

# A D E P T

## R E P O R T

Volume 6 • Number 4

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# A D E P T

*I n s t i t u t e*

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## AT-HOME BLEACHING

### Overview

American society is increasingly concerned with health and beauty. A dazzling smile is commonly associated with youth and vitality. At-home bleaching is a conservative means to a whiter smile and has enjoyed rising popularity in the last decade. Performed under a dentist's guidance, it is safe, fast, and produces results that boost patients' self-esteem and often promote acceptance of additional esthetic or restorative dentistry.

### How Bleaching Works

#### General Mechanism

Bleaching agents contain unstable peroxides that break down to highly unstable free radicals (molecules with an unpaired electron). These free radicals chemically break larger organic pigmented molecules (and a few inorganic ones) in a protein matrix into smaller, less pigmented constituents by either rapidly oxidizing (removing electrons) or occasionally reducing (adding electrons) surrounding molecules. If the bleaching process continues for a long time, it will fully break

down the organic materials and convert them into their basic building blocks of carbon dioxide and water.

#### Tooth Bleaching Mechanism

The mechanism of tooth bleaching works roughly as described above. Saliva causes carbamide peroxide in the bleaching material to break down to hydrogen peroxide and urea. The free radicals released when the hydrogen peroxide breaks down penetrate enamel. The free radicals then react with stain molecules in the dentin, changing them from colored substances to clear ones, and release oxygen, urea, and water.

Bleaching lightens dentin; enamel does not change color very much. The thicker the dentin, the more bleaching required. Yellow and brown stains, which are organic, are generally easily bleached. Inorganic stains, many of which are gray or blue, are more resistant to bleach and typically must be removed or masked. Blue tetracycline stains, which are organic, can be removed with longer bleaching times, such as two to six months.

# A D E P T

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## The Chemistry of Bleaching

Bleaching is widely used in industry, so its chemistry has been extensively studied. Although the processes are complex, the vast majority work by oxidation, the chemical process by which organic materials are converted into carbon dioxide and water. Wood burning in a fireplace is an example of oxidation. The difference between the oxidation that occurs with bleaching compared to wood burning is the speed of the reaction and the number of intermediate byproducts. Burning rapidly transforms objects into carbon dioxide, water, and heat. Bleaching slowly transforms objects into chemical intermediates that are lighter in color. Both processes, if done long enough, will convert organic materials into carbon dioxide and water.

## Saturation Point

As these processes progress, the bleached material continues to lighten until the "saturation point" is reached, which approaches the limit of lightening. Teeth can be over-bleached from an esthetic standpoint, and if bleaching causes any damage to tooth structure, such damage would be more likely to begin to occur as a result of prolonged exposures.

It is critical that a dentist know how to recognize what we term as the saturation point and, thus, when to stop the bleaching process, since the possibility of material loss from over-bleaching is greater than any marginal gain in tooth whitening. The saturation point may or may not be

equivalent to the esthetic limit, the subjective assessment of the appropriate amount of bleaching for a particular patient. The clinical indication to the dentist that the saturation point is being exceeded is a blue tinge to the teeth; when too much pigment is lost, light is transmitted through the teeth, giving them a bluish cast.

Figure 1 illustrates some of the oxidation processes associated with bleaching organic materials. These reactions are common to all proteins, including those of teeth.

## Reversibility

The oxidation (chemical breakdown) portion of the bleaching process is irreversible. However, the chemical processes in the mouth that originally produced dark pigments in the teeth could reverse the whitening effects. Most clinicians agree the reoccurrence of tooth stains is not uniform from patient to patient following bleaching.

## Types of Bleaching

**Vital bleaching**, applying chemicals to the outside of vital teeth, works on stains in enamel and dentin. **Nonvital bleaching**, lightening nonvital teeth by applying chemicals from within the pulp chamber, is most effective in treating stains within coronal dentin. This process is rapid because the bleach is applied close to the origin of the stain.

Sometimes bleaching is applied to the outside of nonvital teeth and to the inside of vital teeth with receded pulps. A more universal classification is **external bleaching** for chemical lightening on the outside of teeth, and **internal bleaching**

for chemical lightening on the inside of teeth. (Regardless of where the bleach is applied, these materials diffuse to some extent through the entire tooth structure and affect both enamel and dentin.)

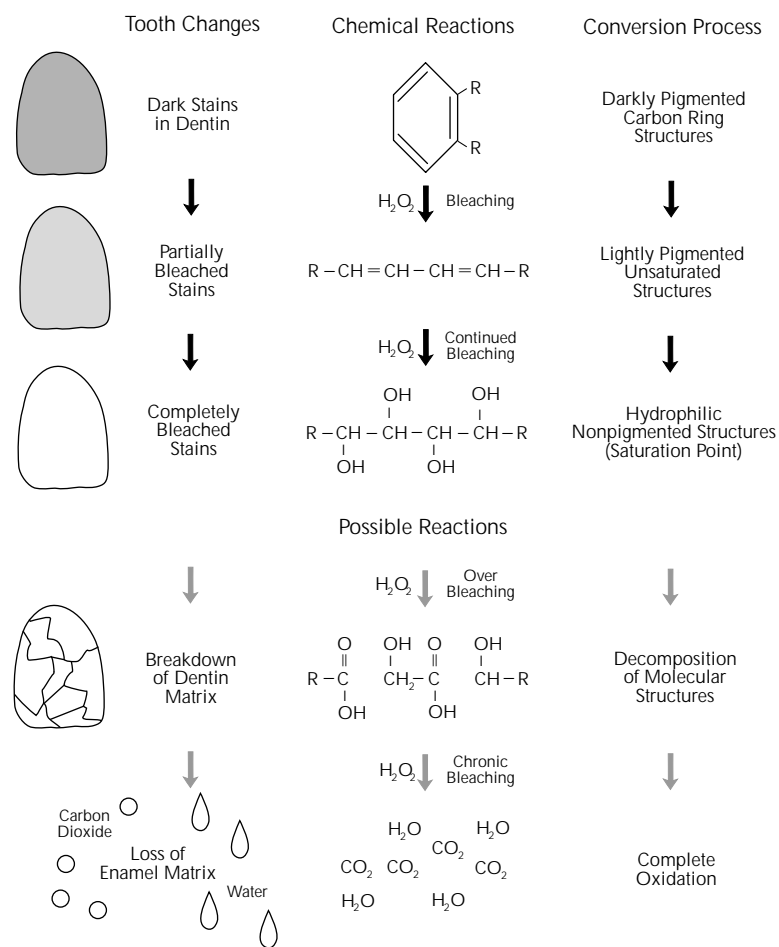
Bleaching materials applied by the dentist or staff is *office bleaching* or *power bleaching*. Bleach applied by the patient is *at-home bleaching*. When both are used together it is *dual bleaching*. At-home bleaching is the subject of this report. It is also known as nightguard, mouthguard, and matrix bleaching.

*Enamel microabrasion* or *acid abrasion* uses both acid and abrasion to remove superficial stains and white enamel defects, such as white striations resulting from fluorosis. Although not bleaching, it is often included in such discussions since it is an alternative treatment for some stains and can be combined with at-home bleaching.

