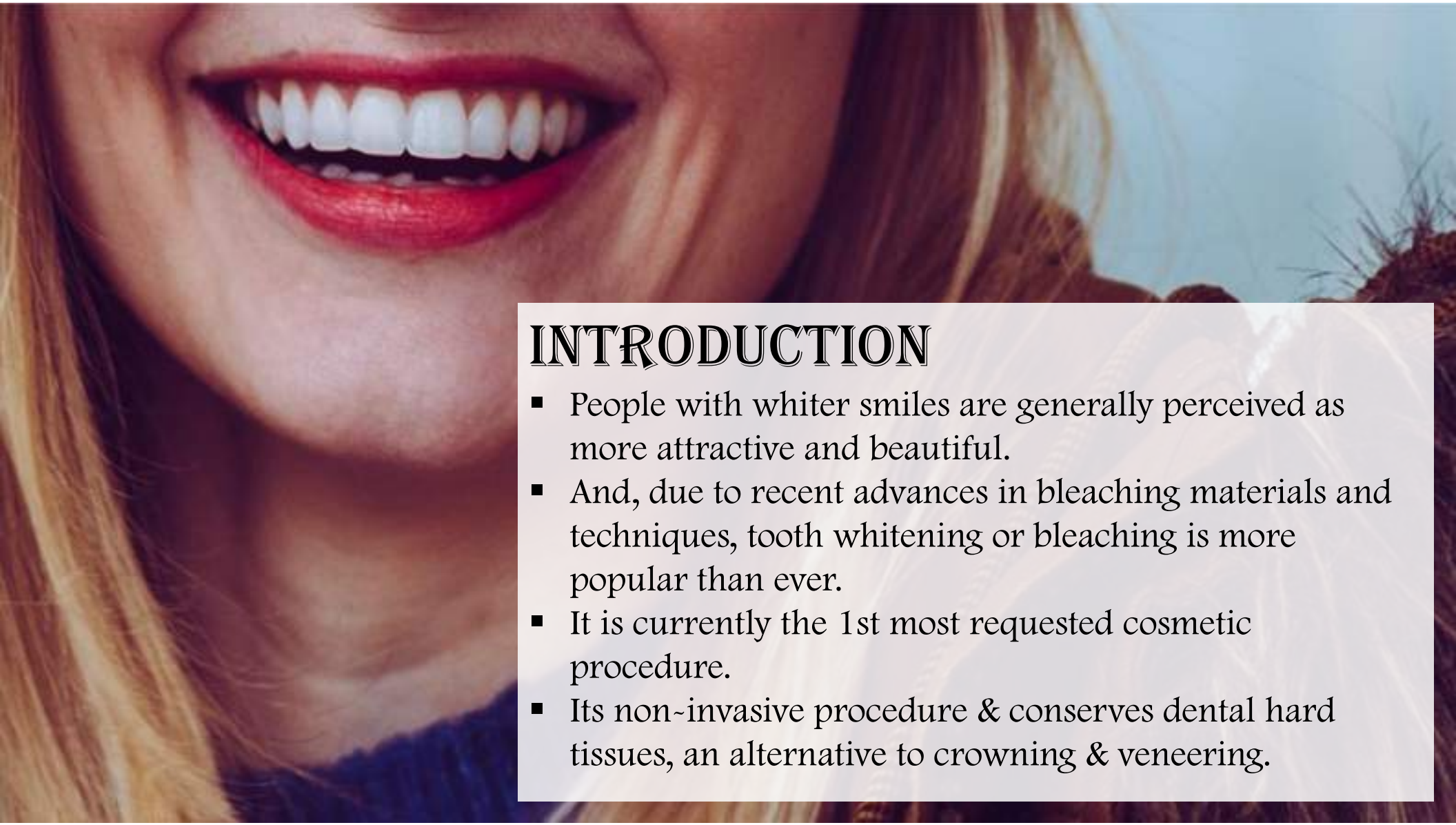
Sri Aurobindo College of Dentistry

Indore, Madhya Pradesh

INDIA

Module plan

- Topic : Bleaching
- Subject: Endodontics
- Target Group: Undergraduate Dentistry
- Mode: Powerpoint – Webinar
- Platform: Institutional LMS
- Presenter: Dr.Sanket Hans Pandey



INTRODUCTION

- People with whiter smiles are generally perceived as more attractive and beautiful.
- And, due to recent advances in bleaching materials and techniques, tooth whitening or bleaching is more popular than ever.
- It is currently the 1st most requested cosmetic procedure.
- Its non-invasive procedure & conserves dental hard tissues, an alternative to crowning & veneering.

HISTORY

1300

- The most requested dental service other than extraction was tooth whitening.

1400

- Guy De Chauliac cleaned teeth with honey and burnt salt to which some vinegar was added.

1800

- Barbers surgeons applied a solution of nitric acid (Aquafortis), after abrading enamel with coarse metal files to whiten teeth.

1864

- Truman used chlorine and acetic acid for non vital tooth bleaching known as Labarrque's solution.

1877	• The first publication of bleaching was by Chapple, the agent of his choice was oxalic acid.
1884	• Harlan used hydrogen peroxide for the first time which he called as hydrogen dioxide.
1960	• Home bleaching was introduced by Klusmier.
1976	• Nutting and Poe introduced the Walking bleach technique.
1996	• Reyto introduced Laser tooth whitening.

- **Tooth bleaching or tooth whitening** is the process of lightning the color of human teeth.
- Whitening is often desirable when teeth become stained over time for a number of reasons.
- The chemical degradation of the chromogens within or on the tooth is termed as bleaching.

INDICATION

- Mild discoloration on surface
- Evenly distributed discolorations without bands or white spots
- Teeth discolored as their innate colors or ageing
- Hemorrhagic discoloration
- Discoloration of anterior teeth after RCT
- Medication discoloration

CONTRAINDICATION

- Sensitive teeth i.e. severe cases of attrition, abrasion, erosion or abfraction.
- Cracks, hypoplastic or severely undermined enamel.
- Extensive restorations.
- Discolorations in the gray, blue gray or black range .
- Discoloration by metallic salts, particularly silver amalgam.
- Generalized dental caries
- Peroxide allergy: A carefully applied rubber dam can help prevent reactions.



- Primary teeth are bluish white in color.
- Permanent teeth are grayish yellow, grayish white, or yellowish white.
- The color of the teeth is determined by translucency and thickness of enamel, thickness and color of underlying dentin and color of pulp.

- For bleaching to be successful, dentist should correctly diagnose the type, intensity and location of the tooth discoloration.
- **Tooth discoloration** is abnormal tooth color, hue or translucency may be physiologic, or pathologic and endogenous or exogenous in nature.

CLASSIFICATION

DISCOLORATION

Intrinsic discoloration

Metabolic
Inherited
Iatrogenic
Traumatic
Medication
Aging

Extrinsic discoloration

Dietary
Habits (Tobacco)
Gingival diseases
Bacterial, CHX, Metal salts, etc.

Internalized discoloration

Dental caries
Dental defects (gingival recession, tooth wear)
Restorative materials, etc.

