

Fading It Out - A Review Literature on Tooth Bleaching

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Abstract: *Tooth whitening has become one of the most popular dental procedures among the general public. The public has been influenced by the portrayal of perfect white smiles in the media and come to demand whiter, more perfect smiles and in response many choices for tooth whitening have been made available. Teeth whitening can be accomplished in a variety of ways, each with its unique mechanism of action. The effectiveness of these various procedures is determined by the type of tooth discoloration being addressed. These include homebased products such as toothpastes, gels, and films, as well as in-office based systems where products containing highly concentrated bleaching agents are applied under professional supervision. Tooth whitening is any process that lightens the colour of a tooth. Whitening may be accomplished by physical removal of the stain or a chemical reaction to lighten the tooth colour. Bleaching is defined here as the chemical degradation of the chromogens. New products and techniques that are less invasive to dental tissues are now being used to fulfil rising patient demands for aesthetics.*

Keywords: tooth bleaching, tooth whitening, stains, hydrogen peroxide, carbamide peroxide

1. Introduction

The last three decades have witnessed immense changes in dentistry beginning with the professions dramatic and unprecedented success in the reduction of caries and periodontal disease. Tooth plays a major role in the beauty and personality of an individual. Attractive teeth have always been the typical patients' primary concern. The development of new restorative materials and techniques has revolutionized contemporary dentistry, with patients demanding not only improvement to their dental appearance but also improvement in their overall facial and dental aesthetics.^[1] Tooth discoloration is a common problem and may be affect both primary and permanent teeth.

The lightening of the colour of the tooth through the application of chemical agents to oxidize the organic pigmentation in the tooth is referred to as bleaching.^[2] Colour of the tooth is of particular importance to the patient because of social and psychological concern. one of the major motivations of the patient to seek cosmetic dental treatment is to have teeth that make them look younger, healthier and more attractive and match the colour of the adjacent teeth. In comparison with other restorative modalities, bleaching or tooth whitening is currently the least expensive and effective treatment for discoloured teeth.^[1] The popularity of bleaching is clearly understood for the appropriate patient with careful diagnosis, case selection and treatment planning and attention to the technique. Dental bleaching has been reported as the most conservative method of treating tooth discoloration. Bleaching techniques

have been markedly improved, from using pure chemical peroxides until reaching the recent light/laser assisted bleaching systems.

2. Classification

Historically, tooth discoloration has been classified according to the location of the stain, which may be either intrinsic or extrinsic or combination. It may also be of merit to consider a further category of internalized stain or discoloration.^[3] Depicted in Table 1 and 2.

- Extrinsic stains
- Intrinsic stains
- Internalised discoloration (Feinman et al 1987)

Table 1: Colors products by various causes of tooth discoloration

Types Of Discoloration	Colour Produced
Extrinsic (Direct stains) Tea, Coffee and other foods Cigarette/Cigars Plaque/ poor oral hygiene	Brown to black Yellow/ brown to black Yellow/ brown
Extrinsic (Indirect stains) Polyvalent metal salts and cationic antiseptics E.g.: -Chlorhexidine	Brown and black
Intrinsic (Metabolic causes) e.g.: congenital erythropoietic porphyria (Inherited causes) e.g.: Amelo/Dentinogenesis (Iatrogenic Causes) e.g.: Tetracycline Fluorosis (Traumatic Causes)	Purple/ brown Brown/ black Blending appearance Yellow, brown, blue, black or grey White, yellow, grey or

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Enamel Hypoplasia Pulpal Hemorrhage products Root resorption (Ageing causes)	black Brown Grey spot Yellow
Internalized Caries Restoration	Orange to brown Brown, grey, black

Table 2: Etiology of tooth discolouration

<p>1) Extrinsic stains</p> <ul style="list-style-type: none"> • Plaque, chromogenic bacteria • Mouthwashes, eg. Chlorhexidine • Beverages, eg. Tea, coffee, red wine, cola • Dietary precipitate • Illness • Antibiotics • Iron supplements
<p>2) Intrinsic stains</p> <p><i>Pre eruptive</i> Disease:</p> <ul style="list-style-type: none"> • Hematological diseases • Liver disease • Disease of enamel and dentin <p>Medication</p> <ul style="list-style-type: none"> • Tetracycline stain • Other antibiotic use • Fluorosis stains <p><i>Post eruptive</i></p> <ul style="list-style-type: none"> • Trauma • Primary and secondary caries • Dental restorative materials • Ageing • Smoking • Chemicals • Functional and parafunctional changes
<p>3) Internalized stains</p> <p><i>Developmental defects</i> <i>Acquired defects</i></p> <ul style="list-style-type: none"> • Tooth wear and gingival recession • Dental caries

Nathoo classified extrinsic stains into 3 types ^[4]

- 1) N 1 type stains (Direct): chromogen binds to the tooth surface to cause tooth discoloration
- 2) N 2 type stains: chromogen changes colour after binding to the tooth.
- 3) N 3 type stains: pre-chromogen binds to the tooth and undergoes a chemical reaction to cause this stain.

