

Evidence Based Tooth Whitening

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The objective of this presentation is to increase your understanding of tooth whitening. We will do this by reviewing mostly clinical studies in the scientific literature that have been published. The presentation has been divided into eight sections. They are:

Introduction	Tooth concerns
Evaluation of color	Pulpal concerns
Systems used in Tooth Whitening	Effectiveness of systems
Material concerns	Clinical Cases

Introduction

- Why learn about tooth whitening?
 - In vivo studies help us to understand what we will see in our offices.
 - Restorative Dentistry is changing. "The more we cut tooth, the more we weaken tooth."
- How do we present it to our patients without insulting them?
 - To promote bleaching have posters, offer staff bleach or discuss color at treatment planning appointment. Ask "How do you like your smile?" or "Are you pleased with the color of your teeth".
 - Listen, evaluate, discuss bleaching with patients. Beware of patients with unrealistic expectations. A patient who expects pure white teeth is seldom satisfied.
 - Don't ask if they have already bleached, but look to see if cuspids are as light as the incisors
- How important is tooth whitening to our patients?
 - Teeth are rated as the most important facial feature.
Jornung et al., JADA 138:1544;2007.
 - A smile has been said to be among man's most important interactive communication skills.
Hattab et al., J Esthet Dent 11:291;1999.
- How does tooth whitening work?
 - Peroxide alters compound double bonds usually to single bonds and a shorter molecule. The action alters the light properties of the stain, making the tooth appear lighter.
Joiner, J of Dent 34:412-419;2006.
 - Example of a conjugated double bond molecule, crocetin having a dark red color changing to white upon degradation, using peroxide.
Thompson et al J Chem Soc, Faraday Transactions 89:4035-4043;1993.
- What are the two kinds of stains that develop?
 - Extrinsic—Stain, which is deposited on the outside surface. Whiteners will lighten calculus and the subsurface structure.
 - Intrinsic—Stain, which is incorporated into the tooth structure before or after eruption.
- What agent/s lighten teeth?
 - Peroxide is active agent. Found in Carbamide Peroxide. Breakdown:
10% CP=3% HP+7% Urea; HP=Oxygen + Water; Urea=Ammonia + Carbon Dioxide
- What are the advantages to using Carbamide Peroxide versus Hydrogen Peroxide?
 - Does not degrade as fast as hydrogen peroxide.
 - Carbamide degrades to ammonia, which has a high pH.

Summary of Section

- In vivo studies are most reliable
- Patients desire lighter teeth but do not think they have light colored teeth
- Color is determined by reflection and absorption of light waves
- One-third of Carbamide peroxide is Hydrogen Peroxide
- Carbamide peroxide degrades to create a high pH

Evaluation of Color

-How is color evaluated in the scientific literature?

- Tooth color should be evaluated both subjectively and objectively.
 - Subjectively shade guides are used. Lightest is usually #1.
 - Objectively a colorimeter or spectrophotometer is used to measure L*, a*, b* and Delta E.

-Are the methods accurate?

- Subjective methods depend on the shade guide, skill of the examiner and the environment.
 - Even spacing of tabs, accommodation, overhead light source, skill of examiner, state of examiner, place of examination
- Objective methods are very accurate if machine is calibrated correctly.
 - Calibrated correctly, placement of measuring device same each appointment

-As we age our teeth become darker, more yellow and slightly more red.

Odioso, Compendium 21:S35-S41;2000

-“Patients and consumers now demand not only a healthy mouth but also a perfect smile.”

Joiner, J Dent 32:3-12;2004

Summary of Section

- There are two ways to measure color
 - Objective—Instruments
 - Subjective—Human visual
- Our patients want whiter teeth
- People look younger with lighter teeth

Systems used in Tooth Whitening

-How many systems are there for whitening teeth?

- There are six major systems, three are At-home systems and three are In-office system.

-What are the advantages and disadvantages of each system?

--At-home custom tray bleaching

---Advantages-Lower tooth sensitivity, more effective, less peroxide ingested (with reservoirs)

---Disadvantages-Not predictable, takes longer.