Understanding stain etiology is necessary to select the correct treatment. Figure 2 compares four types of tooth lightening. Figure 3 compares the common causes of discoloration and suggests the most common treatment.

**Indications for At-Home Bleaching.** Teeth with mild uniform yellow discolorations (e.g., the darkening associated with the formation of secondary dentin during aging) are the easiest to treat, usually dramatically lightening within two to six weeks. Blue and gray stains generally require much longer treatment times. Recent research indicates that long protocols of at-home bleaching (i.e., two to six months) can also reduce tetracycline staining for

## Chemical Reactions of Bleaching



**Figure 1.** Illustrates some of the most common chemical reactions associated bleaching, showing the visible changes in the tooth (left column), the chemical reactions (middle column), and the chemical conversions (right column). The bleaching process proceeds from top to bottom. Note that reactions shown in the top half of the illustration are known to occur in teeth bleaching. There is as yet no evidence that those shown in the lower half occur in teeth, but these reactions are common in the bleaching process.

many patients.

**Indications for In-Office Bleaching.** Patients with mild uniform yellow discoloration and who desire whiter teeth more quickly are candidates for in-office bleaching, which produces similar effects in a few hours.

**Indications for Internal Bleaching.** Teeth darkened from blood breakdown products, endodontics, or receded pulp chambers benefit from

internal bleaching. Recent studies show that dark tetracycline stains located primarily in dentin respond to very long-term at-home bleaching. Another, quicker, approach is internal bleaching following endodontic treatment.

**Indications for Enamel Microabrasion.** Superficial white, brown, and yellow spots commonly associated with fluorosis can be treated by microabrasion. Since the stain

## Tooth Lightening Systems Compared

FEATURE/TECHNIQUE	Whitening Agent	Best Used On	Longevity
Office Bleaching	Superoxol (35% H <sub>2</sub> O <sub>2</sub> )	Mild Yellow Stains from Aging or Fluorosis	Typically 3 Years
Acid Abrasion	Hydrochloric Acid (8–18%)	White Striations and Brown Spotted Stains from Fluorosis or Mild Demineralization	Generally Permanent
Home Bleaching	Carbamide Peroxides (10–22%)	Yellow Stains from Aging, Fluorosis, or Tetracycline	Typically 3 Years
Internal Bleaching	Sodium Perborate with and without H <sub>2</sub> O <sub>2</sub> (35%)	Yellow or Black Stains from Tetracycline and Nonvital Discoloration	Typically 5+ Years

Figure 2. Comparisons of the four most common tooth lightening systems.

## Classification of Tooth Discoloration

Color	Etiology	Treatment
White:	Fluorosis Δ	Microabrasion
Bluish Gray:	Dentinogenesis imperfecta § Δ Erythroblastosis fetalis § Tetracycline (Type II & III) §	Restorative Restorative Ext. Blch./Restor.
Gray:	Silver oxide (from root canal sealers)	Restorative
Light Yellow:	Fluorosis Δ Physiological changes due to aging § Obliteration of the pulp chamber § Tetracycline (Type I) §	Ext. Blch./Microabrs. External Bleaching Internal Bleaching External Bleaching
Dark Yellow:	Physiological changes due to aging § Tetracycline (Type II) § Pulpal necrosis §	External Bleaching Restor./Int. Blch. Internal Bleaching
Brown:	Fluorosis Δ Caries § Porphyria § Tetracycline (Type III), pulpal necrosis §	Microabrs./Ext. Blch. Restorative Restorative Restor./Int. Blch.
Black:	Caries § Fluorosis Δ Amalgam mercury stain Δ	Restorative Restorative Restorative
Amber:	Pulpal necrosis § Dentinogenesis imperfecta Δ §	Internal Bleaching Restorative
Pink:	Internal or external resorption §	Calcium Hydroxide

§ = Organic stains involving matrix structures

Δ = Inorganic stains involving crystalline structures

Figure 3. A partial list of tooth stain colors, commonly associated etiologies, and most common method of treatment. The most common etiologies are fluorosis, aging, and pulpal necrosis or endodontic therapy. Less common and more difficult to treat are stains from tetracycline.

is physically removed, there is no potential for relapse. Microabrasion, however, removes enamel. We do not encourage the use of acids to remove stains since they are difficult to control and usually result in nonuniform removal of enamel. Disking or a micron diamond (e.g., Brasseler 133F-016) is a better approach.

**Indications for Restorations.** Very dark or black stains (e.g., from pulp sealers containing heavy metals such as bismuth [Grossman Sealer]) are seldom bleachable and should be treated restoratively. Treat small, deep, discolored or opaque white spots by removing (with a micron diamond bur) as much of the discoloration as possible while remaining in enamel, then mask with a color modifier and composite. Deep stains with banding, including severe tetracycline stains, are the most difficult on which to achieve esthetic results. They may respond to long-term at-home bleaching. If bleaching is ineffective, they can be treated with bonded restorations or crowns.

## Safety

Carbamide peroxide, at 10% or 15% concentration, and 3% hydrogen peroxide have been classified since 1979 by the U.S. Food and Drug Administration as oral antiseptics. The only noted side effect from ingesting large doses of ADA-approved bleaching products (Figure 4) is a laxative effect from the glycerin in most preparations; this is very rare. Carbamide peroxides are in a variety of over-the-counter external-use products (e.g., ear drops and hair dyes).

The acidity of these materials, usually pH 4–7, concerns some clinicians because of the potential for decalcification and sensitivity. When bleaching materials contact saliva, however, their pH is neutralized.

The vast majority of studies show no enamel etching in the pH 4–7 range. Some studies show slight enamel etching, partially removing the dentin smear layer and the surface of radiopaque macrofilled composite, and still others show some microfilled composites are also affected. Studies based on scanning electron microscopy, however, show these surface changes are minor. Studies with 10% carbamide peroxide (3.65% hydrogen peroxide equivalent) show no difference in tooth morphology compared to nonbleached teeth.

**Possible Complications.**

Since a portion of at-home bleaching solutions is ingested, there are understandable concerns about safety. Carbamide peroxide breaks down to hydrogen peroxide and urea (Figure 5). Hydrogen peroxide breaks down to water and oxygen. Urea is antiplaque and anticariogenic and is safely excreted by the kidney. Studies of carbamide peroxide on laboratory animals show it requires doses in excess of body weight to produce serious systemic effects.

Roughly 65% of at-home bleaching patients experience tooth sensitivity in their first four days of treatment. Other complications, such as soft tissue lesions, tissue sloughing, nausea, sore throat from swallowing the bleaching material, or TMJ disorders from tray-induced malocclusion occur in up to 10% of patients.

Peroxides have mutagenic potential, boost the effects of

known carcinogens and, with prolonged use, can inhibit wound healing. Smoking or using other potential carcinogens while undergoing bleaching is contraindicated. Long-term use can alter normal oral flora and contribute to lingual papillary hypertrophy (hairy tongue) and *Candida albicans*. While pulpal enzymes are inhibited by peroxides, long-term effects are unknown.

