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Learning Objectives:

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

- describe the process of nightguard vital bleaching.
- list the indications and contraindications of at-home whitening.
- discuss the treatment of side effects such as tooth sensitivity during whitening.
- discuss when and how to present tooth whitening to patients.

Current Status of Nightguard Vital Bleaching

Abstract: Indications for using a 10% carbamide peroxide material in a custom-fitted tray to whiten teeth include teeth discolored from aging, chromogenic foods and drinks, and smoking, and also brown fluorosis-stained teeth, single dark teeth, and tetracycline-stained teeth. Tetracycline-stains may require 2 to 6 months of nightly treatment, whereas other discolorations generally resolve in 2 to 6 weeks. After an initial relapse in the first 2 weeks after the end of treatment, color tends to be stable for 1 to 3 years, with some treatments being permanent. The ADA has approved only six 10% carbamide peroxide materials, which have extensive research and publications on safety and efficacy. Considering the average cost of \$196 per arch, and the noninvasive nature of this treatment, nightguard vital bleaching is probably the safest, most cost-effective, patient-pleasing method to improve the appearance of a smile. However, it should be supervised by a dentist for the proper examination, diagnosis of the cause of discoloration, treatment options, and fabrication and fitting of the carrier. Sensitivity during whitening may be treated with fluoride and potassium nitrate.

ightguard vital bleaching (NGVB) was first introduced in 1989.¹ It originally involved the application of 10% carbamide peroxide in a thin custom-fitted tray. The patient wore the tray overnight or for several hours during the day for 2 to 6 weeks (Figures 1A and 1B). A decade of research and clinical experience has added credibility to the technique and broadened its scope.

Treatment Expectations

For maximum benefit of NGVB per application and compliance for longterm treatment, the whitening tray should be worn at night. However, a minimum of 2 to 4 hours daily is the second option because the material is active for 4 to 10 hours.² Less than 2 hours wastes product and may extend treatment. The length of treatment varies from patient to patient. The average is 2 to 6 weeks, although it could be shorter. Nine out of ten patients achieve successful lightening. Typically, the teeth lighten to a certain shade and then plateau. There is an initial color relapse upon completion because the residual peroxide in the tooth changes the optical qualities. Dentists should wait 2 weeks on color stability for any restorative work and for bond strengths to achieve their maximum strength before attempting bonded composite restoration.³

The duration of color stability without retreatment is generally 1 to 3 years, although it could be permanent. When evaluating the efficacy of NGVB after 6 weeks of treatment, discoloration caused by aging, smoking, inherent staining, brown spots, or single dark teeth were successfully removed in 97% of the situations.⁴ At a follow-up of 13 to 25 months (average 18 months), 74% of the patients had no noticeable change without retreatment. At 31 to 42 months (average 38.5 months), 62% reported no noticeable change without retreatment. And at 75 to 89 months (average 82 months), 35% reported no noticeable change from the time of treatment.

Product Safety

Although there were initial concerns about safety and efficacy, the guidelines established by the American Dental Association (ADA) have set the stan-



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Figure 1A—Preoperative view demonstrating yellow inherit staining from birth.

dard for product safety.⁵ Currently, the ADA has approved six 10% carbamide peroxide products: Rembrandt[®] Classic^a, Opalescence^{®,b}, Nite White® Classic^c, Platinum and Platinum Overnight^d, and Patterson Toothwhitening gel^e. These products have had extensive research and clinical trials, and can be defended as safe. Manufacturers of these products cannot make claims that are not supported by scientific research or the products will lose the ADA seal. On the other hand, companies that do not have the seal can make any claim about their product, some of which may be untrue. When these claims are presented by companies who do not have the seal, there is no guarantee of their truth, or any way to challenge the company because the ADA seal is a voluntary program.

As a result of some false or misleading claims, I have limited my use and research to products with the ADA seal. With these products, there is a large body of literature supporting their safety and efficacy, and ADA sanction for the public and dentists' protection. However, companies that have the ADA seal on their 10% carbamide peroxide product may manufacture other products of higher concentrations or even the same concentration but different composition that are not included by the ADA seal. The dentist cannot assume that all concerns have been addressed in the other products until research is published.