INTRINSIC DISCOLORATION

1. Metabolic causes:
   - Alkaptonuria-brown
   - Congenital erythropoietic porphyria-red-brown
   - Congenital hyperbilirubinemia-yellow green

2. Inherited causes of discoloration:
   - Amelogenesis Imperfecta
   - Dentinogenesis Imperfecta
   - Dentinal dysplasia
   - Systemic syndrome

3. Iatrogenic causes:
   - Endodontic- Pulp tissue remnants, Intracanal & Obturating materials
   - Restorative- Amalgam fillings, Pins& posts, Composites

4. Traumatic causes:

- **Pulpal necrosis:**
  - Bacterial, mechanical, or chemical irritation to the pulp may result in tissue necrosis and release of disintegration byproducts that may penetrate tubules and discolor the surrounding dentin.
  - Trauma leads to rupture of vessels, causing diffusion of blood into dentinal tubules.

  - Breakdown of erythrocytes occur, which result into breakdown of haemoglobin into chromatic compounds such as hemin, hematin, hematidine, hematoporphyrin and hemosiderin.
  - Immediately- dark pink, After some time- pinkish brown
  - Sometimes hydrogen sulphide produced by bacteria combine with haemoglobin to darken tooth.

- **Pre-eruption trauma:**
  Discoloration of a permanent tooth may occur after trauma to its primary counterpart.

- **Dentin hyper-calcification:**
  - During trauma 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 crown gradually decreases, giving rise to a yellowish or yellow-brown discoloration.

5. Medication:

- **Tetracycline staining:**

TETRACYCLINE- A broad-spectrum bacteriostatic antibiotic.

- First reported in mid1950s, less than a decade after its widespread use.
- Its administration during odontogenesis causes discoloration of both primary & secondary dentitions.
- The brown discoloration is due to photo-oxidation.
- Staining effect- Chelation of tetracycline molecules with Ca ions in hydroxyapatite, primarily in dentine (Swift 1998).
- The chelated molecules arrive at the mineralizing predentine-dentine junction via the terminal capillaries of the dental pulp (Patel et al 1998).

- **Fluoride staining:**

- May arise endemically from naturally occurring water supplies or from fluoride delivered in mouth rinses, tablets or toothpastes as a supplement.

- High concentration of fluoride in excess of 1 ppm is believed to cause a metabolic alteration in the ameloblasts resulting in defective matrix and improper calcification.

- Appears as white or brown patches of irregular shape & form.
- The acquisition of stain is post-eruptive—surface is porous— absorb the colored chemicals (Rotstein 1998).

6. Aging:

- With age Enamel becomes thinner.
- Dentin becomes thicker- Yellow or grayish yellow
- Physiologic deposition of secondary dentin

affects the light transmitting properties of teeth resulting in more opaque hue.

<u>Discoloration due to dental caries:</u>

- Opaque, white halo or gray discoloration.
- Bacterial degradation of food debris in areas of

tooth decay or decomposing filling can cause even deeper brown to black discolorations.

EXTRINSIC DISCOLORATION

- Extrinsic tooth discoloration has been classified according to its origin
  - Metallic
  - Non-metallic.

- **Metallic staining** of teeth may be associated with occupational exposure to metallic salts and with a number of medicines containing metal salts.
  - Potassium permanganate in mouth rinses
  - Violet to black color
  - Stannous fluoride- Golden brown
  - Silver nitrate salt- Grey color

- **Non-metallic extrinsic stains** are adsorbed onto tooth surface deposits such as plaque or the acquired pellicle.
  - Tobacco(smoking)
  - Tea stain
  - Coffee stain
  - Stain induced by use of chlorhexidine mouthwash
  - Stain from use of antibiotics Green stain from chromogenic bacteria



A newer classification of extrinsic stains based on chemistry was put forth by Nathoo in 1997:

❖ **N1 type or direct dental stains:**
Chromogen bind to tooth surface and causes discoloration

❖ **N2 type or direct dental stains:**
Chromogen changes color after binding to tooth surface

❖ **N3 type or indirect dental stains:**
Colorless material or pre-chromogen binds to tooth and undergoes chemical reaction to cause stain.

CHEMISTRY OF BLEACHING

- The process of bleaching is based on the oxidation of the bleaching agent.
- Oxidation is the chemical process by which organic materials are converted into carbon dioxide and water.

- The oxidation-reduction reaction that takes place in the bleaching process is called the REDOX REACTION.

- In the process of bleaching, tooth is considered as the reducing agent and bleaching material is the oxidizing agent.
- After bleaching, tooth is oxidized i.e. organic pigment of tooth is oxidized and the bleaching material is reduced.

MECHANISM OF BLEACHING

Principle: Oxidizing agent reaches the sites within enamel and dentin to allow a chemical reaction to occur between the discolored segment and active ingredient. Bleaching is a slow transformation of organic substance into chemical intermediates lighter in color than original.

Chromogens (unsaturated double carbon bonds) + Bleaching agent

↓

Low molecular weight organic molecules (relatively colorless)-saturated carbon bonds .

- Bleaching agents break the pigmented carbon rings and convert them to carbon chains.
- Carbon chains are further broken down to hydroxyl group, amount of light absorbed in reduced.
- Hence tooth appears light in color.

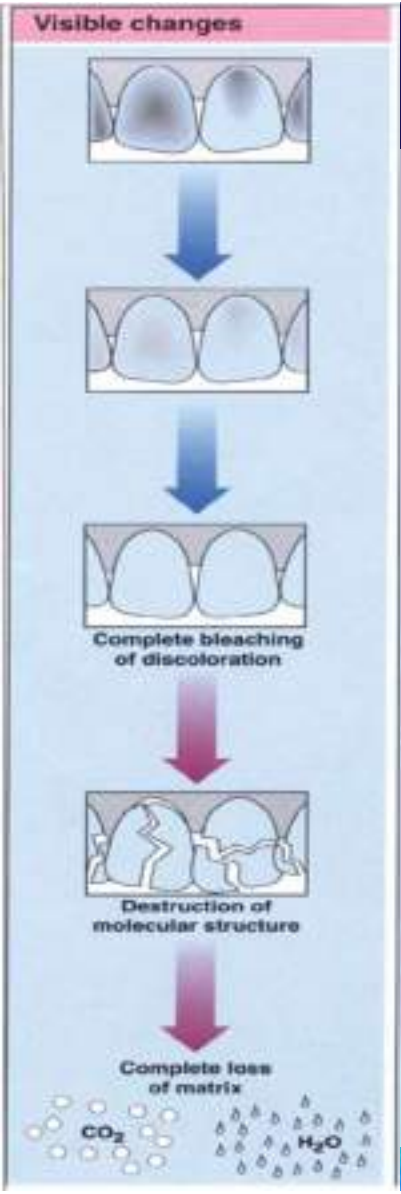
SATURATION POINT

- As bleaching proceeds, a point is reached at which only hydrophilic structure exist.

This is the material's SATURATION POINT.

- If bleaching process is allowed to continue, it begins to breakdown the carbon backbone of proteins to form CO_2 & water.

- <u>Clinical significance:</u>
- The dentist should know that bleaching must be stopped at or before the saturation point, since the material loss (tooth brittleness & increased porosity) would be greater than any gain in tooth whitening.
- Optimal bleaching achieves maximum whitening, while over bleaching degrades tooth enamel without further whitening.



BLEACHING AGENTS

❖ HYDROGEN PEROXIDE

- Clear, colorless, odorless unstable liquid stored in light proof amber bottles.
- Various concentrations of this agent are available, but 30 to 35% stabilized aqueous solutions (Superoxol) are the most common.
- Amount of chemical used for bleaching is 1-2 ml
- Can alone be used or mixed with sodium perborate into a paste for use in the 'Walking bleach'.
- Ischemic effect on skin and mucous membrane causes chemical burn

❖ SODIUM PERBORATE

- Stable, water soluble, white powder, supplied in granular form.
- It is available in a powdered form or as various commercial preparations.

