

# focus on...

*Reviewing the latest in products  
essential to your practice.*

## The “Bottom Line” on Bleaching 2008

Van B. Haywood, DMD

*Bleaching options could* involve any of three classes: in-office procedures, tray bleaching (called nightguard vital bleaching), or over-the-counter (OTC) products. Within each of these classes, there are variations in techniques, type and concentration of material, barrier technique, and duration of treatment. When considering which technique to choose, the dentist must consider the available literature on safety, efficacy, and cost. Each procedure has a risk-benefit ratio and a cost-benefit ratio. What follows is the “bottom line” of what we know in bleaching in 2008 in all three classes.

### EXAMINATION FOR BLEACHING

No bleaching treatment should be initiated without a proper dental examination,<sup>1</sup> which generally includes radiographs and determines a diagnosis for the cause of the discoloration. The examination should include an explanation to the patient of all their treatment options, as well as considering existing restorations—which will not bleach—and other esthetic needs.

It should be noted that there are several causes for discoloration (abscessed teeth, caries, internal or external resorption) for which bleaching will mask the indication of pathology but not resolve the problem. Other treatments will be required before or instead of bleaching.

### TOOTH INSIGHTS

All teeth do not reach the same whiteness. Rather, each tooth has its maximum whiteness beyond which it will not whiten, regardless of the technique or material.<sup>1,2</sup> Teeth among different patients do not bleach at the same rate. Some will bleach faster than others (in a matter of days or

a single appointment), while others may take an extended time (2 to 6 weeks or multiple in-office treatments). Once the rate of the tooth change is exceeded, higher concentrations of peroxides or reaction activations make no difference in the color change.<sup>1,3,4</sup>

Peroxide goes through the enamel and dentin to the pulp in 5 to 15 minutes and changes the genetic color of the dentin and the enamel, as well as removes stains.<sup>5,6</sup> Because of the permeability of the tooth to peroxide, there is no need to etch teeth to improve permeability. Cracks are not a contraindication to bleaching, but a history of sensitivity along with frequent applications and higher concentrations of material contributes to sensitivity.<sup>1,7-10</sup>

Most teeth get more opaque upon bleaching, but some that are already translucent may become more translucent and may not appear to whiten. If the occlusion allows, placement of a lingual composite to block the translucency may improve esthetics.<sup>1</sup> Lingual or occlusal amalgams on teeth in the esthetic zone may show through translucent teeth when bleached, and so these should be considered for replacement before bleaching.<sup>1,11</sup> Existing mismatched composite restorations can require replacement after bleaching, but the dentist should wait at least 2 weeks (for low-concentration products) for shade stabilization and bond-strength recovery.<sup>1,12-14</sup>

### MATERIAL INSIGHTS

Hydrogen peroxide is different from carbamide peroxide in composition (carbamide peroxide = hydrogen peroxide plus urea), concentration (10% carbamide peroxide has 3.5% hydrogen peroxide) and time of activity.<sup>1,15</sup> Hydrogen peroxide

products are active for 30 to 60 minutes, which is normal wear or application time.<sup>1,8</sup> Carbamide peroxide products are active for 2 to 10 hours, which favor longer wear times, especially overnight.<sup>1,2,12</sup>

Carbamide peroxide products increase oral pH to above 7 and reduce plaque, as well as kill bacteria that cause tooth decay. Hence, there is no concern for small carious lesions being restored before bleaching unless they are sensitive or close to the pulp.<sup>16-19</sup>

Patients receiving higher concentrations of peroxide experience greater sensitivity, greater color relapse after termination of bleaching, and require a longer wait time before bonding with composite resin. Some properties of dentin are never recovered with the highest concentrations, possibly because of the acidic nature of hydrogen peroxide.<sup>4,9,20-23</sup>

The eventual outcome of whitening is the same regardless of the material if the time is extended long enough, as the outcome is determined by the tooth not the product.<sup>1,4,24-26</sup>

The majority of research available is on 10% carbamide peroxide (trays) and on 35% hydrogen peroxide (in-office). Other concentrations and recommendations are extrapolations of this data and may or may not be valid.<sup>4,15,27,28</sup>

### TRAY DESIGN

Reservoirs are not needed to bleach; they merely reduce the tightness of the tray. Teeth bleach just as quickly without the reservoir as they do with it. Scalloping is only needed with higher concentrations of peroxide, or patient/dentist concerns for tissue contact. However, if you scallop the tray, you will generally need reservoirs.



