牙體復形學 Operative dentistry

Nature Teeth Bleaching

臺北醫學大學 牙醫學系
董德瑞老師
drdong@tmu.edu.tw

學習目標

- 期許同學在瞭解病患的需求及材料的特性後，能依據所學善加利用，做到不僅是幫病患解決病痛的牙醫師，同時也是個讓病患永遠也忘不了的藝術家。
  1. 牙齒的生理，解剖形態
  2. 齲齒的生理，診斷及治療計劃
  3. 窩洞的修形及材料的選擇
  4. 窩洞的充填方式及其修飾
  5. 美觀性材料的選擇及其運用
  6. 變色牙的修飾

參考資料

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2. Fundamental of operative dentistry. A contemporary approach 3rd edition, James B. Summitt.

Summary

Operative dentistry is the basic science in clinical dental practices. It included dental physiology, morphology, cariology, tooth preparation for restoration. The purpose of Operative dentistry is to complete the function and create the aethestic outlook.

Bleaching has been used to achieve a lighter and more desirable tooth color for over a century. Dental journals in the last half of the 19th century frequently contained articles on the efficacy of bleaching teeth. The safety of the procedure was well investigated and the chemistry understood. Although the process was thought to be time-consuming and relapse was considered a consistent problem, bleaching was well accepted.

By the mid-1800s, the bleaching agent of choice for nonvital teeth was chloride of lime. Around that time, Truman introduced chlorine from a calcium hydroxide and acetic acid solution for bleaching nonvital teeth; this was supplied commercially as a liquid chloride of soda.

Other agents used in the 1800s for nonvital tooth bleaching included aluminum chloride, oxalic acid, Pyrozone (etherperoxide) (McKesson and Robbins), hydrogen dioxide (hydrogen peroxide or perhydrol), sodium peroxide, sodium hypophosphate, chloride of lime, and cyanide of potassium.

The active ingredient common to all of these was as an oxidizing agent, which acted either directly or indirectly on the organic portion of the tooth. Sulfurous acid, in contrast, achieved results as a reducing agent. Generally, the most effective yet safe bleaching agents were direct oxidizers or an indirect oxidizer such as a chlorine derivative. However, the choice of bleaching agent depended primarily on the stain being removed. Iron stains were removed with oxalic acid, silver and copper stains with chlorine, and iodine stains with ammonia.

The metallic stains (such as from amalgam) were considered the most resistant to bleaching. Concern about the effect of some of these bleaching agents on the teeth, tissues, and health of the patient was raised because some agents used, such as cyanide of potassium, were very poisonous. Other bleaching agents were caustic.

The early emphasis was on bleaching nonvital teeth. However, as early as the 1890s, a 3% solution of Pyrozone was used safely as a mouthwash by both children and adults. It reduced caries and whitened the teeth. A 5% solution proved to be safe and effective, but a 25% solution was caustic, causing tissue burns.

By 1910, the current technique, using hydrogen peroxide activated by heat or light, was well established. Over the next few decades, the bleaching agents varied. By the 1940s, hydrogen peroxide and ether were used for vital teeth, while, by the late 1950s, etherperoxide (Pyrozone) and sodium perborate were used for nonvital teeth.

The current home bleaching technique, employing a custom-fit tray containing 10% carbamide peroxide solution, was first used by Klusmier in the late 1960s. However, the profession did not embrace the concept until it was described in a 1989 article, the publication of which coincided with the market introduction of carbamide peroxide as a bleaching agent. This ushered in the current technique for at-home bleaching.

Types and Nature of Stains/Discolorations

Types and Nature of Stains/Discolorations

Many types of color problems affect the appearance of the teeth. Because the cause of these problems varies, the speed with which they may be removed also varies. Discolorations may be extrinsic or intrinsic. Extrinsic stains are located on the surface of the tooth and are most easily removed by external cleaning. Intrinsic stains are located within the tooth and are accessible only by bleaching. Some extrinsic stains that remain on the tooth for a long time become intrinsic. Extrinsic color changes may be due to poor oral hygiene, ingestion of chromatogenic foods and drinks, and tobacco use.

Intrinsic color changes may be caused by aging, ingestion of chromatogenic foods and drink, tobacco usage, microcracks in the enamel, tetracycline medication, excessive fluoride ingestion, severe jaundice in infancy, porphyria, dental caries, restorations, and the thinning of the enamel layer. Other, but less frequent, medical situations and conditions may also cause the loss of a desirable tooth color.

Types and Nature of Stains/Discolorations

The causes of staining need to be carefully assessed to better predict the rate and degree to which bleaching will improve tooth color, since some stains are more responsive to the process. For instance, the yellow discoloration of aging responds quickly to bleaching in most cases, whereas a blue-gray tetracycline stain is tenacious.

In general, tetracycline-stained teeth are the slowest to respond to bleaching; brown-fluoresced teeth are moderately responsive; and teeth discolored by age, genetics, smoking, or coffee are the fastest to respond. White spots are not removed by bleaching, but may be less noticeable when the remainder of the tooth is lighter. By recognizing the likely cause of the stain, the dentist can better tell the patient the rate at which the teeth may lighten in color and the limits on the amount of improvement that can be expected.

Types and Nature of Stains/Discolorations

Discoloration from drug ingestion may occur either before the tooth is fully formed or later. Tetracycline is incorporated into the dentin sometime during tooth calcification (Fig 15-1), probably through chelation with calcium, forming tetracycline orthophosphate. There are several variations of tetracycline, and each derivative produces a different color in the tooth. Some teeth may be "banded" from the ingestion of different derivatives of tetracycline. When the teeth are exposed to sunlight, they become darker, with a distinct gray/blue-gray tinge. The teeth not exposed to the sunlight (eg, molars) do not darken to the same degree but remain more yellow in color.