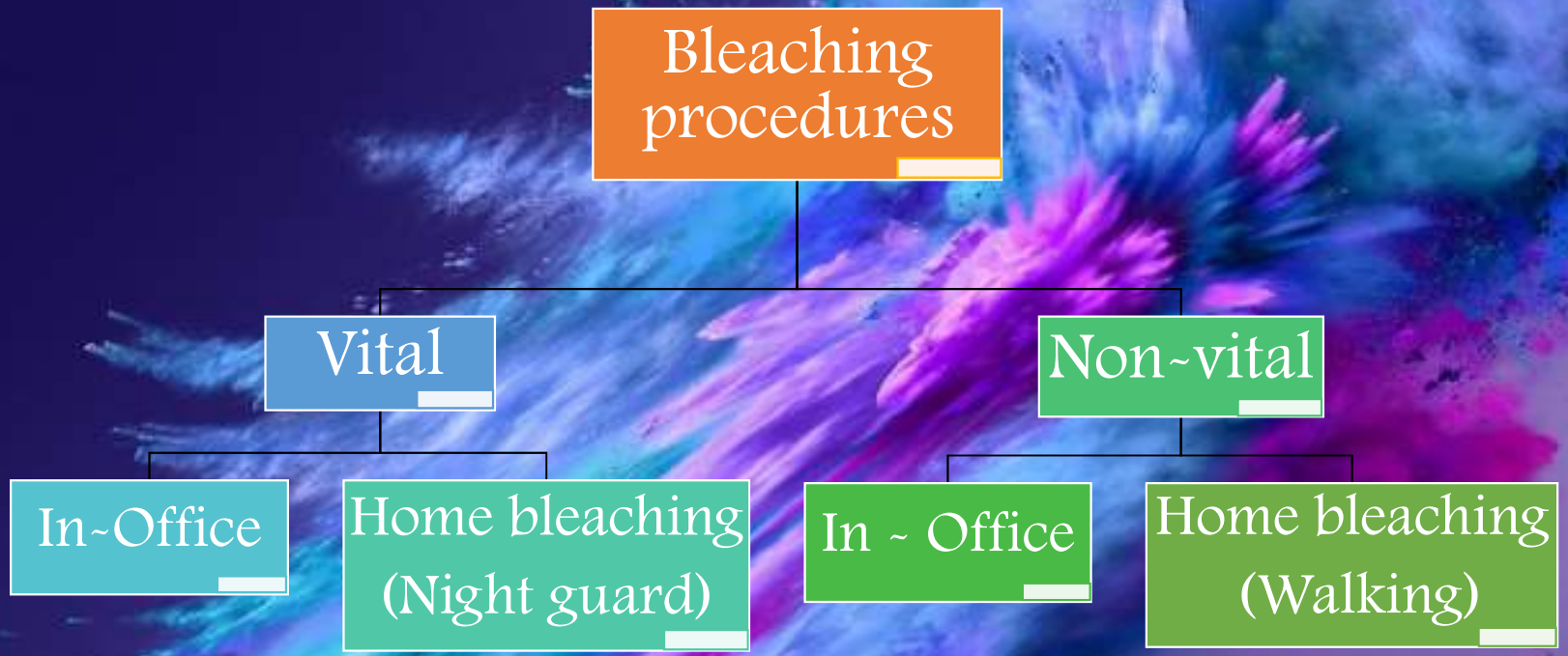
- THREE TYPES:
- They differ in oxygen content,
  - Sodium perborate Monohydrate
  - Sodium perborate Trihydrate
  - Sodium perborate Tetrahydrate

- It decomposes into sodium metaborate and hydrogen peroxide releasing oxygen.

❖ CARBAMIDE PEROXIDE (UREA HYDROGEN PEROXIDE)

- It is a bi-functional derivative of carbonic acid
- Concentration ranges from 3 to 45% .
- Commercial solution have concentration of 10% which breakdown into urea, ammonia, carbon dioxide.
- H_2O_2 is the active ingredient whereas urea raises the pH of the solution
- Bleaching preparations containing carbamide peroxide usually also include Carbopol, urea, glycerin, preservatives and flavoring agents.

BLEACHING PROCEDURES



VITAL BLEACHING

- The techniques used for bleaching of vital teeth

❖ **IN-OFFICE BLEACHING:**

- Also called as Chairside bleaching.
  - Thermo/Photo Bleaching
  - Bleaching using Mc Innes solution
  - Power Bleaching

❖ **DENTIST PRESCRIBED HOME BLEACHING:**

- Matrix bleaching-or night guard vital bleaching

❖ **OVER-THE-COUNTER KITS:**

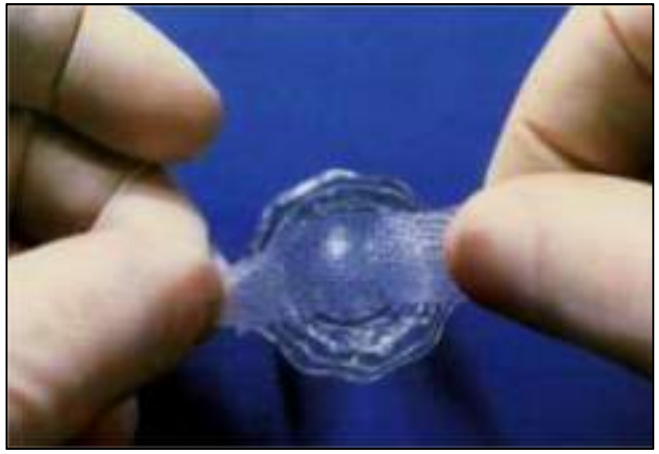
- Whitening strips
- Whitening pastes
- Tray-based bleaching systems

IN-OFFICE VITAL BLEACHING

- Higher concentrations of H_2O_2 (25-40%) are used in the clinics to achieve quicker tooth lightening.
- In-office bleach, with its immediate positive outcome, can kick-start a home bleaching regimen.
- The treatment in office mandatorily needs isolation and protection, owing to the caustic nature of the high concentration of H_2O_2.

Etching (37%phosphoric acid)

Wash after 10 secs



Wet the gauze with SUPEROXOL

Apply saturated gauze on teeth

Conventional light source

Add new solution every 4~5 min

POWER BLEACHING

- The oxidation potential of H_2O_2 can be intensified by exposure to heat, LASERs, or intense blue light with a spectrum of wavelength between 480 nm and 520 nm,
either to activate the bleaching agent or decrease the time required for bleaching.

- **ADVANTAGES**
  - Time factor(fast result)
  - Avoids problems of home bleaching
- **DISADVANTAGES**
  - Caustic nature of 35-50% H_2O_2
  - Increased in office time
  - Dehydration of teeth-false light shade
  - Expensive

❖ Energizing/activating source

HEAT:

- Heat up bleach by using one of two methods:
  - immerse the bleaching material in water bath at 80C;
  - or boil bleach in a crucible over flame or with hot air.

- It should be heated until it starts bubbling.
- Place bleach on tooth for 2 minutes.
- Remove it with gauze piece and don't use water spray as it will cool down tooth.
- Apply 3-4 times for 2-3 minutes each for 20 minutes.

TUNGSTEN-HALOGEN CURING LIGHT:

- Tungsten-halogen light provide heat and activate chemical reactions.
- Time consuming process(40-60sec/tooth)
- This heat increases the further breakdown of H_2O_2 into free radicals by increasing its activity.
- LED lamps emit cold blue light of 465 nm can be used for 15- 20 minutes.

