



## RESEARCH ARTICLE

### RECENT TRENDS IN TOOTH WHITENING: A REVIEW

**1,\*Pradnya V. Bansode, <sup>2</sup>Seema D. Pathak, M.B. <sup>3</sup>Wavdhane and <sup>4</sup>Devika M. Kalaskar**

<sup>1</sup>Professor and Head of the Department, Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra, India

<sup>2</sup>Associate Professor, Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra, India

<sup>3</sup>Associate Professor, Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra, India

<sup>4</sup>Post-graduate Student, Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra, India

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#### ABSTRACT

In recent years, there has been an increased demand for improvement in the appearance of natural teeth. The conservative technique of tooth bleaching has gained attention and acceptance from both patients and clinicians. A subjective perception of tooth discoloration, or of having an unattractive natural tooth colour, can entice a patient to seek aesthetic enhancing procedures such as tooth bleaching. (1)

#### Key words:

Discoloration,  
Bleaching,  
Over the Counter Products.

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## INTRODUCTION

The history of dentistry is comprised of many efforts undertaken to achieve an effective tooth-whitening method. Non-vital tooth bleaching began in 1848 with the use of chloride of lime (Dwinelle, 1850), and in 1864, Truman introduced the most effective technique for bleaching non-vital teeth, a method which used chlorine from a solution of calcium hydrochlorite and acetic acid (Kirk, 1889). (Subsequently, it became known that the most effective direct oxidizers were Pyrozone, Superoxol, and sodium dioxide, while the indirect oxidizer of choice was a chlorine derivative (Franchi, 1950). In fact, when Superoxol was introduced, it became the chemical substance used by most dentists, because of its high safety (Pearson, 1951). In 1911, the use of concentrated hydrogen peroxide with a heating instrument or a light source was regarded as an acceptable method in dental clinics (Fisher, 1911).

Then, Haywood and Heymann (1989) described a home-bleaching technique in their article, "Nightguard vital bleaching", and an at-home bleaching product "White and Brite" (Omni International, Albertson, NY, USA) was introduced. Later, many other bleaching products and techniques have been introduced (Haywood, 1991). The "over-the-counter" (OTC) bleaching agents were first launched in the United States in the 1990s, containing lower concentrations of hydrogen peroxide or carbamide peroxide and sold directly to consumers for home use (Greenwall *et al.*, 2001). Finally, the current in office bleaching technique typically uses different concentrations of hydrogen peroxide, between 15% and 40%, with or without light and in the presence of rubber dam isolation (Haywood, 2000; Ontiveros, 2011).

**Indications:** Ageing, generalized staining/ discoloration, tetracycline staining, pulp changes as a result of trauma.

**Contraindications:** Recession/ severe dentin exposure, existing restorations in the smile zone, decay/unrestored teeth and/or periapical lesions, unrealistic expectations, pregnancy,

\*Corresponding author: Pradnya V. Bansode,

Head of the Department, Department of Conservative Dentistry and Endodontics, GDCH, Aurangabad, Maharashtra, India.

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cracks with exposed dentin, dry mouth and poor oral hygiene. (Simmons)

