

CE 1

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Learning Objectives:

After reading this article, the reader should be able to:

- describe the process of nightguard vital bleaching and discuss indications and contraindications.
- list the situations amenable to at-home whitening, including extended bleaching times for tetracycline-stained teeth.
- explain how to treat side effects, such as tooth sensitivity during whitening.
- discuss treatment options for a single dark tooth.
- compare at-home bleaching with in-office bleaching.

Frequently Asked Questions About Bleaching

Abstract: *Nightguard vital bleaching, or at-home bleaching using a 10% carbamide peroxide material in a custom-fitted tray, has become the standard for tooth whitening. This article answers many of the questions associated with this process, and compares the procedure with other whitening options.*

In 1989, I coauthored the first article on nightguard vital bleaching using a 10% carbamide peroxide in a custom-fitted tray.¹ Since then, I have had the unique experience of watching a completely new area of dentistry develop. From my own experience and research, as well as that of my colleagues, I have developed answers to many of the questions I regularly receive. They are featured in the following article.

What is the safest, most cost-effective and efficacious method for bleaching teeth?

The use of 10% carbamide peroxide in a custom-fitted tray is the safest, most efficacious, and cost efficient method, for the least investment. It provides the best ultimate result, with possibly the longest duration, and is easiest for the dentist and most patients.² Higher concentrations of carbamide peroxide produce more sensitivity,³ have greater rebound to a stable color, and do not appreciably alter the treatment time. In-office options of high concentrations of hydrogen peroxide still require two to six visits, with an average of three, to reach maximum whiteness, although results will certainly be seen after one treatment.⁴ Over-the-counter (OTC) products achieve some lightening; however, a proper diagnosis is not required. Additionally, the results may not be as good, the process not as safe, and long-term treatment options not as available as those offered by a dentist.⁵ The best technique must consider safety, efficacy, and cost-benefit ratio.

Can you describe the process of tray bleaching?

The generic technique consists of a bleaching material, an application prosthesis, and a treatment regime. I use an American Dental Association (ADA)-approved 10% carbamide peroxide material. The more viscous the material, the better the potential for retention in the prosthesis. The best prosthetic material is a thin, clear, soft material. The original prosthesis was a horseshoe design, extending approximately 2 mm onto the attached gingival, with no spacers on the facials of the teeth. If there is concern about soft tissue contact, scalloping the prosthesis to cover only the teeth can be performed. With the highly viscous materials, the reservoirs formed by placing a spacer on the facials of the teeth on the cast before fabrication of the prosthesis facilitates the seating and adaptation of the loaded prosthesis without distortion.

The treatment regime consists of wearing the loaded prosthesis at night, or in 2- to 4-hour intervals during the day. Nighttime use generally

shows better patient compliance because of the ease of application, minimal lifestyle interruption, maximum contact time per application, and minimal saliva flow. Daytime use may be indicated when sleep is disrupted by the prosthesis, shorter wear times are necessary to minimize tooth sensitivity, less tissue contact time is desired, or more rapid bleaching from more frequent applications is desirable. Treatment time for normal teeth can be 1 to 6 weeks, 1 to 3 months for nicotine-stained teeth, and 2 to 6 months or longer of nightly application for tetracycline-stained teeth.⁶ The time required to achieve desired results will vary, and the patient's expectations must not be unrealistic. The key is to "bleach until they are white."

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What are the different conditions that can be improved by whitening?

Teeth discolored from aging, chromogenic foodstuffs, or that are inherently discolored are most responsive. Teeth discolored from tetracycline ingestion during tooth formation respond, but may never completely lose their gray color. Teeth may be stained secondarily from minocycline, a tetracycline taken for treatment of facial skin conditions during adult years.⁷ This adult tetracycline staining often occurs in the secondary dentin that is deposited coincident with drug ingestion, as well as secreted in the saliva and absorbed into the tooth. Teeth discolored from trauma bleach well, especially those for which there is no radiographic evidence of any pulp chamber or periapical pathology. These teeth may be vital or nonvital, but have an excellent prognosis and avoid more aggressive treatments with poorer outcomes. Teeth discolored by brown fluorosis generally respond, although white spots are not changed.⁸

Bleaching is considered before porcelain veneer placement to either eliminate the need

for veneers, reduce the amount of opacifiers needed to mask discoloration, or to give the patient the option of attempting a less expensive/invasive treatment before committing to veneers. After veneer placement, bleaching may be used to relighten bleached teeth if they relapse, to further lighten the apparent color of the existing veneers by bleaching the underlying nonbleached tooth structure from the lingual, or to clean stained margins on existing veneers.

What is the difference when bleaching brown and white fluorosis stains?

White or brown discolorations are often associated with high fluoride ingestion. Dentists are more familiar with using abrasion techniques for treating white or brown discolorations. Abrasion techniques predate the recent home-bleaching era. Microabrasion involves the softening and removal of the enamel with hydrochloric acid and pumice.⁹ The teeth are isolated with a rubber dam, and a special geared-down handpiece is used. Microabrasion is not bleaching, but the removal of enamel along with the surface defect. Generally, 12 μm to 26 μm of enamel is removed per 5-second application.

There is also a related abrasion technique called macroabrasion, or megabrasion, which uses rotary instruments for enamel removal. One technique involves the use of a carbide bur in a high-speed handpiece, followed by polishing with composite finishing disks and polishing points or pastes. The Sof-LexTM disc^a system (black and three blue), followed by composite polishing instruments such as Enhance[®],^b points and diamond polishing pastes work well, especially when a rubber dam is not easily applied for microabrasion.