XENON PLASMA ARC LIGHT:

- Plasma arc lamps significantly contribute to effective bleaching using HP without thermal changes as it releases energetic ions, free electrons, and hydroxyl radicals.
- A full-smile illuminator is kept a few centimeters ahead of teeth in the usual protocol of three 10-min passes to activate 35% HP.
- They emit high intensity light of blue-green spectrum having short wavelength 380-500 nm.
- Adv: Very fast-3sec/tooth
- Dis adv: Thermal trauma to the pulp and surrounding soft tissues

LASERS:

- When the source of activation is laser it is known as laser bleaching technique.
- Application-1 to 2 W of laser energy for 30 seconds per tooth.

Types of lasers:

- **1. Argon laser:** (488 nm)
  - Blue light is absorbed by dark stains
  - Action is to stimulate the catalyst in the chemical.

- **Carbon dioxide laser:** (10,600nm)
  - Invisible infrared light, energy is emitted in heat
  - Directly interacts with catalyst/peroxide
  - Deeper penetration
- **Diode laser light:** (830 and 980 nm)
  - It is ultra fast takes 3-5 sec to activate the bleaching agent

- **Advantages**
  - No thermal effect
  - Less dehydration of enamel
  - Less time(10sec/tooth)
  - It may act as a jump start for difficult cases by helping to remove difficult stains caused by tetracycline and fluorosis.
- **Disadvantages**
  - Expensive
  - Post operative sensitivity can be high

ULTRASONICS

- Ultrasonics, an expedite method of in-office bleaching has been recently introduced.
- Ultrasonic energy is used to enhance bleaching by placing 6–7.5% HP within custom-made trays in either arch for approximately two cycles of 5 min each.
- It is thought that ultrasonic energy may result in an increased production of free radicals.
- Other than hastening the chemical reaction, the current research on whitening literature using ultrasonics observes no added benefits.

HOME VITAL BLEACHING

- Dentist prescribed home bleach technique.
- Introduced by Dr. Van Haywood and Dr. Harald Haymann in 1989.

- Home bleaching is a simple technique whereby, after an initial consultation with the dentist, a mouth guard or tray is made to bleach teeth.

- The patient is given the bleaching materials (normally 10% carbamide peroxide) to take home together with a bleaching protocol.

- The patient applies the bleaching material into the tray.
- The tray with the material is worn for several hours during the day or at night depending on the patient's schedule, while the teeth are allowed to lighten.

Pre-existing shade evaluation

Alginate impression

Fabrication of bleaching tray

Brushing & Flossing

Placement of Bleaching agent

Application of loaded tray

- Familiarize the patient with the use of bleaching agent and wearing the guard.
- Instruct the patient that this procedure should be performed 3-4 hours per day or over night.
- Recall the patient every 2 weeks to monitor stain lightening.
- 10% carbamide peroxide is used for this technique, this can be later increased to 16%,or up to 20% as per the case requirement.

- <u>DISADVANTAGES:</u>
  - Soft tissue irritation.
  - Altered taste sensation
  - Tooth thermal sensitivity

BLEACHING USING McInnes Solution

- Dr. Walter Kane in 1916 used HCl to successfully remove the fluorosis stains.
- In the year 1937 Ames reported an alternative for removing fluorosis using hydrogen peroxide instead of hydrochloric acid.
- Later it was McInnes who reported a technique where hydrogen peroxide, hydrochloric acid and ethyl ether were used.
- This technique has been found to be successful for bleaching the teeth of patients with endemic fluorosis.

McInnes Solution (pH~4.6)	
CONSTITUENTS	**RATIO**
30% H_2O_2	5 parts
36% HCl	5 parts
0.2% Ether	1 part

- HCL has some deleterious effects such as
  - Loss of contour
  - Irritation of gingiva
  - Sensitivity of teeth

- Chen, Xu and Shing (1993)
  - Replaced HCL by NaOH 20%
  - NaOH is highly alkaline in nature and therefore dissolves calcium at a
  - slower rate.
  - Loss of contour is minimized.(Nagarani et al)

McInnes Solution (pH-9)	
CONSTITUENTS	RATIO
30% H_2O_2	1 parts
20% NaOH	1 parts
0.2% Ether	1 part

Procedure:

- The solution should be freshly mixed and applied directly to the enamel surface for 5min at 1-min interval
- On completion of the bleaching, the solution is neutralized with a Sodium bicarbonate solution and copious irrigation with water.
- Bleached surface should be polished with disc and a prophylactic paste.
- Procedure may have to be repeated 2 or 3 times before the desired shade is obtained.

OVER-THE-COUNTER KITS

BLEACHING STRIPS

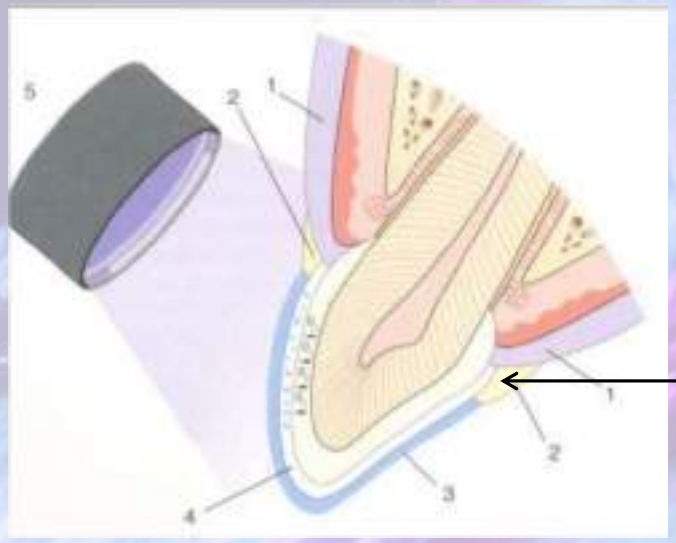
- The Trayless Approach to Tooth Whitening
- Whitening strip system with 6.5%HP.
- 30 minutes twice daily for 21 days.
- Thin, flexible polyethylene strips coated with HP on one side.

Advantages:

- No tray is needed
- Less visible
- No gagging, salivation, speech problem, jaw joint problem.
- More convenient & compatible

COMPRESSIVE BLEACHING TECHNIQUE

- This technique, reported by Miara, suggests that the Power bleaching technique can be made more effective by compressing the gel against the teeth.
- In order to enable the permeation of oxidizing ions through the enamel, the nascent oxygen must be guided under pressure.
- The procedure involves the usual isolation and placement of 35 % hydrogen peroxide gel in custom made tray, which is put in place and any excess material is removed before the lingual and buccal edges of the tray are sealed with light cured resin material to prevent any leakage during decomposition.



Sealing the margin of the tray with composite resin.

- Once edges are sealed , the gel is activated using either a halogen light or plasma arc.
- After 30 minutes the gel and isolation are removed and teeth are washed . Sealing the margin of the tray with composite resin

NON-VITAL BLEACHING

- Darkening and loss of translucency in teeth may follow loss of vitality, both before and subsequent to endodontic therapy.

- It is seen in cases of,
  - Acute trauma.
  - Seepage of toxins from a necrotic pulp
  - Staining form medicaments, cements, metal posts , or the optical effects of dehydration.