Types and Nature of Stains/Discolorations

Tetracycline has also been reported to discolor fully formed, erupted permanent teeth. This discoloration is most often associated with minocycline, a drug commonly used in the treatment of acne. The primary route of deposition is thought to be in the secondary dentin, although some reports suggest a staining similar to iron deposition. Other antibiotics may also interact with calcium, iron, or other elements to form insoluble complexes that stain teeth.

Types and Nature of Stains/Discolorations

Excessive fluoride in drinking water, greater than 1 to 2 parts per million (ppm), can cause metabolic alteration in the ameloblasts, resulting in a defective matrix and improper calcification of teeth. An affected tooth shows a hypomineralized, porous subsurface enamel and a well-mineralized surface layer. These teeth have a glazed surface and may be very white except for areas of yellow, brown (Fig 15-2), or even black shading.

Types and Nature of Stains/Discolorations

Some systemic conditions can cause tooth discoloration. Severe jaundice leads to staining by bilirubin. Erythroblastosis fetalis may also stain the teeth by the destruction of red blood cells. Porphyria, a rare condition, manifests with purplish-brown teeth.

Types and Nature of Stains/Discolorations

Aging is. a common cause of discoloration. Over time, the underlying dentin tends to darken from the formation of secondary dentin, which is darker and more opaque than the original dentin. This occurs while the overlying enamel is thinning, a combination that often produces distinctly darker teeth.

Types and Nature of Stains/Discolorations

Dental caries produces varying stains during its process. Examples of caries-induced discolorations include an opaque white "halo," a grayish tinge, or a brown-to-black stain. These stains arise from the bacterial degradation of food debris. Metallic restorations, most notably dental amalgam, may cause a distinct staining of the tooth in addition to the shadow they may cast through adjacent enamel walls.

Current Bleaching Modalities

Mode of Action

The bleaching process is designed to enable the oxidizing agent to reach sites within the enamel and dentin to allow a chemical reaction to occur. No matter the bleaching technique or specific bleaching action, the intention is to deliver the active ingredient to the discolored segments of the tooth to dislodge or decolor the chromatic particles.

Mode of Action

Hydrogen peroxide diffuses through the organic matrix of the enamel and dentin because of its low molecular weight. One current theory of whitening is that the free radicals attack organic molecules to achieve stability; this releases other radicals. These radicals can react with other unsaturated bonds, disrupting the electron conjugation and providing a change in the absorption energy of the organic molecules in the enamel. The simpler molecules formed reflect less light so the tooth appears lighter in shade. In the early stages of this process, bleaching opens the more highly pigmented carbon-ring com- pounds and converts them to chains that are lighter in color. The carbon double-bond compounds (yellow in color) are converted to hydroxy groups (essentially colorless).

Mode of Action

The bleaching process continues to the extent that all the original pigment is rendered essentially colorless. At this point, lightening of the teeth reaches a plateau in regard to the speed at which it progresses. The continuation of the bleaching process is not beneficial beyond this point. Further research is needed to determine both what gives the tooth its baseline color and, in turn, the oxidation reaction of bleaching that changes the tooth color.

Types of Bleaching Therapy

Generally, bleaching can be first categorized into treatment for either nonvital teeth or vital teeth. Furthermore, nonvital teeth can be treated in the office or outside of the office. Outside-the-office treatment consists of applying a material inside or outside the tooth that actively lightens the tooth while the patient is away from the office. The in-office technique accomplishes all lightening during treatment in the office.

Types of Bleaching Therapy

The chemistry of carbamide peroxide used in at-home bleaching is thought to be a bit different from hydrogen peroxide, although the final stages do involve the reaction of hydrogen peroxide with the compounds within the tooth. When introduced into the mouth, the agent breaks down into urea and hydrogen peroxide, both of which access the internal portions of the tooth in minutes. In addition, bleaching not only removes discoloration from within the tooth, it also alters/brightens the inherent color of the dentin itself.

Types of Bleaching Therapy

Vital tooth bleaching also has an in-office technique or an outside-the-office (at-home) technique from which to choose. Inside-the-office techniques include the application of a bleaching material to teeth isolated by a rubber dam and may include activation of the process by heat or light. At-home bleaching uses a different bleaching agent applied in a custom-fit tray that the patient wears at home, usually while sleeping.

Factors Affecting Both the In-Office and At-Home Bleaching Processes

Several factors must be carefully considered before bleaching is begun and then controlled during the process to ensure maximum benefit. The factors include the following.

Surface Cleanliness

All surface debris must be removed to distinguish intrinsic stains from extrinsic staining and to ensure that the agent has maximum contact with the tooth surface. However, bleaching should not be initiated until 2 weeks after cleaning to allow any gingival or tooth sensitivity related to the prophylaxis to abate.

Concentration of Peroxide

The higher the concentration of peroxide, the more rapid the lightening effect. In-office bleaching materials are usually supplied in concentrations of 35% hydrogen peroxide, although some concentrations may be as high as 50%. The caustic nature of 35% to 50% hydrogen peroxide mandates that the soft tissues be isolated from any possible contact with the bleaching material. Tissue contact results in an immediate chemical burn (Fig 15-3). The usual concentration of the at-home bleaching agents is 10% carbamide peroxide (equal to approximately 3.4% hydrogen peroxide), which is relatively safe in contact with soft tissue.

The range of concentrations of carbamide peroxide may vary from 5% to 35%. When evaluating concentrations of peroxide for appropriate bleaching techniques, it is important to distinguish hydrogen peroxide from carbamide peroxide because of their radically different safety indices and effects on tissue. A 10% solution of carbamide peroxide is approximately 3% hydrogen peroxide and 7% urea. Concentrations higher than 10% carbamide peroxide may also cause increased tooth sensitivity, tissue irritation, or increased tooth surface alterations.