Van B. Haywood, DMD

Professor, Department of Oral Rehabilitation  
School of Dentistry  
Medical College of Georgia  
Augusta, Georgia

Thermoplastic trays made by the dentist in the office for direct placement in the mouth may offer alternatives to traditional impression and tray fabrication, especially in youth.<sup>1,29-32</sup>

It is important to note that having a one-arch fee is desirable, because some patients may never bleach the mandibular arch. The American Dental Association (ADA) code for tray bleaching (09972) is per arch, not per patient.

### Treatment Times for Tray Bleaching

Normal teeth take 3 days to 6 weeks, depending more on the individual's tooth response than on the product used.<sup>1,33</sup> Nicotine-stained teeth take 1 to 3 months of nightly bleaching with 10% carbamide peroxide.<sup>1</sup> Tetracycline stained teeth take 1 to 12 months of nightly bleaching, with an average of 3 to 4 months, using 10% carbamide peroxide.<sup>1,34</sup> Tray bleaching overnight is the most practical for tetracycline stained teeth. The prognosis for tetracycline staining depends on color (different analogues give a different color and gray is the most difficult to remove), and the location (the gingival is harder because of thicker and different dentin characteristics from the dentin in the incisal portion of the tooth).<sup>1,34-36</sup> When



**Figure 1** A single dark tooth will bleach well, but may not lighten as much as the other teeth if all are bleached at the same time.



**Figure 2** Fabrication of a non-scalloped, no-reservoir single-tooth tray allows the dentist to only bleach the dark tooth to determine how well it will respond to bleaching.



**Figure 3** For this patient, bleaching the single dark tooth matched the other non-bleached teeth well, but the single tooth did not get any lighter than the other teeth, so the other teeth were not bleached.



**Figure 4** The single dark lateral incisor after endodontic treatment can be bleached both inside and outside for best results with minimum appointments and risk of side effects.



**Figure 5** Use of 10% carbamide peroxide internally in a “walking bleach style” with the use of external bleaching using 10% carbamide peroxide in a non-scalloped, no-reservoir tray produces a more esthetic result.



**Figure 6** The preoperative examination is important to prepare the patient for realistic expectations, and reveals faint white spotting with baseline tooth discoloration.



**Figure 7** White spots occasionally go through a “splotchy stage,” which occurs in the first few days of bleaching when the white areas respond quicker than normal enamel.



**Figure 8** Continuation of bleaching will allow the background of the tooth to lighten such that the white spots are less noticeable. Upon termination, white areas tend to return to their original color.

bleaching tetracycline-stained teeth, a “pay as you go” approach of monthly fees for material is fair to both the patient and the dentist as the treatment time is unknown at the outset.

The long-term safety of extended bleaching times using low concentrations of carbamide peroxide is well established. Stability of tetracycline bleaching parallels normal teeth, which can be 1 to 10 years before any touch-up or retreatment is needed.<sup>1,15,37,38</sup> Bleaching may or may not eliminate the need for veneers, but lighter teeth will make it easier to make veneers look natural.<sup>39,40</sup>

## EFFECTS ON COMPOSITE RESTORATIONS

Composite restorations do not change color and are not affected by low concentrations of bleaching materials.<sup>41-44</sup> The dentist should wait 2 weeks after low-concentration (10% carbamide peroxide) bleaching before composite bonding to allow bond strengths to return to normal.<sup>1,45</sup> The dentist should wait 2 weeks or longer for shade stabilization of lower concentrations of carbamide peroxide/hydrogen peroxide, but longer (up to 6 weeks) for higher concentrations of peroxide.<sup>1,46</sup> Not all composite restorations will need replacement as a result of the metamerism effect of composite, but the patient should be informed of all possible replacements in their esthetic zone.

## SAFETY

Long-term safety of tray bleaching has been established through 4- and 10-year recalls.<sup>47,48</sup> Enamel is not significantly affected by low concentrations of bleaching material when compared to normal diet and other treatments, though fluoride in the product is helpful.<sup>49-56</sup> Dentin may have some minor effects with higher concentrations of hydrogen peroxide.<sup>57-59</sup> Review articles in both the United States and Europe of all safety papers published on bleaching have determined that low concentrations of peroxide are safe to use after a proper dental examination and do not cause cancer.<sup>15,60-64</sup> However, use of chlorine dioxide as a bleaching agent has not been scientifically established as either safe or efficacious.



**Figure 9** Brown tetracycline stains located in the incisal one half of the tooth are more readily bleached than gray, especially if located at the gingival, although all tetracycline stained teeth take months of nightly treatment.



**Figure 10** Two months of nightly treatments with 10% carbamide peroxide in a non-scalloped, no-reservoir tray—which is the average for moderate tetracycline-stained teeth—yields a successful outcome on the maxillary arch.