---Two parts in making a custom tray

----Prepare a proper model:

-----Make sure holes or adhesive in tray

-----Place alginate on occlusal and buccal surfaces with finger

-----Wet impression after removing from mouth

-----Make stone model (vacuum spatulate)

-----Vibrate stone into impression

-----Fill to at least 1 cm past cervical area

-----Trim excess stone to 5 cm from cervical area

-----Fill holes with block out resin

-----Remove bubble/s from stone cast

- Fabricate tray
 - Place resin using palm method
 - Keep resin 1 mm from mesial, distal and cervical borders
 - Vacuum form plastic sheet to model
 - Gross and finer reduction on model
 - Carefully lift tray off model
 - Trim to cervical margin (indicated by transparent rainbow)
 - Reverse directions on trimming
- Instructions at delivery (involve patient)::
 - Thoroughly brush teeth
 - Express agent into reservoirs
 - Seat tray and express excess
 - Brush off excess
 - Rinse twice with water
 - Remove residual gel after removing tray
- Give patient written instructions from the manufacturer
- At-home Over-the-counter bleaching
 - Advantages-Less expensive, no doctor visits
 - Disadvantages-Not as effective, higher concentration than recommended
 - There are four major types of over the counter products; Strips, Wraps, Tray-in-Tray and Paint-On
- In-office bleaching-outside surface (Sometimes called “Power Bleaching”)
 - Advantages-Rapid tooth whitening; no gel ingested.
 - Disadvantages- Greater sensitivity; rapid reversal of tooth whitening; cannot use it on people who are taking medications that make them sensitive to light; possible “burning” of tissues.
 - Variables with In-office bleaching systems include: light activation, concentration, isolation, treatment time and follow-up
 - Important to isolate with rubber dam or resin dam from the strong concentrations of bleaching agents.
- In-office outside layer (Sometimes called “Microabrasion”)
 - Advantages- No gel ingested, no tooth sensitivity, accomplished in one setting
 - Disadvantages-Must use rubber dam, demineralizes 8-22 microns, only works on superficial stains
- In-office bleaching-inside the pulp chamber (Sometimes called “Walking Bleaching”)
 - Advantages-No gel ingested, no tooth sensitivity
 - Disadvantages- Need to see patient multiple times, difficult to seal lingual, requires entry into pulp chamber and a barrier placed.
 - Has caused iodopathic root resorption when barrier not placed.

Summary of Section

- There are six systems of tooth whitening
- Each has advantages and disadvantages
- If At-home make good fitting trays
- If In-office isolate gingiva from gel

Material Considerations—Concentration recommended

- What concentration to use for At-home tooth bleaching
 - The higher the concentration, the more rapid the tooth whitening.
Harris et al., JRD 80:172 Abst 1096; 2001.
- What criteria are required for American Dental Association's Seal that a materials is "Safe" and "Effective"?
 - American Dental Associations (ADA) first guidelines on safety and efficacy of bleaching agents were issued in 1994.
J Am Dent Assoc 125:1140-42;1994
 - Efficacy standard was revised in 2006.
 - The following product is accepted as safe and effective by the ADA.
Opalescence Whitening Gel **10% CP**
http://www.ada.org/ada/seal/adaseal_consumer_shopping.pdf 4/11/11
- What criteria are required for American Dental Association's Seal that a materials is "Safe" and "Effective"?
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http://www.ada.org/ada/seal/adaseal_consumer_shopping.pdf 4/11/11
- What do other major organizations recommend to dentists regarding tooth whitening agents?
 - International Organization for Standardization
 - Concentration: must be on label
 - Peroxide concentration during use life (+10% to -30% variance from label)
 - Surface microhardness (not more than -10% loss)
 - Surface erosion (no more loss than 10 micrometers)

Material Considerations -- Restorative Materials

- Is surface hardness and surface finish of dental materials compromised when using tooth whitening agents?
 - Those values are material dependent and minimally affected by bleaching agents.
*Yap et al. Op Dent 27:137-141;2002
*Watanapayungkul et al. Op Dent 28:15;2003

Material Considerations -- Bleaching Agents

- How long is the carbamide peroxide bleaching material active?
 - Determined by ability to recover agent after it is placed.
 - Rapid initial degradation of carbamide peroxide agent and then it slows down.
 - 87% of agent recoverable after 15 seconds in vivo
 - 66% of agent recoverable after 1 hour in vivo
 - 53% of agent recoverable after 2 hours in vivo
 - 31% of agent recoverable after 4 hours in vivo
 - 18% of agent recoverable after 6 hours in vivo
 - 6% of agent recoverable after 10 hours in vivo

Matis et al., J Am Dent Assoc 130:227-235;1999

-How much is used during bleaching?