## Types

**Vital tooth bleaching:** 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 (Kihn, 2007). First, in-office bleaching utilizes a high concentration of tooth-whitening agents (25–40% hydrogen peroxide). Here, the dentist has complete control throughout the procedure and has the ability to stop it when the desired shade/effect is achieved. In this procedure, the whitening gel is applied to the teeth after protection of the soft tissues by rubber dam or alternatives (Powell and Bales, 1991), and the peroxide will further be activated (or not) by heat or light for around one hour in the dental office (Sulieman, 2004). Different types of curing lights including; 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. The in-office treatment can result in significant whitening after only one treatment, but many more may be needed to achieve an optimum result (Sulieman, 2005). Second, at-home or dentist-supervised night-guard bleaching basically involves the use of a low concentration of whitening agent (10–20% carbamide peroxide, which equals 3.5–6.5% hydrogen peroxide). In general, it is recommended that the 10% carbamide peroxide be used 8 h per day, and the 15–20% carbamide peroxide 3–4 h per day. This treatment is carried out by the patients themselves, but it should be supervised by dentists during recall visits. The bleaching gel is applied to the teeth through a custom-fabricated mouth guard worn at night for at least 2 weeks. This technique has been used for many decades and is probably the most widely used (Sulieman, 2005). The at-home technique offers many advantages: self administration by the patient, less chair-side time, high degree of safety, fewer adverse effects, and low cost. Despite the fact that patients are able to bleach at their own pace, this at-home bleaching technique, with its various concentrations of bleaching materials and regimens, has become the gold standard by which other techniques are judged. However, it is by no means without disadvantages, since active patient compliance is mandatory and the technique suffers from high dropout rates (Leonard *et al.*, 2003). In addition, color change is dependent on diligence of use, and the results are sometimes less than ideal, since some patients do not remember to wear the trays every day. In contrast, excessive use by overzealous patients is also possible, which frequently causes thermal sensitivity, reported to be as high as 67% (Haywood, 1992). A 35% concentration of hydrogen peroxide is recommended by some clinicians for in-office dental bleaching, followed by at-home bleaching with gels containing 10%, 15%, or 20% carbamide peroxide (Langsten *et al.*, 2002). Bailey and Swift (1992) showed that higher-concentration bleaching agents can produce more peroxide radicals for bleaching, resulting in a faster whitening process. However, this rapid process of bleaching may increase the side-effects of tooth sensitivity, gingival irritation, throat irritation, and nausea (Broome, 1998). Finally, 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 gum shields, strips, or paint-on product formats. They are also

available as whitening dentifrices, pre-fabricated trays, whitening strips, and toothpastes (Zantner *et al.*, 2007). They should be applied twice per day for up to 2 weeks.

**Non-vital tooth bleaching:** 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-vital power 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°C maintained for five minutes before the tooth is allowed to cool for a further 5 min. Then, the gel is removed, the tooth is dried, and the ‘walking bleach technique’ is used between visits until the tooth is reviewed 2 weeks later to assess if further treatment is needed. Finally, the inside/outside bleaching technique is a combination of internal bleaching of non-vital teeth with the home bleaching technique (Setien *et al.*, 2008).

**Recent trends in tooth whitening:** For most of the last century, when it came to oral care, the profession of dentistry was the only scientific and professional resource available to the individual. This reality has changed and the industry has led the way in scientific research on a vast array of over-the-counter (OTC) dental products. Considering the many choices of OTC products available in the marketplace, it is increasingly difficult to select the proper product(s). A large supply and variety of OTC dental products has prompted a great number of questions by the population and even by the general dentist. (Maltz, 2009). An *in vitro* study was to evaluate the whitening effect of four available OTC products (one whitening dentifrice, one mouth rinse, one paint-on gel and one set of strips) compared with a 10% carbamide peroxide at-home bleaching gel. On the basis of these findings, all groups were effective in tooth whitening in comparison with conventional toothpaste, with the exception of Crest 3D White toothpaste. Crest 3D White mouth rinse showed significantly lower color changes than Dazzling White, Crest 3D White strips and Opalescence PF. Dazzling White and Crest 3D White strips were found to be as effective as Opalescence PF in tooth whitening. Further clinical studies are required to confirm the whitening effect of these products in *in vivo* conditions (Karadas *et al.*, 2015). Another clinical study compared the efficacy of three different bleaching techniques with respect to the bleaching times required in order to achieve six grades of whitening in human teeth. Following the manufacturers’ instructions (cycles), it took an average of 16 days with the over-the-counter bleaching technique, seven days when using the at home bleaching technique and, with the in-office bleaching technique, the result may be achieved in one day. In principle, the higher the concentration of the active ingredient, the faster tooth lightening occurs (in minutes) (Auschill *et al.*, 2015).