**Figure 11** One problem with OTC products is that they do not allow a proper examination by a dentist before bleaching. The patient did not realize where the composite restorations closing the spaces between her teeth were located, and that the restorations would not change color with bleaching.

## SINGLE DARK TOOTH

Tray bleaching works well on vital or non-vital single dark teeth, although single dark teeth seldom equal the non-damaged teeth with any bleaching technique. Bleaching all of the teeth as well as the single dark tooth may still leave a discrepancy between the teeth (Figure 1).

Outside bleaching of any single dark tooth is best performed with a single-tooth tray made by removing the tooth molds on either side of the single dark tooth.<sup>1</sup> This approach allows the dentist to see how well the dark tooth responds before trying to lighten the other teeth for the best color match (Figure 2 and Figure 3).

A combination of one internal bleaching/cleaning and continuation of external bleaching with the single-tooth tray is the most time- and outcome-efficient method. Final shade matching of the single dark tooth to the other teeth can be enhanced with internal placement of opaque white composite.<sup>1</sup>

The root portion of a tooth does not bleach very well with any technique because of the difference in the composition of the dentin toward the pulp and toward the apex, so gingival recession is better treated esthetically with periodontal root coverage.<sup>1</sup>

Bleaching of endodontically treated teeth may be done internally with 10% carbamide peroxide and sealed with cotton and Cavit™ (3M ESPE, St. Paul, MN) or some other provisional restoration. Cleaning out the pulp remnants and placing a base over the gutta-percha excavated

2 mm below the cemento-enamel junction is standard procedure, as in the “walking bleach” technique.<sup>1</sup> Materials can be changed weekly (Figure 4 and Figure 5). Other variations involve an open chamber “inside-outside” bleaching with 10% carbamide peroxide or use of sodium perborate internally with no high concentration of hydrogen peroxide.<sup>65</sup>

## WHITE SPOTS AND BROWN DISCOLORATIONS

White spots do not bleach, but may be less noticeable if the background color of the tooth is lightened to avoid the contrast (Figure 6). White spots may go through a splotchy stage during bleaching, but will generally return to baseline, so bleaching should be continued until the background tooth color reaches maximum lightness (Figure 7 and Figure 8).

Amorphous calcium phosphate (CCP-ACP) may be effective in lessening the white spots if the lesion is not more than one third through the enamel, and the surface is not glazed or fluoride-rich.<sup>66,67</sup> Etching and abrasion may also be used to remove white spots (micro-abrasion or macro-abrasion), or to prepare the surface for CCP-ACP application.<sup>68-71</sup> Brown discoloration is very responsive to bleaching, being successful approximately 80% of the time,<sup>72</sup> (Figure 9 and Figure 10).

## AGE FOR BLEACHING

Generally patients are candidates for bleaching when they are 10 years old or

older, as that is when permanent teeth erupt. The primary teeth are generally milk-white already. If a young person has a problem with tooth discoloration, it is better to bleach the teeth than wait and have them deal with the embarrassment of the discoloration. Although young people have large pulps, they also have large apices and good blood supply, so sensitivity is seldom seen during bleaching. No pulpal damage has ever occurred with 10% carbamide peroxide.<sup>1,73,74</sup> No line of demarcation will be seen on the unerupted part of the partially erupted tooth if bleached before full eruption.

Non-scalloped, no-reservoir trays are used because they seal better, use less material, and are more comfortable to wear.<sup>1</sup> Thermoplastic trays may do well for mixed-dentition bleaching, and are cost- and time-effective.

The only indication for primary tooth bleaching is trauma darkening without pathology.<sup>75</sup> Older patients’ teeth bleach well, although in cases of recession, the root surface does not respond well.<sup>1</sup> In the author’s experience, patients older than 45 generally appear 10 years younger with whiter teeth and patients look most natural when the white sclera of their eyes is matched by the whiteness of their teeth.