External bleaching with 35% hydrogen peroxide alters the structure of both enamel and dentin in tetracycline-stained rat teeth, and causes pulpal inflammation and pulpal damage in dogs’ teeth.

Although such laboratory results are disconcerting, clinical studies have yet to report long-term clinically significant

tooth damage (e.g., brittleness, pulp death). The most common clinical symptom from controlled bleaching under a dentist’s guidance is mild sensitivity to cold after treatment, which decreases rapidly over time.

**At-Home Bleaching Advantages**

At-home bleaching provides esthetic improvement through a noninvasive technique and seems safer and more effective than office bleaching. It is also highly cost-effective for both patient and dentist.

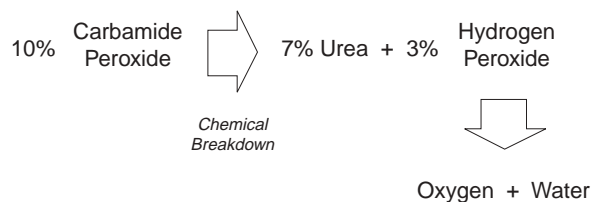
At-home bleaching works best on yellow, orange, or light-brown stains. Ninety percent of patients achieve a relatively stable change in tooth lightness in the first six weeks of daily at-

**Table of ADA-Accepted Products**

ADA-Accepted Products (10% carbamide peroxide only)	
Product Name	Manufacturer
NiteWhite (viscous gel in syringe)	Discus Dental, Inc.
Opalescence (viscous gel in syringe)	Ultradent Products, Inc.
Patterson’s Toothwhitening Gel	Patterson Dental Supply
Platinum (white paste in tube)	Colgate Oral Pharmaceuticals
Platinum Overnight (white paste in syringe)	Colgate Oral Pharmaceuticals
Rembrandt (fluid gel in tube)	Den-Mat Corp.

**Figure 4.** Products bearing the American Dental Association (ADA) seal are approved as having demonstrated both safety and efficacy according to ADA guidelines. The approval process includes review of product instructions and advertising to avoid inaccuracies and misleading claims.

**Breakdown of Carbamide Peroxide**



**Figure 5.** The breakdown products of a 10% carbamide peroxide product.

## Light-Assisted Bleaching

A relatively new development in chairside bleaching methods is the use of curing lights. Quick to show results, compared to conventional in-office and at-home techniques, light-assisted bleaching has rapidly gained adherents.

How it works: Heat from a halogen, arc, or laser lamp speeds the breakdown of the bleaching product (usually 35% hydrogen peroxide), causing the release of a higher concentration of free radicals than occurs in other bleaching techniques. The many free radicals penetrate the tooth enamel, and oxygen is released. The effect is an immediate and noticeable whitening, mostly due to the larger number of oxygen bubbles released in the tooth. These oxygen bubbles reflect light, so the tooth looks lighter, but since there has been no significant lightening of the dentin, tooth color relapses once the oxygen bubbles dissipate.

Some products also contain photoinitiators, which are activated by the light of the lamps to enhance bleaching material reactivity.

The net result is that light-assisted bleaching:

- Is more traumatic to teeth
- Causes more tooth sensitivity than other techniques
- Does not allow dentin enough time to absorb the bleaching chemical
- Gives the patient only a temporary solution to tooth discoloration

One answer to the temporary nature of light-assisted bleaching is a treatment protocol involving immediate follow up with at-home bleaching. In this approach, the in-office bleaching step gives the patient a psychological boost, and the expectable tooth color relapse is masked by the impact of the at-home bleaching process.

The photoinitiators used in light-assisted bleaching products are light-sensitive dyes that give the material a color (typically orange or red). Exposed to light, the dye molecules break down into smaller molecules that are less pigmented. The immediate change in tooth color and, in some cases, a significant color shift in the dye, gives clinicians and patients alike a feeling of progress and success.

Nevertheless, the dye color change does not represent real change in tooth color nor indicate bleach activity. A bleaching liquid can lose much of its peroxide activity and still maintain a color shift.

### **Other Activation Methods.**

Light-assisted bleaching is not any more effective than other techniques in which bleach is activated rapidly by, for instance, the addition of chemical activators (metal ions) or amino acids (enzymes). These activators stimulate the release of hydrogen peroxide so that it is available to the tooth. The two-part bleaching materials now on the market for at-home bleaching use divalent metal ions and result in a 40% increase in available hydrogen peroxide, as compared to 10% carbamide peroxide products. The use of enzymes to activate hydrogen peroxide bleaching material is proven in the lab but not yet incorporated in any products.

home bleaching. Effects are less dramatic with dark gray and blue stains, and with tetracycline banding, particularly stains in the gingival one-third. However, some improvement is possible, even with severe tetracycline stains, if treatment time is extended.

We consider at-home bleaching the treatment of choice for bleaching multiple teeth that show yellowing or browning. The most common candidates are patients who want to generally lighten the shade of their teeth. Other interested parties include those 40–50 years of age (or older), and younger patients who smoke or drink coffee or tea.

## Treatment Considerations

The incisal edges of teeth often bleach more quickly. This may be due to the thinness of the incisal edge and the longer bleach contact time in the deeper areas of the tray. Generally, lower centrals bleach more quickly than upper centrals. If different parts of teeth respond at different rates to bleaching, continue the treatment as planned. The lagging areas will catch up.

Restorations generally do not lighten with bleach treatment. In fact, methylmethacrylate temporaries turn orange if bleached. However, restorations stained with superficial plaque will occasionally appear lighter after treatment.

**Patient Compliance.** The major limitation to treatment is patient compliance. Highly motivated patients will follow through with the recommended at-home bleaching treatment. Compliance is higher with nighttime use or short treatment times daily be-

tween meals (1–2 hours per day with appliance refills every 30–60 minutes).

**Dual Bleaching.** Office and at-home bleaching can be combined into a multiphase approach by doing the office bleaching first to “jump start” the case and enhance patient confidence through visible improvement in tooth color. In this two-part treatment, the start of at-home bleaching should be postponed a few days following office bleaching to reduce postoperative discomfort. The major disadvantage of dual bleaching is increased time, cost, and the discomfort resulting from office bleaching. We have tried both dual bleaching and at-home bleaching in our study groups and prefer to start cases with at-home bleaching alone unless the patient is impatient or needs extra motivation. Office bleaching is then used only upon patient request (and only with good judgment regarding the implications for tooth health).

## History

In 1968, Dr. Bill Klusmier, an orthodontist in Fort Smith, Arkansas, discovered by accident that an over-the-counter oral antiseptic, applied in a positioner at night, it greatly improved tissue health and lightened tooth stains. From 1970–1975, he continued to experiment with and utilize the technique with patients, eventually utilizing a custom-fitted tray. He presented table clinics on his findings at the Arkansas Dental Meeting and other collegial seminars.

Dr. Jerry Wagner, a pedodontist in Fort Smith, Arkansas, heard about and tried the technique, using Proxigel™ (Reed & Carnrick Pharm.) in an

orthodontic positioner. At recall, he noted improved gingival tissues and lighter teeth without side effects. After four more weeks of treatment, the results were dramatic.