The Bleaching Materials ^[5]

There have been numerous changes to materials since home bleaching materials were introduced.

- **First generation materials** were in liquid form. These materials did not remain in trays for a long time. Eg - Glyoxide.
- **Second generation materials** are currently available which are more viscous and in gel form. This is to stop materials leaching out of tray and causing soft tissue irritation Eg - Proxigel.
- **Third generation** differs in their vehicle and color.

Constituents of Bleaching Gels:

- Carbamide peroxide -10% - 35%
- Hydrogen peroxide and sodium hydroxide – 10 – 50%

- Non- hydrogen peroxide containing materials i.e; sodium perborate
- Thickening agent carbopol or polyx
- Urea
- Vehicle- glycerin, dentifrice, glycol
- Surfactant
- Preservatives
- Flavorings
- Fluoride

1) **Carbamide Peroxide: (CH₆N₂O₃):** Carbamide peroxide in a 10% aqueous solution is used in most of the home bleaching kits. Also called urea peroxide, carbamyl peroxide or perhydrol urea. This breaks down to a 3.35% solution of hydrogen peroxide and 6.65% solution of urea. Hydrogen peroxide liberated from carbamide peroxide is effective in bleaching teeth.^[5] While 10 % carbamide peroxide gel is safe and efficient for home tooth bleaching, 5% to 35% (pH 5 – 6.5) solutions of carbamide peroxide are also available. 35% solution of carbamide peroxide is available as Ultra White (Ammadent), Quick start (Den Mat Corp. Santa Ana, CA) and Opalescence Quick (Ultradent Products Inc., South Jordan, and UT). Lower concentration takes a longer time to whiten teeth but has got the same result as higher concentration. Higher concentration causes sensitivity of the teeth.

2) **Hydrogen Peroxide:** First discovered in 1818 by French chemist Louis Jacques Thenard (1777-1857) Available in concentrations from 10%-50%. Hydrogen peroxide breaks down into water and oxygen.^[6] It is the oxygen molecules that penetrate the tooth and liberate the pigment molecule causing tooth to whiten.^[7] Hydrogen peroxide forms free radicals like hydroxyl and perhydroxyl radicals, and superoxide anions.^[8]

3) **Sodium Perborate:** It contains 95% perborate, providing 10% of available oxygen. It is available in variety of preparation – monohydrate, trihydrate and tetrahydrate. Alkaline in nature. Material of choice for intracoronal bleach. This oxidizing agent is available in powder form. It is stable when dry. In the presence of acid, water, or heat, it is converted into sodium metaborate, hydrogen peroxide and nascent oxygen.^[9]

4) **Over The Counter Bleaching Kits:** (All in One kit) The benefits achieved with bleaching systems with trays associated with the consumers and patients' needs have stimulated the marketing of over the counter (OTC) products for at-home tooth bleaching.^[10] OTC products appeared in the USA in the beginning of the 2000s, as an alternative to treat tooth discolouration with lower cost than traditional professional- prescribed/guided products. Currently, gels, rinses, dentifrices, whitening strips or paint on films with low levels of carbamide or hydrogen peroxide are widely available to consumers at pharmacies, supermarket and over the internet. However, these self-applied bleaching treatments can be harmful and the results may be not as good as those offered by dentists guided treatments.^[10]

Properties of the ideal agent: ^[5]

- Be easy to apply to the teeth for maximum patient compliance.

- Have a neutral pH
- Lighten the teeth successfully and efficiently
- Remain in contact with oral tissues for short periods
- Have adjustable peroxide concentrations
- Use the minimum quantity of bleaching agent to achieve the desired results
- Not irritate or dehydrate the oral tissues
- Not cause damage to the teeth or enamel to be etched
- Be well controlled by the dentist to customize the treatment to the patients' needs

Factors Influencing Tooth Whitening^[11]

Minoux and Serfaty recognize that tooth whitening is a very complex process that depends on several factors: 1) the pH of the bleaching agent, 2) the method of application and thickness of the bleaching agent to the enamel, 3) the fluctuation of irradiation, 4) length of photoactivation, 5) tooth size, 6) selective absorption of the wavelength of irradiation, among others.