- Successful bleaching depends upon two important criteria-
  - The root canal obturation must be complete 3-dimensionally.
  - The remaining tooth structure must be intact.

ALKAPTONURIA

- Alkaptonuria is a rare inherited autosomal recessive condition.

ETIOLOGY:

- Alkaptonuria is caused by a mutation on homogentisate 1,2-dioxygenase (HGD) gene.
- It occurs when body cannot produce enough of HGD enzyme.
- This enzyme is used to break down a toxic substance called homogentisic acid. When enough of HGD is not produced, homogentisic acid builds up in body.
- The build up of homogentisic acid causes teeth, bones and cartilage to become discolored and brittle.

TREATMENT:

- No specific treatment for alkaptonuria.
- Low-protein diet, large doses of ascorbic acid, or vitamin C, to slow down the accumulation of homogentisic acid
- Symptomatic relief

CONGENITAL ERYTHROPOIETIC PORPHYRIA

- Rare, inherited, autosomal blood disorder

ETIOLOGY

- Heme part of Hb is made up of certain enzymes such as porphyrin.
- Error in porphyrin metabolism leading to the accumulation of porphyrins in bone marrow, red blood cells, urine, faeces and teeth causing reddish brown discoloration.

TREATMENT

- Symptomatic relief.
- Hematin supplements
- Gene therapies, such as givosiran.

FLUOROSIS

- Fluorosis is a crippling disease resulted from deposition of fluorides in the hard and soft tissues of body.

ETIOLOGY

- Fluorosis is caused by excessive intake of fluorides from multiple sources. However, drinking water is the most significant source.

MECHANISM OF FLUOROSIS

- Fluoride being an electronegative element, having a negative charge is attracted by positively charged ions like calcium.
- Bone and teeth having highest amount of calcium in the body, attract the maximum amount of fluoride and is deposited as calcium fluorapatite crystals.

DEAN FLUOROSIS INDEX

Table 1 Restorative treatment protocol for dental fluorosis of varied severity

Modified dean's fluorosis index score	Clinical findings	Suggested treatment options
Normal (0)	Enamel represents usual transparency, semi-vitriform type of structure. The surface appears smooth, glossy and usually of a pale, creamy white colour	No treatment
Questionable (0.5)	Few flecks to occasional white spots	No treatment/bleaching
Very Mild (1)	Small, opaque, paper white areas scattered over < 25% of the tooth surface	No treatment /bleaching
Mild (2)	White opaque areas in enamel of the teeth are more extensive, but do not involve as much as 50% of the tooth	Bleaching/composite restoration
Moderate (3)	All enamel surfaces of the teeth are affected and surfaces subject to attrition show wear. Brown stain is frequently a disfiguring feature	If discolorations accompanied by wear: Full coverage If only discoloration without any wear: 1 Bleaching or 2 Veneers (Direct or indirect) or 3 Bleaching followed by Veneers (Direct or indirect)
Severe (4)	All enamel surfaces affected, severe hypoplasia, discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded-like appearance	Full coverage

CHROMOGENIC BACTERIA

- Chromogenic bacteria cause stains, typically at the gingival margin of the tooth.

BLACK STAINS

- The most common stain, caused by Actinomyces species.
- The stain is composed of ferric sulfide and is formed by the reaction between hydrogen sulfide produced by bacterial action and iron in the saliva and gingival exudates.

GREEN STAINS

- They are attributed to fluorescent bacteria and fungi such as Penicillium and Aspergillus species.

ORANGE STAINS

- They are less common than green or brown stains and is caused by chromogenic bacteria such as Flavobacterium lutescens.

MECHANISM OF CHLORHEXIDINE WITH DISCOLOURATION

Staining side effect limits long-term use of chlorhexidine in preventive dentistry (Flotra et al. 1971)

Proposed mechanisms for chlorhexidine staining includes:

1. Degradation of CHX molecule to release para-chloraniline

2. **Catalysis of Maillard reactions:**

   Carbohydrates and proteins, which adhere to the enamel surface undergo a series of condensation and polymerization reactions in the presence of CHX,

   leading to the formation of brown pigmented substances known as melanoidins, giving the film a brownish color.

3. **Protein denaturation with metal sulfide formation:**

   - CHX causes protein denaturation and breaks down the disulphide bridges, forming highly reactive sulfhydryl groups.
   - Proteins, carbohydrates, Fe^{+3} ions and polyphenol compounds, present in saliva and on oral surfaces, can react with these groups, forming organic ferric sulfides, which are of a yellow brownish color and deposit on the hard and soft tissues of the oral cavity

4. **Precipitation of anionic dietary chromogens:**

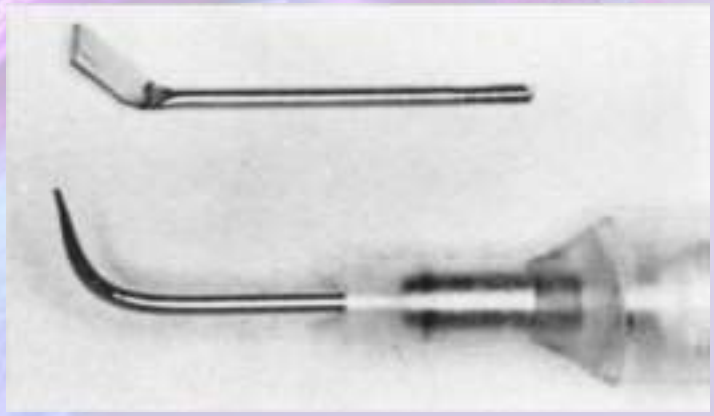
   - Locally bound antiseptics and polyvalent metal ions react with the polyphenols present in the dietary substance and thus precipitating anionic dietary substance.

POWER BLEACHING TECHNIQUES USING HEAT

USING HEATED INSTRUMENT

- Rubber dam is placed the teeth and the mucosa is protected.
- Gauze soaked in 35% hydrogen peroxide liquid is placed on the teeth.

- Heating instrument can be placed on to the teeth to enhance the effect of bleaching depending on the individual tolerance level it is applied for a period of 1 to 3 minutes
- This technique has been superseded after the introduction of power bleaching gels.



USING HEATED BLEACHING GELS (Rembrandt Products)

- Also called as HOT BLEACH.
- This technique employs the use of 35% carbamide Peroxide Gel, heated to 80° Celsius and applied directly to the tooth by using one of the two methods
  - immerse the bleaching material in water bath at 80° C;
  - or boil bleach in a crucible over flame or with hot air.
- It should be heated until it starts bubbling.
- Place bleach on tooth for 2 minutes.
- Remove it with gauze piece and don't use water spray as it will cool down tooth.
- Apply 3-4 times for 2-3 minutes each for 20 minutes.

Bleaching Techniques in Restorative Dentistry 1st Edition. by Greenwall Linda/ Freedman George A.

TEMPERATURE CHANGES ON PULP

- External heat applied to the teeth can cause pulp damage in varying degrees, depending on the magnitude and duration of the increase in temperature.
- For vital bleaching purposes, HP has been commonly used at concentrations of 30 to 35% with temperatures ranging from 30 to 70 °C for 20 to 40 min.

1. Nyborg and Brannstrom showed that external application of a 150 °C heat for 30 s caused histopathological changes in all teeth, but only 10% showed necrosis.
2. Where as, Zach and Cohen reported that increase in the intra-pulpal temperature in the range of 5 -15 °C have been associated with pulp necrosis.
3. Cohen examined pulps of human teeth subjected to bleaching procedures with no final differences between control and experimental groups, although 78% of the patients reported sensitivity for 24 hrs.