However, the advent of the nightguard vital bleaching has offered a more conservative option to be considered first. If the enamel surface is intact and hard, then nightguard vital bleaching should be the first choice for brown discoloration, or minor white areas. This whitening technique avoids the removal of the fluoride-rich enamel layer, and still leaves the abrasion technique as an option, if required.

Brown discolorations can be removed approximately 80% of the time. In one case

^a3M ESPE, St. Paul, MN 55144-1000; (800) 634-2249

^bDENTSPLY Caulk, Milford, DE 19963; (800) LD-CAULK

reported, it took 4 to 6 weeks to remove an isolated brown discoloration on a central incisor.¹⁰ This brown discoloration has remained absent for 10 years with no further treatment.¹¹ Most other brown areas are showing similar patterns. Only a few brown areas have required re-treatment in 1 to 3 years.

If there is an unsightly, white, poorly-formed discoloration covering the entire tooth surface, then microabrasion may be the treatment of choice. However, generally, the teeth are more yellow after the white surface is removed, and the bleaching technique still may be required.

If the white area is a single isolated spot or a few spotty areas, it may still be better to bleach first to lighten the background of the tooth. Often, this makes the white areas less noticeable, and no further treatment is needed. White spots do not actually disappear, but the background gets lighter, which makes them less noticeable.¹² Sometimes the original white spots become more noticeable during bleaching (called the “splotchy stage”), but generally revert back to their original color after termination of the treatment. This temporary lightening of white spots is caused by the differently formed portions of enamel, which are responding to the carbamide peroxide faster.

If the white spots are still a distraction after bleaching has been completed, then microabrasion or macroabrasion can be performed. However, if you do perform abrasion, tell the patients that if the isolated defect gets worse subsurface, the defect may have to be aggressively removed and be covered with a composite. By bleaching first, the color of the composite can be properly selected the day the abrasion is used.

Why does most of your work show bleaching only of the maxillary arch?

The biggest reason for one arch treatment is that it improves compliance. Most patients can see the change in one arch, compared with the other arch, and they are encouraged to continue. In long-term treatment, such as with tetracycline staining, patients often forget how dark the teeth were after several months of treatment and become discouraged. Single arch treatment provides them with continuous comparison between the two arches.

Wearing a tray on only one arch has several other advantages. First, this approach minimizes the impact of occlusion on the teeth, because there is only one thickness of material between the teeth.¹³ This can reduce mechanical tooth sensitivity and eliminate joint problems. For patients with an existing temporomandibular disorder (TMD), a technique has been published¹³ using a tray design that covers only the facial of the teeth. For bruxers, you may have to use a thicker material or make several trays to use as they grind through each tray.

Single arch treatment also reduces the incidence of chemical tooth sensitivity because there are fewer teeth being treated at one time. The smaller teeth (maxillary lateral incisors and mandibular incisors) seem to have more sensitivity, so one arch treatment reduces the sensitivity potential.

I usually whiten only one arch at a time, so I recommend that most practices offer a single arch fee.¹⁴ In my whitening research projects, I have been surprised that after completing the maxillary arch treatment and obtaining a significant improvement, many patients elect not to whiten the mandibular arch, even when it is free. If your practice has only one fee for both arches, you may be creating an obstacle for patients who want to whiten their teeth, but feel the total cost is too high. A one arch fee allows them to experience whitening, and if they have a dramatic change, they can complete the other arch later, depending on their finances. If the change is not dramatic, or they do not care about the mandibular teeth, they have less invested and may choose not to lighten the lower arch.

Why do you emphasize the need for dental supervision in all bleaching situations?

The most important service the dentist offers patients is the initial examination and diagnosis, which cannot be performed without the patient going to the dental office. Many times, people will go to the dentist to have their teeth bleached, and the dentist finds that they need endodontic therapy, which is why the tooth is dark. They may have internal resorption and need aggressive endodontic treatment, or Class 3 decay that is dark and needs restorative treatment. Also, they may have composite restorations that are dark and need replacing because

of secondary caries. Proper examination and diagnosis, including radiographs, are needed to rule out pathology that will require completely different treatment from bleaching.

The second service dentists offer is a custom-fitted tray. There can be a loss of efficacy if the bleaching material is not properly contained in the tray, and an increased risk of temporomandibular joint (TMJ) problems or occlusal problems, or even orthodontic movement of the teeth, with an ill-fitting tray. Dentists can also ensure quality of product by using an ADA-approved product, and by knowing the shelf life of the product. Some products bought OTC or by mail order may not have good quality standards, may have a

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low pH, or may have a short shelf life. The dentist can monitor any side effects and take immediate action to address them. And the dentist can take before-and-after photographs, which will demonstrate changes in color and properly document pre-existing conditions in the teeth, such as defects in the tooth surface or incisal edge that patients could incorrectly blame on the bleaching itself if preoperative photographs were not taken.

What are the components of a dental examination for bleaching?

The diagnosis should be based on an examination that includes a screening periapical radiograph of the anterior teeth, and periapical radiographs of any single dark teeth, if previous radiographs are not available. Pulp testing may be appropriate, especially for single dark teeth. The dentist would identify existing restorations in the esthetic zone and inform the patient that those restorations will not change color. This information would prepare them for the additional financial burden of replacing composites (Class 3, 4, and 5), veneers, or crowns if these restorations do not blend with the new tooth color after the bleaching treatment.

