

# The recent trends in the management of tooth discoloration: An updated Review

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## SUMMARY

Discoloration of the tooth is one of the most frequent reasons why a patient seeks dental care. Tooth staining can have an adverse psychosocial effect on a patient and can create an esthetic challenge for the clinician. The treatment of tooth discoloration consists of identifying the etiology and implementing the required therapy. Scaling and polishing of the teeth using prophylactic paste applied with a rotating rubber cup may remove many extrinsic stains. Mild to moderate enamel staining can be treated with enamel microabrasion, bleaching or combination. Partial or full-coverage dental restorations may be used to treat generalized intrinsic tooth discoloration. However, these conventional approaches are often associated with loss of tooth structure, post-operative sensitivity and relapse. As more and more patients are demanding for conservative cosmetic enhancement without anaesthesia and drilling, newer minimal to non-invasive treatment modalities such as ultra thin/no preparation veneers, resin infiltration and lasers are gaining increased popularity for management of tooth discoloration providing good esthetic results.

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## INTRODUCTION

Teeth form an important part of the body that aids chewing, speech as well as contributing to physical appearance. The color of the teeth is an important feature in determining the attractiveness of the face. **Tooth discoloration** is defined as any change in the hue, color or translucency of a tooth due to any cause. Restorative filling materials, drugs (both topical and systemic), pulp necrosis or haemorrhage may be responsible (Ingle 6<sup>th</sup> edition).

Dental discoloration, either of part or the whole tooth, occurs for many reasons and can result in a wide range of tooth colors, from beige or yellow through blue, gray, brown, violet, green, to brown and black.<sup>1</sup>

Tooth discoloration can cause significant cosmetic problem especially when it affects the anterior teeth, which is usually exposed when a patient smiles. Anterior tooth discoloration is one of the most frequent reasons for patients seeking dental treatment.<sup>2</sup> Bryan and Welbury reported that esthetic problems in childhood and adolescence can have a significant effect on psychosocial development and interaction with peers.<sup>3</sup> Negative emotions such as fear, anxiety, depression and timidity are sometimes exhibited in cases of anterior tooth discoloration. This can affect the general health and ability of an individual to participate fully in society, fulfilling roles as family members, friends, co-workers and other roles requiring interaction with others.<sup>4,5</sup>

Determination of the etiologic factor causing staining plays an important role in planning a specific treatment modality and its related outcome.<sup>6</sup> Management of tooth discoloration involves both personal and professional interventions. The professional interventional techniques for management of tooth discoloration range from traditional approaches such as oral prophylaxis, air jet polishing for superficial stains to more extensive treatment options for deep stains such as vital and non-vital tooth bleaching, enamel macroabrasion/microabrasion or combination, composite resin restorations, porcelain veneers, porcelain crowns, combination of these techniques, or even extraction in severe cases followed by prosthesis. However, these conventional techniques are often associated with adverse effects such as pulp sensitivity, cervical root resorption, alteration of enamel structure and its loss,

erosion and decrease in abrasion resistance. Therefore new minimal to non-invasive treatment options are gaining popularity for management of tooth discoloration including ultra thin/no preparation veneers, resin infiltration and lasers.

The present paper highlights the treatment options for discolored teeth with special emphasis on the recent advances in management of tooth discoloration.

### Classification of tooth discoloration<sup>7,8</sup>

#### 1. Based on location of discoloration by Dayan et al 1983 and Hayes et al (1989):

Extrinsic stains	Intrinsic stains
<ul style="list-style-type: none"> <li>These are located on the outer surfaces of the teeth.</li> <li>These are common and may result of various causes: <ul style="list-style-type: none"> <li>i. Remnants of Nasmyth membrane</li> <li>ii. Poor oral hygiene</li> <li>iii. Existing restoration</li> <li>iv. Gingival bleeding</li> <li>v. Plaque and calculus accumulation</li> <li>vi. Eating habits : tea, coffee stains</li> <li>vii. Tobacco chewing habit</li> <li>viii. Chromogenic bacteria</li> <li>ix. Mouthwashes - chlorhexidine</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>These are located on internal surfaces of the teeth.</li> <li>These are caused by deeper internal stains or enamel defects.</li> <li>Teeth with vital or non-vital pulp or endodontically treated teeth can be affected.</li> <li>Causes: <ul style="list-style-type: none"> <li>i. Hereditary disorders</li> <li>ii. Medications</li> <li>iii. Excess fluoride</li> <li>iv. Staining may be located in enamel or in dentin</li> </ul> </li> </ul>