Vital Bleaching: The Effects of Heat and Hydrogen Peroxide on Pulpal Enzymes -William H. Bowles, and Loren R. Thompson

- In an in vivo study with monkeys, an increase in temperature inside of the pulp chamber of 5.5°C (46°C)caused irreversible pulpits.
- Some authors claim that the highest temperature tolerated by human pulp, is 5.5°C and considered it as the critical point of tolerance for intra-pulpal temperature.
- There was an increase in intra-pulpal temperature with all light sources tested, and the maximum temperature remained below the critical level (5.5°C).

Evaluation of temperature increase during in-office bleaching -Rafael Francisco Lia MONDELLI, Ana Flávia SOARES, Eugenio Gabriel Kegler PANGRAZIO, Linda WANG, Sergio Kiyoshi ISHIKIRIAMA, Juliana Fraga Soares BOMBONATTI

DEPTH OF PENETRATION OF VARIOUS LASERS

Laser	Wavelength (nm)	Depth of penetration (mm)
Argon	516	1-2 mm
Diode	808	1 mm
Nd:YaG	1,060	0.5-1.5 mm
$C0_2$	10,600	0.23 mm

OPALESCENCE BOOST

- The Opalescence Boost Teeth Whitening System is an "alternative, conservative method for treating dark, discolored teeth," which may be used to treat some tooth stains caused by intrinsic factors, including dental fluorosis, tetracycline and trauma.

- The difference between Opalescence's in-office system and other chairside whitening systems is its chemically-activated gel, which eliminates the need for dental lasers or lights normally used to activate the process. That means no heat or ultraviolet rays, which could be beneficial to patients with sensitive teeth or dry mouth.
- Opalescence Boost consists of two syringes: The first contains 38 percent hydrogen peroxide, the active tooth whitening ingredient. The second syringe contains fluoride and potassium nitrate (PF), which helps strengthen tooth enamel, reduce sensitivity and protect against cavities.

CHEMICALLY ACTIVATED BLEACHING

- In 2000, Viscio considered that the future technology for bleached teeth could involve the use of chemical activators to improve the performance of bleaching gels.
- If a chemical agent can accelerate the decomposition reaction of hydrogen peroxide/bleaching agents on tooth structure, one could reduce in-office treatment time or diminish the daily time spent on the bleaching procedure at home.
- Decomposition of hydrogen peroxide may be accelerated by chemical activators associated with, or used separately from, bleaching gels.

- A study done by Travassos tested the ability of various types of chemical catalyzing agents to intensify bleaching results when added to 35% hydrogen peroxide gel.

- The agents were ferric chloride, ferrous sulfate, manganese gluconate, manganese chloride, and mulberry root extract. Those authors found that manganese gluconate exhibited the highest means for shade perception variation, representing an increase in the process's efficiency to the order of 55.21%.
- Gaffar and Fakhry-Smith11 studied the efficiency of a bleaching gel containing 35% hydrogen peroxide, which was mixed with manganese gluconate. The results indicated that the presence of the chemical activator increased the efficacy of hydrogen peroxide by 1.5 to 8 times.

IN-OFFICE NON-VITAL BLEACHING

The techniques used for bleaching of non-vital teeth:

- Walking Bleaching Technique
- Intra-coronal bleaching using the thermo-catalytic technique
- Modified intra-coronal bleaching technique

Figure 1a: Preoperative view of a severely discolored central maxillary incisor subsequent to a traumatic episode and endodontic treatment some fifteen years ago.

Figure 1b: 24 hour post-walking bleach result. Note acceptable restitution of natural color.

WALKING BLEACHING

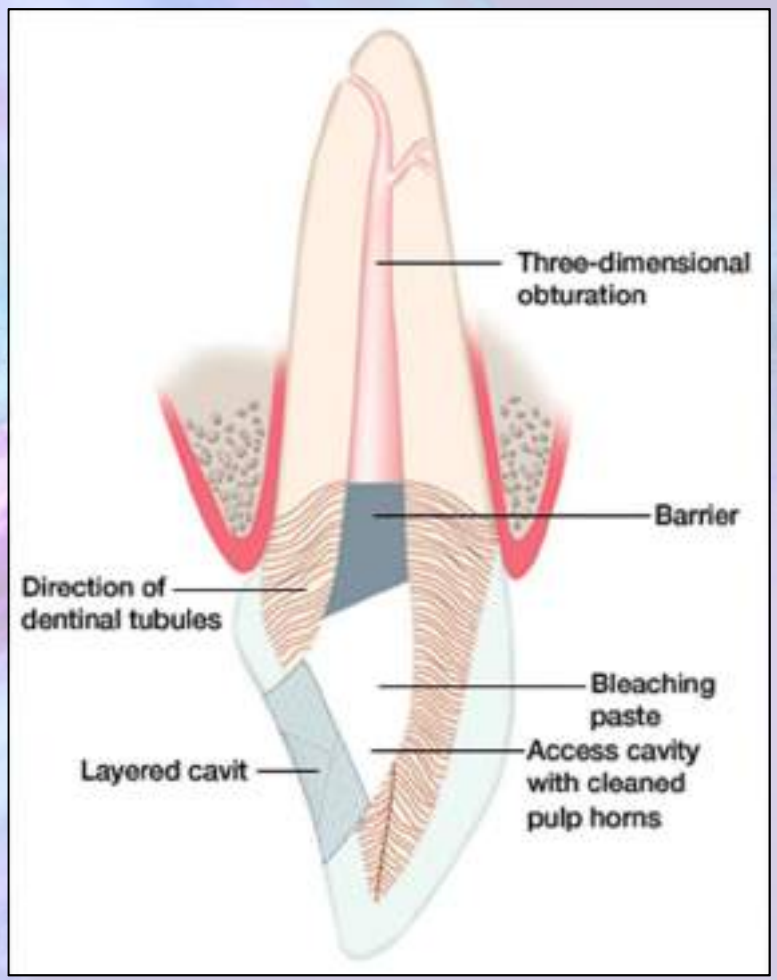
- A mixture of sodium perborate and distilled water was mentioned in a congress report by Marsh and published by Salvas

- The mixture of sodium perborate and water was reconsidered by Spasser and modified by Nutting and Poe,

who advocated the use of 30% hydrogen peroxide instead of water to improve the bleaching effectiveness of the mixture.

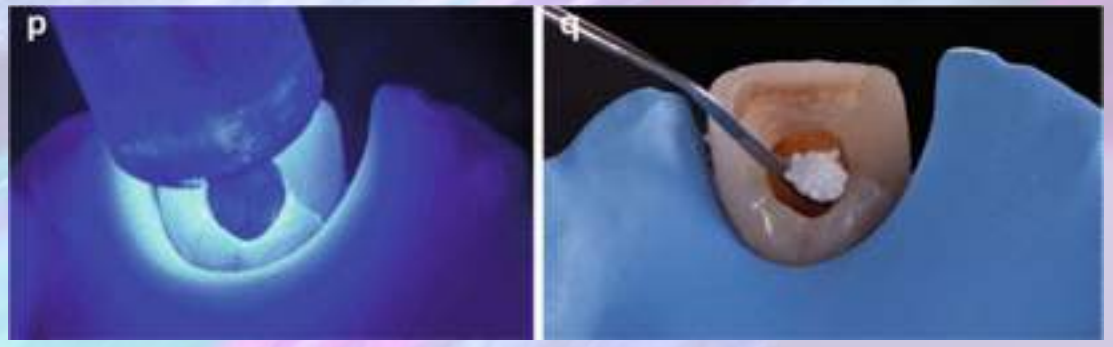
- A mixture of sodium perborate and water or hydrogen peroxide continues to be used today

- Remove all restorative material from the access cavity level just below the labial gingival margin
- Seal the orifice of canal with 1 mm intra-coronal barrier over gutta percha. (GIC, Resin modified GIC, MTA)
- Prepare the walking bleach paste by mixing sodium perborate and inert liquid, such as water etc.
- Place cotton pellet, slightly moistened with hydrogen peroxide, over bleaching paste.
- Seal access cavity by 3 mm thick adhesive material to avoid leakage of solution in the cavity.