The dentist should also identify older amalgam restorations on teeth in the esthetic zone (often the lingual surfaces of maxillary incisors and the occlusal surfaces of premolars) that may need replacement before bleaching to avoid any greening or discoloration of the tooth around the restoration from the bleaching or from the resultant translucency of the tooth. With radiographs, the dentist should evaluate the teeth for any internal resorption or periapical radiolucencies that may require endodontic therapy, as well as caries or calcific metamorphosis, which may require additional restorative treatment or extended bleaching treatments.

The dentist should prescribe the estimated treatment time to achieve the desired result, as well as counsel the patient on their questions, expectations, and side effects. They would evaluate the patient's current level of sensitivity and develop plans for treatment of any sensitivity. They would then provide a custom-fitted tray and offer follow-up of the treatment, as well as touch-up options. The dentist should counsel the patient on reasonable expectations, and advise whether additional treatment will be required to meet the patient's esthetic demands.

How do you introduce bleaching to patients without offending them about the color of their teeth?

I suggest whitening anytime a restoration is planned. Otherwise, I ask patients whether they are happy with their smile, or wish they could change something about it. Also, if they inquire about toothpaste or OTC products, I may discuss bleaching. It is important to have brochures and pamphlets with information readily visible and available to the patient. Having a whitening question on the health history form is also beneficial.

Are there any contraindications for nightguard vital bleaching?

Contraindications to bleaching result primarily from preexisting conditions, such as crowns or extensive restorative dentistry, where the restorations are tooth-colored (eg, porcelains or composite restorations will not change color with bleaching). Bleaching will lighten the natural teeth, but if replacing existing restorations to match the bleached teeth is

a financial burden for the patient, this can be a contraindication to bleaching. I do not bleach teeth in pregnant women, although there is no scientific evidence that pregnancy is a contraindication. I simply do not want the woman to ever think bleaching caused a problem with her pregnancy. If a woman discovers she is pregnant during bleaching, I ask her to stop. Bleaching may also exacerbate gingivitis which she might develop during pregnancy. If patients cannot tolerate the taste of the product, they cannot bleach. Also, if patients do not like white teeth, that is a contraindication.

Overwhitening does not pose a physical problem, unless the solution being used has a low pH and causes damage to tooth structure. The esthetic danger is that the patient would not look natural. The suggestion that the teeth match the whites of the eyes is a good standard for patients to follow. However, if they want whiter teeth than that, it is their choice. Conversely, not everyone can achieve the whiteness they desire because teeth whiten to a certain level, and go no further regardless of extended treatment time.

Are there any areas that have a guarded prognosis?

Patients with existing tooth sensitivity, or who experience sensitivity during bleaching, to the degree that it becomes problematic, represent a contraindication. While severe tetracycline staining is not necessarily a contraindication, these cases are difficult to bleach, especially the dark grays and blues. If the discoloration is located in the gingival third, which is the most difficult part of the tooth to bleach, patients must be informed that the prognosis for such cases is guarded and to consider other options.

Elderly patients often present with gingival recession and roots that are yellow and evident to observers. The roots do not tend to whiten during bleaching, therefore the patient will be left with white teeth on the anatomical crown but yellow roots and they must be aware of this. This could limit bleaching in this group. Translucent teeth may become more translucent from bleaching, and appear darker, rather than lighter. Patients should be informed of that situation as a guarded prognosis. Placement of a lingual composite may alleviate the darkness if the occlusion allows a

restoration. Teeth that are gray could have a varied prognosis. If the gray is from tetracycline, it is difficult. If the gray is from a lingual amalgam, the amalgam should be replaced. Long-term bleaching can cause the tooth to become green around older amalgams, so replacement before bleaching is suggested. Extensive white spots have a guarded prognosis, because the dentist cannot predict how much the background will lighten. However, the white spots probably will not get worse from bleaching.

If patients have a history of TMD problems or bruxism, they should proceed with caution, and possibly use a daytime regimen.

How is carbamide peroxide different from hydrogen peroxide?

Hydrogen peroxide is very unstable. Like the hydrogen peroxide one buys at the drugstore in amber bottles, it foams and fizzes as soon as it contacts organic material. The original at-home bleaching products used a 10% solution of carbamide peroxide as the bleaching agent, which is basically 3% hydrogen peroxide and 7% urea. The urea in carbamide peroxide primarily acts as a stabilizer to give these products a longer shelf life, slower release of the hydrogen peroxide, and it has additional cariostatic benefits. Hydrogen peroxide penetrates the tooth more quickly than carbamide peroxide. The basic mechanism of action is the same, but the formulation affects shelf life and time required for penetration of the tooth.

What substance actually changes color in the tooth—the surface, the enamel, or the dentin?

Hydrogen and carbamide peroxide¹⁵ penetrate through the enamel, the dentin, and to the pulp in a matter of minutes.¹⁶ Bleaching is not a mere surface treatment of the tooth; it causes internal color changes. We are not simply removing stains that have occurred after formation of the tooth, but are changing the inherent color of the tooth.¹⁷ We typically think of bleaching as an oxidation process, but we do not know what gives a tooth its color, therefore, when we change the color we do not know exactly what we are changing. Bleaching does not appear to affect the tooth's hardness or structural integrity, but there is no real scientific evidence regarding what is being affected during the color change process.