Colleagues eventually passed the technique to the Coastal Dental Study Club in North Carolina. In 1986, the Proxigel technique with a plastic nightguard was widely used by the group. In 1988, doctors Van Haywood and Harald Heymann learned of the technique and began clinical trials at the University of North Carolina. In 1989, Haywood and Heymann published the first report on Proxigel, a solution of water, glycerin, carbopol (a synthetic polymer thickening agent), and 10% carbamide peroxide (also called carbamide urea, urea peroxide, perhydrol urea, or perhydelure).

In their study, the solution was placed in a vacuum-formed, soft plastic nightguard for an average of 7.5 hours a night for two to five weeks. This produced an average lightening of two Vita shades. The average time for optimal changes was six weeks.

When Dr. John Munro, a general practitioner from Tennessee, learned of the 10% carbamide peroxide treatment, he presented the information to Omnii International in 1988. This led the company to develop a 10% carbamide peroxide solution, White and Brite™, the first commercial product introduced specifically for tooth lightening. It went on the market in 1989 as a daytime-use bleaching product.

## Materials

**Carbamide Peroxide.** Most at-home bleaching products con-

tain about 10% carbamide peroxide, the bleaching equivalent of an approximately 3.65% solution of hydrogen peroxide. This provides good oxygen release with minimum tissue irritation.

Products containing carbamide peroxide are largely glycerin or propylene glycol (85% or more), with carbopol or another thickening agent, such as polyox (1–3%), sodium stannate, and flavors. Since these materials are more stable in acid solutions, most manufacturers add phosphoric or citric acid. Their shelf life is about two years refrigerated and one year unrefrigerated. Glycerin and propylene glycol are benign substances, inactive in the bleaching process.

**Carbopol** is a class of water-soluble resin common to toothpaste, shampoo, and other household products as thickeners. Chemically, carbopols are polyacrylic acid polymers similar to the acid in glass ionomers except they have a molecular weight over 10 times that used in glass ionomer liquids.

When used in bleaching materials, these resins are unique because they do not break down themselves nor increase the breakdown of bleaching materials. Even more important, carbopols bind with carbamide peroxide and increase their active peroxide-releasing time to 1–3 hours, depending on the concentration and environment.

Carbopol is relatively acidic and is generally neutralized with trolamine (triethanolamine), which improves bleaching by inhibiting salivary peroxidase, the enzyme that breaks down bleach in the mouth. The most

## Bleaching and Restorations

Bonding immediately after bleaching is contraindicated, even if the tooth is to be prepared. Whether at-home or in-office bleaching is conducted, oxygen bubbles diffusing from the teeth inhibit the polymerization process. A waiting period of two weeks after bleaching is ideal to allow adequate time for oxygen release and tooth color relapse. Once relapse has occurred, there is no longer any oxygen on the tooth surface to inhibit the bonding process, and the tooth shade is stable for generally three years.

Tooth color stability is essential prior to selecting a restoration shade. If bleaching has been unsuccessful and the patient is now electing to change tooth color via restorations, wait a minimum of three weeks and disc the enamel to expose a new layer of enamel rods before bonding a restoration in place.

common in dental products is Carbopol 940® (by B. F. Goodrich). Carbopol is found in Proxigel, NiteWhite, Patterson's, Ultra-lite, Opalescence, and Rembrandt Lighten.

All currently marketed bleaching products contain some thickening agent. Products with higher concentrations of carbopol or other thickener perform better clinically since the bleach stays active longer and greater viscosity reduces bleach loss from the tray.

**Hydrogen Peroxide.** Hydrogen peroxide bleaches at least twice as fast as the same con-

centration of carbamide peroxide because of higher peroxide content. Hydrogen peroxide solutions for bleaching are available in concentrations from 1.5% to 10%. Currently, relatively few products use hydrogen peroxide as the active ingredient because it is significantly less stable than carbamide peroxide.

## Bleaching Appliance

Tray appliances are constructed of stiff or flexible plastic sheets (0.015–0.040 inches thick) using a pressform machine. Thinner trays have less impact on occlusion and are preferred for daytime use. Most patients, within a relatively short time, can speak normally with the appliance in place. Both arches can be covered simultaneously but single-arch treatment decreases the likelihood of TMJ problems and allows the opposing arch to act as a control (nice for initially showing patients the value of the treatment). Some clinicians prefer thicker (0.08 inch or more) sheets for increased durability, but these trays are considerably less comfortable to wear and increase orthodontic forces on teeth.

Some clinicians use quick-set plaster for tray construction. This allows a patient to receive the appliance on the day of their initial appointment. There is no known drawback to this practice.

The addition of a reservoir is believed by some to shorten total bleaching time. In our experience, they decrease the bleaching time only slightly (20% at best), but present a number of disadvantages. Not only do trays with reservoirs take longer to fabricate, they are looser and more prone to fall out, and they are more likely

to interfere with normal talking while in the mouth.

## Treatment

### Initiating Treatment

When introducing the concept of at-home bleaching to patients, present it as a single-package treatment for both arches. Establish a fee for the entire course of treatment, including a set number of treatment appointments and follow-ups for a specific period; before and after patient photographs; instructions and educational materials; appliance; and bleaching materials. State a reasonable expectation of results without guarantees.

The single-package approach permits setting a fee based on an hourly office rate for the average time spent, plus 25% for contingencies, and usually results in better patient compliance, higher patient satisfaction, and considerably reduced stress for both patient and dentist. National data show dentists are charging \$185–\$240 per arch for at-home bleaching treatment.

### Treatment Method

**Step 1.** Prophylaxis.

**Step 2.** Preoperative photograph with a matching shade tab in the photographic field to document existing conditions and changes. Prepare two sets: one for the patient and one for recordkeeping.

**Step 3.** Make the appliance: Take an alginate impression and pour in gypsum. Outline the guard on the model with a pencil so that it will extend 1 mm past the teeth to be bleached. Second molars generally do not need to be covered unless doing so provides a better fit. Some manufactur-

ers recommend trimming just short of gingival contact as a hedge against gum irritation when using stronger bleaching agents (i.e., 15% carbamide peroxide or more). To compensate for potential leakage, this type of tray requires use of thicker bleaching materials.

Heat the plastic material and vacuum-adapt to the cast with a suitable vacuum device. A cooking oil spray (e.g., Pam) works nicely to keep the tray material from sticking to the stone. Cut the tray to the outline with a sharp Bard Parker knife while the plastic is on the cast. Remove the excess, then carefully remove the guard. Trim with crown-and-bridge scissors to or slightly past the tooth–tissue junction. Adjust any folds with an acrylic trimming bur.

**Step 4.** Patient Instruction: Instruct the patient to place a small amount of bleach on the inner wall of the appliance along each tooth to be bleached, and then immediately place the appliance over their teeth.

Studies show the presence of pellicle has no impact on the degradation rate of the bleaching agent; therefore, it is not necessary to have patients brush their teeth just prior to bleaching.