THERMOCATALYTIC BLEACHING

- This technique involves placement of the oxidizing chemical, generally 30% to 35% HP (Superoxol), into the pulp chamber followed by heat application either by electric heating devices or specially designed lamps.
- Intermittent treatment with cooling breaks preferred.
- In addition, the surrounding soft tissues should be protected with Vaseline, Orabase, during treatment to avoid heat damage.
- Potential damage of external cervical root resorption is present, hence walking bleach is indicated.



COMBINED BLEACHING TECHNIQUES

- Inside/Outside bleaching technique
- The technique combines the intra-coronal bleaching technique with the home bleaching technique.
- It is used to lighten non-vital teeth in a simple manner.

Fig 3-12 Upper left central incisor before treatment.

Fig 3-13 Upper left central incisor after treatment. (It has also been shortened.)

Incisor showing access cavity

Ultrasonic cleaning of below CEJ

GP cut back beyond CEJ

Injecting 10% CP into tooth

Tray being loaded with CP

Change of colour within 24 hrs

ADVANTAGES:

- More surface area is available both internally and externally for the bleach to penetrate.
- A lower concentration (10% Carbamide peroxide with neutral pH) of the bleach is used.
- This technique will hopefully eliminate the incidence of cervical resorption that has been reported with the conventional intra-coronal bleaching technique.
- The need to change the access cavity dressing is eliminated as the access cavity is left open.
- Treatment time is reduced to days rather than weeks.
- No heat is required to activate the bleaching material.

MICROABRASION TECHNIQUE

- It is a procedure in which a microscopic layer of enamel is simultaneously eroded and abraded with a special compound (McInnes solution) leaving a perfectly intact enamel surface behind.

- Apply the solution on tooth and gently abrade surface with pumice in rubber cup on slow speed contra angle handpiece.
- Its neutralized with Sodium bicarbonate and washed with water.
- Repeated 2-3 times for required result

- Bleaching of mild fluoride stains occurs in 2-3 weeks, whereas moderate in 4-6 weeks.

EFFECT OF BLEACHING AGENTS ON OTHER MATERIALS

AMALGAM

- A number of studies have found that CP and HP change the properties of dental amalgam restorations, such as microhardness and surface roughness.
- Studies have also identified that factors such as the age of the dental amalgam, an unpolished amalgam surface and the acidity of the bleaching agent, caused increased release of mercury.
- In a case report, Haywood described a green discoloration around certain dental amalgam restorations of a patient was seen.
- In another case report, dental amalgam restorations presented superficial chipping at the cavosurface margins.

- Overall, these studies revealed minor effects of bleaching on surface roughness and microhardness of dental amalgam restorations that are within a clinically acceptable range.

GLASS IONOMER CEMENT

- A recent in situ study by Li and colleagues found a significant difference in the color of a conventional GIC after 4 weeks of bleaching with 15% CP.
- However, 2 weeks after the whitening treatment ceased, the color returned to that noted before the treatment, showing that bleaching did not affect the color of the GIC.
- When using 15% CP and 35% HP on resin modified glass ionomer cement restorations, softening effect and a significant decrease in their surface hardness was noted.
- Additionally, scanning electron microscopy (SEM) revealed a slight surface dissolution.
- It was also found that bleached GIC restorations were more susceptible to different staining solutions.
- Consequently, because GIC restorations are changed when bleached, they may need to be replaced.

COMPOSITE RESINS

- Using a spectrophotometer, Li and colleagues found significant changes in the color composite resins after bleaching with 15% CP.
- Using the Knoop hardness test, Hannig and colleagues reported a significant decrease in the surface hardness of composites, not only in superficial surfaces, but also in the deeper layers of the restoration.
- Many investigators have reported a severe decrease in the average bond strength.
- It has been noted that the resin tags are reduced in number, less defined and shorter in bleached enamel .
- Bleaching has been shown to increase the microleakage of existing restorations.
- Yu and colleagues found that bleached composite resins stain more easily than unbleached ones.
- Therefore, they may not require replacing to match the color of bleached enamel after teeth whitening.

PORCELAIN

- A number of recent articles have studied the impact of bleaching treatment on the physical properties of ceramic restorations.
- In a recent in vitro study, feldspathic porcelain had a rougher surface after 21 days of exposure to 10% and 35% CP.
- Because the increased ceramic roughness could lead to more plaque retention, bacterial adherence and gingival irritation, it is suggested protecting these materials with a barrier before bleaching to preserve the integrity of the ceramic surface.

MICRO AND MACRO ABRASION

MICRO-ABRASION	MACRO-ABRASION
Indicated for extrinsic stains to a depth of no more than 0.2-0.3mm.	Indicated in deeper stains and defects which extend beyond 0.4mm of enamel.
It involves both chemical erosion and physical abrasion of the tooth surface.	Unlike micro abrasion dissolution of enamel before physical abrasion is not the initial step.
Traditionally, this technique involves the use of 18% HCl and a pumice paste in a slow speed handpiece with light pressure.	A 12-fluted round diamond fissure bur in high speed handpiece with copious water irrigation is used.

SIGNIFICANCE OF DENTINAL TUBULES

- It is speculated that Hydrogen peroxide when placed in the pulp chamber penetrated the dentin and the further application of heat increased the penetration (Rotstein et al., 1991)
- This caused denaturation of the dentin.
- The penetration has been found, to be higher in teeth with cervical defects of the cementum (Rotstein et al., 1991).
- Hence, the idea is to block the dentinal tubules so that the internal bleaching agent stays within the access cavity.
- Hence the shape and location of placement of the barrier is important.