What are the pros and cons of using different concentrations of bleaching material?

Higher concentrations of peroxide have a slightly faster rate of whitening, but also a possible higher incidence of sensitivity.³ The final color is the same. While the higher concentrations may reach the end point sooner, they also “overshoot” the color and have a greater relapse, and a longer time for the color to become stable. Another important consideration is having adequate scientific research to defend the use of higher concentrations in a lawsuit. At this time, the vast majority of research is on 10 % carbamide peroxide, and only 10% carbamide peroxide products have the ADA seal. Very little research exists on the higher concentrations, although some has been published recently.¹⁸

T*he patient must be willing to undertake the extended treatment time, recognizing that investing a reasonable amount of time and money is the only way to determine whether whitening will work.*

You often talk about extended treatment times. For what types of discolorations are these indicated?

There is a misconception that all teeth will whiten to their maximum in 2 weeks, or they will not respond at all. This error discourages private practitioners from treating stubborn discoloration that will respond well to whitening, but require a longer treatment time. The initial 1989 article on nightguard vital bleaching (at-home bleaching using a 10% carbamide peroxide in a custom-fitted tray) prescribed treatment times of 2 to 6 weeks as the expected time frame, and that still is the case. Average tooth discoloration will lighten in 2 weeks or less, but some discoloration requires more time. For these patients, 2 weeks is an unrealistic expectation, while 6 weeks may produce a great outcome.

This is especially true of stubborn stains, such as those from nicotine, which may require 1 to 3 months to eliminate. The most

difficult stains, such as those from tetracycline, generally require 2 to 6 months of nightly treatment to reduce or eliminate the discoloration. Patients with tetracycline discoloration should be willing to commit to a minimum of 2 months of nightly treatment to determine whether their teeth have a chance of success. However, once the teeth begin to change color, it is obvious to the patient and dentist that progress is being made. The goal is to bleach until they are white, regardless of the time frame.

Some dentists wonder how compliant a patient will be for 2 to 6 months of treatment. The answer lies in how the treatment is presented. Difficult discoloration treatment is like a weight-loss or exercise program. If the patient understands the benefits, and there is a reasonable cost-to-benefit ratio, with reasonable treatment instructions, then the conservative health-oriented person has no problem adjusting to a routine of wearing the tray for months. Long-term wear for whitening is no different than wearing a bruxism splint or an antisnoring device.

I find that long-term treatment is best rendered by wear of the loaded tray overnight. Compliance is better and the patient achieves the optimum benefit per application with nightly wear, which reduces cost.

Research has shown that while approximately 50% of the peroxide material is used in the first 1 to 2 hours, the remaining material is still releasing peroxide for another 2 to 6 hours. Therefore, if the patient removes the tray after only 2 hours of wear, he or she is discarding half of the active ingredient and lengthening the treatment time (as well as increasing cost).

Several factors should be considered when using extended treatment times for whitening tetracycline-stained teeth. First, the location of the stained area has a great impact on the prognosis for success. Teeth generally lighten from the incisal to the gingival area. The tooth also becomes progressively thicker from the incisal to gingiva with more discolored dentin and less enamel. Teeth that are heavily stained in the gingiva area, especially dark blue-gray discoloration, have the poorest prognosis for complete lightening. Conversely, the farther away from the CEJ the stain resides, the better the prognosis for lightening.

In any situation, there is no way to predict whether the patient will experience success. The patient must be willing to undertake the extended treatment time, recognizing that investing a reasonable amount of time and money is the only way to determine whether whitening will work. Patients must be prepared that they may not see results in the first few months, although each discoloration responds very differently.

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What is the long-term safety data on nightguard vital bleaching?

At this time, we have 10-year follow-up studies on patients who bleached their teeth for 2 to 6 weeks nightly,¹⁹ with no remaining sensitivity outside normal limits, no root canals needed, and no internal or external resorption. If it had not been noted in the charts, it would have not been obvious that their teeth were treated. Also, we have 7 1/2-year follow-up studies on those patients who bleached their teeth for 6 months nightly, again with the same positive outcome.²⁰

How do you address concerns about the safety of nightguard vital bleaching?

The reason that the 10% to 15% carbamide peroxide materials and other 1% to 3% hydrogen peroxide materials were considered reasonable treatment options for dentist-dispensed home bleaching is that these materials had already been evaluated and used extensively as an oral antiseptic and cleaner since the late 1960s.²¹ These oral antiseptics had been approved by the Federal Drug Administration (FDA) as generally recognized as safe for that use.^{22,23} The 10% carbamide peroxide materials have a long history of use in newborn infants for the treatment of thrush (10 drops directly on the tongue 10 minutes after each feeding). Treatment success averaged 4 days for the resolution of infection

(range of 2 to 7 days) compared with 2 to 8 weeks healing time when there was no intervention. Many other uses in teenagers and older adults have been reported, with no detrimental effects. Peroxides have always generated some concern because of the possible formation of free radicals and their potential for cellular changes. However, the World Health Organization, an international body that reviews chemicals and their potential for causing cancer, reviewed all existing literature up to 1985 and published a monogram, concluding that there was insufficient evidence that hydrogen peroxide caused cancer in animals or humans. Additionally, the mechanism of action of materials, when used in the oral environment, varies from laboratory studies because of the effect of salivary peroxidases, the instability of the different peroxide solutions, and the containment afforded by the prosthesis delivery system. More recent direct research on carbamide peroxide materials shows no carcinogenic initiation from peroxide, although some studies indicate peroxide does enhance the action of known carcinogens. This supports the recommendation that patients not smoke while bleaching their teeth. However, other more scientific studies with longer treatment times and larger populations of animals indicate no detrimental effects, tumor promotion, or initiation from long-term use of low concentrations of (3% hydrogen peroxide)²⁴; there may be no enhancement of the known carcinogens found in smoking. A large number of clinical trials in humans over the last 10 years have further demonstrated the safety of bleaching.