The hydrogen peroxide activity of most bleaching products is reduced by 50% after the first two hours in the mouth.

The safest length of wear time is 2 to 3 hours a day, replenishing the bleaching material every 1 to 2 hours. Longer wear per day results in faster lightening but can also increase tissue irritation, tooth sensitivity, and cause other complications. Fluoride treatments may be applied to teeth

daily before bedtime to reduce sensitivity.

The appliance should not be worn while eating.

**Step 5.** Have the patient return when they run out of bleaching material. Instruct them to come in sooner if they experience any irritation from the tray. With carbamide peroxides, see the patient at six weeks to monitor lightening, check for complications, and provide necessary supplies. Almost all (90%) patients achieve 90% of final lightening within six weeks of daily bleaching.

If complications occur, stop treatment for a few days, then proceed with less wearing time; for example, every other day.

**Step 6.** When treatment is complete (usually one or two shades lighter), take postoperative photographs to verify changes.

### Patient Instructions (*what to tell patients*)

- No guarantees of tooth lightening
- Expect a one to two shade change in color
- Minor sensitivity to cold may occur
- Discontinue if tray is uncomfortable
- For faster bleaching, increase wear time to a maximum of 8 hours per day (with appropriate bleach changes)
- Do not use the mouthpiece while eating
- Expect to see some results after two to five days; significant results after six weeks
- Save the tray in case future touch up is needed

### Sensitivity

Some patients experience heightened sensitivity to cold during at-home bleaching. Sensitivity for one to four days is experienced by 65% of patients at the onset of treatment. This sensitivity often lessens over the course of treatment and generally ceases altogether with the termination of treatment with no aftereffects. The only predictors of sensitivity are a previous history of tooth sensitivity and the frequency of bleach application within a 24-hour period. Products with 15% versus 10% carbamide peroxide cause more sensitivity in patients prone to sensitivity; lower concentration products are necessary for these patients.

Of particular concern are patients with dentin sensitivity. These are most apt to be younger patients (those under 40 years old). Almost all dentin surfaces in the mouth are covered with a smear layer that reduces tubular flow from the tooth. Bleaching materials dissolve this layer, which increases fluid flow. Because bleaching materials are also hypertonic and absorb water, they absorb water from the tooth if the tubule is open. This absorption of water stimulates nerve endings, as would the application of sugar (also hypertonic). In mature patients, removal of the smear layer is of no consequence because the dentin is sclerotic (completely sealed).

If a patient is experiencing dentin-related sensitivity, have the patient come to the office for immediate treatment. There are two options. One is to coat the area with a varnish or unfilled resin; however, when this treatment wears off,

*Continued on p. 13*

# Dentin and Sensitivity

## Dentin Physiology

**Histology.** One square millimeter of dentin can contain 30,000 tubules (depending on the depth). The cellular extensions from the odontoblasts (that line the pulpal surface of the dentin) extend 0.5 to 1 mm into each tubule. The ends of the many nerve fibers located at the pulp periphery (called C-fibers) are in synaptic connection with the odontoblasts and often extend into the tubules along the protoplasmic protrusions.

The pulp contains fluid that is much like other tissue fluid with a hydrostatic pressure of about 30 mm Hg toward the outside. Because these tissues are normally covered with enamel or cementum, which are relatively impermeable, there is an extremely slow outward movement of fluid in the normally sealed tubule. The fluids hydrate the dentin and enamel, which enables different stimuli to reach the pulp. However, if the enamel or cementum is removed through tooth preparation or erosion, the rate of outward fluid flow increases sharply and can result in extreme sensitivity.

Considerable research has confirmed that dentin hypersensitivity is mainly caused by the transmission of pain to the pulp through a hydrodynamic mechanism. Based on this, it is thought that teeth with cervical sensitivity have open tubules at the dentin surface that connect to the pulp. The most common goal of treatment includes occlusion of the tubules or reduction in their diameter.

Since the nerve fiber is interwoven along the odontoblast, desiccation can trigger a pain response. Excess desiccation can draw the odontoblast into the tubule and result in a chronic inflammatory response of the odontoblastic cells.

Normally, exposed tubules become plugged by the contents of the dentinal fluid, saliva, or gingival crevicular fluid that has become insoluble. Over time, this organic plug becomes calcified and protects the dentin from further insult. Permeability due to decalcification by acids such as hypotonic bleach solutions increase fluid flow, which causes excessive stimulation of the odontoblast within the tubule.

If the stimuli and sensitivity persist, either the pulp responds and produces a barrier of secondary or sclerotic dentin to protect the pulp, or the pulp tissues become irritated or damaged from the trauma.

**C-Fibers:** These nerve fibers are myelinated, fast conducting, and have a low threshold. Stimulating these fibers results in sharp localized pain of very short duration. C-fibers are commonly involved in dentin sensitivity.

**A-Fibers:** These fibers are unmyelinated, slow conducting, and have a high threshold. Stimulation of these fibers results in a dull, poorly localized pain of generally long duration. A-fibers are commonly involved in cases of chronic pulpitis and heat sensitivity.

Patients with sensitive areas generally have open dentinal tubules which are wider and more

numerous than tubules in non-sensitive areas. The feeling is dull, as it is with A-fibers.

## Incidence of Hypersensitivity

The incidence of hypersensitive teeth in the general population is estimated as 9–30%. Hypersensitivity is most common among patients between 20 and 30 years of age, and occurs equally in males and females. Cold is the most common stimulus (74%).

Sensitivity is most common on canines (25%), followed by first premolars (24%). Sensitivity occurs most commonly on facial surfaces (93%) associated with gingival recession (68%). Generally, sensitive incisors are the most painful, followed by premolars, followed by molars. This descending order of sensitivity can be attributed to the thickness of enamel and cementum on these teeth.

Older teeth are generally less sensitive than younger teeth. This can be attributed to the progressive deposition of secondary dentin and the narrowing of the pulp chamber.

## Common Pain Stimuli

**Desiccation.** If a dry cotton pellet placed on exposed dentin causes pain and a wet cotton pellet does not, this generally indicates that open tubules exist and the pain is from tubular fluid movement.

**Air Pressure.** Short air blasts evaporate fluid and trigger the pain response. Prolonged air blasts evaporate water and condense proteins and other constituents, which produces a precipi-

tate of debris that can close off tubules and reduce pain.

**Changes in Osmolarity.** Changes in osmolarity can alter intertubular flow and trigger pain. Sweet beverages are usually highly hyperosmotic and will stimulate outward movement of tubule fluid.

**Thermal Stimuli.** Fluids generally expand when heated and contract when chilled. A mechanical stimulation results since the thermal expansion of dental fluids is over 10 times that of the tubule wall.

#### Treatment

Many materials have been used to treat dentin sensitivity, including strontium, fluoride, formaldehyde, and oxalates.

**Silver nitrate** has strong protein-precipitating properties. The risk is that silver ions, if transmitted to the pulp, can cause pulpal inflammation. Hence, this material is generally not recommended for use.