Indications^[12]

- Fluorosis in mild to a medium degree
- Tooth discolouration due to age-related changes
- Tooth staining due to smoking and dietary stains
- Hemorrhagic discolouration
- Medication discolouration

Contraindications^[12]

General contraindications

- Age rating (children and adolescents);
- Pregnancy and lactation;
- Allergy to whitening components;
- Taking a number of medications (tretinoin, doxycycline, hydrochlorothiazide, ciprofloxacin, etc.);
- Hypertension, cancer, endocrine system diseases.

Local contraindications:

- Tooth fillings, tooth decay, crowns, restorations in the bleaching zone;
- Wide pulp chamber;
- Hypersensitivity of teeth;
- Acute periodontal and oral mucosa diseases;
- Diseases of the lower jaw joint, which restrict the opening of the mouth

Bleaching Mechanism

Although the bleaching processes are complex, the vast majority of it works by oxidation. This is the chemical process by which organic materials are eventually converted into carbon dioxide and water. The oxidation-reduction reaction that takes place in the bleaching process is known as redox reaction.^[13]

A more extensive bleaching process has been described by *Albers*: "the extent of bleaching determines the amount of whitening compared to the amount of material loss. During the initial bleaching process highly pigmented carbon ring compounds are opened and converted into chains which are lighter in colour. Existing carbon double bond compounds, usually pigmented yellow are converted into hydroxy groups (alcohol like), which are usually colorless. [Fig.1] As the

process continues the bleached material continually lightens".^[14]

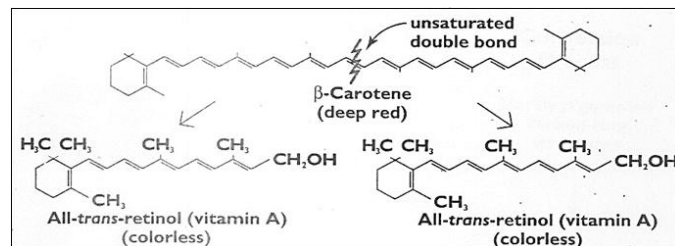


Figure 1: Carbon compound ring

As bleaching proceeds a point is reached at which only hydrophilic colorless structures exist. This is a material's saturation point.^[15] Lightening then slows down drastically and the bleaching process if allowed to continue begins to breakdown the carbon backbones of protein and other carbon containing materials. Compounds with hydroxy group (usually colorless) are split breaking the material into smaller constituents. Loss of enamel becomes rapid, with the material being quickly converted into carbon dioxide and water. [Fig.2]

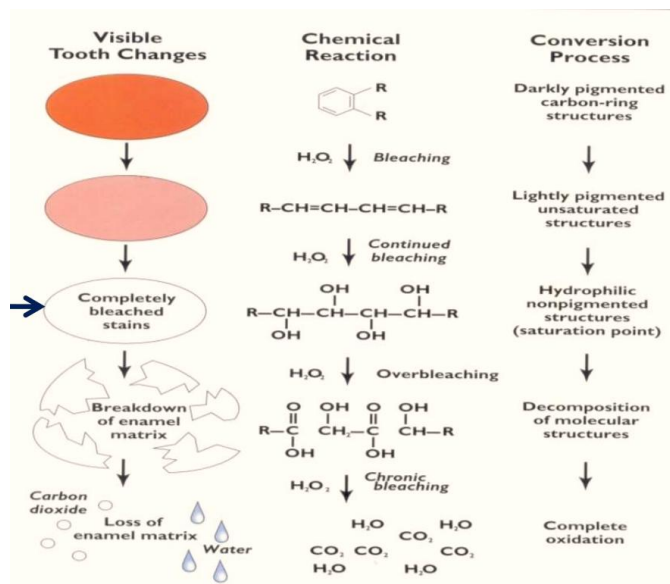


Figure 2: Bleaching Process

Vital Bleaching

Hydrogen peroxide or peroxide releasing agents such as carbamide peroxide are agents used most commonly for vital tooth bleaching.

i) In Office Bleaching Technique

In-office bleaching is useful in the removal of stains throughout the arch or for lightening a single tooth or treating specific areas of a single tooth. Materials generally used are- 35% hydrogen peroxide liquid, liquid/power products or a gel, 35% carbamide peroxide, various concentrations or combination of the above materials, Dual activated bleaching system. Some most commonly used products include: Office white (Life-Like Cosmetic Solutions), Perfection White (Premier Dental Products), Niveous (Shofu Dental), Opalescence Xtra Boost (Ultradent Products), Laser Smile (Biolase Technology), Brite Smile