Do patients have to make a choice between porcelain veneers or bleaching?

Some dentists have been warned that they must make a choice between whitening or veneers. However, Haywood and Parker have shown that teeth covered by veneers can be whitened from the lingual to remove tetracycline staining and change the apparent color of the veneers by changing the tooth color.²⁵ Therefore, if there is any regression in whitening after esthetic translucent veneers are placed, the teeth can be relightened from the lingual.

Even if there is no dramatic change with whitening, the patient is confident that the most conservative avenues have been attempt-

ed first, and that porcelain veneers are the best option they now have for an esthetic smile. The minor cost of whitening, compared with the extensive cost of many veneers, makes whitening the first choice for virtually any discoloration.

What is the main side effect of bleaching, and how frequently does it occur?

A review of the double-blind, placebo clinical trials that have been conducted involving at-home bleaching will show that 55% to 75% of patients in the treatment group will experience some sensitivity, if only for one day. The interesting finding here is that the placebo groups have 30% to 35% sensitivity without using carbamide peroxide at all; and one study showed that 18% of a group wearing an empty tray had sensitivity. From these data, one can assume that sensitivity does not result only from the bleaching product, but from the manipulation of teeth. Anything that places forces on the teeth has the potential to cause sensitivity.

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Can you describe the different treatment options for sensitivity?

The clinician can treat sensitivity either passively or actively. With at-home bleaching, passive treatment involves adjusting the frequency of treatment (every day, or skip a day, etc) and duration of treatment (1 to 8 hours per day), and the concentration of carbamide peroxide. Often, simply stopping treatment for a few days will alleviate sensitivity when treatment resumes. Originally, the traditional way to treat sensitivity was with fluoride, or brushing with a desensitizing toothpaste. However, recent studies indicate that potassium nitrate and fluoride, placed in a bleaching tray, is an effective way to treat bleaching sensitivity.²⁶ This technique was originally used by Jerome to treat tooth sensitivity after periodontal surgery.²⁷ Just as hydrogen peroxide penetrates through the enamel and dentin and to the pulp, so does potassium nitrate. Fluoride acts

primarily as a tubular blocker, plugging the holes and slowing down the fluid flow that causes the sensitivity. Potassium nitrate acts more like an analgesic or anesthetic by keeping the nerve from repolarizing after it has depolarized in the pain cycle. Therefore, there are two mechanisms of action, one affecting fluid flow, and the other a direct effect on the nerve.

Several companies provide 3% to 5% potassium nitrate in a syringe for application in the bleaching tray as needed. Or, one can take a desensitizing toothpaste that contains 5% potassium nitrate, which is the maximum approved by the FDA, place it in the tray and apply it in this fashion for 10 to 30 minutes. Some patients may have a gingival reaction to the ingredient sodium lauryl sulfate in the toothpaste (not to the potassium nitrate) and get a tissue burn; therefore, the clinician may have to experiment with various OTC formulations for certain patients.

For patients with chronic sensitivity unrelated to bleaching, the toothpaste gives them an OTC product that they can use whenever they need it, even before a prophylaxis.²⁸ The syringe materials that must be purchased from the companies may be more appropriate for episodic sensitivity associated with the bleaching itself. More recently, companies have found ways to incorporate potassium nitrate into the bleaching gel.²⁹ This apparently does not hinder the bleaching, and can reduce side effects, including those from mechanical irritation.

Are children or adolescents candidates for bleaching?

There are some indications for bleaching children's teeth, mostly in the mixed dentition stage. These include children born with yellow teeth, and children who have brown or white spots lesions, usually associated with fluorosis. Also, the single dark tooth, which may or may not have had endodontic therapy, as well as tetracycline-stained teeth, may appear in this age group. Probably for children, the nonscalloped tray design is desirable, because this provides a better seal to retain the material in the tray.

Primary teeth are not generally considered for bleaching, because they typically are very white (hence the term *milk teeth*). However, trauma to the anterior primary tooth between eruption and exfoliation can result in a dark-

ening of the teeth and an esthetic compromise for the young child. Treatments to date have included composite crowns or bonding to cover the brown discoloration, or pulpectomy therapy and internal bleaching or composite restorations to lighten the teeth. These techniques require a high level of patient compliance and dental skill; they also incur a significant fee. The esthetic outcome does not always warrant the time, patient management issues, and expense, especially because the life of the tooth is limited.

Bleaching with carbamide peroxide in a nonscalloped, no-reservoir custom-fitted tray is another option for altering the color of discolored primary teeth associated with trauma. In one report,³⁰ the parent of a 4-year-old patient initially applied a small amount of the bleaching material on the child for 1 hour per day for 2 weeks. Some improvement was noted, but not complete lightening. The patient had experienced no sensitivity, and compliance was excellent. With no contraindications for continued treatment, the parent then applied the bleaching solution in the tray overnight every third night for 2 more weeks. Total wear time was approximately 47 hours.

