Mustansiriyah University
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Tooth discoloration & bleaching I

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PATIENT-RELATED CAUSES

Pulp Necrosis

Bacterial, mechanical, or chemical irritation to the pulp may result in tissue necrosis and release of disintegration by-products that may penetrate tubules and discolor the surrounding dentin. The degree of discoloration is directly related to how long the pulp has been necrotic. The longer the discoloration compounds are present in the pulp chamber, the greater the discoloration. Such discoloration can usually be bleached intracoronally.

Intrapulpal Hemorrhage

Intrapulpal hemorrhage and lyses of erythrocytes are a common result of traumatic injury to a tooth. Blood disintegration products, presumably iron sulfides, flow into the tubules and discolor the surrounding dentin. If the pulp becomes necrotic, the discoloration persists and usually becomes more severe with time. If the pulp recovers, the discoloration may be reversed, with the tooth regaining its original shade. The severity of such discoloration is time dependent; intracoronal bleaching is usually quite effective in this type of discoloration.

Causes of Tooth Discoloration

Patient-Related Causes	Dentist-Related causes
Pulp necrosis	Endodontically related
Intrapulpal hemorrhage	Pulp tissue remnants
Dentin hypercalcification	Intracanal medicaments
Age	Obturating materials
Tooth formation defects	Restoration related
-Developmental defects	Amalgams
-Drug-related defects	Pins and posts
	Composites

Dentin Hypercalcification

Excessive formation of irregular dentin in the pulp chamber and along canal walls may occur following certain traumatic injuries. In such cases, a temporary disruption of blood supply occurs, followed by destruction of odontoblasts. These are replaced by undifferentiated mesenchymal cells that rapidly form irregular dentin on the walls of the pulp lumen. As a result, the translucency of the crowns of such teeth gradually decreases, giving rise to a yellowish or yellow brown discoloration.

Extracoronal bleaching may be attempted first. However, sometimes root canal therapy is required followed by intracoronal bleaching.

Age

In elderly patients, color changes in the crown occur physiologically, a result of excessive dentin apposition, thinning of the enamel, and optical changes. Food and beverages also have a cumulative discoloration effect. These become more pronounced in the elderly, owing to the inevitable cracking, incisal wear of the enamel and underlying dentin. In addition, amalgam and other coronal restorations that degrade over time cause further discoloration. When indicated, bleaching can be successfully done for many types of discolorations in elderly patients.

TOOTH FORMATION DEFECTS

Developmental Defects

Discoloration may result from developmental defects during enamel and dentin formation, either hypocalcific or hypoplastic. Enamel ***hypocalcification*** is a distinct brownish or whitish area, commonly found on the facial aspect of affected crowns. The enamel is well formed with an intact surface.

Enamel ***hypoplasia*** differs from hypocalcification in that the enamel is defective and porous. This condition may be hereditary, as in amelogenesis imperfecta, or a result of environmental factors such as infections, tumors, or trauma. Presumably, during enamel formation, the matrix is altered and does not mineralize properly. The defective enamel is porous and readily discolored by materials in the oral cavity. In such cases, bleaching effect may not be permanent depending on the severity and extent of hypoplasia and the nature of the discoloration.

High fever during tooth formation may also result in chronologic hypoplasia, a temporary disruption in enamel formation that gives rise to banding-type surface discoloration. Porphyria, Amelogenesis imperfecta may result in yellow or brown discolorations. Dentinogenesis imperfecta can cause brownish violet, yellowish, or gray discoloration. These conditions are usually not amenable to bleaching and should be corrected by restorative means.

Drug-Related Defects

Administration or ingestion of certain drugs during tooth formation may cause severe discoloration both in enamel and dentin.

Tetracycline. This antibiotic was used extensively during the 1950s and 1960s for prophylactic protection and for the treatment of chronic obstructive pulmonary disease, *Mycoplasma*, and rickettsial infections. It was sometimes prescribed for long periods of time, years in some cases, and therefore was a common cause of tooth discoloration in children. Although, today, tetracycline is not usually administrated chronically, dentists still face the residue of damage to the appearance of the teeth of the prior two generations.

