotoxic at concentrations ranging from 1.7 to 19.7 mg/mL (0.05–0.58 mmol/L). At concentrations of 10% or more, H₂O₂ is potentially corrosive to the mucous membranes or skin, causing a burning sensation and tissue damage. Studies also reported that commercial peroxide-based gels induced cytotoxicity. During the in-office bleaching procedure, which routinely involves the use of H₂O₂ at a concentration of 25% or more, adequate barriers are necessary to protect the gingiva from mucosal damage. If a leakage exists, serious tissue burn can occur.⁵

Effects of hydrogen peroxide on hard tissues

Lewinstein et al. studied the microhardness of human enamel and dentin. Thirty per cent hydrogen peroxide was used at 37°C and 50°C. This study found a reduction in the microhardness of enamel and dentin. The hardness reduction was time-related and results were statistically significant on dentin following a five-minute treatment and on enamel after a fifteen-minute treatment.¹⁶

Attin et al. observed an initial significant loss of enamel microhardness after bleaching. Rehardening of the enamel after treatment was attributed to the remineralization capacity of saliva.¹⁷

Rotstein et al. subjected human premolars to solutions of 30% hydrogen peroxide, 10% carbamide peroxide, sodium perborate, and three commercially-prepared bleaching agents (utilizing 10–15% carbamide peroxide with pH ranges from 6.0 to 6.5). Results showed that most of the bleaching agents caused changes in

the levels of calcium, phosphorus, sulfur, and potassium in the hard tissues. Alterations in the inorganic components of hydroxyapatite are the result of changes in the calcium/phosphorus ratio found within the hydroxyapatite crystals of dental hard tissues. The decrease was more significant in cementum and dentin than in enamel.¹⁸ It was concluded that bleaching materials may adversely affect dental hard tissues.

To date, studies examining the adverse effect of peroxides on the microhardness of dental hard tissues have shown conflicting results.¹⁵

Conclusion

Cosmetic dentistry appears to be emerging as a health service. Researchers agree that more investigation into psychological factors associated with appearance is needed. With the knowledge on peroxide-based whitening materials and the recognition of potential adverse effects associated with the procedure, dental professionals are able to formulate an effective and safe tooth whitening regimen for individual patients to achieve maximal benefits while minimising potential risks.

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