Treating teeth with 3–10% **potassium oxalate** produces calcium oxalate crystals on the teeth. These crystals have low solubility and can obstruct dentin tubules and prevent the penetration of fluids and acids. Some research shows that the effect of potassium oxalate is equal to or better than that of a cavity varnish, which is minimal. Potassium oxalate is found in products such as DDS™ (O.P. Laboratories), and Protect (Butler).

**Sodium fluoride** promotes the deposition of calcium phosphate in fluorapatite. It is also effective against root caries that often ac-

company sensitivity. However, sodium fluoride works very slowly. Numerous fluoride gels (neutral pH is best) are available (e.g., Prevident). Fluoride is the treatment of choice for most mild to moderate cases of dentin sensitivity.

**Strontium**, by combining with the phosphate in the dental tubule, produces strontium phosphate crystals that close off tubules. These crystals were once the active ingredient in Sensodyne® and Thermodent™ dentifrices.

**Potassium nitrate** is the most commonly used chemical that reduces dentin sensitivity without causing pulpal changes. It is fast-acting and has some anesthetic properties. Potassium nitrate is the most commonly used active ingredient in over-the-counter products used to treat tooth sensitivity (including Promise™, Denquel™, Colgate Sensitive™, UltraEze™, and Sensodyne-F® dentifrices). Potassium nitrate is also available in pharmacies as potash. It can be used by the dentist in liquid form on severely sensitive teeth.

A 5% solution of **glutaraldehyde** in water or saline is effective in reducing acute sensitivity. It will fix the fluid in the dentin tubules and form collagen plugs. These plugs will reduce intertubular fluid flow and therefore dentin sensitivity. Collagen plugs can also form for a matrix that can later mineralize by the saliva. It is applied to the sensitive dentin with a cotton pellet for 5–10 seconds and then rinsed off. Not available commercially, the solution can be made up by a pharma-

cist or chemical supply company.

**Unfilled Primers and Resins.** A number of resin treatments have been proposed for sensitive roots. Many feel these treatments, although restorative, are ideal for moderate and severe cases of tooth sensitivity. Some dentin bonding agents contain desensitizing components. For example, Gluma (Bayer) contains 5% glutaraldehyde.

Brännstrom was one of the first to recommend filling tubules with resin. His technique involves: 1) treating the surface with EDTA to remove the smear layer, 2) washing and drying the surface with water, 3) placing a free-flowing resin on surface, 4) removing the excess with a cotton pellet, and then curing.

Jensen also recommended using a phosphate dentin bonding agent over the smear layer. He reported higher success with this method than with sodium fluoride and strontium chloride.

Fusayama uses a variation of Brännstrom's method but he acid-etches the dentin for 30 to 60 seconds with a phosphoric etching solution prior to placing a resin. He feels etching is necessary to retain the resin coating. Most of the resin bonding agents available today would seal dentin tubules.

Resins remain a good alternative treatment when more conservative topical agents such as potassium nitrate are ineffective.

# Place Your Masthead Here

You are invited to place your masthead here and copy this page for use in your dental office.

## At-Home Bleaching Information and Instructions

*At-home bleaching is a procedure by which you, supervised by your dentist, can easily and effectively lighten your teeth.*

### Informed Consent

- Ingredients of the bleaching solution are carbamide peroxide, hydrogen peroxide, glycerin, and trace amounts of fluoride and flavorings. Do not begin treatment if you are allergic to any of these materials.
- As with any procedure, there are benefits and risks. The hoped for benefit is whiter teeth. The risks include, but are not limited to tooth sensitivity, a burning sensation in the gums, soft tissue ulcers, nausea, soreness in the teeth and changes in the bite, jaw joint soreness or disorders from the appliance, sore throat from swallowing bleach, and facial pain. These problems occur in less than 10% of patients treated. Discuss any symptoms with your dentist.
- Dental crowns and fillings usually do not lighten and may be more noticeable after treatment. In addition, these restorations can occasionally be damaged by bleaching and may need replacement.

### Contraindications to Treatment

- Pregnant women or those expecting to be pregnant should not undergo treatment. Long-term effects of bleaching materials on pregnancy have not been studied.
- Patients with root sensitivity may not wish treatment since sensitivity can be aggravated.

### Expected Results

- While there is no guarantee of tooth whitening and the amount of tooth lightening is unpredictable, most

teeth lighten 1 to 2 shades on a dentist's shade guide.

- Average treatment time is two to six weeks. More difficult cases require extended treatment times and may result in teeth looking chalky.
- Yellow and brown stains usually respond well; gray and blue stains usually improve less.
- In some patients, stains relapse when treatment is discontinued.
- The exact duration of whitening varies among patients. Usually 1–3 years. Periodic retreatment sometimes necessary.

### Patient Instructions

- Place a small amount of bleaching solution on the inner wall of the bleaching appliance near the teeth to be whitened. With both hands, carefully place the filled appliance in your mouth. Expectorate excess solution. Swallowing bleach, although not harmful, can irritate your throat. Wear for the recommended time.
- To change the solution, remove the appliance with both hands, rinse your mouth with water, rinse and dry the appliance, and replace the solution. Brush the appliance inside and out every day. Clean your teeth as usual.
- The more treatments per day the faster the bleaching. However, this can also increase sensitivity and cause other complications. Whiteness is not related to bleaching speed. Bleaching slowly will result in teeth that are just as white.
- Recommended pace: The safest approach is to wear the filled appliance 2 to 3 hours a day, replenishing every 1 to 2 hours, or as indicated by your dentist. Always use the recommended replenishing time.
- Faster bleaching: Maximum wearing time is 8 hr/day, replenished as directed. This should only be done

under the direction and supervision of your dentist.

- Nighttime treatment is an option although day use works faster since you replenish the bleach. If this approach appeals to you, discuss it with your dentist.
- Fluoride may be applied to the teeth daily before bedtime. Some patients say this reduces sensitivity while others say it has no effect. Discuss this with your dentist.
- Do not wear the appliance while eating.
- Your dentist should check your mouth after four weeks to ensure no damage is being done to your teeth, gums, or dental restorations.
- Discontinue treatment if any discomfort or problems occur.

### Special Instructions

Recommended wearing time: \_\_\_\_\_ hours

Replenish solution every: \_\_\_\_\_ minutes

I have read the above and my questions and concerns have been answered and explained to me. I agree to return for examination during treatment as recommended by my dentist. I also agree to return for periodic oral examinations after treatment is completed. I have received a copy of this information and instruction sheet. I understand the directions and the risks, and I consent to treatment.

I also consent to photographs being taken. I understand they will be used for documentation, treatment study, and for educational purposes.

Patient: \_\_\_\_\_

Doctor: \_\_\_\_\_

Date: \_\_\_\_\_

*Notes and Special Instructions:*

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the sensitivity will return. We prefer to gently rub an aqueous solution of 5% glutaraldehyde on the sensitive dentin. Continue the application at 10-second intervals until the sensitivity abates. Immediately follow the glutaraldehyde treatment with an application of neutral fluoride, preferably in the bleaching tray. Send the patient home with a neutral fluoride (e.g., prescribe Prevident) and instruct them to place one drop of fluoride in the tray next to each sensitive tooth and wear the tray 1 to 2 hours a day for 10 days (replenishing the fluoride every hour). This allows the mucus pull effect of the glutaraldehyde to calcify enough to allow continuation of bleaching.