Temperature (in-Office Bleaching)

The higher the temperature, the faster the rate of oxygen release and, therefore, the faster the rate of color change. An increase of $10^{o}C$ doubles the rate of chemical reaction. However, temperatures elevated to an uncomfortable level may result in tooth sensitivity or even irreversible pulpal inflammation. Bleaching materials are always administered without anesthesia to avoid overheating the tooth. Nonvital teeth should not be heated to a temperature higher than one acceptable for a vital tooth.

pH

Hydrogen peroxide may have an acidic pH to help preserve its potency during shipping and storage. The optimum pH for hydrogen peroxide in bleaching is 9.5 to 10.8. A pH of 10.8 produces a 50% faster rate of bleaching than a pH of 9. Most carbamide peroxide materials approved by the American Dental Association have a pH of approximately 7. Materials with a significantly lower pH can cause surface alterations by their acidic nature. However, carbamide peroxide breaks down quickly when applied, raising the pH above 8 for a number of hours.

Time

In addition to the concentration, the degree of bleaching is directly related to the amount of time that the bleaching agent is in contact with the tooth. The longer the time, the more lightening will occur, but the longer the time, the greater the likelihood of tooth sensitivity.

Sealed Environment

The bleaching efficiency' of hydrogen peroxide is increased when it is placed in a sealed environment, an important factor for the nonvital tooth bleaching technique.

Additives

Many of the peroxides have additives to alter the handling characteristics or patient acceptability of the product. Liquid hydrogen peroxide may be formed into a gel for easier handling and safety, but this additive may also reduce the efficacy of the material. Carbamide peroxide, composed of hydrogen peroxide and urea, is much more stable than hydrogen peroxide. It has a shelf life of I to 2 years compared to hydrogen peroxide's shelf life of a few weeks. Carbamide peroxide may have various ingredients added to promote thickness, stickiness, or viscosity. Carbamide peroxide also has many different base vehicles, including variations of glycerin, glycol, and toothpaste-like materials. Additionally, carbamide peroxide is manufactured in many flavors, some of which can cause mild adverse responses in certain patients. Because all of these factors affect the rate and degree of bleaching, each must be considered when planning treatment.

Techniques for bleaching both vital and nonvital teeth are well accepted and have a good record of safety. Although the specific techniques for bleaching nonvital teeth vary from those for bleaching vital teeth, the principle remains essentially the same. Both rely on oxidation of the inorganic matrix to remove the chromatic materials. The techniques can be divided into the general categories of nonvital bleaching and vital bleaching.

Nonvital Bleaching

Nonvital teeth are especially susceptible to discolorations from blood products caused by trauma or endodontic therapy. A common bleaching method uses 30% hydrogen peroxide applied to the pulp chamber in one of two techniques (Fig 15-4). The thermocatalytic technique uses heat applied several times during a 30-minute period to activate the solution in the pulp chamber, after which the solution is rinsed from the chamber. The alternative method, called a "walking bleach," uses a mixture of 30% hydrogen peroxide and sodium perborate to make a paste that is scaled into the chamber to permit the solution to undergo activation over several days. The two techniques are equally effective. Internal bleaching by either method has been shown to return teeth to their desired color in 83% to 91% of cases. Other options include the use of sodium perborate alone or 10% carbamide peroxide sealed in the pulp chamber.

Nonvital Bleaching

This success is not long term in most cases, however. Within 1 to 5 years, only 35% to 50% of the teeth maintain their esthetical]y pleasing appearance. Therefore, the process must be repeated periodically. Unfortunately, rebleaching presents a problem for a tooth restored internally with resin composite. Attempting to rebleach would require removal of the previously bonded resin composite restoration. This removal generally results in additional loss of tooth structure, which weakens the tooth. A better treatment option once the tooth has been bleached internally and restored with resin composite is to bleach the tooth externally using the same techniques used for vital teeth.

Nonvital Bleaching

A more serious problem with about 7% of the teeth that have undergone internal bleaching is the occurrence of external root resorption. Root resorption (Fig 15-5) jeopardizes the tooth. While the causes of this resorption are not fully known, a re- view of the literature indicates a number of possible causes. The patients tended to be younger than 25 years old, and most had had traumatic injury. Some underwent bleaching with the application of heat, but some did not; however, heat does seem to be a causative factor. Animal studies have shown a cause- and-effect relationship between internal bleaching with 30% hydrogen peroxide and resorption, with a resorption incidence of 18'% to 25% when heat was applied and 0% to 6% without heat application. Any of several factors may also need to be present for resorption to occur, including: (1) deficiency in the cementum, exposing the cervical dentin to the oral cavity (normally affecting approximately 10% of the population); (2) injury to the periodontal ligament, triggering an inflammatory response (trauma); and (3) infection, sustaining the inflammation.

Nonvital Bleaching

The cementum deficiencies expose permeable dentin that can allow toxic substances and bacteria from within the chamber and root canals to emerge at the root surface where they may cause an inflammatory process in the periodontal ligament. A 30% solution of hydrogen peroxide is caustic enough to alter the chemical structure of cementum and dentin, decrease their microhardnessss and resorbability, and enhance transtubular propagation of bacteria. The solution diffuses through the radicular dentinal tubules at an enhanced rate if cementum deficiencies are present and when heat is applied. These data indicate that internal bleaching with 30% hydrogen peroxide is not as safe as originally believed. However, a history of trauma and marked overheating are major factors in resorption, in addition to cementum defects.