Product Composition

Variations exist among carbamide peroxide products,⁶ including the concentration of the material, which can vary from below 10% up to 35%. A 10% solution of carbamide peroxide is roughly 3% hydrogen peroxide and 7% urea. The base vehicle may be a glycerin, an anhydrous glycerin, a type of glycol, or even a



Figure 1B—Six weeks of 10% carbamide peroxide on the maxillary arch shows a dramatic change in color.

dentifrice. There are also different thickeners. Release time of the peroxide can be slow over a long period, quick initially but prolonged over a long time, or quick with no long-term release. Viscosity varies from a thick gel, to honey-like, to a toothpaste-like cream. The tray design varies with the material and the patient. Soft-tissue response may vary among products because of the stickiness and the water solubility of the product. Retention in the trav may be altered by the water solubility of the product, influencing tray design. Delivery systems vary from tubes to syringes to bottles. There are mild effects on restorative materials, but no color change will occur. The color of the whitening material can vary from clear to white, and different flavors are available.

Laboratory and Clinical Safety

Laboratory research, generally associated with ADA-approved products, has shown the surface changes within normal variation for neutral pH solutions.7 Ten percent carbamide peroxide does not etch like phosphoric acid, although products with a low pH or high concentration may affect the enamel surface. The hardness of enamel is not affected by 10% carbamide peroxide at neutral pH, nor is subsurface hardness affected in the dentinoenamel junction.8 Minor effects on teeth are consistent with other normally occurring events. For example, the amount of calcium loss from whitening (in vitro) for 6 hours is the same as the amount from contact with a soft drink for 2.5 minutes, which is the approximate time it takes to drink a 16-ounce soft drink.⁹

There is a long history of other uses of 10% carbamide peroxide.¹⁰ The most notable is treating thrush with 10 drops of carbamide peroxide on the tongue of a new-born infant at every feeding for 7 days,¹¹ which demonstrates the safety from ingestion. It is also noteworthy that the body makes hydrogen peroxide and has internal mechanisms for handling it.

^aDen-Mat, Santa Maria, CA 93456 ^bUltradent Products Inc, South Jordan, UT 84095 ^cDiscus Dental, Culver City, CA 90232 ^dColgate Oral Pharmaceuticals, Canton, MA 02021 ^ePatterson Dental, St. Paul, MN 55120



Figure 2A—White areas on teeth are highlighted by natural yellow color of the teeth.

Important to understanding case selection options and efficacy is that 10% carbamide peroxide easily and rapidly penetrates enamel and dentin,¹² allowing whitening under restorations such as veneers and composites. Different concentrations of solutions eventually yield the same color change, just at different treatment times.¹³ A significant color change occurs in dentin, in addition to what occurs in enamel.¹⁴ The change in dentin color explains that we are not only removing discoloration from extrinsic and intrinsic stains, but also changing the tooth's baseline color.

Dentist Supervision

This relatively safe procedure requires dentist supervision. First, the dentist must conduct a complete examination to determine if the patient is a good candidate.¹⁵ The examination should include medical and dental health, including the soft-tissue, temporomandibular joint, and occlusal status; the history of the discoloration; and a diagnosis for the existing color. A prophylaxis may be needed to eliminate extrinsic stains. The diagnosis must eliminate abscessed teeth, existing caries, internal or external resorption, stained or metallic restorations, and translucency of the teeth.¹⁶ This diagnosis may require radiographs to determine the existence of periapical pathology, pulp size discrepancies, resorption or other pathological problems, as well as pulp testing.¹⁷ The examination should also identify all restorations visible in the patient's smile that may not match after whitening.¹⁸ Patients must be financially and mentally ready to replace restorations that do not match the final outcome, which is often a contraindication for whitening.

After proper examination and diagnosis of the discoloration, the dentist can advise the patient of the options for whitening, the expected treatment time, costs, and side effects. The dentist can then determine the best tray



Figure 2B—After bleaching with 10% carbamide peroxide, the white is still present but less noticeable.

design and material for the patient, depending on the patient's concerns and history, as well as tissue and bony architecture. The importance of a custom-fitted tray cannot be over-emphasized; it impacts patient comfort, reduces side effects, and maximizes efficacy. The dental office has the best available materials for the tray material and the whitening material.