(Brite Smile), Rembrandt Lightening Plus (Johnson & Johnson), Luma White Plus (Luma Lite).

ii) Dual Activated Technique:

Some in office bleaching system is formulated for both light and chemical activation. Such as Hi-lite (Shofu), Niveous (Shofu), Accel plus 50 (Brite Smile).

iii) The Home Bleaching Technique:

Original term used was ‘Night guard Vital Bleaching’ as patients bleached the teeth at night while they slept with the tray in their mouths. Introduced by Dr. Van Haywood and Dr. Harald Hayman. Among the vast array of bleaching materials available, the most predominantly used material for nightguard vital bleaching is carbamide peroxide. The greater the concentration of carbamide peroxide and thicker the material the quicker the material the quicker the bleaching will take place and the less trays will need to be worn.

Home bleaching trays (Fig 3)



Figure 3: A- Full Vestibule Tray, B- Scalloped / Reservoir Tray, C- Non-Scalloped / Non-Reservoir Tray, D- Scalloped Non reservoir Tray, E- Trays with Reservoir, F- Trays with Windows

Nonvital Bleaching

Intra coronal bleaching of non-vital teeth involves the use of chemical agents within the coronal portion of an endodontically treated teeth to remove tooth discoloration. (American Association of Endodontics). The bleaching agents that are most commonly used for whitening of root filled teeth are hydrogen peroxide, carbamide peroxide and sodium perborate.

i) Walking bleach technique:

Marsh reported this procedure with a mixture of sodium perborate and distilled water. Spasser and Nutting and Poe, advocated the use of 30% hydrogen peroxide instead of water to improve the bleaching effectiveness of the mixture.

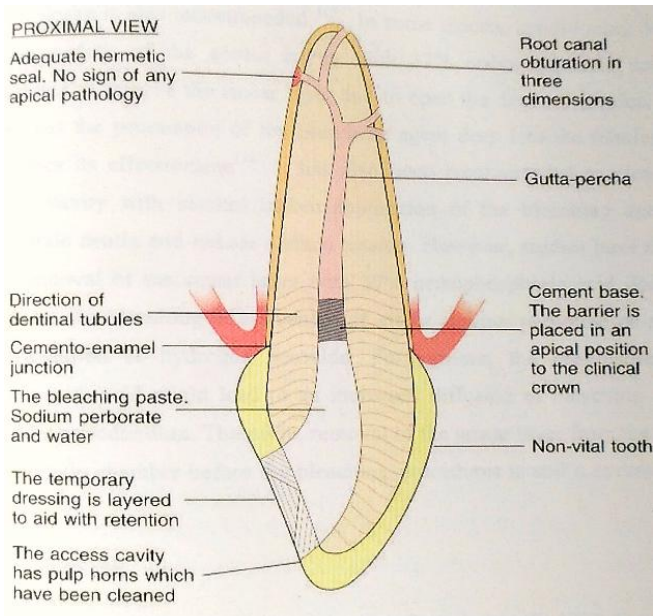


Figure 4: Walking Bleach Technique

ii) Thermo-catalytic/photo bleaching procedure:

This technique involves placement of the oxidizing, chemical bleaching material generally 30-35% hydrogen peroxide in pulp chamber, followed by either heat application by electric heating devices, light application by specially designed lamps, or both. It has been observed that heat application causes a reaction that increases bleaching properties of the hydrogen peroxide.^[16]