At the 3-month recall appointment, the teeth had lost most of their discoloration and were very pleasing to the patient and the parents. The teeth were exfoliated at their normal time, approximately 2 years later, with no further complications. The parents reported there was some slight darkening just before to exfoliation, but it did not seem to be noticeable to the child. When the permanent teeth erupted, there was no apparent damage to the permanent teeth.

How do you treat the single dark tooth that is either still vital, or has no apparent signs and symptoms of being abscessed?

A single dark tooth, which may or may not still be vital, usually results from trauma. The brown discoloration of the tooth is a result of the iron pigments in the blood which have been aspirated into the dentinal tubules. This single brown discolored tooth is responsive to nightguard vital bleaching, and should be considered the first and best treatment of choice. The patient should not have any symptoms,

nor should the periapical radiograph indicate any periapical pathology. The dentist may either try changing only the one tooth, or may involve all the teeth in the arch.

If only one dark tooth is to be treated, the tray is fabricated, and the tray material covering the teeth on either side of the dark one is removed. Then the bleaching material is placed only on the dark tooth. Treatment is continued until that tooth blends in with the color of the untreated teeth.

If the other teeth, in addition to the single dark tooth, are somewhat yellow and need bleaching, or if the remaining teeth are already very white and not expected to lighten any further, then the typical bleaching tray is fabricated. During the typical bleaching process, all

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teeth achieve a certain level of whiteness, and then they do not change any further. The final level of whiteness varies from patient to patient, and cannot be predicted. However, when one tooth is darker, treatment can be continued on that tooth after the other teeth are no longer changing color. The dark tooth will eventually match the other teeth, or be very close. When the other teeth are already very white, the patient merely places the bleaching material in the space for the dark tooth only. Marking that tooth in the tray with an indelible marker is helpful.

What technique do you use for bleaching endodontically treated teeth that are discolored?

This single dark tooth bleaching approach can also be used for the patient who has received endodontic therapy and has a composite restoration that has been placed in the access opening. If the tooth subsequently has turned dark, external bleaching with a low concentration of peroxide avoids removing the acid-etched restoration or endangering the tooth by bleaching with 35% hydrogen perox-

ide. Internal or cervical resorption is a concern for nonvital teeth that have had trauma and been bleached with 35% hydrogen peroxide, especially if heat is used.

If endodontic therapy has been completed, but the restoration has not been placed, then internal bleaching with 10% carbamide peroxide is both safe and efficacious. The tooth is prepared in the same manner as conventional “walking bleach” technique. The “walking

This single dark tooth bleaching approach can also be used for the patient who has received endodontic therapy and has a composite restoration that has been placed in the access opening.

bleach” technique is so named because the bleaching occurs while the patient is “walking away” from the office. The technique is as follows: The restoration is removed from the endodontic access preparation, and pulpal remnants are removed from the pulp chamber. A light-cured glass ionomer is used to seal the root canal orifice. The glass ionomer is placed over the canal entrance at the level of the CEJ in a thickness of about 0.5 mm and light-cured. A small amount of 10% carbamide peroxide is injected into the pulp chamber. A cotton pellet is placed over the material, and the orifice is closed with a provisional material. This can be changed every 2 to 3 weeks until the color change has been achieved. At the final recall visit, when the bleaching result is satisfactory, the endodontic access is sealed with a provisional material but without bleaching material in the chamber for 2 weeks before the placement of a definitive composite restoration. This 2-week delay is necessary to ensure an adequate bond between the composite restoration and the tooth structure and to allow the shade to stabilize before choosing the color of composite. Before the incremental placement of the composite, the pulp chamber and margins are etched with 37% phosphoric acid. The preparation is then rinsed and lightly dried to remove standing water before the placement of the bonding adhesive system and the composite restoration according to manufacturer’s rec-

ommendations. Final color matching can be achieved by using a either lighter or darker opaque composite material in the pulp chamber to make minor color adjustments.

An unusual option that may work for the special patient is the “inside-outside bleaching” of an endodontically treated, single dark tooth.^{31,32} At the first treatment appointment a maxillary alginate impression is made and a traditional nightguard-bleaching tray is fabricated. While the nonscalloped tray is being fabricated, the endodontically treated tooth is prepared in the same manner as conventional walking bleach technique, except that there will be no closure of the pulp chamber during treatment. The patient is instructed in the use of 10% carbamide peroxide as the bleaching agent via the “inside-outside technique.” The patient injects a small amount of 10% carbamide peroxide into the pulp chamber of the tooth for the “inside bleaching.” The 10% carbamide peroxide for the “outside bleaching” is placed into the nightguard so that it will contact the external surface. The patient is instructed to wear the nightguard during sleep. Each morning, the chamber is irrigated with water from a plastic syringe and a cotton pellet or orthodontic wax is placed in the chamber to prevent food entrapment during the day. While in the office, the patient rehearses the placement of the 10% carbamide peroxide as well as the insertion and removal of the cotton pellet or wax. The pellet is manipulated with a toothpick. Before dismissal, the patient is instructed to monitor the daily progress of the whitening process and to stop treatment if the tooth matches the adjacent teeth. If no match is achieved, the patient is to note when a stable color level is achieved (no further color change for several days) and return in 1 month. Closure is the same as an internally bleached tooth.