### Intrinsic discolouration

Intrinsic discolouration occurs following a change to the structural composition or thickness of the dental hard tissues. A number of metabolic diseases and systemic factors are known to affect the developing dentition and cause discolouration as a consequence such as alkaptonuria, congenital erythropoietic porphyria, congenital hyperbilirubinaemia, amelogenesis imperfecta, dentinogenesis imperfecta, tetracycline staining, fluorosis, enamel hypoplasia, pulpal haemorrhagic products, root resorption and ageing.<sup>9</sup>

## MANAGEMENT OF TOOTH DISCOLORATION

### Extrinsic Stains

The most commonly used procedure to treat extrinsic stains is by a professional hygiene treatment and by polishing tooth surfaces with polishing cups and more or less aggressive abrasive pastes.

#### 1. Personal Management

**a) Diet and habit:** The patient should control the amount and type of beverages causing extrinsic stains, brush their teeth immediately after consumption of stain producing food.<sup>10</sup>

**b) Tooth brushing:** Patients must be advised on correct tooth brushing technique with dentifrice containing sufficient cleaning and polishing power, or chelating agents, such as sodium citrate and citric acid, and proteolytic enzyme. Apart from that, some dentifrices now contain tooth-whitening agents.<sup>10,11</sup>

#### 2. Professional Management

**a) Oral Prophylaxis:** Most of the extrinsic stains and calculus are removed by professional scaling i.e., hand, sonic or ultrasonic scaling.<sup>10</sup>

**b) Polishing:** It involves the use of hand piece with a rubber cup or disc insert and abrasive fine polishing paste. Experiments indicate that application of pumice and water slurry with a rotating rubber cup for 30 seconds removes about a 3-micron thick enamel layer.<sup>10,11</sup>

**c) Air jet Polishing:** It was first introduced in the late 1970s that aids in easy removal of extrinsic stains and soft deposits using a water soluble sodium bicarbonate mixture. It also reduces the fatigue in hand, wrist, neck and eyes because of quicker action. Air polishing is effective in the removal of stains due to smoking, coffee, tea, chlorhexidine and other extrinsic factors. Aluminumtrihydroxide can be used instead of sodium bicarbonate for patients with sodium restriction.<sup>10</sup>

## Intrinsic Stains

Different kinds of intrinsic stains require different approach for treatment, according to location and etiology of the stain. Generally surface enamel stains can be treated using enamel microabrasion whereas deeper internal stains can be managed by bleaching technique.<sup>11</sup>

### 1. Enamel Microabrasion

This technique is done by removal of a layer of enamel surface. It involves 'abrasion' with dental instruments and 'erosion' with acidic agents, therefore also sometimes referred as 'abrosion'. Either hydrochloric acid or phosphoric acid with pumice can be used, which requires careful isolation of the teeth.

**Indications :** Microabrasion is a simple, quick, and safe technique indicated for fluorosis, post-orthodontic demineralisation, localised hypoplasia due to infection or trauma, and idiopathic hypoplasia when the stains is limited to the outer layer of enamel. The evaluation of effectiveness of microabrasion should be done after one month post treatment, as the teeth appearance will continue to improve during this time.<sup>12</sup>

**Advantage:** It is a simple, safe and effective technique with stable esthetic results.

**Disadvantage:** loss of enamel structure can lead to increased tooth sensitivity and dental erosion.

### Modifications of microabrasion technique:

#### ❖ Mc Innes Technique

Mc Innes<sup>13</sup> in 1966, reported a technique that combined hydrochloric acid and hydrogen peroxide to remove fluorosis stains. He used a solution of five parts 30% hydrogen peroxide, five parts 36% hydrochloric acid, and one part ethyl ether. This solution was applied with a cotton tip applicator to stained areas for 5 to 10 minutes. However, this method has its disadvantages: little pressure could be applied using a cotton tip; the solution could flow to the unaffected enamel surface; the working solution had to be mixed immediately before application; patients experienced a great deal of discomfort; and the results were only temporary.