During insertion of the custom-fitted tray, the dentist ensures there is no irritation to the tissue and that the change in occlusion can be satisfactorily tolerated or adjusted accordingly. Finally, follow-up care for questions and treatment of side effects ensures the patient can have a successful outcome. In addition, dentist supervision is important because normal dental problems may arise during treatment.

Indications and Limitations of Whitening

Indications for whitening include teeth discolored by aging, ingestion of chromogenic foods and drinks, smoking, or being born with discolored teeth. The single dark tooth, whether vital or nonvital, is a good candidate for whitening, as are some brown fluorosis-stained teeth. Tetracycline-stained teeth can have a favorable prognosis, depending on the location and color of the stain. White spots cannot be removed, but whitening the rest of the tooth may make them less noticeable (Figures 2A and 2B). Brown stains can be eliminated about 80% of the time. Otherwise, some form of abrasion technique with possible composite bonding is appropriate.^{19,20}

The restrictions or limitations for bleaching are few. Generally, the age of the patient can be as young as 10 years, when the permanent teeth have erupted. There are no reported cases involving primary teeth because they are generally very white. However, we have had success with primary teeth that were darkened from trauma (Dr. David Brantley, personal communication). There is no upper limit for

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age, but older patients must accept that root surfaces remain darker when whitening. The only real restrictions to whitening are the number of existing restorations that may need replacement, the severity of tooth sensitivity, problems with taste, or lack of compliance. Whitening is not offered to pregnant or nursing mothers as a precaution, although there are no known adverse effects.

The guidelines established by the ADA have set the standard for product safety.

Side Effects During Whitening

The most prevalent side effects are tooth sensitivity and gingival irritation.²¹ Tooth sensitivity is most often cited, and can be chemical (reversible pulpitis) or mechanical (tray pressure). Generally, two out of three patients experience some sensitivity, which is mainly sporadic.⁴ There are no predictors for who will experience sensitivity. It usually depends on inherent patient sensitivity (as determined from the preoperative examination and history) and the frequency of application (more than once per day increases sensitivity).²² Sensitivity has not correlated with age, gender, exposed dentin or cementum, cracks, pulp size, allergies, decay, or other patient factors. Contributors to sensitivity include rigid tray material, soft-tissue contact, the base vehicle, viscosity, flavors, or patient habits. Gingival irritation, which is the lesser of the two side effects, is primarily mechanical (tray fit) or secondarily chemical (tissue irritation). The average duration on either side effect is 1 to 4 days, but not necessarily consecutive days. All side effects cease when treatment is terminated, with no reoccurrence or additional side effects.

Treatment of Tooth Sensitivity

Tooth sensitivity can be treated passively or actively. The passive approach includes reducing the time the tray is worn or frequency of application, temporarily interrupting treatment, or ultimately ceasing treatment. The active approach involves the application of two materials using the tray: a fluoride (neutral) or a 3% to 5% potassium nitrate.

The secret to treating sensitivity is the use of tray delivery for the desensitizing materials.

The tray material should be soft so it does not introduce orthodontic forces, and the design may or may not extend onto soft tissue. Fluoride has traditionally been applied as a tubular blocker and can have good results when used alone. However, potassium nitrate has been used extensively in desensitizing toothpaste.²³ Potassium nitrate penetrates the tooth and has a calming effect on the nerve.²⁴ The tray delivery of potassium nitrate is most effective.²⁵ Three commercial products contain both fluoride and 3% to 5% potassium nitrate: UltraEZ^{TM,b}, Desensitize!^a, and Relief^{TM,c}. In addition, several brands of toothpaste, such as varieties of Sensodyne^{®,f}, Crest[®] six Desensitize^g, and Colgate[®] Sensitive^d contain potassium nitrate. Although the toothpaste may be more cost effective for patients in the long-term treatment of sensitivity, some ingredients may irritate gingival tissues, requiring a switch to commercially available products.