What design of custom trays have you found to be most effective?

The design is related to the type of material being used, the type of discoloration being treated, and the specific patient being served. Bleaching trays can be designed with or without facial or lingual scalloping, and with or without reservoirs. Materials that are more viscous and sticky work best in reservoir trays to allow complete seating of the tray. However, neither reservoirs nor foam inserts are neces-

sary for bleaching.³³ Also, scalloping (trimming the tray to approximate the free gingival margins) allows the dentist to eliminate most soft tissue contact, which may avoid tissue irritation.³⁴ Conversely, bleaching material is more likely to leak from a scalloped tray, and the tray may irritate the tongue and lips.³⁵ On the other hand, more viscous gels stay in the scalloped tray more readily.

When the discoloration is located at the gingival area, I use nonscalloped tray designs to ensure proper application of the material to the discolored site. If a more fluid bleaching material is used, a nonscalloped, no-reservoir tray design retains the material in the tray better with more patient comfort. If tissue irritation occurs, the tray can then be scalloped. The original trays for bleaching did not have reservoirs and were not scalloped. Part of the gingival irritation came from the rigidity of the tray material used, and part was caused by the chemical nature of the material that came into contact with the soft tissue.

With the newer more flexible tray materials, there is less potential for gingival irritation. Sticky bleaching materials adhere to gingival tissues more easily, and can cause contact irritation. More water-soluble materials do not seem to cause this problem. I generally use a nonscalloped, no-reservoir tray design, because bleaching is achieved with a minimal amount of material. If the patient is concerned about soft tissue contact because of the free radicals in peroxide, or I am concerned about irritation because the tissue is thin and frail and the patient is delicate, then I will scallop the tray. If I plan to scallop the tray, I will use reservoirs to help in those areas. If tissue undercuts or frail tissue is a concern, I will often place reservoirs and scallop only the six anterior teeth.

I have heard that reservoirs are not necessary for bleaching. What is your opinion?

Reservoirs are a patented design feature³⁶ that allow the complete seating of a tray containing a thick sticky viscous bleaching material.³⁷ Reservoirs also avoid the pinching effect of the tray by eliminating contact on one side, which reduces the chance for tooth sensitivity.³⁸ Conversely, clinical research has shown that foam inserts (a type of reservoir) are not necessary for bleaching, nor are reservoirs.³³ In clinical

trials, half the arch was treated with foam or a reservoir design tray, and the other half without any spacer. There was no clinical difference in the rate of whitening between the sides.⁶ Hence, reservoirs are not needed for efficacy of bleaching, but may influence success in other ways.

There is some evidence that the reservoirs may prolong the active effect of the peroxide in the thick sticky materials. In a recent in vivo study of the peroxide activity of several bleaching products including Opalescence^{®c} without reservoirs, there was only minimal material present after 4 hours³⁹; however, in another similar in vivo study using Opalescence^{®c} with reservoirs, there was active material remaining in the tray even after 10 hours.⁴⁰ Although there are differences in measuring techniques in these studies, it seems about half of the peroxide is released in the first 1 to 2 hours, depending on the amount of carbopol or other thickener in the product.

The remaining peroxide can continue to be released for several hours later in certain products. Many products may contain the same concentration of carbamide peroxide, which is only 10% carbamide peroxide in ADA approved products. However, the vehicle (glycerine, glycol, dentifrice, etc), the thickener (carbopol, polyx, etc), the viscosity, the pH, the soft tissue or restoration response, the solubility, the flavoring or other ingredients, and physical characteristics play a role in determining the best tray design for the given product with a specific patient.

With all of the new OTC products for bleaching, how can the dentist be cost-competitive with the tray system?

New innovations to tray fabrication continue to make the treatment more affordable. There are at least two tray fabrication systems that do not require an alginate impression, but still provide the dentist and the patient with the advantages of a custom-fitted tray. One directly formed thermoplastic tray (Day Tray System^d) consists of a disposable outer tray holder, which is used to carry a white rigid inner treatment tray to the mouth when softened for adaptation.⁴¹ More recently, a single "boil and form" tray (EZNow^c) uses a newer thin clear material similar to the indirectly fabricated custom tray to form the tray directly in the mouth.

^cUltradent Products Inc, South Jordan UT 84095; (800) 552-5512

^dArchTek, Inc, Golden, CO; (800) 356-9026

The immediate thermoplastic tray system provides a number of advantages. First there is no need for an alginate impression. This benefits both the patient and dentist. The patient does not have to deal with an unpleasant procedure, especially if they are a “gagger,” and the dentist saves valuable chair time and laboratory expenses. Generally, the thermoplastic tray can be fabricated in approximately the time it takes to make a quality alginate impression. Another advantage is that the patient can begin bleaching the same day as the diagnosis appointment.

There are some limitations to both of these tray systems. Patients with unusual arch sizes or shapes, or patients with limited access opening are not good candidates for these tray systems. The mandibular arch is also more difficult to fit, because of the tongue and access for molding. Additionally, patients who wish to wear the tray during the day may not accept the white color of the Arch Tek^d tray, because of its visibility. Neither of the trays may cover all the posterior dentition in all patients.