## Products

**Whitening Dentifrices:** Toothpastes that claim to have tooth-whitening properties represent more than 50% of the OTC

products and rarely contain carbamide or hydrogen peroxide, or any other kind of bleaching agent. Their stain-removal ability is related to the large quantity of abrasives in their formulation, which remove superficial extrinsic stains. The active components of tooth whitening dentifrices include enzymes that break down the organic molecules of biological film. Additionally, abrasives such as alumina, dicalcium phosphate dihydrate and silica are also present in the formulation to promote stain-removal. However, the toothpaste abrasiveness needs to be moderated in order to prevent excessive wear to the underlying enamel and dentin (Demarco, 2009).

**Whitening Mouthrinses:** Whitening mouthrinses appeared recently in the market and manufacturers advertised that they could prevent stains and fight plaque build-up. Generally, a low concentration of hydrogen peroxide (1.5%) is present and sodium hexametaphosphate can also be included in the formulation to protect the teeth surface from new stains (Demarco, 2009).

### Listerine Whitening

**Composition:** Water, alcohol (8%), hydrogen peroxide (2%), sodium phosphate, poloxamer 407, sodium lauryl sulfate, sodium citrate, mint flavoring, menthol, eucalyptol, sodium saccharin, and sucralose

pH: 5.6

**Manufacturer:** KIK Custom Products, Etobicoke, Canada(8)  
Colgate Plax Whitening.

**Composition:** Water, sorbitol, ethyl alcohol, hydrogen peroxide (1.5%), poloxamer 338, polissorlato 20, methyl salicylate, menthol, saccharin sodium, and CI 42090.

pH: 3.4

Manufacturer: Colgate Palmolive Indústria e Comércio Ltda., São José dos Campos, Brazil (Lima *et al.*, 2012).

**Whitening Strips:** These products were created aiming to avoid the use of trays. Adhesive strips containing bleaching agents are bonded to the anterior teeth, and they release the active ingredient during relatively short time periods (5 to 60 minutes), once or twice a day. The active ingredient is hydrogen peroxide (HP) in low concentrations (5 to 14%). Studies have demonstrated that there is an increase in the whitening effect when the strips are used for 28 days compared to 14 days, and that the whitening effect could be maintained for 2 years. In a recent systematic review, when whitening strips were compared to the ADA recommended bleaching protocol, i.e. 10% carbamide peroxide in a tray, a similar bleaching effectiveness was observed. However, tooth sensitivity was more pronounced than that observed when the trays were used. It was also observed that strips with higher concentrations (14%) of hydrogen peroxide increased both the whitening effect and the side effects when compared to strips containing 6% of HP. It should be kept in mind that the 10% carbamide peroxide gel contains a 3.3% hydrogen peroxide proportion, almost half of the 6% concentration found in the strips, but a greater volume of gel is placed in the tray as compared to the amount of active ingredient present in the

strips (Demarco *et al.*, 2009). There are two strip-based systems described in the literature and currently marketed (Crest Whitestrips™ and Crest Professional Whitestrips™, The Procter and Gamble Company, Cincinnati, OH, USA). Both of these whitening systems use a flexible, polyethylene strip that is coated with an adhesive hydrogen peroxide bleaching gel. The strips carry 150-200 milligrams of whitening gel distributed uniformly across the strip surface. (Strip size and surface area varies based on arch form, hence the differences in total dose.) The hydrogen peroxide concentration on whitening strips has ranged from 5.3% up to 6.5% in the professionally- dispensed system. Wearing time has been for 30 minutes twice daily for 14 days or longer (Gerlach *et al.*, 2001).

**Whitening dental floss and toothbrushes:** Recently, manufacturers of oral care products have developed other methods with alleged whitening properties. Whitening dental floss has been introduced to promote stain reduction around the interproximal and sub-gingival areas. The stain-removal properties are associated with the presence of silica in the composition, which promotes a superficial surface abrasion during application in the interdental region. However, no clinical report is available comparing its effectiveness in relation to non-whitening dental floss. Besides being used in a home oral hygiene routine, manual or power toothbrushes can also be used to maintain the whitening effect or prevent extrinsic stains after bleaching treatments. A clinical study compared the ability of two toothbrushes (power or manual) to maintain the color of whitened teeth after an at-home bleaching treatment with 15% carbamide peroxide. After 6 months, the post-bleaching results demonstrated that the power toothbrush group showed a better ability to maintain the whitening effect than that of the manual toothbrush group (Demarco *et al.*, 2009).