More recently, McCloskey<sup>14</sup> described a relatively simple method of eliminating fluorosis staining using 18 % hydrochloric acid. The acid is applied with cotton wrapped over the end of a serrated steel instrument, and the stained areas are rubbed with a light erasing motion. This step is followed by the application of acid and pumice slurry to the entire labial surface using a slow- rotating rubber prophylaxis cup.

### 2. Other described methods for removal of superficial enamel discoloration defects include:

a) Utilizing a composite finishing bur or diamond bur followed by polishing with an abrasive rubber point, a procedure referred to as **enamel macroabrasion**.<sup>15</sup>

b) Etching the enamel with 35% phosphoric acid for 30 seconds followed by removing the etched enamel with a composite finishing bur, and subsequent smoothening with pumice and water slurry in a slow-rotating rubber prophylaxis cup. The mean thickness of enamel removed was 164 pm. This technique is known as **etch and microcutting**.<sup>16</sup>

c) A **combination of enamel macroabrasion and microabrasion**, in which the stained enamel is reduced by a fine-grit diamond bur followed by application of Prema compound containing a low concentration of hydrochloric acid and silicon carbide abrasive. The thickness of enamel removed ranged between 50 and 150 pm.<sup>17,18</sup> Relatively deep enamel discoloration defects have been removed using macroabrasion followed by acid and pumice microabrasion.

### 3. Bleaching

**Definition:** the lightening of the color of a tooth through the application of a chemical agent to oxidize the organic pigmentation in the tooth is referred to as bleaching. (Sturdevant 5<sup>th</sup> edition). It is accomplished using oxidizing materials like hydrogen peroxide, carbamide peroxide, and sodium perborate. These materials have the ability to penetrate the enamel and dentin, emit reactive oxygen, which dissolves and releases stain producing chromogens. Bleaching may be done for vital or non-vital teeth and it can be done in the dental office or at home.<sup>11,19</sup>

#### ▪ Vital Tooth Bleaching

**The commonly used techniques of bleaching vital teeth are:**

- I. Dentist prescribed home bleaching,
- II. In-office vital bleaching.
- III. Over the counter preparations (OTC)

These methods are not different solely in the concentrations of hydrogen peroxide used but also in the vehicles and modes of application.

### **I. Dentist Prescribed Home Bleaching**

Haywood and Heman published their first report of dentist prescribed home bleaching in 1989.<sup>20</sup> Bleaching materials containing 10% carbamide peroxide are commercially available as a solution or in gel form for use in home bleaching.

**Indications:** This technique is indicated in case of staining due to aging, smoking, chromogenic materials. It is also called dentist-home bleaching, Night guard vital bleaching (NGVB), and matrix bleaching.<sup>21,22</sup>

**Advantages:** Dentist prescribed home bleaching is simpler, less expensive, less complicated, and requires less in-office time.

**Disadvantages:** active patient compliance is mandatory and the technique suffers from high dropout rates and the excessive use by overzealous patients is also possible, which frequently causes thermal sensitivity.

### **II. In Office Vital Bleaching**

In-office vital bleaching or **power bleaching** was the first vital bleaching technique. In this technique, high concentration of tooth-whitening agents (usually 25% to 40% hydrogen peroxide) is used.<sup>21</sup>

**Advantage:** The dentist has absolute control over the procedure and he can stop it whenever the desired shade of tooth is reached.

**Disadvantage:** pulpal necrosis caused by the inability to control the highly reactive and caustic 35% H<sub>2</sub>O<sub>2</sub>.