--Causes of loss of recoverable agent: bleaching process and remaining in tooth (13%); physical loss of agent (14%), anti-oxidant degradation/increased temperature/product degradation (31%)

*Matis, Compendium 24(SI4A):354-362;2003

-Does hydrogen peroxide degrade at the same rate as carbamide peroxide?

--HP degrades more rapidly than carbamide peroxide

---61% of agent recoverable after 5 minutes in vivo

---56% of agent recoverable after 10 minutes in vivo

---49% of agent recoverable after 20 minutes in vivo

---44% of agent recoverable after 30 minutes in vivo

---38% of agent recoverable after 45 minutes in vivo

---32% of agent recoverable after 60 minutes in vivo

Al-Qunaian et al., Op Dent 28:236-241;2003

-Bleaching is polydirectional

--Area under brackets is lightened

Jadad, Am J Orthod Dentofacial Orthop 140:e43;2011

-Accuracy of concentration on label

--Product label concerns may be in manufacturing process, or could occur during shipment and storage in the US and other countries. Products tested using method advocated in US Pharmacopia for carbamide peroxide

---In United States 35 products within 30% of concentration indicated on label

---In China 13 products tested within 30% of concentration indicated on label

---In Saudi Arabia 1 of 8 products had greater than 30% difference in concentration than indicated on label

---In Brazil 3 of 15 products had greater than 30% difference in concentration than indicated on label

Matis et al., Op Dent e-press online pub Oct 2012; doi:10.2341/11-367-L

--Dental schools in different countries should assay tooth whitening products available in their countries and publish it. Method for assay available on website: www.bamatis.com

Summary of Section

- 10% CP is recommended concentration to use
- Does not harm dental restorations
- CP retains ~50% initial concentration after 2 hours
- HP retains ~50% initial concentration after 20 minutes
- Bleaching is polydirectional
- Check literature for label concentration accuracy

Tooth Concerns

-In dental procedures there are “Benefits” and “Risks”

-Is there loss of adhesion in enamel with resin composites after bleaching?

--Study in vivo completed recently showed changes in shear bond strength returned to baseline values two weeks after bleaching.

*Metz et al., Op Dent 32(5) 427:2007

--The reason is “oxygen inhibition” that occurs with Bis-GMA resins.

--Why not place resin immediately after bleaching?

Cannot bond properly because of oxygen inhibition internally.

Cannot color match because color reversal will occur.

- Is there a loss of enamel microhardness?
 - Loss of microhardness of enamel has been reported with use of many products.
Ren et al., J Dent 37:424-437;2009
 - Review of 55 scientifically valid studies on microhardness recently published.
Attin et al., Den Mat 25:143-157;2009
 - Study in vivo shows no changes in microhardness after bleaching for two weeks.
*Metz et al., Op Dent 32(5) 427:2007
- Are there morphological changes on tooth surface?
 - Effect on enamel micromorphology when 38% HP or 35% CP were used in an *in vivo* study on teeth.
Cadenaro et al., Op Dent 33(2):127-134;2008
- Is there an increase in caries susceptibility?
 - Use of PF will make tooth more resistant to caries.
*Al-Qunaian, Op Dent 30:265;2005

Summary of Section

- Loss of adhesion occurs for two weeks
- No loss of microhardness with in vivo
- No change in micro-morphology
- No increase in caries susceptibility