## SENSITIVITY

Tooth sensitivity is the most common side-effect of bleaching.<sup>1,20,65,66,73,76,77</sup> Sensitivity may be treated actively or passively, but at-home treatment is most favorable. Passive treatment involves



reducing the frequency of application, the duration of treatment, or interrupting continuous application. Active treatment involves using a material with potassium nitrate in the product, applying potassium nitrate in the tray instead of bleaching material for 10 to 30 minutes when needed, and pre-brushing with a potassium-nitrate toothpaste for 2 weeks before bleaching initiation. Having patients wear the tray alone or with potassium nitrate before bleaching can also minimize their perceived pain response.<sup>8,77</sup>

Gingival sensitivity is related to higher concentrations of peroxide, tray irritations, and inherent patient sensitivity.<sup>1,20</sup> In-office bleaching with higher concentrations of peroxide results in greater sensitivity, so 1 week should be allowed between multiple appointments for the teeth and tissues to rest.<sup>27,78,79</sup> OTC products generally cause more gingival sensitivity than tooth sensitivity.<sup>80</sup>

## IN-OFFICE BLEACHING

One in-office treatment does not yield the same outcome as tray bleaching. The average is three in-office visits for maximum outcome, or some combination of in-office and tray bleaching to complete the bleaching process.<sup>1,3,27,81-83</sup> The lights do not make a difference, but only give the appearance of whitening as a result of dehydration. There is an immediate color relapse in 1 to 2 weeks that must be followed by either another in-office treatment or tray application to continue the whitening to completion.<sup>27,81,46,84-90</sup> The best time to evaluate the success of in-office bleaching is at least 2 weeks after treatment (or longer), to allow time for the shade to stabilize.<sup>27</sup>

A combination of in-office and tray bleaching may shorten the time somewhat, but will also increase the cost and sensitivity to the patient. The outcome in combination bleaching is the same with or without the in-office treatment. Patients should be aware that the additional charge for in-office is their choice, not the dentist's. Some major in-office systems are designed for in-office followed by tray bleaching (and possibly in-office again) to complete the process.

If the patient prefers in-office bleaching alone, appointments should be scheduled about 1 week apart to allow the pulp to rest from the insult. Often the recommendation is to premedicate with non-steroidal anti-inflammatory drugs before bleaching and during treatment to reduce tooth sensitivity.<sup>79</sup>

Etching of teeth before bleaching is not desirable, and has been shown to not make any difference because of the permeability of the enamel. Sealing teeth after bleaching is only helpful if the teeth are rough (to minimize surface stains) or have been etched, but does not maintain tooth color. Polishing the teeth with composite polishing instrumentation may be more effective.<sup>7,10</sup>

There is some evidence that in-office bleaching with a barrier such as a plastic

sheet or a tray is more effective than traditional in-office bleaching.<sup>89</sup> New improvements in in-office bleaching with paint-on rubber dams, cheek and lip retractors, and lower concentrations of peroxide have made it safer for the dentist and the patient.<sup>1</sup>

## OTC PRODUCTS

There is a wide variety of products, including strips, wraps, trays, and paint-ons. Some of these will bleach teeth and some do not make a clinical difference in color.<sup>91,92</sup> The main concern for OTC products is the lack of dental examination before bleaching (Figure 11). Those products that can be effective typically need some type of barrier to maintain the peroxide in place, so OTC strips, wraps, and tray products can be somewhat effective.

The European directive is that OTC products cannot be purchased without an examination and prescription by a dentist, to avoid masking signs of pathology (teeth darkened from abscesses, decay, or resorption) or improper use.<sup>1,15,63</sup>

Paint-ons are similar to dentifrice in efficacy, in that they do not change the color of the tooth, but merely remove extrinsic stains. Some have been shown to etch the teeth.<sup>93</sup>

Differences between patient arch size and standardized OTC product designs that do lighten teeth may mean that all the patient's teeth shown in their full smile will not be bleached.<sup>1</sup>

## SUMMARY

A comparison of the three classes of bleaching to determine the amount of bleaching needed for a six-shade change indicated that three in-office applications of 38% hydrogen peroxide achieved the same result as 1 week of 10% carbamide peroxide nightly or 16 days of daily application of 5.3% hydrogen peroxide on a strip.<sup>81</sup> A comparison of the equivalent concentrations of hydrogen peroxide and carbamide peroxide in different wear techniques (day-wear of hydrogen peroxide strips, day wear of hydrogen peroxide trays and night-wear of carbamide peroxide trays) indicated that the night-wear was more efficient (more color change per days of treatment) and that strips and day-trays had the same efficacy. However, all treatment choices should eventually achieve the maximum whiteness allowed by the tooth given enough treatment time.<sup>94</sup> Whitening is best performed in a professionally supervised manner, with a proper examination and diagnosis, using appropriate materials for the patient and situation, with a fair fee for service.