Tooth shades can be yellow, yellow-brown, brown, dark gray, or blue, depending on the type of tetracycline, dosage, duration of intake, and patient’s age at the time of administration. Discoloration is usually bilateral, affecting multiple teeth in both arches. Deposition of the tetracycline may be continuous or laid down in stripes depending on whether the ingestion was continuous or interrupted.

The mechanism of tetracycline discoloration is not fully understood. Tetracycline bound to calcium is thought to be incorporated into the hydroxyapatite crystal of both enamel and dentin. However, most of the tetracycline is found in dentin.
Tetracycline discoloration has been classified into three groups according to severity. **First-degree discoloration** is light yellow, light brown, or light gray and occurs uniformly throughout the crown, without banding. **Second-degree discoloration** is more intense and also without banding. **Third-degree discoloration** is very intense, and the clinical crown exhibits horizontal color banding. This type of discoloration usually predominates in the cervical regions.

Endemic Fluorosis. Ingestion of excessive amounts of fluoride during tooth formation may produce a defect in mineralized structures, particularly in the enamel matrix, causing hypoplasia. The severity and degree of subsequent staining generally depend on the degree of hypoplasia and are directly related to the amount of fluoride ingested during odontogenesis. The teeth are not discolored on eruption, but their surface is porous and will gradually absorb colored chemicals present in the oral cavity.
Discoloration is usually bilateral, affecting multiple teeth in both arches. It presents as various degrees of intermittent white spotting, chalky or opaque areas, yellow or brown discoloration, and, in severe cases, surface pitting of the enamel. Since the discoloration is in the porous enamel, such teeth can be bleached externally.

DENTIST-RELATED CAUSES

Discolorations owing to various dental materials or unsuitable operating techniques do occur; such dentist related discolorations are usually preventable and should be avoided.

Endodontically Related

Pulp Tissue Remnants: Tissue remaining in the pulp chamber disintegrates gradually and may cause discoloration. Pulp horns must always be included in the access cavity to ensure removal of pulpal remnants and to prevent retention of sealer at a later stage. Intracoronal bleaching in these cases is usually successful.

Intracanal Medicaments: Several intracanal medicaments are liable to cause internal staining of the dentin. Phenolics or iodoform-based medicaments sealed in the root canal and chamber are in direct contact with dentin, sometimes for long periods, allowing penetration and oxidization. These compounds have a tendency to discolor the dentin gradually.

Obturating Materials: This is a frequent and severe cause of single tooth discoloration. Incomplete removal of obturating materials and sealer remnants in the pulp chamber, mainly those containing metallic components, often results in dark discoloration. This is easily prevented by removing all materials to a level just below the gingival margin.
Intracoronal bleaching is the treatment of choice; prognosis, however, in such cases depends on the type of sealer and duration of discoloration.

Restoration Related

Amalgams: Silver alloys have severe effects on dentin owing to dark-colored metallic components that can turn the dentin dark gray. When used to restore lingual access preparations or a developmental groove in anterior teeth, as well as in premolar teeth, amalgam may discolor the crown. Such discolorations are difficult to bleach and tend to rediscolor with time. Sometimes the dark appearance of the crown is caused by the amalgam restoration that can be seen through the tooth structure. In such cases, replacing the amalgam with an esthetic restoration usually corrects the problem.

Pins and Posts:
Metal pins and prefabricated posts are sometimes used to reinforce a composite restoration in the anterior dentition. Discoloration from inappropriately placed pins and posts is caused by the metal seen through the composite or tooth structure. In such cases, coverage of the pins with a white cement or removal of the metal and replacement of the composite restoration is indicated.

Composites: Microleakage around composite restorations causes staining. Open margins may allow chemicals to enter between the restoration and the tooth structure and discolor the underlying dentin. In addition, composites may become discolored with time, affecting the shade of the crown. These conditions are generally corrected by replacing the old composite restoration with a new, well-sealed one.

BLEACHING MATERIALS

Many different bleaching agents are available today; the ones most commonly used are hydrogen peroxide, sodium perborate, and carbamide peroxide. Hydrogen peroxide and carbamide peroxide are mainly indicated for extracoronal bleaching, whereas sodium perborate is used for intracoronal bleaching.

Hydrogen Peroxide :Various concentrations of this agent are available, but 30 to 35% stabilized aqueous solutions (Superoxol, Perhydrol Merck.) are the most common. Silicone dioxide gel forms containing 35% hydrogen peroxide are also available, some of them activated by a composite curing light.