In less severe cases, an alternative is to switch patients to a potassium nitrate-containing toothpaste (e.g., Denquel, Promise, Colgate Sensitive, or Sensodyne). For patients who continue to be bothered by sensitivity, recommend they bleach on an every-other-day basis.

Bleaching products that contain potassium nitrate in their

formulas lessen sensitivity for patients experiencing problems. In one study, the addition of 3–5% potassium nitrate to a 10% carbamide peroxide preparation reduced sensitivity in about 70% of patients.

Haywood recommends patients use a 3–5% potassium nitrate solution in the tray 30 minutes prior to bleaching, or, if bleaching at night, that they use potassium nitrate in the tray, alternating nights with the bleach. Use potassium nitrate materials only with patients who are experiencing sensitivity; otherwise, it can induce sensitivity in previously unaffected patients.

### Longevity

A shortcoming of external bleaching is that it is seldom permanent, typically lasting one to three years—with significant individual variation. Only discing, which removes rather than bleaches, or restoration, which covers stains, can permanently eliminate superficial surface stains. The graph in Figure 6 demonstrates the typical longevity of treatment.

Studies of at-home bleaching show 90% of patients

achieve lighter teeth within six weeks of daily nighttime bleaching. According to results from the University of North Carolina, in 74% of cases, the shade change remained stable after one-and-a-half years. For 62% of patients, the tooth color remained unchanged three years following bleaching, and 35% of patients experienced no noticeable color change seven years post-treatment. In sum, clinical studies show that, on average, 50% of at-home bleaching patients experience just slight relapse after four to five years. Usually, the younger the patient the longer the bleaching lasts. Yellow stains seem to take longer to reoccur than blue or gray stains. However, research data are still too sparse to make reliable assertions to patients. Bleaching longevity is unpredictable and highly patient-specific.

Touch-up bleaching to maintain a lighter tooth shade should be considered only after a one-year follow-up exam. Current data suggest that only a relatively small percentage of patients will require such additional treatment. When touch up is needed, Haywood recommends having the patient bleach one day per week for as many weeks as the initial course of bleaching (i.e., if the original treatment ran eight weeks, give the patient enough material to bleach once a week for eight weeks).

### REFERENCES

Berry JH: What about whiteners? Safety concerns explored. *JADA* 121:223–225, 1990.

Blankenau R, Goldstein RE, Haywood VB: The current status of vital tooth whitening techniques. *Compendium* 20:781–794, 1999.

*Clinical Research Associates Newsletter*, Vol. 24, Issue 4, April 2000.

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### Stability of Lightening

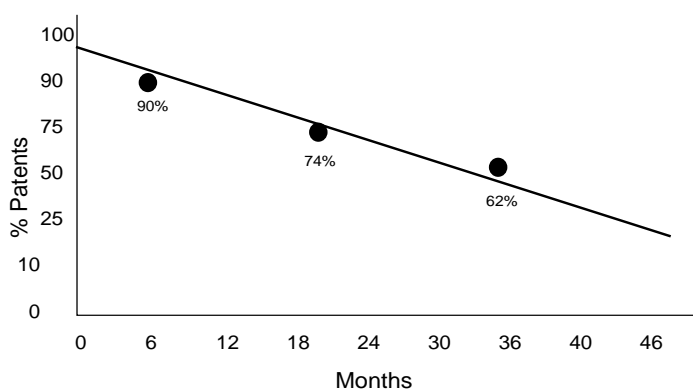


Figure 6. Home bleaching data longevity studies done at the University of North Carolina have found that 94% of patients retain tooth color change after 18 months, 62% after 36 months, and 35% after 84 months.

## The Psychology of Bleaching

There are two general categories of bleaching patients: individuals to whom a dentist recommends the treatment because of obvious stains, and individuals who seek the treatment on their own accord. These categories may represent two very different psychologies, something that dentists are wise to take into account during clinical interactions.

Patients to whom the treatment must be suggested are likely self-effacing and unassuming. They are not “trend-setters” and may not readily agree to (medically unnecessary) esthetic treatment. They need educating and examples of others’ successes to provide a rationale for accepting treatment. Be patient, offer gentle reminders of this option, and don’t push; they may simply need time to come around to this decision.

Patients who ask for bleaching treatment are more likely self-conscious, particularly regarding their physique, and typically more used to spending money on self-enhancement. These patients usually have cosmetic work done when an upcoming event heightens their sensitivity to appearance. Common events are weddings, class reunions, first dates, or reentry to the “singles market.”

These patients seek treatment with a sense of urgency. On a subconscious level, many may hope the dentistry will do more than just improve their smile; that once it’s done, they’ll have a perfect marriage, find their soulmate partner, etc. In addition, these patients often believe that whiter is better, and, regardless

of results, will wonder if their teeth could be bleached more.

Indeed, these patients may seek further bleaching treatment—either unnecessary touchup bleaching after initial treatment, or a continuation of treatment beyond the saturation point during initial treatment.

Across all ages and genders, it is the female adolescent patient who is most likely to have necrotic tendencies to bleach beyond refrigerator white. These patients must be attended to carefully and helped to accept their saturation point color.

A method that works with some patients is to hand them a shade guide without a mirror and ask them to identify the shade tab that represents the color of their teeth. Patients usually pick a dark shade from the shade guide. Then give the patient a mirror and show them how the shade tab contrasts with their natural teeth. They are usually surprised to see that the shade they picked is much darker than their natural teeth.

It is usually a good idea to pursue conversation with them along the lines of, “Well, what does that mean?” Often they are slow to conclude, “I guess my teeth are a lot lighter than I thought.” This is an opportune moment to explain that their teeth are really very white: “You are lucky that your teeth came out so light. You see that your teeth are now one of the lightest shades dentists treat.”

Helping these patients achieve a relative understanding of the success of their procedure is invaluable. Without this understanding, they may continue to

seek unhealthy bleaching treatment from another provider.

When such frank discussion does not seem to resolve a patient’s anxiety about tooth color and they insist on further bleaching, I like to say: “If you see enough dentists, someone will agree with you. However, that does not mean that you are acting in your best interest.” At this point, I explain the chemistry of the bleaching process in a very simple way, advising them they have reached the esthetic limit and saturation point for their teeth, such that any further bleaching could be destructive.

Multiple repetitions of bleaching process information is often necessary before a patient understands that additional bleaching is not a good idea. Be patient when a patient makes repeated requests for unnecessary touchup bleaching.

## Frequently Asked Questions

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of the major manufacturers now selling these products ensure expanded public awareness and acceptance of the bleaching process, and a growth market for their OTC products.

### **Question: Can you bleach porcelain veneers?**

**Answer:** Bleaching solutions have no effect on ceramic materials. However, if teeth have exposed enamel on the lingual, this provides a route for at-home bleaching materials to access and change the dentin. The bleach saturates the tooth from the back and diffuses to the facial, thereby lightening the tooth overall. This is a slower and more

variable process than typical at-home bleaching but is successful for some patients, particularly those with thin teeth.