A 10% carbamide peroxide treatment in a custom-fitted tray is generally the safest, most cost-effective, best-researched whitening treatment available. Other bleaching treatments may be indicated based on patient preference, lifestyle, finances, or other limitations, but all treatments require informed consent after presenting cost/benefit and risk/benefit ratios.<sup>1,27,54,83</sup>

The biggest challenge in esthetic dentistry is to maintain the ethics of the dental profession, and to place patient care ahead of financial gain. Patients should be presented all options for treatment, including the cost/benefit ratio and the risk/benefit ratio, based on research where possible. Conservative treatment that preserves enamel and tooth structure is always preferred.<sup>86,95,96</sup> "Do unto others as you would have them do unto you" is the best operational plan.

## REFERENCES

- Haywood VB. *Tooth Whitening: Indications and outcomes of Nightguard Vital Bleaching*. Hanover Park, IL: Quintessence Publishing Company Inc; 2007.
- Matis BA. Tray whitening: what the evidence shows. *Compend Contin Educ Dent*. 2003; 24(4A):354-362.
- Gottardi MS, Brackett MG, Haywood VB. Number of in-office light-activated bleaching treatments needed to achieve patient satisfaction. *Quintessence Int*. 2006;37(2): 115-120.
- Browning WD, Swift EJ. Critical appraisal: comparison of the effectiveness and safety of carbamide peroxide whitening agents at different concentrations. *J Esthet Restor Dent*. 2007;19(5):289-296.
- Cooper JS, Bokmeyer TJ, Bowles WH. Penetration of the pulp chamber by carbamide peroxide bleaching agents. *J Endod*. 1992; 18:315-317.
- McCaslin AJ, Haywood VB, Potter BJ, et al. Assessing dentin color changes from nightguard vital bleaching. *J Am Dent Assoc*. 1999;130:1485-1490.
- Hall DA. Should etching be performed as a part of a vital bleaching technique? *Quintessence Int*. 1991;22:679-686.
- Haywood VB. Treating sensitivity during tooth whitening. *Compend Contin Educ Dent*. 2006;26(9):11-20.
- Leonard RH, Haywood VB, Phillips C. Risk factors for developing tooth sensitivity and gingival irritation associated with nightguard vital bleaching. *Quintessence Int*. 1997;28: 527-534.
- McKamie A. Deep bleaching: one practice's protocol for enhanced patient satisfaction. *Contemporary Esthetics*. 2007;10:12-19.
- Haywood VB. Greening of the tooth-amalgam interface during extended 10% carbamide peroxide bleaching of tetracycline-stained teeth: a case report. *J Esthet Restor Dent*. 2002;14:12-17.
- Matis BA, Gaião U, Blackman D, et al. In vivo degradation of bleaching gel used in whitening teeth. *J Am Dent Assoc*. 1999;130(2): 227-235.
- Matis BA, Mousa HN, Cochran MA, Eckert GJ. Clinical evaluation of bleaching agents of different concentrations. *Quintessence Int*. 2000;31(5):303-310.
- Matis BA. Degradation of gel in tray whitening. *Compend Contin Educ Dent*. 2000;21(28): S28-S35.
- Scientific Committee on Consumer Products (SCCP), European Commission. Opinion on Hydrogen Peroxide in Tooth Whitening Products. Adopted 15 March 2005 (SCCP/0844/04).
- Available at: [http://ec.europa.ed/health/index\\_en.htm](http://ec.europa.ed/health/index_en.htm). Accessed November 29, 2007.
- Bentley CD, Leonard R, Crawford JJ. Effect of whitening agents containing carbamide peroxide on cariogenic bacteria. *J of Esthet Dent*. 2000;12(1):33-37.
- Haywood VB. Bleaching and caries control in elderly patients. *Aesthetic Dentistry Today*. 2007;1(4):47-49.
- Leonard RH Jr, Bentley CD, Haywood VB. Salivary pH changes during 10% carbamide peroxide bleaching. *Quintessence Int*. 1994; 25(8):547-550.
- Napimoga MH, de Oliveria R, Reis AF, et al. In vitro antimicrobial activity of peroxide-based bleaching agents. *Quintessence Int*. 2007;38(6):E329-E333.
- Browning WD, Blalock JS, Frazier KB, et al. Duration and timing of sensitivity related to bleaching. *J Esthet Restor Dent*. 2007;19(5): 256-264.
- Kihn P, Barnes DM, Romberg E, Peterson K. A clinical evaluation of 10 percent vs. 15 percent carbamide peroxide tooth-whitening agent. *J Am Dent Assoc*. 2000;131(10): 1478-1484.
- Leonard RH, Smith LR, Garland GE, Caplan DJ. Desensitizing agent efficacy during whitening in an at-risk population. *J Esthet Restor Dent*. 2004;16(1):49-56.
- Machado JDS, Candido MSM, Sundfeld RH, et al. The influence of time interval between bleaching and enamel bonding. *J Esthet Restor Dent*. 2007;19(2):111-118.
- Christensen GJ. Bleaching teeth: which way is best? *J Esthet Dent*. 2003;15(3):137-140.
- Mokhlis GR, Matis BA, Cochran MA, Eckert GJ. A clinical evaluation of carbamide peroxide and hydrogen peroxide whitening agents during daytime use. *J Am Dent Assoc*. 2000;131(9):1269-1277.
- Suliman M, Macdonald E, Rees JS, et al. Tooth bleaching by different concentrations of carbamide peroxide and hydrogen peroxide whitening strips: an in vitro study. *J Esthet Restor Dent*. 2006;18(2):93-101.
- Matis BR. Ask the experts: in-office bleaching. *J Esthet Dent*. 2004;16(2):87-88.
- Haywood VB. History, safety, and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. *Quintessence Int*. 1992 23(7):471-488.
- Haywood VB, Leonard RH, Nelson CF. Efficacy of foam liner in 10% carbamide peroxide bleaching technique. *Quintessence Int*. 1993; 24(9):663-666.
- Haywood VB. Are reservoirs necessary? *J Esthet Dent*. 1999;11(1):3.
- Javaheri DS, Janis JN. The efficacy of reservoirs in bleaching trays. *Oper Dent*. 2000; 25(3):149-151.
- Miller MB, Castellanos IR, Rieger MS. Efficacy of home bleaching systems with and without tray reservoirs. *Pract Periodontics Aesthet Dent*. 2001;12(6):611-614.
- Haywood VB. Frequently asked questions about bleaching. *Compend Cont Educ Dent*. 2003;24(4A):324-338.
- Leonard RH Jr, Haywood VB, Caplan CJ, et al. Nightguard vital bleaching of tetracycline-stained teeth: 90 months of post treatment. *J Esthet Restor Dent*. 2003;15(3):142-152.
- Haywood VB, Leonard RH, Dickinson GL.