**Waiting room bleaching technique** involves heating 35% Carbamide peroxide under running hot water to activate it and then putting it in custom made trays and inserting it in patients mouth and the patient is told to sit in the waiting room for 30 min. Apart from that ultrasonic technology is also being used in the belief that it will create more free oxygen radicals from the bleaching agent to achieve improved whitening effect.<sup>23</sup>

### **III. Over The Counter Preparation (OTC)**

A recently introduced method of vital bleaching is over-the-counter home bleaching (patient-applied bleaching). The method involves a three-step procedure:

1. An acidic pre-rinse,
2. Application of a lower strength peroxide material without a mouthguard, and
3. A final application of titanium dioxide toothpaste.<sup>18</sup>

There has been increase in popularity for over the counter (OTC) bleaching products in recent years. They are composed of a low concentration of whitening agent like 3% - 6% hydrogen peroxide and are applied to the teeth via gum shields, strips or paint-on form. It is also available as whitening toothpastes, pre-fabricated trays and whitening strips. They should be applied twice per day for upto 2 weeks.<sup>24</sup>

The use of these bleaching agents has high safety concerns because they are not regulated by the Food and Drug Administration (FDA). Patients using over-the-counter bleach should be educated about the more effective and potentially safer characteristics of professionally applied bleach.<sup>25</sup>

#### **Complications of vital tooth bleaching:**

- **Systemic effect** – Accidental ingestion of large amount of these gels may be toxic and cause irritation to the gastric and respiratory mucosa.
- **Dental hard tissue damage**
- **Tooth sensitivity** – mild to moderate
- **Pulpal damage, gingival and mucosal damage**
- **Damage to restorations** – Composite resins (softening and cracking of the resin matrix), liberation of mercury and silver from amalgam restorations (associated with the use of 10% carbamide peroxide and 10% hydrogen peroxide).<sup>26</sup>

#### **❖ Etch, bleach and seal technique**

Bleaching of yellow-brown hypomineralized discolorations accomplished using 5% sodium hypochlorite (household bleach) is referred to as etch-bleach-seal technique. This simple and conservative technique should be used first for treatment of deep internal stains in young permanent incisors. The treated teeth then need to be

etched, rinsed, dried, and coated with a bonding agent or a clear sealant - which is then cured. This is done to prevent new organic material from re-staining the enamel.<sup>27</sup>

**Disadvantage:** the esthetic improvement accomplished is temporary and reversible.

#### ▪ Non Vital Tooth Bleaching

In the middle of the 19th century bleaching of non-vital teeth was introduced. It is also called intracoronal bleaching. The tooth must be endodontically treated prior to starting non-vital bleaching. Chemicals like oxalic acid, Chlorinated lime, chlorine compounds, sodium peroxide, sodium hypochlorite, or combination of 25% hydrogen peroxide in 75% ether (pyrozone) were often used. The bleaching agents can be activated by using light, heat or electric currents to accelerate the bleaching reaction.<sup>11,28</sup>

**Indications:** discoloration of pulp chamber, dentin discoloration, discoloration not amenable to extra coronal bleaching.

**Contraindications:** superficial enamel stains, presence of caries, defective enamel formation, discolored composites, severe dentin loss.

Some of the most commonly used methods of non-vital tooth bleaching are walking bleach and modified walking bleach, thermocatalytic, and inside/outside bleaching.

#### Walking Bleach

This procedure was first introduced by Salvas. It involves sealing a mixture of hydrogen peroxide and sodium perborate or sodium perborate mixed with water inside the pulp chamber of the discoloured tooth. When dissolved in water, it decomposes into sodium metaborate and hydrogen peroxide, releasing nascent oxygen. This process is repeated at intervals until the desired bleaching result is obtained. It is effective in managing staining due to tetracycline.<sup>28</sup> The technique is considerably less aggressive to the dental tissues and requires less chair side time than thermocatalytic bleaching.<sup>11</sup>

#### Modified Walking Bleach

Nutting and Poe used 30% hydrogen peroxide instead of just water as in walking bleach technique to improve the bleaching effectiveness of the mixture.<sup>11,28</sup>

#### Thermocatalytic Bleaching

It is the best technique to bleach non-vital teeth due to effective activation of hydrogen peroxide on heat application. It combines the steps involved in walking bleach along with application of 30%–35% hydrogen peroxide in the pulp chamber followed by heat treatment with electric heating devices or specially designed lamps.