Nonvital Bleaching

Research has been conducted to determine if a protective restorative material can be placed in the cervical portion of the tooth to prevent this problem (Fig 15-6). Unfortunately, this restorative base reduces the diffusion but does not prevent it, and does not necessarily protect the tooth against root resorption. However, most of the teeth reported with cervical resorption did not have a base placed over the gutta-percha.

Nonvital Bleaching

The alternative to hydrogen peroxide is sodium perborate used by itself. The sodium perborate may not be as powerful a bleaching agent. Studies have shown that three applications of sodium perborate mixed with water are as effective as 30% hydrogen peroxide and sodium perborate. One study showed no root resorption after 3 years using sodium perborate, with a 90% esthetic success rate initially and a 49% esthetic success rate after 3 years. A newer technique involves the placement of 10% carbamide peroxide sealed into the chamber. This lower concentration of peroxide also provides a large safety margin.

Nonvital Bleaching

Another technique, which has limited application, is the practice of preparing the tooth as for the walking bleach technique combined with the at-home tray technique. The pulp chamber is left open, allowing the patient to place 10% carbamide peroxide inside the chamber and, at the same time, apply it externally with the tray. This technique, called "inside-outside bleaching," is very effective. However, it is best suited for patients who are very responsible and capable of applying the solution intraorally. With this technique, a barrier should be placed over the gutta-percha to prevent contamination of the root canal.

Nonvital Bleaching

The initial esthetic success rate of internal bleaching is limited and may be temporary. Furthermore, external root resorption is a definite, though small, risk with the high concentration of hydrogen peroxide. Even after several applications of sodium perborate mixed with water, the results may not be satisfactory. Satisfactory results, when achieved, usually persist for i to 3 years, although they may be permanent. Nevertheless, the safest treatment for internal bleaching remains sodium perborate mixed with water or 10% carbamide peroxide, used after the placement of a protective material in the cervical area.

Vital Bleaching

Vital bleaching may be accomplished by either of two techniques, each with some variations. The in-office technique currently is not as popular as the at-home technique, but it has historically met with success, and there are some definite indications for its use (Figs 15-7a and 15-7b).

In-Office Technique

In-office bleaching of vital teeth generally uses a 35% hydrogen peroxide solution placed directly on the teeth and may involve application of light/heat to activate/enhance the peroxide release. Because the hydrogen peroxide concentration is so high, soft tissues must be very well protected to prevent injury (Fig 15-8). This technique is intended to quickly produce the bleaching effect with limited need for patient compliance. It is indicated for achieving more rapid results or for patients who may have difficulty following the regimen for the at-home technique. There are several potential disadvantages, however. The fee is usually higher because more chairtime is required, there is a possibility of tissue injury from the more potent agent used, and the results may not be as good as with the slower at-home method.

At-Home Technique

At-home bleaching is the more commonly used bleaching process because it is easy to perform and is usually less expensive for the patient. It uses a custom-fit tray with a 10% solution of carbamide peroxide (Fig 15-9) (approximately equal to a 3.4% solution of hydrogen peroxide). Although the process requires longer contact time compared to the in-office bleaching technique. it is safe, and the results are generally excellent. Manufacturers have offered carbamide peroxide in a variety of concentrations, ranging from 10% to over 20%, but the best combination of safety, limited side effects, and speed of action is obtained with a 10% solution of carbamide peroxide approved by the American Dental Association (ADA). Products carrying the ADA accepted label have passed a rigorous set of safety and efficacy standards. A survey indicated that 90% of the dentists surveyed used a 10% carbamide peroxide for at-home bleaching of vital teeth.

Safety Factors

Safety concerns include: tooth/pulpal problems; periodontal/adjacent oral structures response; and systemic effects.

Tooth and Pulpal Problems

The short-term pulpal response varies from patient to patient and even from tooth to tooth. Although penetration of peroxide through the tooth to the pulp can produce sensitivity, the pulp remains healthy and the sensitivity is completely reversible. It is important that the process be carefully monitored to avoid creating great sensitivity in the teeth. The patient should not be anesthetized for an in-office procedure so that he or she will be able to detect early onset of sensitivity. Patients undergoing at-home bleaching must also be informed that there will be minor sensitivity in as many as two of three patients.

Tooth and Pulpal Problems

If sensitivity occurs, there are a number of approaches that can involve either passive treatment or active treatment. Passive treatment involves shortening the duration of treatment or the frequency of treatment, or interrupting the process for a day or more to allow the teeth to recover. The procedure can then be resumed. Active treatment involves the application of medicaments using the same bleaching tray. Historically, fluoride has been applied for sensitivity. Fluoride acts as a tubule blocker to limit the fluid flow to the pulp. Even fluoride treatment prior to initiating bleaching may reduce sensitivity. A more direct treatment is the application of 3% to 5% potassium nitrate gel in the tray. (Potassium nitrate preparations are available from several bleaching agent manufacturers.)

Tooth and Pulpal Problems

Potassium nitrate penetrates the tooth to the pulp and has a numbing or calming effect on nerve transmission. Potassium nitrate is found in many desensitizing toothpastes, but generally takes 2 weeks to be effective via toothbrushing. However, application of a potassium nitrate preparation in the tray for 30 to 60 minutes before or after bleaching can reduce or eliminate sensitivity in many patients. Often treatment for sensitivity is a combination approach involving alteration of treatment time, frequency of treatment, and medications, including ibuprofen for inflammation, desensitizing toothpaste, and desensitizing medicament applied in the tray.

Tooth and Pulpal Problems

Questions have been raised about the effect of bleaching on the structure of the tooth itself. Recent studies have shown, with low pH solutions, a detectable loss of calcium from the surface enamel, along with a slight loss in surface hardness to a depth of approximately 25 μm. However, this loss has not been shown to be significant because the surface quickly remineralizes after the procedure is completed. In fact, there is less change in the calcium content of the tooth and surface hardness from 6 hours of bleaching with 10% carbamide peroxide than when a carbonated drink is consumed in a 2- to 3- minute period. No noticeable change in the surface luster and topography is seen clinically.