- Efficacy of six months of nightguard vital bleaching of tetracycline-stained teeth. *J Esthet Dent*. 1997;9(1):13-19.
36. Matis BA, Wang Y, Eckert GJ, et al. Extended bleaching of tetracycline-stained teeth: a 5-year study. *Oper Dent*. 2006;31(6):643-651.
  37. Leonard RH, Bentley C, Eagle JC, et al. Nightguard vital bleaching: a long-term study of efficacy, shade retention, side effects, and patients' perceptions. *J Esthet Restor Dent*. 2001;13(6):357-369.
  38. Matis BA, Cochran MA, Eckert G, et al. The efficacy and safety of a 10% carbamide peroxide bleaching gel. *Quintessence Int*. 1998;29(9):555-563.
  39. Deliperi S, Congiu MD, Bardwell DN. Integration of composite and ceramic restorations in tetracycline-bleached teeth: a case report. *J Esthet Dent*. 2006;18(3):126-134.
  40. Haywood VB, Parker MH. Nightguard vital bleaching beneath existing porcelain veneers: a case report. *Quintessence Int*. 1999;30(11):743-747.
  41. Swift EJ, Perdigo J. Effects of bleaching on teeth and restorations. *Compend Contin Educ Dent*. 1998;19(8):815-820.
  42. Polydorou O, Hellwig E, Auschill TM. The effect of different bleaching agents on the surface texture of restorative materials. *Oper Dent*. 2006;31(4):473-480.
  43. Okte Z, Villalta P, Garcia-Godoy F, et al. Surface hardness of resin composites after staining and bleaching. *Oper Dent*. 2006;31(5):623-628.
  44. Mujdeci A, Goday O. Effect of bleaching agents on the microhardness of tooth-colored restorative materials. *J Prosthet Dent*. 2006;95(4):286-289.
  45. Nour El-din AK, Miller BH, et al. Immediate bonding to bleached enamel. *Oper Dent*. 2006;31(1):106-114.
  46. Shethri SA, Matis BA, Cochran MA, et al. A clinical evaluation of two in-office bleaching products. *Oper Dent*. 2003;28(5):488-495.
  47. Ritter AV, Leonard RH Jr, St Georges AJ, et al. Safety and stability of nightguard vital bleaching: 9 to 12 years post-treatment. *J Esthet Restor Dent*. 2002;14(5):275-85.
  48. Leonard RH Jr. Efficacy, longevity, side effects, and patient perceptions of nightguard vital bleaching. *Compend Cont Educ Dent*. 1998;19(8):766-774.
  49. Tinanoff N, Wei SH, Parkins FM. Effects of a pumice prophylaxis fluoride uptake in tooth enamel. *J Am Dent Assoc*. 1974;88(2):384-389.
  50. Gladwell J, Simmons D, Wright JT. Remineralization potential of a fluoridated carbamide peroxide whitening gel. *J Esthet Restor Dent*. 2006;18(4):206-212.
  51. Metz MJ, MA Cochran, Matis BA, et al. Clinical evaluation of 15% carbamide peroxide on the surface microhardness and shear bond strength of human enamel. *Oper Dent*. 2007;32(5):427-436.
  52. Wiegand A, Schreier, Attin T. Effect of different fluoridation regimes on the microhardness of bleached enamel. *Oper Dent*. 2007;32(6):610-615.
  53. Da Costa JB, Mazur RF. Effects of new formulas of bleaching gel and fluoride application on enamel microhardness: an in vitro study. *Oper Dent*. 2007;32(6):589-594.
  54. Tezel H, Ertas OS, Ozata F, et al. Effect of bleaching agents on calcium loss from the enamel surface. *Quintessence Int*. 2007;38(4):339-347.
  55. Grobler SR, Senekal PJ, Laubscher JA. In vitro demineralization of enamel by orange juice, apple juice, Pepsi Cola and Diet Pepsi Cola. *Clin Prev Dent*. 1990;12(5):5-9.