**Disadvantage:** In some studies hydrogen peroxide is shown to have caustic effect and often associated with a risk of external root resorption.<sup>11,28,29</sup>

#### Inside Outside Bleach

It was first described by Settembrini et al in 1997. This is the technique of bleaching non-vital root canal treated teeth with carbamide peroxide gels or hydrogen peroxide at high concentrations (15%–35%). It is mainly used in case of failure of walking bleach technique, using low concentration of bleaching gel enough to get the optimum shade that adds up to its advantage.<sup>30</sup>

**Disadvantage:** poor bacterial control that can lead to failure of endodontic treatment.<sup>30</sup>

#### Restorative techniques

**1. Composite Resin Restorations:** This technique mainly masks the staining of the tooth using resin composites. It is mostly used in children and adolescents. It can cover either a localised area on the tooth or full veneering can be done that can either be placed directly in clinics or fabricated in labs.<sup>12</sup>

**Indications:** localised hypoplasia, fluorosis, tetracycline staining, amelogenesis imperfecta, dentinogenesis imperfecta etc.<sup>12</sup>

**2. Porcelain Veneers:** This technique is useful in case of severe tooth staining or failure of other techniques. An important requirement of this technique is that, the tooth in question should have a good amount of enamel thickness present to provide good bond strength.

Porcelain is contraindicated in tooth with large immature pulp chamber and pulp horns, and presence of immature gingival contour as in case of adolescent patient.<sup>12,31</sup>



### ❖ Extraction

Patients with severe dental involvement (genetic defects in the formation of enamel or dentin; amelogenesis imperfecta or dentinogenesis imperfecta) may be candidates for extractions; after which either partial or complete removable dentures or osseointegrated implant-borne prostheses can be used.<sup>32</sup>

## RECENT ADVANCES IN MANAGEMENT OF TOOTH DISCOLORATION

### 1. Ultra-thin/no-preparation veneers

The idea of not removing tooth structure and pain-free dentistry has helped to create the demand for no preparation veneers. No-preparation or minimally invasive veneers are veneers that have ultra-thin or “contact lens” thickness of 0.3-0.5 mm. They are placed without the tooth being altered, so they do add to the overall structure of the tooth and might feel a little bulkier than the classic porcelain veneers. Example: Lumineers by Cerinate.<sup>33</sup>

**Lumineers** are an improved variant of the porcelain veneer. They have the same function as the porcelain veneers and provide the same benefits to the patient. The placement of lumineers does not involve the peeling of the enamel of the tooth and therefore might be a better long term solution than veneers. When placing lumineers the structure of the tooth remains unchanged.<sup>33</sup>

### 2. Resin infiltration technique

Resin infiltration technique is described as a micro-invasive technology that fills, reinforces and stabilizes demineralized enamel without drilling or sacrificing healthy tooth structure.<sup>34</sup>

The concept of resin infiltration was first developed at the Charite Berlin and the University of Kiel as a micro-invasive approach for the management of smooth surface and proximal non-cavitated caries lesions. It is marketed under the trade name Icon.<sup>34,35</sup>

The principle of resin infiltration is to perfuse the porous enamel with resin by capillary action thereby occluding the microporosities that provide diffusion pathways for the acids and dissolved materials. Resin infiltration, with its near similar refractive index (RI= 1.46) to that of healthy enamel (RI= 1.62) creates a chameleon effect- a blend shading of the teeth lesions with the tooth surface.<sup>34,35</sup>

Resin infiltration technique can be successfully used to mask fluorosis and hypomineralised areas of enamel.

**Resin infiltration kit:Composition** – Icon etchant (15% hydrochloric acid), Icon dry (99% ethanol), resin infiltrant (methacrylate based resin matrix, initiators and additives).