Soft Tissue Response

The more powerful in-office bleaching agents (30% to 35% hydrogen peroxide) can easily produce a tissue burn, turning the tissue white (Fig 15-10). If the exposure is limited in time and in quantity, it is quickly reversible with no long-term consequences. Rehydration and application of an antiseptic ointment (eg, Orabase B, Colgate Oral Pharmaceutical) quickly return the color to the tissue, reassuring the patient that the problem is not permanent. Nevertheless, it can cause significant temporary discomfort and some alarm when first seen. It is important to protect soft tissues with a rubber dam or other means to avoid tissue burns (Fig 15-11). The conclusion, after decades of use and extensive research, is that the use of hydrogen peroxide in bleaching teeth is safe.

Soft Tissue Response

Although soft tissue irritation during at-home bleaching has been reported, the irritation is most likely the result of an ill-fitting tray rather than from the agent itself? Reports concerning any harmful effects to soft tissues from hydrogen peroxide indicate that the effects resulted from dosages and exposure times that greatly exceeded those prescribed in any at-home bleaching technique. At-home agents containing 10% carbamide peroxide are not potent enough to produce significant or long-lasting effects on the soft tissues.

Soft Tissue Response

Studies have indicated that approximately one third of the patients experienced no detectable side effects after bleaching. The other two thirds experienced only transitory and minor tooth sensitivity and/or tissue irritation of short duration. When examined at the cellular level, these effects on the soft tissue are less than or equal to those produced by commonly accepted dental medicaments such as eugenol and endodontic sealers. The toxicity and mutagenicity of hydrogen peroxide are dose related. Concentrations used in the at-home bleaching technique are not sufficient to be of concern. A low dose of hydrogen peroxide over a long time actually allows the cells of the oral tissues to adjust to the dosage even if it is increased beyond the original tolerable dosage. In the long history of these materials involving tissue contact in patients ranging in age from infancy to old age, there has been no demonstrated problem.

Systemic Effects and Responses

There is more concern about possible adverse effects of at-home bleaching agents, although their concentrations are far less potent than those of the in-office bleaches. In-office bleach is carefully controlled and placed on the teeth only, avoiding contact with soft tissues. The patient swallows no solution. Very little, if any, of the agent is absorbed systemically. The at-home bleach, applied in the tray, unavoidably contacts soft tissues in many areas over several hours each day. Additionally, it is likely that the patient swallows small amounts of very dilute hydrogen peroxide during the bleaching procedure, This has not proven to be a problem, however. Although very high concentrations of some forms of peroxide are mutagenic, physiologic mechanisms quickly repair any limited damage that might occur. Low levels of hydrogen peroxide do not cause real problems. In fact, hydrogen peroxide has been approved as safe for use as a human food additive with no residues. Carbamide peroxide is also used for the treatment of candidiasis in newborn infants. The conclusion, after decades of use and extensive research, is that the use of hydrogen peroxide in bleaching teeth is safe.

Indications for Bleaching

The primary indication for bleaching is patient dissatisfaction with tooth color. While the source of the discoloration affects the degree of success and the rapidity with which it can be eliminated or minimized, it has been shown that even the most persistent discolorations can be lightened if the treatment is sufficiently extended. Bleaching may be done in lieu of bonded resin composite restorations, porcelain veneers, or crowns to improve the tooth color. Patients may be satisfied with the results of bleaching such that more invasive treatment is not needed. Even if laminate veneers are to be placed, the lighter color of the bleached teeth allows lighter and more translucent veneers, enhancing the natural appearance. Other indications include extending the esthetic life of existing crowns that are lighter than the natural teeth by re- turning the color of the natural teeth to the shade of the crown, or treating single dark teeth that are vital or nonvital.

Contraindications for Bleaching

Although bleaching is a safe and effective aid in improving the appearance of the teeth, not every discolored tooth requires bleaching. Superficial or extrinsic stains may be completely removed by a rubber cup with prophylaxis paste or by light abrasion with a rotary polishing device. The removal of a discolored lesion and/or a dark restoration and placement of a tooth-colored material may well make a marked improvement in the appearance of a tooth. Patients with hypersensitive teeth are generally not good candidates for bleaching. In-office bleaching advocates do not use bleaching for children with large pulps or teeth with cracks. At-home bleaching is generally not indicated for pregnant women or persons allergic to the ingredients in the carbamide peroxide preparations.

Contraindications for Bleaching

There are few contraindications to bleaching. Since there is some evidence that peroxides may enhance the effect of known carcinogens, it may be prudent to have the patient forego tobacco use during the period of the bleaching process. Although there is no evidence that bleaching is harmful to the fetus or to infants, it has been recommended that pregnant and lactating women do not undergo bleaching because of gingival irritation and total drug ingestion restrictions. Patients with existing esthetic restorations must be warned that when bleaching lightens the natural tooth color, restorations may appear relatively dark and unattractive. The need for new restorations lighter in shade should be discussed with the patient.

Contraindications for Bleaching

Some teeth are very sensitive for any one of several reasons. Contraindications cited for in-office bleaching with high concentrations of hydrogen peroxide include teeth with extremely large pulps, exposed root surfaces, or severe enamel loss. In one study, Nathanson and Parra determined that there was no noticeable difference in the sensitivity reported by young patients compared to sensitivity reported by older patients, so larger pulp size may not be a factor, In a study of at-home bleaching with carbamide peroxide, Leonard et al. determined that there were no predictors of individuals who would experience sensitivity other than a history of sensitive teeth and more than one bleach application per day. All other delineators, such as pulp size, exposed dentin, cracks, gingival recession, caries, sex or age of the patient, or other physical characteristics, were not predictive of those who would have sensitivity.