  56. McCracken MS, Haywood VB. Demineralization effects of 10 percent carbamide peroxide. *J Dent*. 1996;24:395-398.
  57. De Oliveria DP, Teixeira ECN, Ferraz CCR, Teixeira FB. Effect of intracoronal bleaching agents on dentin microhardness. *J Endod*. 2007;33(4):460-462.
  58. Jiang T, Ma X, Wang Y, et al. Effects of hydrogen peroxide on human dentin structure. *J Dent Res*. 2007;86(11):1040-1045.
  59. Tam LE, Kuo VY, Noroozi A. Effect of prolonged direct and indirect peroxide bleaching on fracture toughness of human dentin. *J Esthet Restor Dent*. 2007;19(2):100-110.
  60. Leonard RH, Smith LR, Garland GE, et al. Evaluation of side effects and patients' perceptions during tooth bleaching. *J Esthet Restor Dent*. 2007;19(6):355-366.
  61. Li Y. The safety of peroxide-containing at-home tooth whiteners. *Compend Contin Educ Dent*. 2003;24(4A):384-9.
  62. Vachon C, Vanek P, Friedman S. Internal bleaching with 10% carbamide peroxide in vitro. *Prac Periodontics Aesthet Dent*. 1998;10(9):1145-1152.
  63. Scientific Committee on Consumer Products (SCCP), European Commission. Guidance Document on Epidemiological and clinical studies on Tooth Whitening Products; adopted 28 March 2006 (SCCP/0974/06). Available at: [http://ec.europa.ed/health/index\\_en.htm](http://ec.europa.ed/health/index_en.htm). Accessed November 29, 2007.
  64. Munro IC, Williams GM, et al. Use of hydrogen peroxide-based tooth whitening products and its relationship to oral cancer. *J Esthet Restor Dent*. 2006;18(3):119-125.
  65. Settembrini L, Gultz J, Kaim J, Scherer W. A technique for bleaching nonvital teeth: inside/outside bleaching. *J Am Dent Assoc*. 1997;128(9):1283-1284.
  66. Matis BA, Cochran MA, Eckert GJ, Matis JL. In vivo study of two carbamide peroxide gels with different desensitizing agents. *Oper Dent*. 2007;32(6):549-555.
  67. Ardu S, Castioni NV, Benbachir N, Krejci I. Minimally invasive treatment of white spot enamel lesions. *Quintessence Int*. 2007;38(8):633-636.
  68. Sundfeld RH, Rahal V, Croll TP, et al. Enamel microabrasion followed by dental bleaching for patients after orthodontic treatment: case reports. *J Esthet Restor Dent*. 2007;19(2):71-78.
  69. Benbachir N, Ardu Stefano, Krejci I. Indications and limits of the microabrasion technique. *Quintessence Int*. 2007;38(10):811-815.
  70. Ardu S, Stavridakis M, Krejci I. A minimally invasive treatment of severe dental fluorosis. *Quintessence Int*. 2007;38(8):455-458.
  71. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. *Quintessence Int*. 1986;17(2):81-87.
  72. Haywood VB, Leonard RH. Nightguard vital bleaching removes brown discoloration for 7 years: A case report. *Quintessence Int*. 1998;29(7):450-451.
  73. Swift EJ. Critical Appraisal: At-home bleaching: pulpal effects and tooth sensitivity issues, Part 1. *J Esthet Restor Dent*. 2006;18(4):225-228.
  74. Haywood VB. Bleaching children's teeth: questions and answers. *Georgia Academy of General Dentistry Newsletter*. September 2006;4-7.
  75. Brantley DH, Barnes KP, Haywood VB. Bleaching primary teeth with 10% carbamide peroxide. *Pediatr Dent*. 2001;23(6):514-516.
  76. Haywood VB, Cordero R, Wright K, et al. Brushing with a potassium nitrate dentifrice to reduce bleaching sensitivity. *J Clin Dent*. 2005;16(1):17-22.