Hydrogen peroxide is caustic and burns tissues on contact, releasing toxic free radicals, perhydroxyl anions, or both. High-concentration solutions of hydrogen peroxide must be handled with care as they are thermodynamically unstable and may explode unless refrigerated and kept in a dark container.

Sodium Perborate: This oxidizing agent is available in a powdered form or as various commercial preparations. When fresh, it contains about 95% perborate, corresponding to 9.9% of the available oxygen. Sodium perborate is stable when dry. In the presence of acid, warm air, or water, however, it decomposes to form sodium metaborate, hydrogen peroxide, and nascent oxygen. Three types of sodium perborate preparations are available: monohydrate, trihydrate, and tetrahydrate. They differ in oxygen content, which determines their bleaching efficacy. Commonly used sodium perborate preparations are alkaline, and their pH depends on the amount of hydrogen peroxide released and the residual sodium metaborate.

Sodium perborate is more easily controlled and safer than concentrated hydrogen peroxide solutions. Therefore, it should be the material of choice in most intracoronal bleaching procedures.

Carbamide Peroxide :This agent, also known as urea hydrogen peroxide, is available in the concentration range of 3 to 45%.However; popular commercial preparations contain about 10% carbamide peroxide, with a mean pH of 5 to 6.5 **.** Solutions of 10% carbamide peroxide break down into urea, ammonia, carbon dioxide, and approximately 3.5% hydrogen peroxide.

BLEACHING MECHANISM

The mechanism of tooth bleaching is unclear. It differs according to the type of discoloration involved and the chemical and physical conditions at the time of the reaction. Bleaching agents, mainly oxidizers, act on the organic structure of the dental hard tissues, slowly degrading them into chemical by-products, such as carbon dioxides, that are lighter in color. Inorganic molecules do not usually break down as well. The oxidation- reduction reaction that occurs during bleaching is known as a redox reaction. Generally, the unstable peroxides convert to unstable free radicals. These free radicals may oxidize (remove electrons from) or reduce (add electrons to) other molecules.
Most bleaching procedures use hydrogen peroxide because it is unstable and decomposes into oxygen and water. The **mouth guard** bleaching technique employs mainly carbamide peroxide as a vehicle for the delivery of lower concentrations of hydrogen peroxide, which require more exposure time. The rate of hydrogen peroxide decomposition during mouth guard bleaching depends on its concentration and the levels of salivary peroxidase. With high levels of hydrogen peroxide, a zero-order reaction occurs, so that the time required to clear the hydrogen peroxide is proportional to its concentration. The longer it takes to clear the hydrogen peroxide, the greater the exposure to reactive oxygen species and their adverse effects.

BLEACHING TECHNIQUES FOR ENDODONTICALLY TREATED TEETH

Intracoronal bleaching of endodontically treated teeth may be successfully carried out many years after root canal therapy and discoloration. A successful outcome depends mainly on the etiology, correct diagnosis, and proper selection of bleaching technique.
The methods most commonly employed to bleach endodontically treated teeth are the **walking bleach** and the **thermocatalytic** techniques. Walking bleach is preferred since it requires less chair time and is safer and more comfortable for the patient.

The walking bleach technique should first be attempted in all cases requiring ***intracoronal*** bleaching. It involves the following steps:

1. Familiarize the patient with the possible causes of discoloration, procedure to be followed, expected outcome, and possibility of future rediscoloration.

2. Radiographically assess the status of the periapical tissues and the quality of the endodontic obturation. Endodontic failure or questionable obturation should **always be re-treated** prior to bleaching.

3. Assess the quality and shade of any restoration present and replace if defective. Tooth discoloration frequently is the result of leaking or discolored restorations. In such cases, cleaning the pulp chamber and replacing the defective restorations will usually suffice.

4. Evaluate tooth color with a shade guide and, if possible, take clinical photographs at the beginning of and throughout the procedure. These provide a point of reference for future comparison.

5. Isolate the tooth with a rubber dam. The dam must fit tightly at the cervical margin of the tooth to prevent possible leakage of the bleaching agent onto the gingival tissue. Interproximal wedges and ligatures may also be used for better isolation. If Superoxol is used, a protective cream, such as Orabase or Vaseline, must be applied to the surrounding gingival tissues prior to dam placement.