LOCATION OF THE BARRIER

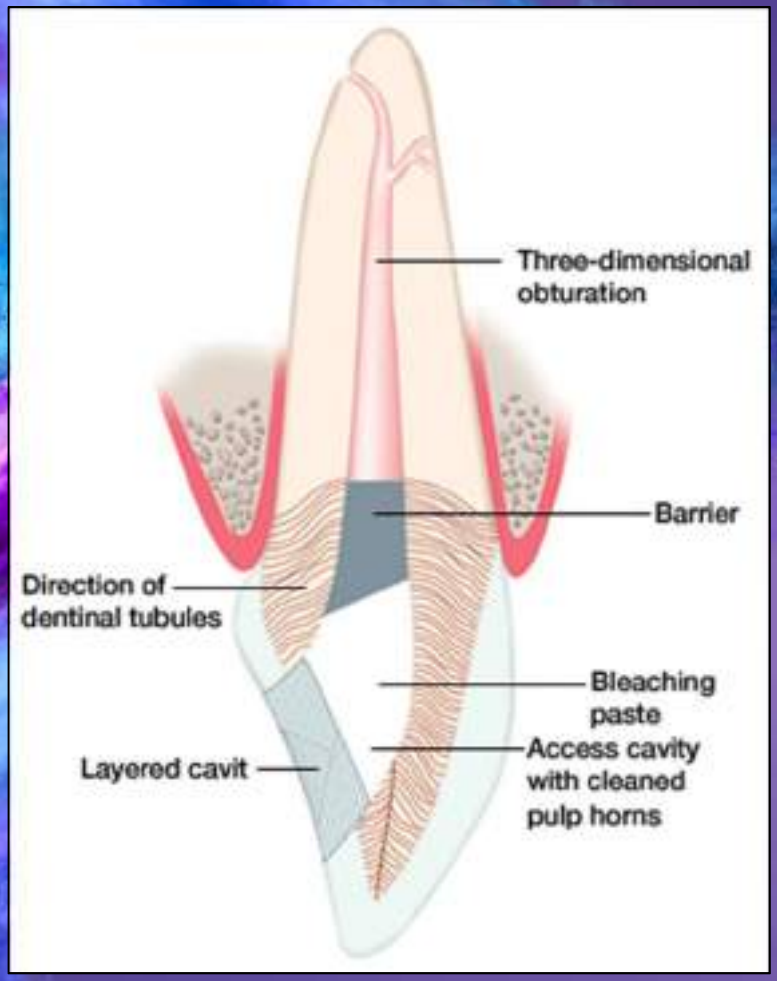
- Previous studies and techniques have suggested to use labial CEJ as a guide for barrier placement.
- However, not the CEJ, but rather curves in an incisal direction on the proximal sides of the tooth should be considered to protect the proximal tubules from the entry of bleaching agent.

- There is also an esthetic reason for avoiding the CEJ as a guide for barrier placement.
- In an instance of gingival recession the root would not be completely bleached using the CEJ guideline as a reference.

- Instead a more biologically critical and esthetically essential landmark is the epithelial attachment.

SHAPE OF THE BARRIER

- An effective barrier should be placed to prevent the passage of peroxide.
- A flat barrier leaves the proximal dentinal tubules unprotected
- Positioning the palatal portion of the barrier coronal to the barrier's proximal height protects the palatal CEJ without compromising the esthetic results.
- The resultant shape from a facial view is the "bobsled tunnel" outline.
- The outline from the proximal view resembles a "ski-slope".



ANTIOXIDANT THERAPY

- A number of studies have shown that the bond strengths of adhesive restorations to tooth structures reduces when the tooth has been bleached.

- The general approach is to postpone any bonding procedure for a while after bleaching since the reduction of bond strength has been shown to be temporary.

- Yet some techniques have been suggested to solve this clinical problems,
  - Cvitko et al. proposed to remove the superficial layer of enamel
  - Barghi and Godwin treated the bleached enamel with alcohol before restoration
  - Kalili et al. and Sung et al. suggested the use of adhesives containing organic solvents.

- Application of 10% sodium ascorbate solution for 10 mins on the enamel surface with a sterile brush before resin bonding can be used as an alternative to the delayed bonding procedure after bleaching – Antioxidant therapy.

- Sodium ascorbate allows free-radical polymerization of the adhesive resin to proceed without premature termination by restoring the altered redox potential of the oxidized bonding substrate thus reversing the compromised bonding.

ADVERSE EFFECTS OF TOOTH BLEACHING

CERVICAL ROOT RESORPTION

- Cervical root resorption is a distinctive type of external inflammatory root resorption.
- This form of external root resorption is characterized by a cervical location and invasive nature.
- The exact mechanism of cervical root resorption is not clear;

however, it was postulated that bleaching agent escapes through dentinal tubules to reach periodontal tissues and initiates inflammatory process.

CROWN FRACTURE

- There is a possibility of crown fracture after intra-coronal bleaching, most likely due to the extensive removal of the intra-coronal dentin.

- In addition, use of 30% hydrogen peroxide for the purpose of bleaching in intra-coronal area could decrease the microhardness of dentin and enamel and deteriorate the mechanical properties of the dentin.

TOOTH SENSITIVITY

- One of the common side effects of external tooth bleaching is the tooth sensitivity.
- Albanai et al. reported the incidences of dentin sensitivity ranging from 15% to 65% by using 10% carbamide peroxide.

- It is common to have tooth sensitivity for 4 days after tooth bleaching, and it ceases at the end of the treatment.

- The exact mechanism concerned with tooth sensitivity is not clearly established; however, in vitro experiments have suggested that peroxide penetrated enamel and dentin and entered the pulp chamber.

MUCOSAL DAMAGE:

- It has been shown that a high concentration of hydrogen peroxide in the range of 30%–35% is destructive to mucus membrane and may lead to burns and bleaching of the gums.

- Most of the findings from animal studies have revealed that exposure of the gingiva to 1% hydrogen peroxide for approximately 6–48h damaged the epithelium and caused acute inflammation of subepithelial connective tissue.

RECENT ADVANCES IN BLEACHING

WHITENING PEN

- Brite-Smile To Go is an easy to use bleaching system that uses a pen-like applicator to whiten teeth without the involvement of bleaching trays or strips.

- Simple, convenient, easy to use
- Dries rapidly.

- Just two easy 30-second applications a day for two weeks, then use as desired.

NITE WHITE ACP

- In an attempt to decrease tooth sensitivity, to re-establish surface hardness and to support remineralization of initial white spot lesions, some manufacturers have incorporated fluorides into their bleaching gel formulas.

- More recently, amorphous calcium phosphate (ACP) has become available in tooth whitening products
- In addition to forming a calcium fluoride layer on the enamel surface which inhibits demineralization, it has been suggested that the presence of fluorides might accelerate remineralization.

- Nite White ACP has been clinically proven to remineralize teeth while also whitening them.

VIVASTYLE PAINT ON~

- The professional varnish system for whitening teeth
- It is insoluble in water.
- Consequently, the varnish is not prematurely washed off the teeth by saliva.

- It contains 6% carbamide peroxide when applied.
- Once it has dried, its concentration is about five times higher.
- It is applied directly to the teeth with a brush and allowed to dry for 30 seconds.

- The dried varnish remains on the teeth for 20 minutes and is subsequently removed with a toothbrush.

CONCLUSION

- The use of bleaching agents provides an effective and conservative approach to the removal of unaesthetic discolorations from vital & non-vital teeth.
- Bleaching treatments have been a topic of interest for dentists and patients alike for over 100 years.

- The dentist must evaluate each patient carefully to determine the source of the staining in order to determine the best treatment option.
- The dentist must also make sure the patient is educated about the outcome of treatment, so unrealistic expectations are identified and corrected upfront.

- Overall, bleaching is a very safe and satisfying experience for patients.
- With proper treatment planning and patient education, bleaching can be an important esthetic adjunct to any dentist's office.

REFERNCES

- Endodontics, Ingle, 5th Edition
- Pathways Of The Pulp, Cohen, 8th Edition
- Endodontic practice, Grossman, 11th edition
- Bleaching Techniques In Restorative Dentistry, Linda Greenwall
- Tooth whitening techniques, 2nd edition, Linda Greenwall
- Complete Dental Bleaching- Ronald Goldstein
- Dental bleaching- Martin Kelleher
- The effects of light on bleaching and tooth sensitivity during in-office vital bleaching: A systematic review and meta-analysis; JOURNAL OF DENTISTRY; 2012
- Nonvital Tooth Bleaching: A Review of the Literature and Clinical Procedures; JOE; 2008


Thank You