The treatment protocol for potassium nitrate is to apply the material in the tray for 10 to 30 minutes before or after whitening. Some patients may only need to apply the potassium nitrate when sensitivity occurs because some sensitivity may not occur until 8 hours after cessation of treatment. Also, potassium nitrate can be used on alternate nights from the whitening material. The success rate of allowing patients to continue treatment after using potassium nitrate in the tray has been 90%+.²⁶

Although many whitening companies may claim to have eliminated or reduced sensitivity, there are no published reports to substantiate this claim. In the general sensitivity reports from clinical trials, the treatment group experienced 55% to 75% sensitivity, the placebo group had 20% to 30% sensitivity, and a group wearing the tray alone had 15% to 20% sensitivity.²⁷ Percentages vary by tray design and material, treatment time, and the manner in which questions were presented to participants.

Tray Design Options

Tray design options include reservoirs or spacers on teeth and scalloping the edge to conform to the tooth-gingival interface. Reservoirs are not needed to whiten teeth, but they may reduce sensitivity because they are not tight fitting. Reservoirs are most often needed with sticky materials to allow complete seating

^f Block Drug Company, Jersey City, NJ 07302

^g Procter & Gamble Co, Cincinnati, OH 45202



Figure 3A—A mild form of tetracycline-stained teeth, the color of which depends on the brand of tetracycline ingested.

of the tray. However, reservoirs may not be indicated on the mandibular teeth because of occlusal interferences from vertical overlap.

The scalloped design, which may include the entire tray or only portions of the tray, prevents the tray from contacting gingival tissue and causing irritation. This design is best with sticky viscous materials, but not with watersoluble materials. Nonscalloped trays eliminate tongue and lip irritation and maintain material in the tray better than the scalloped design. When treating the mandibular arch, the nonscalloped design is often preferred because of the mobile tongue, salivary gland location, and the tendency for the material to drain from the inverted tray. Another tray, for patients with temporomandibular disorder, is designed so that it does not extend onto the occlusal surfaces.²⁸ This design can be used only with sticky viscous materials.

Treatment for Tetracycline-Stained Teeth

After learning that some nicotine stains require 3 months of whitening, there have been several clinical trials and reports on whitening times beyond 2 to 6 weeks.^{29,30,31} When whitening tetracycline-stained teeth, patients should commit to a minimum of 2 to 6 months of treatment (Figures 3A, 3B, 4A, and 4B). When discoloration is located at the neck of the tooth, the prognosis is poorest; when it is dark gray or blue, the prognosis also is poor. However, all patients who have tried this extended treatment have seen some lightening. Those who were not successful were candidates for veneers, but now the veneers could be placed on a lighter tooth. Of those who were successful, 84% have maintained the color change for 4.5 years with no interim treatment.³²

Although physicians are aware of the staining potential of tetracycline drugs during tooth formation, tetracycline is indicated for such diseases as Rocky Mountain Spotted Fever and cystic fibrosis. However, fully



Figure 3B—After 3 months of whitening with 10% carbamide peroxide, there is a noticeable change in the maxillary arch.

formed teeth in adults may be stained from taking the tetracycline Minocycline for acne.³³ This discoloration can be caused from deposition of tetracycline in the secondary dentin as well as from soaking in saliva.

Presenting Whitening to Patients

Whitening can be offered as a stand-alone treatment, but it must be done tactfully. Try questions such as, "Are you happy with your smile?" or "Is there anything you would like to change about your smile?" If the dentist or patient is uncertain whether bleaching would improve the patient's appearance, compare the sclera (whites) of the patient's eyes to his or her tooth color. Beauty consultants state that for a natural appearance, the teeth should be as light or lighter than the whites of the eyes. Whitening should be presented before any restorative treatment, and patients must be informed of the options. If they decide against whitening, their chart should document that. After restorative treatment, there are options to whiten darker teeth to match lighter restorative materials, but this treatment must be performed carefully to achieve a proper shade match.

The secret for effectiveness in treating sensitivity is the use of tray delivery for the desensitizing materials.