Contraindications for Bleaching

Because bleaching tends to produce some sensitivity under ordinary circumstances, patients with pre-existing tooth sensitivity must be cautioned that increased sensitivity, albeit transitory, will occur. If this is likely to be a problem, the placement of a desensitizing solution containing fluoride or potassium nitrate can be alternated with the bleaching solution. This will increase the time needed to achieve the desired lightness of the teeth.

Contraindications for Bleaching

Patients with a history of temporomandibular disorder (TMD) may not be good candidates for at-home bleaching or may need to wear the tray during the day only. Bruxers also may have to alter wear times for at-home treatment or have several trays fabricated during treatment.

Contraindications for Bleaching

Bleaching does interfere with the bonding process because it results in a very high oxygen concentration in the enamel and dentin, which hinders polymerization of the resin composite. A delay of 7 to 10 days after bleaching allows dissipation of the excess oxygen from the tooth structure so there is no interference with the polymerization reaction. Waiting 1 to 2 weeks is also important in resin composite bonding to allow the shade of the bleached teeth to stabilize.

Treatment Planning and Patient Education

Projecting the amount of time expected for treatment, as well as integrating the time in the complete treatment plan for bleaching to occur, is important to successful therapy. A basic understanding of the cause of the discoloration is necessary to better predict the course and duration of the treatment as well as the final outcome. Whether to use at-home or in-office bleaching is based on patient preference and on the patient's ability and willingness to comply with the treatment protocol. Patients who are unwilling or unable to comply with the protocol for the at-home technique, or who are eager to finish the bleaching in a very short period of time regardless of the cost, are good candidates for in-office bleaching. Subsequent treatment procedures need to be planned so that the limits of the bleaching treatment are discussed in the total context of solving the patient's other dental problems.

The patient should be informed that bleaching should be performed before any esthetic restorative procedures, since the shade of any restoration placed previously will not be altered by bleaching. Therefore, restorations that matched the teeth prior to bleaching will no longer match. The information concerning the decision to bleach or not, as well as the rationale and costs for choosing a particular method, must be recorded to verify that the dentist and patient agree on the procedures and their predicted outcomes.

Shade Selection and Record Collection

A shade guide identifies the existing tooth color to establish the baseline (Fig 15-12). If the shade guide does not have a match for the tooth color, it should be estimated. It is important that the patient agree that the shade tab is the closest match to the current shade of the teeth. This shade should be recorded in the chart with the patient observing the entry. The patient may have difficulty recalling the original shade and, therefore, may be disappointed in the out- come because he or she may not believe that significant change has occurred. The patient should see the shade tab that represents the predicted target shade. The contrast between the tab representing the original shade and one showing the shade to be achieved may lead to more realistic patient expectations, especially if the patient already has light teeth.

Shade Selection and Record Collection

The best way to avoid such a problem is to bleach one arch at a time. In addition to minimizing the potential for TMD problems, it preserves one arch for an ongoing comparison of progress. Another reason for treating one arch at a time is that the cost to test the success of the procedure is reduced, making the treatment option more attractive to many patients. If it is deemed a success by the patient, the opposing arch can be bleached for an additional fee (Fig 15-13).

Shade Selection and Record Collection

For added documentation, close-up photographs of the patient's teeth and a full face photograph of the patient with a full smile should be kept as part of the patient's record. The photographs may be helpful in treatment planning, in reminding the patient of the original appearance of the teeth, and as a record for a ceramist fabricating any restorations. The photographs should be taken at a consistent magnification and pose. Placing the incisal edges of the teeth in the bleached arch against the incisal edges of the teeth in the unbleached arch enables the best comparison of the before and after shades, emphasizing the effect of bleaching. Impressions for diagnostic casts are necessary if bleaching trays are to be used for the at-home technique.

Patient Education

The patient needs to be well informed about the bleaching procedure. The office/clinic should have in- formation available for each patient explaining the process, precautions, possible side effects, number of applications or appointments, total time required, and the likely results. The dentist should explain to the patient why the particular technique has been chosen. The steps of the procedure and consequences for not following them should be outlined. For the at-home technique, loading and insertion of the bleaching tray should be demonstrated and the length for each wear session outlined. Any questions the patient might have should be answered at the appointment. The patient should sign a consent form that indicates that he or she has been informed about the procedure, its expected outcome, and any potential side effects. The consent form should also list other treatment options for this condition and state that those remain if the bleaching is not successful.

Bleaching Techniques

In-Office Technique for Vital Teeth

In-office bleaching utilizes a much more potent agent (usually a 35% solution of hydrogen peroxide, as op- posed to a 10% solution of carbamide peroxide for the at-home technique). This powerful agent (10 times as powerful as a 10% carbamide peroxide) is necessary to produce the rapid improvement expected of an in-office procedure (Figs 15-14a and 15-14b).

Bleaching Techniques

The oral/perioral structures must be protected during the procedure. Generally, this is best accomplished with a well-placed, ligated rubber dam, tightly adapted around the cervical areas of the teeth. For the single isolated tooth, it may be possible to protect the gingiva with cotton rolls and a "liquid rubber dam" (light-polymerized resin). The light-polymerized resin is ejected onto the gingival tissues surrounding the target teeth and then light cured. Additional resin can be added if an insufficient amount is dispensed initially. Any material covering the teeth should be trimmed to the proper extension to allow the bleach to reach that area. Cotton rolls and cheek retractors may be needed to protect the lips and tongue.