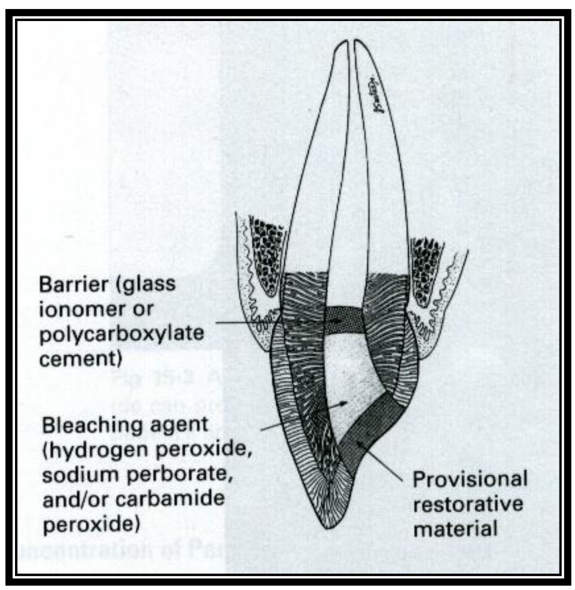
6. Remove all restorative material from the access cavity, expose the dentin, and refine the access. Verify that the pulp horns and other areas containing pulp tissue are clean.

7. Remove all materials to a level just below the labial-gingival margin. ***Orange solvent***, chloroform, or xylene on a cotton pellet may be used to dissolve sealer remnants. Etching the dentin with phosphoric acid is unnecessary and may not improve the prognosis.

8. Apply a sufficiently thick layer, at least 2 mm, of a protective white cement barrier, such as **polycarboxylate cement**, **zinc phosphate cement**, **glass ionomer**, ***IRM*** or ***Cavit*** to cover the endodontic obturation. The coronal height of the barrier should protect the dentinal tubules and conform to the external epithelial attachment.

9. Prepare the walking bleach paste by mixing sodium perborate and an inert liquid, such as water, saline, or anesthetic solution, to a thick consistency of wet sand. Although a sodium perborate and 30% hydrogen peroxide mixture bleaches faster, in most cases, long-term results are similar to those with sodium perborate and water alone and therefore need not be used routinely. With a plastic instrument, pack the pulp chamber with the paste. Remove excess liquid by tamping with a cotton pellet. This also compresses and pushes the paste into all areas of the pulp chamber.

10. Remove excess bleaching paste from undercuts in the pulp horn and gingival area and apply a thick well-sealed temporary filling (preferably ***IRM***) directly against the paste and into the undercuts. Carefully pack the temporary filling, at least 3 mm thick, to ensure a good seal.



11. Remove the rubber dam and inform the patient that bleaching agents work slowly and significant lightening may not be evident for several days.

12. Evaluate the patient 2 weeks later and, if necessary, repeat the procedure several times. Repeat treatments are similar to the first one.

13. As an optional procedure, if initial bleaching is not satisfactory, strengthen the walking bleach paste by mixing the sodium perborate with gradually increasing concentrations of hydrogen peroxide (3 to 30%) instead of water. The more potent oxidizers may have an enhanced bleaching effect but are not used routinely because of the possibility of permeation into the tubules and damage to the cervical periodontium by these more caustic agents.

Thermocatalytic

This technique involves placement of the oxidizing chemical, generally 30 to 35% hydrogen peroxide ***(Superoxol)***, in the pulp chamber followed by heat application either by electric heating devices or specially designed lamps. Potential damage by the thermocatalytic approach is external **cervical root resorption** caused by irritation to the cementum and periodontal ligament. This is possibly attributable to the oxidizing agent combined with heating.
Therefore, application of highly concentrated hydrogen peroxide and heat during intracoronal bleaching is questionable and should not be carried out routinely.

Ultraviolet Photo-Oxidation

This technique applies ultraviolet light to the labial surface of the tooth to be bleached. A 30 to 35% hydrogen peroxide solution is placed in the pulp chamber on a cotton pellet followed by a 2-minute exposure to ultraviolet light. Supposedly, this causes oxygen release, like the thermocatalytic bleaching technique.