Some practitioners feel that they have to choose between whitening and veneers. They fear that if the teeth are whitened and veneers are placed on those teeth, then the color might regress, making the veneers unsuccessful. However, a recent report demonstrates that teeth can be whitened from the lingual, which should allay those fears.³⁴ It is always best to attempt whitening before veneers, either to eliminate the need for veneers or to obtain a lighter tooth on which to place the veneers.



Figure 4A—A moderate form of tetracycline staining, along with an endodontically treated left central incisor restored with a Class 4 composite restoration.

There are many reasons patients whiten teeth: to look younger, to look healthier, to smile more, to feel better about themselves, to have better oral hygiene, and to be generally better looking. Reasons given for not whitening teeth include: to look distinguished, safety concerns, because of extensive restorations that would require replacement, or poor selfconcept. This procedure is elective, and it cannot be assumed that everyone wants it.

Fees and Other Treatment Options

Fees are primarily related to the amount of chairtime required and office overhead. Total treatment time is an average of 3 appointments, or 1.5 to 2 hours of chairtime. The cost to the patient should be less than that for 1 porcelain veneer. In 1999, the national average fee per arch was \$196, although fees vary across the country.³⁵

For patients being treated for tetracyclinestained teeth, most changes occur after the first 2 months of treatment, but to be fair to both the dentist and the patient, the fee is not predetermined because the treatment time could be as long as 6 months.³⁶ Patients pay an initial fee for the first month's treatment, which is generally the normal one-arch fee and uses all the material in a standard whitening kit. Afterward, patients are seen on monthly recalls to determine progress and amount of material used, and they are assessed a monthly fee for the examination and additional material required for another month's treatment. In this way, patients can pay as they go, and continue as long as they see results.

Single-Arch Treatment

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During the whitening research trials I have conducted, many patients elect not to whiten their lower arch, even when there is no fee. For that reason, I recommend all offices have a single-arch treatment fee. Allowing the patient to



Figure 4B—Twelve months of whitening with 10% carbamide peroxide nightly, followed by replacement of the composite in the endodontically treated tooth yields a satisfactory result.

experience whitening without a commitment to the higher fee of both arches may reach a wider number of patients. Also, single-arch treatment allows comparison between arches for encouragement and compliance. There is also less chance for side effects because fewer teeth and tissue are covered and there is less impact on the occlusion.

In-Office Whitening

While in-office whitening using 35% hydrogen peroxide is still an option, it generally takes 2 to 6 appointments of 45 to 60 minutes each to achieve the same results as at-home whitening.³⁷ Appointments are scheduled a week apart to reduce sensitivity. Generally, the cost of one in-office appointment is the same as the total cost for successful at-home treatment, so the cost-benefit ratio is much better using at-home whitening.38 Inoffice whitening may be used as a start to athome whitening, or for patients who cannot or do not want to comply with at-home whitening.³⁹ Laser whitening, which has only been sanctioned by the ADA using the argon laser,⁴⁰ has not been shown to be any more effective than conventional in-office whitening.⁴¹

Over-the-Counter Products and Other Uses

Toothpaste removes only extrinsic stains by mechanical means; very little if any change in tooth color is possible. Over-the-counter and television advertised whitening products have been shown at best to be ineffective, and some are damaging to enamel.⁴²

During whitening, the salivary pH elevates above 8 within 5 minutes and remains there for at least 2 hours,⁴³ so additional uses for 10% carbamide peroxide in tray delivery are being examined. These include controlling root caries (with and without fluoride), treating mouth ulcers and malodor, reducing chlorhexidine staining by alternating with the peroxide, and reducing plaque for patients with poor oral hygiene because of mental or physical handicaps.

Conclusions

Nightguard vital bleaching using 10% carbamide peroxide in a custom-fitted tray provided by the dentist has proven to be one of the most cost-effective, patient-pleasing, dentistfriendly, safe, and effective treatments to improve a patient's smile. Use of the technique requires a proper examination, diagnosis, and treatment plan relative to patient needs or conditions. The dentist should be aware of indications and contraindications of the technique, as well as other treatment options that may be required. The dentist should be knowledgeable in custom-fitted tray design options for specific whitening materials and patient conditions, and in treating side effects during treatment.

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