  77. Haywood VB, Caughman WF, Frazier KB, et al. Tray delivery of potassium nitrate-fluoride to reduce bleaching sensitivity. *Quintessence Int*. 2001;32(2):105-109.
  78. Goldstein RE. In-office bleaching: Where we came from, where we are today. *J Am Dent Assoc*. 1997;128:11S-15S.
  79. Blankenau R, Goldstein RE, Haywood VB. The current status of vital tooth whitening techniques. *Compend Cont Educ Dent*. 1999;20(8):781-796.
  80. Gerlach RW, Sagel PA. Vital bleaching with a thin peroxide gel: The safety and efficacy of a professional-strength hydrogen peroxide whitening strip. *J Am Dent Assoc*. 2004;135(1):98-100.
  81. Auschill TM, Hellwig E, Schmidate S, et al. Efficacy, side-effects, and patients' acceptance of different bleaching techniques (OTC, in-office, at-home). *Operative Dent*. 2005;30(2):155-163.
  82. Papathanasiou A, Bardwell D, Kugel G. A clinical study evaluating a new chairside and take-home whitening system. *Compend Cont Educ Dent*. 2001;2(4):289-298.
  83. Dietschi D, Rossier S, Krejci I. In vitro colorimetric evaluation of the efficacy of various bleaching methods and products. *Quintessence Int*. 2006;37(7):515-526.
  84. Hein DK, Ploeger BJ, Wagstaff, et al. In-office vital tooth bleaching: what do lights add? *Compend Cont Educ Dent*. 2003;24(4A):340-352.
  85. Kugel G, Papathanasiou A, Williams AJ, et al. Clinical evaluation of chemical and light-activated tooth whitening systems. *Compend Cont Educ Dent*. 2006;27(1):54-62.
  86. Liebenberg W. Masters of esthetic dentistry: another white lie? *J Esthet Restor Dent*. 2006;18(3):155-160.
  87. Papathanasiou A, Kastali S, Perry RD, Kugel G. Clinical evaluation of a 35% hydrogen peroxide in-office whitening system. *Compend Cont Educ Dent*. 2002;23(4):335-346.
  88. Matis BA, Cochran MA, Franco M, et al. Eight in-office tooth whitening systems evaluated in vivo: a pilot study. *Oper Dent*. 2007;32(4):322-327.
  89. Kwon SR. Clinical: the sealed bleaching technique. *Aesthetic Dentistry Today*. 2007;1(3):14-18.
  90. Zekonis R, Matis BA, Cochran MA, et al. Clinical evaluation of in-office and at-home bleaching treatments. *Oper Dent*. 2003;28(2):114-121.
  91. Zantner C, Derdilopoulou F, Martus P, Kielbassa AM. Randomized clinical trial on the efficacy of 2 over-the-counter whitening systems. *Quintessence Int*. 2006;37(9):695-706.
  92. Shahidi H, Barker ML, Sagel PA, et al. Randomized controlled trial of 10% hydrogen peroxide whitening strips. *J Clin Dent*. 2005;16(3):91-95.
  93. Leonard RH, Teixeira ECN, Garland GE, Ritter AV. Effect on enamel microhardness of two consumer-available bleaching solutions when compared with a dentist-prescribed, home-applied bleaching solution and a control. *J Esthet Restor Dent*. 2005;17(6):343-350.
  94. Li Y, Lee SS, Cartwright SL, Wilson AC. Comparison of clinical efficacy and safety of three professional at-home tooth whitening systems. *Compend Cont Educ Dent*. 2003;24(5):357-378.
  95. Jenson L. Restoration and enhancement: is cosmetic dentistry ethical? *J Am Coll Dent*. 2005;72(4):48-53.
  96. Dietschi D. Masters of esthetic dentistry: bright and white: is it always right? *J Esthet Restor Dent*. 2005;17(3):183-190.