There are several indications for this immediate tray system in addition to the typical at-home bleaching patient. For patients who bleached their teeth with a conventional bleaching tray, either of these thermoplastic tray systems can be used as a touch-up option when postbleaching restorative work renders the original trays unusable. Also, these tray systems are indicated for young patients in the mixed dentition stage, for whom a more conventional tray is short-lived because of the changing nature of their dentition. In the highly motivated patient, a direct thermoplastic tray can be used to initiate bleaching while a conventional custom tray is being fabricated. In addition to its use as a bleaching tray, the more rigid white tray system could provide an immediate TMD splint, or the soft EZNow tray could serve as a carrier for various medicaments in the treatment for tooth sensitivity or caries.

While neither of these systems is as ideal as the custom-fitted tray made from an alginate impression, they do provide options that allow the dentist to offer whitening at a reduce fee.

^dArchTek, Inc, Golden, CO; (800) 356-9026

Can you provide some tips about bleaching and bonding?

One clinical problem encountered when shaping the large composite addition is that the operatory light will cause the material to set prematurely.⁴³ If the operatory light is not used, the clinician has difficulty in viewing the lingual contours or line angles. When the correct shade has been chosen, a solution to that problem is to have the dental assistant hold the orange composite curing shield over the operating field while still using the operatory light.⁴³ The shield is held such that the dentist is not looking through the shield, but the light is shining through the shield. The operating field is bathed in an orange glow, but visibility is good. This approach provides almost unlimited working time and adequate visibility. Companies now supply shades for bleached teeth. The dentist should have a range of opaque and translucent shades lighter than B1 to complete the bleaching and bonding situation.

Do you ever replace restorations before you bleach, or do you wait until the color is stable afterwards to replace restorations?

Any amalgams in the esthetic zone should be considered for removal before bleaching. This avoids the show-through of metal if the tooth becomes more translucent during bleaching. More importantly, this removal can eliminate the possibility for the greening of tooth structure around the amalgam and the resultant esthetic discoloration dilemma.⁴⁴

Will one in-office treatment be the same benefit as at-home tray bleaching?

I have not found this to be the case. In a recent International Association for Dental Research (IADR) abstract presentation on in-office treatment, the dentist cited the average number of in-office treatments to “make the patients happy” was three.⁴⁵ The light may not alter the final outcome, and may give only an illusion of whitening because of dehydration.⁴⁶

In-office whitening should be considered only if patients have been fully informed of all their whitening options, has the financial ability to continue treatment for more than one visit if needed, wants the process to go as speedily as possible, does not have sen-

sitive teeth, does not want the back teeth to be as light, does not want to do any treatment at home, and is willing to pay for additional touch-up treatments at full fee should relapse occur. However, if fully informed patients desire the dental office to administer all the bleaching treatment rather than them have any responsibility or tasks to perform, then in-office bleaching is certainly their choice.

Most in-office product manufacturers measure the extent of whiteness immediately after removal of the rubber dam or the protective barrier. If you place a rubber dam on a patient for an hour, you can achieve up to 12 shade changes just from dehydration alone.⁴⁷ That shade change is with no peroxide, merely isolation. After the rubber dam is removed, the saliva re-moistens the teeth and within days, the teeth return to their original color. To conduct a true in-office bleaching effectiveness study, color measurements need to be taken 3 or more days after removal of the rubber dam to see the actual color difference. Aside from dehydration, you do get some whitening from in-office bleaching, because of the peroxide used, but not necessarily the maximum for the patient.⁴⁸

Are there any ADA codes for bleaching, even though it is usually not covered by insurance?

Originally there was one code, 3960, which initially was indicated for bleaching of endodontically-treated teeth internally, but was later used for all bleaching procedures. Recently the ADA expanded the codes to the following:

- 9972 external bleaching/arch
- 9973 external bleaching/tooth
- 9974 internal bleaching/tooth

Can you describe some of the ethical problems you encounter with whitening?

One problem dentistry may create for itself is charging too much for bleaching in an attempt to make a lot of money on a few patients. The national average in 2000 for bleaching was \$196 per arch. Another problem is presenting the patient with the idea that one in-office bleaching treatment will yield the same results as a complete at-home

tray-bleaching treatment. The dentist cannot make the claim that a single in-office bleaching is the best option and offer only that to the patient. In-office treatment incurs a greater cost to the patient, and generally takes three visits to reach the maximum whiteness.

The proper course for the dentist after the examination is to present the various options and expectations for those options, from toothpaste, OTC products, to at-home tray, to in-office, along with the fees for those provided by the dental office and the dentist's recommendation(s). Then the patient can choose the most suitable option.

Some patients would rather have the dentist "do it all" in the office, regardless of cost and number of visits; for others, this is not desirable or financially possible.

Some patients need extended treatment for difficult staining, or have other problems that require special attention (occlusion, sensitivity). Some patients want just a little whitening, and going through either of the other dental options may not be warranted. The dentist can suggest the most appropriate treatments, based on the best risk-benefit, and cost-benefit ratios for the patient's situation.

Conclusion

There are a number of methods for teeth whitening. The dentist should always examine the patient to diagnosis the cause of discoloration, then recommend the best whitening treatment option(s). Bleaching teeth with 10% carbamide peroxide in a custom-fitted tray has proven to be the safest, most cost-efficient whitening option for a large variety of tooth discoloration conditions. Bleaching has become a good starting point for other types of dental treatment that patients need, but cannot visualize. The dentist is the best person to advise patients of their whitening potential, as well as of other options for improving their smile.

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