**Paint-on gels and liquids:** Paint-on gels or varnishes are OTC barrier-free whitening products that present hydrogen or carbamide peroxide in a suspension that is brushed by an applicator over the tooth surface and which adheres to enamel. (Demarco, 2009) An 18% carbamide peroxide (equivalent to 6.5% hydrogen peroxide) paint-on liquid is available as an OTC agent (Colgate Simply White Clear Whitening Gel, Colgate-Palmolive, New York, NY). Another OTC paint-on liquid is also available (Crest Night Effects, Procter and Gamble, Cincinnati, OH) as a 19% sodium percarbonate bleaching film (Perdigão *et al.*, 2004).

**Otc tray with gel activated by light:** A new product has become available recently in drug stores or on the Internet, consisting of a universal tray that can be adapted by the individual himself. This tray then receives a gel that is activated by a compact LED unit. The manufacturer claims that the bleaching effect is similar to that of a supervised at-home bleaching with a tray, but it does not clarify what is the active ingredient. It should be emphasized that light activation does not seem to be necessary to increase or accelerate the bleaching process. Furthermore, a tray with adaptation problems may cause soft oral tissue damage, occlusal problems and/or poor adhesion to the treatment (Demarco *et al.*, 2009).

**Chewing gum:** Chewing gum with sodium hexametaphosphate (4.0 - 7.5%) has been introduced as an OTC product for home-use bleaching claiming to prevent

extrinsic tooth stain formation. A study showed that a chewing gum containing hexametaphosphate reduced stain formation compared to a non-gum treatment. However, when comparing the stain removal ability of two medicated chewing gums containing nicotine with a whitening chewing gum, it could be observed that the former were more effective in the removal of extrinsic tooth stains than the whitening chewing gum (Demarco *et al.*, 2009). The newest systems that claim to bleach teeth are bleaching kits sold directly to consumers. These kits are described as a three-step process: a 15-second pretreatment acetic rinse, a 1- to 2-minute application of a 6% hydrogen peroxide gel with a cotton swab on the facial surfaces of the teeth, and an application of a tooth-whitening pigment. Early concerns have been expressed as to whether the process actually works, especially as it is shown in television advertisements. Although results shown in advertisements seem dramatic, the manufacturers' literature reports that bleaching may take from 2 days to 2 weeks, and sometimes up to 60 applications, for successful lightening. No reports from dental studies have demonstrated any effectiveness (Haywood, 1992).

**Over-the-counter vs professionally applied products:** There are numerous over-the counter bleaches on the market, and many people who want to bleach their teeth are satisfied to obtain inexpensive bleaching products this way, not knowing that such products are not as acceptable as professionally applied products. Dentists and auxiliary staff should educate patients about the more effective characteristics of professionally applied bleaches, including fitted trays providing homogeneous application of bleach; less bleach swallowed; dentist supervision of color change; dentist direction in regard to type and duration of bleaching; and supervision of any side effects (Christensen, 1997).

The effectiveness and safety of OTC bleaching agents is a serious matter, mainly because their long-term side effects have not been fully studied; in addition, manufacturers conduct their own evaluations or fund researchers to test their products. Thus, there is a need to conduct independent studies using commercially available products to learn the action and possible side effects of mouth rinses and other OTC bleaching products. Using ADA-approved concentrations (10% Carbamide peroxide), color improvement longevity of 1 or 2 years has been demonstrated for at-home vital bleaching treatment. However, long-term clinical trials are not available for most such OTC products. Long-term, randomized clinical trials present the best scientific evidence concerning treatments and, despite the importance of *in vitro* studies, the true response of treatments should be determined with independent clinical trials (Lima *et al.*, 2012).

**Conclusion:** OTC products are considered to be the fastest growing sector of the dental market (Kugel, 2003). Dental home bleaching products are time and moneysaving alternatives to a dental visit (Jardim, 2009). However, these bleaching agents may be of highly questionable safety, because some are not regulated by the Food and Drug Administration. Hence, it is recommended to consult a dental professional for undergoing tooth whitening procedures.

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