Bleaching Techniques

The teeth should not be anesthetized. This allows the patient to detect any developing sensitivity and the dentist to avoid overheating the teeth during the several applications of the solution occurring in the appointment. The patient becomes the "control" for the number of applications that should be placed; he or she should be questioned after each application about any tooth sensitivity or tingling in the gingiva, indicating a gap beginning between a tooth or teeth and the rubber dam. If any of the teeth become sensitive, the treatment should be interrupted and continued at a future appointment to allow the teeth to re- cover. If the patient reports a tingling of the gingival tissues, the procedure should be immediately aborted, the dam removed, and the tissues rinsed with water (with or without baking soda) to neutralize the peroxide and avoid severe tissue burns.

Bleaching Techniques

Manufacturers provide their bleaching agents in various forms. Some are very watery, others are in a gel form. Some are packaged as a powder-liquid combination that is mixed to activate and then placed on the tooth (Figs 15-15a and 15-15b). Other manufacturers provide a ready-to-place solution in a syringe for direct placement. No matter what the manufacturers supply, the solution is applied to the facial and proximal areas of the tooth for the prescribed time interval. If access is limited on the facial aspect be- cause of the presence of restorations, the solution can be placed on the lingual surface. The improvement of color, as observed from the facial surface, will take longer to occur. Heat treatment is optional, and etching of the enamel is not indicated. If heat is to be used to speed the chemical reaction, it should be from a dental curing light or equipment specially fabricated for bleaching, thus releasing oxygen more rapidly.

Bleaching Techniques

In-office bleaching generally takes two to six appointments of 45 minutes to 1 hour each. To achieve the optimal bleaching effect, the bleaching solution should be left on the tooth for the time recommended by the manufacturer. One product signals when the maximum effect of the application has occurred by altering its color (Shorn Hi-Light). The solution is rinsed off the teeth, and the tooth color is evaluated to determine any improvement. The patient must be asked if any tooth sensitivity is occurring. The number of applications to bring about the desired result is not necessarily predictable, although some discolorations (eg, tetracycline stains) are known to be more tenacious. The development of sensitivity is the single most important limitation to the number of applications per appointment. Appointments for subsequent treatment are scheduled 1 week apart to allow sensitivity to abate. Because the number of appointments necessary to achieve the desired whiteness is variable, the patient should be so informed and the fee per appointment set in advance.

Laser-Assisted In-Office Bleaching

Dental lasers have been advocated by manufacturers for use in bleaching. It is claimed that the laser provides a powerful energy source to enhance the action of the hydrogen peroxide by promoting a more rapid release of the bleaching agent. Some concern has been raised over the safety of this use of lasers. Effects on hard tissues depend on the type of laser used, as well as the exposure time. The temperatures created by this energy source, which are influenced by the absorptive properties of enamel and dentin, can be great. The temperature level is also a product of the type of laser used. The argon laser, when used for appropriate indications, generates very little temperature rise in the pulp.

Laser-Assisted In-Office Bleaching

One manufacturer recommends use of an argon laser with a wavelength of 488 nm for 30 seconds to accelerate the activity of the bleaching gel. The gel is left on the tooth for 3 minutes and then removed. This is repeated four to six times. One technique uses a CO_2 laser, after the procedure with the argon laser, to encourage deeper penetration of the peroxide into the tooth structure. Anecdotal reports have indicated that moderate to severe postprocedural pain and sensitivity may occur. In contrast, pulpal irritation or even necrosis has been demonstrated with the use of the CO2 laser. The American Dental Association does not recommend the use of the CO_2 laser for bleaching. Studies of laser bleaching to date have not indicated any better results than with other in-office techniques, and results possibly not as good as those obtained with at-home bleaching.

Laser-Assisted In-Office Bleaching

The argon laser can be used in place of a conventional curing light if the manufacturer's directions are carefully followed. It is important to remember that the hydrogen peroxide performs the bleaching, not the laser. The laser merely serves as a source of heat to activate the bleaching agent in the same way that a conventional curing light does. Its only potential advantage is its faster rate of supplying the heat. Its disadvantages are the cost of the laser itself, which translates to higher patient fees, and the potential for damage to pulpal tissues and the surrounding periodontal tissues.

At-Home Technique

At-home bleaching requires a proper dental and medical history, a clinical examination, radiographs of the teeth to be treated, and impressions for construction of the trays. After tray fabrication, an appointment for insertion is required, unless the tray can be fabricated while the patient waits. Some dentists like to see the patient on. weekly recall visits to assess progress and compliance, while others see the patient at the completion of treatment. One-arch treatment reduces the potential for side effects, the initial fee, and questions concerning the degree of progress. Having additional office visits during treatment may improve compliance, but often results only in higher fees. Plans for treatment of sensitivity and determination of total treatment time should be communicated to the patient during the first visit.

Tray Fabrication

There are several options for the type of tray fabricated for at-home bleaching. Generally, the tray de- sign choice depends on the type of material used, the concerns of the patient and dentist, and the type of tissue and teeth the patient has. Accurate impressions are critical to produce casts on which accurate vacuum-formed trays can be made. To fabricate the bleaching tray, it is beneficial to alter the casts in a manner that likely renders them unsuitable for other uses. Often the initial alginate impression can be properly handled and double-poured to provide an additional cast for other treatment needs. The cast for the bleaching tray should be trimmed to the thinnest and narrowest dimensions possible without damaging surfaces representing the teeth or periodontal structures.