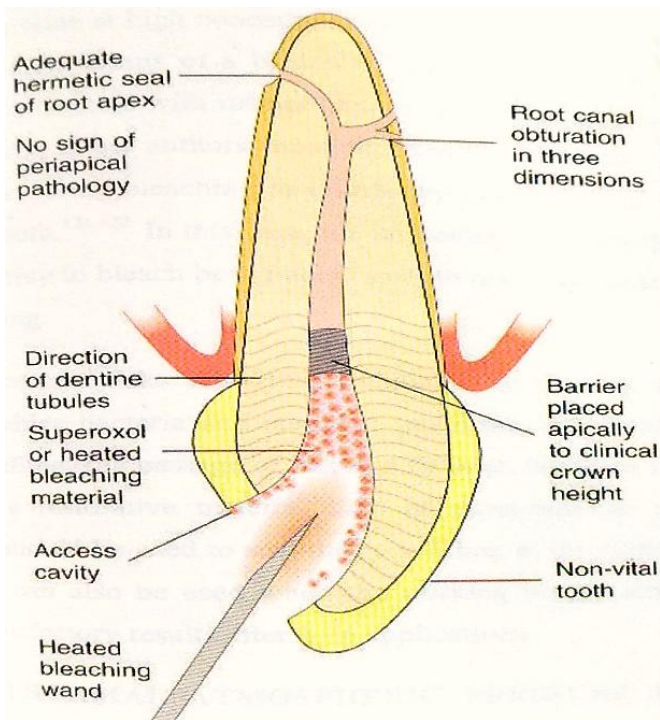


Figure 5: Thermocatalytic Bleaching

The Laser Bleaching Technique:

The word “laser” is an acronym for light amplification by stimulated emission of radiation. Laser assisted bleaching has been introduced as a bleaching technique, in an attempt to accelerate the bleaching process. Laser bleaching officially started in 1996 with the approval of Ion Laser

Technology’s argon and carbon dioxide lasers by the FDA.^[5] There are various lasers that have dental applications. There are two ways to use the lasers for bleaching, individually or in combination.^[5] They are- Carbon dioxide (10600 nm), Argon (515 nm), GaAlAs diode (980 nm), KTP (532 nm)

The lasers provide energy for the hydrogen peroxide to break down into water and oxygen and to release the oxygen into the stained tooth.^[5] They catalyse the oxidation reaction. The free radicals of oxygen liberated in the process, break apart the double valency bonds into simpler, more stable, less pigmented chains.^[5] The carbon di oxide laser energy is rapidly absorbed by water. Darkly pigmented tissues effectively absorb argon laser.

Combining Bleaching Techniques

Bleaching treatment can be combined in various ways depending on the nature of the discoloration. When one agent fails to remove a stain completely, or when multiple stains of different origin are present in the same tooth, a combination of bleaching techniques can be used. Power bleaching can be combined with a home bleaching programme.^[5]

This has also been called inside/outside bleaching, Internal/external bleaching, Patient-administered Intracoronal bleaching technique or Modified Working bleach technique [Liebenberg 1997]. The technique combines Intracoronal-bleaching technique with home bleaching technique.

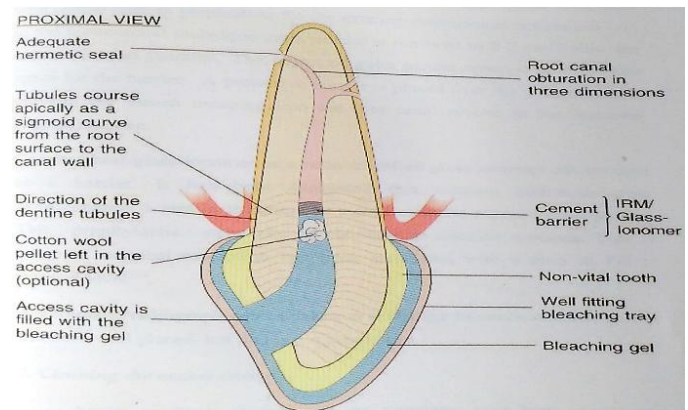


Figure 6: Combination bleach technique

3. Complications

- Gingiva: Tissue sloughing, Minor gingival irritation and /or ulceration, Change in gingival texture, Gingival soreness, Gingival irritation
- Teeth: White spots or banding within tooth may be more noticeable, A demarcation may be visible between the color on the incisal tip and cervical neck, Teeth may become hypersensitive, Cervical area may become sensitive especially in the area of gingival recession.
- Oral mucosa: Sore throat, Unpleasant taste, Burning palate, soft tissue irritation
- Gastric irritation: This is mainly due to glycerin base
- Altered taste sensation: Some patients report a metallic taste.

- Effect on non-vital tooth: Occurrence of external cervical resorption is a serious complication following internal bleaching procedures. Cervical resorption is mostly asymptomatic and is usually detected only through routine radiographs.

4. Conclusion

In the pursuit of looking good, man has always tried to beautify his face. In today's esthetically conscious world a white smile is the greatest asset. Bleaching is an important tool, which has led to a lot of dramatic changes in esthetic dentistry with fewer complications and being biologically acceptable. A variety of whitening options are currently available for patients seeking to enhance the appearance of their smiles. When suggesting a professionally administered whitening option, clinicians must be aware of the variety of options currently available along with proper diagnosis and treatment planning. Based on the patient's existing condition and desired whitening effects, in-office, at-home, or OTC modalities can be used to safely and effectively address a variety of aesthetic concerns.

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