### **Question: It is hard to match bleached teeth with restorative composites.**

**Answer:** The optical properties of highly bleached teeth are different than those of unbleached teeth. Most composites mimic the optical properties of natural teeth and thus appear dissimilar to bleached teeth. In recognition of the mismatch between bleached teeth and composites, manufacturers are now producing special materials to restore bleached teeth; examples include the composite products labeled

"shade A0.5" and "shade A0."

### **Question: After at-home bleaching, the cuspids often remain darker than the central incisors. What can I do to further lighten the cuspids when the centrals are the right shade?**

**Answer:** The simplest method is to section the bleaching tray at the mesial of both cuspids and have the patient continue at-home bleaching wearing the two cuspid-to-molar pieces. This is more effective than merely cutting away the facial areas of the central incisors, since that would allow bleach to diffuse to the centrals.

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Ernst CP, Marroquin BB, Willershausen-Zonnchen B: Effects of hydrogen peroxide-containing bleaching agents on the morphology of human enamel. *Quintessence Int* 27:53-56, 1996.

Feiglin B: A 6-year recall study of clinically chemically bleached teeth. *Oral Surg, Oral Med, Oral Pathol* 63:610-613, 1987.

Flaitz CM, Hicks MJ: Effects of carbamide peroxide whitening agents on enamel surfaces and caries-like lesion formation: An SEM and polarized light microscopic in vitro study. *J Dent Child* 63:249-256, 1996.

Gultz J, et al: Two in-office bleaching systems: A scanning electron microscope study. *Compendium*, Oct. 1999.

Haywood, VB: Current status of nightguard vital bleaching. *Compendium*, supplement 28, June 2000.

Haywood VB: Achieving, maintaining, and recovering successful tooth bleaching. *J Esthet Dent* 8:31-38, 1996.

Haywood VB: History, safety, and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. *Quintessence Int* 23:471-488, 1992.

Haywood VB. Bleaching of vital and nonvital teeth. *Curr Opin Dent* 2(Mar):142-149, 1992.

Haywood VB, Leech T, Heymann HO, et al: Nightguard vital bleaching: Effects on enamel surface texture and diffusion. *Quintessence Int* 21:810-814, 1990.

Haywood VB: Nightguard vital bleaching: Current information and research. *Esthet Dent Update* 1:20-25, 1990.

Haywood VB, Heymann HO: Nightguard vital bleaching. *Quintessence Int* 20:173-176, 1989.

Hunsaker KJ, Christensen GJ: Tooth bleaching chemicals—Influence on teeth and restorations. *J Dent Res* 69:303 (special issue) Abstract #1558, 1990.

Jerome: Acute care for unusual cases of dental hypersensitivity. *Quintessence Int* 26: 715-716, 1995.

Ledoux WR, et al: Structural effects of

bleaching on tetracycline-stained vital rat teeth. *J Prosthet Dent* 54:55-59, 1985.

Matis BA: Degradation of gel in tray whitening. *Compendium*, supplement 28, June 2000.

McCaslin AJ, et al: Assessing dentin color changes from nightguard vital bleaching. *JADA* 130:1485-1490, 1999.

Scherer W, Cooper H, Ziegler B, et al. At-home bleaching system: Effects on enamel and cementum. *J Esthet Dent* 3:54-56, 1991.

Seale NS, McIntosh JE, Taylor AN: Pulpal reaction to bleaching of teeth in dogs. *J Dent Res* 60:948, 1981.

Swift EJ, et al: Two-year clinical evaluation of tooth whitening using an at-home bleaching system. *J Esthet Dent* 11(1), 1999.

Swift, EJ: Restorative considerations with vital tooth bleaching. *JADA* 128: 60S-64S (supplement), 1997.

Zalkind M, Arwaz JR, Goldman A, et al: Surface morphology changes in human enamel, dentin and cementum following bleaching: a scanning electron microscope study. *Endod Dent Traumatol* 12:82-86, 1996.

## Frequently Asked Questions

**Question: A colleague told me that his laser bleaching unit lightens teeth more than conventional at-home bleaching. Should I buy a laser unit?**

*Answer:* First off, although laser bleaching may appear to bleach more thoroughly, it is only appearances: Because the laser bleaching process is quick, it gives off large amounts of oxygen bubbles in a short time. These bubbles refract light and make the teeth appear lighter (the same effect occurs when you shake a bottle of carbonated mineral water). Secondly, bleaching is time/concentration dependent. Therefore, the final result with laser bleaching is no lighter than the final result with standard at-home bleaching (using 10% carbamide peroxide for at least six weeks). Given these facts, I do not recommend buying a laser unit for bleaching. However, high-tech equipment can be a practice-builder with some types of clientele, and the process of laser bleaching

can be impressive. In that case, such a purchase should be considered primarily as a marketing investment. The investment must still be weighed against the expense and space requirements of maintaining additional equipment.

**Question: What is a fair fee for bleaching?**

*Answer:* Fees across the country range from roughly \$350–\$475 for full-mouth treatment. These fees should reflect the cost of 20 minutes of doctor time and 40 minutes of dental assistant time, assuming the assistant takes the impression(s) and makes the tray(s), plus materials. Ideally, a patient is agreeable to full-mouth treatment (if warranted). In other cases, I advise treating the upper arch first so the patient can see the improvement by comparing it to the lower. When following this procedure and pricing arches separately, the lower arch is generally done at a slightly lesser cost. Some of-

fices intentionally price bleaching treatment below cost to attract new patients.

**Question: How will over-the-counter bleaching products affect the dental profession?**

*Answer:* The recently introduced over-the-counter (OTC) bleaching materials have found an eager market. The newer products are as effective as dentist-supplied at-home bleaching materials. The latest advance is a delivery system that does not involve a conventional mouth tray but adheres the bleaching solution to the teeth via plastic strip. This approach has been tested at several universities and found safe. In the future, it is likely that most at-home bleaching will be done with OTC products and the dentist will provide only in-office bleaching for complex cases (e.g., endodontically treated teeth). The marketing efforts

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## The Bottom Line

At-home bleaching is effective, efficient, and reduces chair time in comparison to in-office alternatives. It is a good first choice when tooth lightening is desired. It provides the most lightening for the time and energy spent by the dental office.

One concern is that the incisal edges initially bleach more than the body of the teeth. This seems reduced with high-viscosity bleaches, well-fitting trays, and continued bleaching. Secondly, since existing restorations will not lighten, their replacement may be required.

Bleaching is time-and-concentration dependent. Higher concentrations of bleach and longer contact times produce a faster effect. Even so, all bleaching methods produce the same result. Higher concentrations or more time does not produce more or better lightening; it simply achieves the shade change more quickly. Higher concentration bleaching (e.g., in-office bleaching) has the drawback of increased tooth sensitivity. Therefore, the better choice is lower concentration bleaching and longer contact time; this is, by definition, at-home bleaching.