#### Clinical Steps:

- 1) Placement of rubber dam to protect the soft tissues and achieve a clean and dry working field.
- 2) Application of 15% HCl gel for two minutes. The etchant gel is applied using the special applicator tip provided in the kit and stirred with a micro brush to achieve a uniform “etchy” pattern. Subsequently, the etching gel is washed away with water spray for 30 seconds.
- 3) The next step involves the application of 99% ethanol. The ethanol desiccates the lesion body and removes the water retained in the microporosity of enamel lesion. This is followed by air drying of the tooth surface.
- 4) The last step involves the application of low viscosity resin infiltrant, which is left for 3 minutes to allow its deeper penetration into the lesion. After 3 minutes, the excess resin on the tooth surface is wiped away with cotton rolls and dental floss. This is followed by a light cure polymerization for 40 seconds. Moreover, a second layer of infiltrant is applied and cured for additional 1 minute. This is followed by polishing the enamel surface.<sup>34,35</sup>

### 3. Lasers

In-office bleaching procedures make use of different kind of energy sources such as plasma arc devices, halogen lamps, and light emitting diodes (LEDs) to increase the rate of chemical release of bleaching radicals. Light emitting long wavelengths have lower energy photons with a high thermal character, and these may induce unfavourable thermal effects. Shorter wavelengths such as the argon laser ( $\lambda=514.5$  nm) or potassium titanyl phosphate (KTP) laser (532 nm) have higher energy photons with less direct thermal characteristics. Argon, diode laser and KTP laser are cleared by the FDA for tooth whitening and are commonly used for in-office bleaching treatments.<sup>36</sup>

#### I. Diode laser

Diode laser is a solid active medium laser which is manufactured from semiconductor crystals using some combination of aluminium or indium, gallium, and arsenic. The most common lasers of this group are the gallium-aluminum-arsenide laser (810 nm) and the indium-gallium-arsenide-phosphide laser (980 nm). They are operated in continuous wave and/or pulsed modes.<sup>36</sup>

Klunboot et al<sup>37</sup> conducted a study which evaluated the effectiveness of diode laser on tooth enamel surface in the tooth whitening and found out that diode laser at low-power densities was highly efficient in tooth bleaching.

## **II. KTP Laser**

KTP (Karium-Titanium-Phosphoric acid), which is a type of Nd:YAG laser, seems to be appropriate for bleaching of tetracycline-stained teeth. KTP tends to penetrate into dentin with less damage. This laser does not increase temperature much. Its photons have high energy that facilitate the chemical and photodynamic reactions without damage to both hard and pulp tissues.<sup>38</sup>

It has been shown that KTP laser is capable of producing significantly more effect than LED or diode laser. Lagori et al<sup>39</sup> conducted an in vitro study to compare the bleaching efficiency of KTP lasers and diode laser on teeth stained with different substances. The results showed that diode laser was effective only at bleaching teeth stained with coffee; meanwhile, the KTP laser was efficient at bleaching teeth with coffee, tea, and red fruits stains.

Zhang et al<sup>40</sup> studied the whitening efficacy of Light-Emitting Diode (LED), diode laser, and KTP laser irradiation in dental bleaching by analyzing the change in color, the temperature increase in the pulp cavity, and the microhardness measurement after treatment. The author suggests that the KTP laser is effective in brightening teeth. Within the limits of the study, the LED and the KTP laser induced a safer pulpal temperature increase when assisted with Hi-Lite bleaching gel.

### **Advantages of lasers for tooth discoloration treatment:**

Lasing minimizes post-bleaching hypersensitivity, loss of enamel microhardness and gingival irritation due to lack of hydrogen peroxide use. Decreased chair side time can also be anticipated following laser use (laser bleaching is 15 to 20 minutes, whereas power bleaching lasts 45 to 60 minutes), thereby increasing patient comfort and cooperation.

## **CONCLUSION**

A variety of treatment options are available for masking the discolored teeth and improvement of esthetics. However, conventional techniques carry the risk of post-treatment sensitivity and relapse along with significant loss of tooth structure. Therefore, newer minimal to non-invasive treatment options such as no preparation veneers, resin infiltration and lasers are gaining popularity in recent years and have shown to be increasingly conservative while providing predictable and long-lasting esthetic results.

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