Tray Fabrication

This is best done by trimming the cast, using a model trimmer, from the base rather than from the sides, until the vestibule is eliminated and a hole appears in the palate. The base of the cast should be as thin as 0.5 inch or trimmed to a horseshoe shape, leaving only the maxillary or mandibular teeth and periodontal tissues remaining with no palatal or tongue section included. The base should be fiat, with the central incisors perpendicular to it (Fig 15-16). This makes it easier to adapt the vacuum-formed tray material around the teeth and avoids the development of folds and wrinkles during fabrication. If the palate or tongue section remains, it is helpful to drill a hole through that section so that the vacuum better adapts the tray material in all areas of the cast.

Tray Fabrication

A number of materials have been used in tray fabrication, including materials used in fabricating orthodontic positioners, athletic mouthguards, provisional splints, and antisnoring devices. The original nightguard vital bleaching article proposed a thick, semirigid material. The newer materials that have been developed since that time are thinner and softer, easier to shape and trim, and have reduced gingival and occlusal side effects.

Tray Fabrication

There has been the concern that the inability of the shortened tray to hold the agent against the cervical portion of the tooth could initially produce an uneven bleaching effect by leaving a distinctly darker band at the cervical area. This, however, has not been shown to be the case. If an appropriate material is used and the patient situation does not dictate otherwise, the tray may contact or even cover gingival tissue with no problem. Watery solutions require tissue contact by the tray in order to maintain the bleaching material inside the tray. If tissue contact is preferred, the tray should not* extend into tissue undercuts or be tight enough to blanch tissue. Some clinicians do not cover the incisive papilla to avoid pressure on the underlying nerve. Termination of the tray borders should be smooth and not on the top of palatal rugae. Tori, exostoses, or thin areas of tissue, such as over the canine eminence, should not be covered if avoidable.

Tray Fabrication

These reservoir spaces are easy to form using a light-polymerized resin, supplied by manufacturers, which is placed 0.5 to 1.0 mm thick on the facial surfaces of the teeth of the cast, terminating 1.0 mm short of the gingival area and not extending into the embrasures. Other options are the application of fingernail polish, die spacer, or tin foil to the cast. The reservoir design should still allow the edge of the tray to contact the tooth. Spacers should not be placed in areas of occlusion (such as the incisal aspects of mandibular anterior teeth or the lingual aspects of maxillary anterior teeth), since the contact of the opposing teeth will displace the material from the tray.

Patient Instructions for At-Home Bleaching

Patient instructions should address: expectations and course of treatment; technique for applying the bleaching agent; frequency and length of time for wearing the tray; tooth sensitivity/tissue irritation problems; interim appointments; and variations in total fee related to course of treatment.

It is critical that the patient understands the process and can make appropriate adjustments in the protocol (eg, discontinuing tray wear for 1 or 2 days if sensitivity begins to develop). The patient must recognize any developing problems early and inform the dentist. While this is a dentist-supervised procedure, most of the process occurs out of the sight of the dentist, so the patient becomes the progress monitor. The patient should be instructed to place enough of the solution into the tray to cover the facial surfaces of the target teeth, which includes the most posterior tooth visible when the patient smiles, laughs, or talks. Seating and removing the tray should be demonstrated to ensure that there is no problem and that the patient is able to do so without undue difficulty or harm to the tray or the oral structures. To avoid tissue injury, the tray should be "peeled" from the second molar area rather than being "dug out with fingernails" in the canine region.

Instructions for Tray Wear

The patient should under- stand that he or she is to wear the tray for 4 or more hours per day/night, but that the specific consecutive 4-hour period is discretionary. Wear of less than 4 hours is a waste of the agent because the agent retains its potency for several hours.

Instructions for Tray Wear

One study demonstrated that 60% of the active agent remained after 4 hours?~ Probably the best option is for the patient to wear the tray during the sleep hours. Although the agent has lost most of its potency after 5 plus hours, compliance is much better when the bleaching treatment becomes part of a regular routine. If sensitivity is not a problem, the patient can even have two wearing periods per day. While this speeds the process, it is also likely to provoke tooth sensitivity, so the patient should be informed of this potential problem. After the loaded tray is seated, the patient should use a wet/damp cloth or finger to wipe the areas adjacent to the borders of the tray to clean away any excess. This is to remove any bleaching agent that has escaped the borders of the tray to prevent swallowing. The patient should be reminded to rinse and gently brush the tray after each session before storing it in a cool environment until the next bleaching session.

Instructions for Tray Wear

The bleaching process varies in the amount of time required. Some readily discernible improvement may occur within 2 to 14 days, or it may take as long as 6 to 12 months. The time depends on the type of discoloration, patient compliance, and whether or not any tooth sensitivity occurs. It may be helpful to re- call the patient after 5 to 7 days to check progress. The changes may occur somewhat slowly, albeit steadily, so the patient may forget the original shade. Therefore, the changes may not be readily noticeable to the patient. The patient can be shown the shade tab representing the original color to contrast with the new whiteness of the teeth, or the patient can compare the treated maxillary arch with the untreated mandibular arch. At the interim appointment, tray adjustments may be made if necessary. The protocol can be reviewed to ensure that the patient is following it correctly.

Instructions for Tray Wear

Alterations in protocol can be made to eliminate or minimize any problems or to speed the process. Some teeth may respond to bleaching more rapidly than others. More severely discolored and less responsive teeth may need more sessions of bleaching than others. When isolated problem teeth exist, one approach is to begin treatment of the problem tooth/teeth before the other teeth (Fig 15-18a to 15- 18c). Place the bleaching solution in the area(s) of the tray corresponding to the problem area for a few days before treating all the teeth. The patient should be made aware extra bleaching time for certain teeth may be necessary and that the problem tooth/teeth may become even more of a contrast for a short time because the other teeth whiten more rapidly. Some teeth exhibit a splotchy look as different portions of the tooth respond at different rates. The patient should be encouraged to continue treatment until the remainder of the tooth achieves the same color.