Pulpal Concerns

- How rapidly does the peroxide penetrate to the pulp?
 - Penetration of the pulp chamber by carbamide peroxide bleaching agents occurs very rapidly, within fifteen minutes.
Cooper et al., J of Endo 18:315;1992
- Patient may have gingival and/or tooth sensitivity
 - Both occur, but gingival sensitivity is easier to reduce
Matis et al., Quint Int 29:555;1998
 - To reduce tissue sensitivity, have patient more effectively remove excess bleaching agent that comes out of the tray and have tray trimmed shy of cervical collar of gingival.
 - Tooth sensitivity occurs more frequently
 - Tray alone causes tooth sensitivity in 20% of patients, add placebo agent and 36% report tooth sensitivity, add active agent instead of placebo and 69% report tooth sensitivity.
Leonard, Whitening Symposium, Loma Linda 2010
- Does peroxide placed on the tooth during cause histological changes to the pulp?
 - Mild histological changes that were observed with 10% CP used overnight are considered to be reversible. No moderate or severe histological changes observed.
Gonzalez-Ochoa, J. Op Dent 29:363-368;2004
- What else can be done to reduce tooth sensitivity?
 - Tooth sensitivity
 - Use of 10% CP for shorter time periods can decrease tooth sensitivity.
Cardoso et al. J Am Dent Assoc 141:1213-1220;2010
 - Ask patients about sensitivity to cold water when they brush their teeth. If sensitive to cold water, have them start brushing with potassium nitrate containing toothpaste before bleaching.
 - Potassium nitrate gel faster acting than toothpaste.
Haywood, Dental Products 43:82;2000

- Sodium Lauryl Sulfate in toothpaste may cause gingival irritation and aphthous ulcer. Potassium nitrate alone does not cause tissue sensitivity.
- Amorphous Calcium Phosphate is also being used to reduce tooth sensitivity. There appears to be no difference in capability to reduce color change with use of either of the two most popular tooth sensitivity reducing agents.
Matis et al., Op Dent 32:549;2007

Summary of Section

- Peroxide penetrates to pulp by 15 minutes
- Can cause mild histological changes that are reversible
- If sensitive, bleach for shorter periods of time
- Potassium Nitrate and Amorphous Calcium Phosphate reduce sensitivity, some
- Neither reduce bleaching potential

Effectiveness of various concentrations and systems

- In-office systems vary in use instruction considerably.
 - Survey reported in 2007 that there were 14 products on the market and today there are 18 products on the market.
Dentistry Today.com/Buyers-Guide 29(12);118;2010
- How effective are the In-office systems?
 - In-office bleaching outside tooth surface, Conventional (Power Bleaching)
 - In vivo study of eight In-office bleaching systems: A pilot study (alphabetical order). Manufacturer's were invited to come observe use of their product.

Accelerated In-Office by Life Like	ArcBrite by Biotrol
Illumine by Dentsply	BriteSmile by BriteSmile
Niveous by Shofu	PolaOffice by SDI Industries
One Hour Smile by Den-Mat	Zoom! by Discus Dental

*Matis et al., Op Dent 28:324;2007
 - Light use did not improve the effectiveness of the In-office conventional system
Effectiveness evaluated with and without use of light.

Opalescence Xtra Boost	PolaOffice	Rembrandt Lighten Plus
LumaArch	Niveous	LaserSmile
Zoom!		

CRA Newsletter 27(3):3;2003
 - Light does not enhance tooth bleaching and may pose a health risk especially those with ultraviolet light.
Bruzell, et al. Photochem and Photobio Sci., 8:377;2009
 - In-office systems are more effective and create less sensitive with 3X45 min instead of 1X45 min bleaching application.
Reis, et al. Op Dent 36:590-596;2011
 - At-home systems will boost In-office systems
*Matis et al. Op Dent 34;142-149;2009
 - In-office bleaching outside tooth surface (Microabrasion)
 - Microabrasion is effective on superficial enamel defects
Benbachiretal et al., Quint Int 38;811-815;2007
 - In office bleaching inside tooth chamber (Walking Bleach)
 - Sodium perborate can be mixed with water as well as peroxide with equal effectiveness.
de Souza-Zaroni et al., Oral Surg, Oral Med, Oral Path, Radoil, Endod 107:e43-e47;2009

-How effective are the At-home systems used with a custom tray?

--All studies had at least **24 subjects**, bleached for **14 days** and **used reservoirs** in trays.
Maxillary anterior teeth evaluated for color **objectively** and **subjectively**.

--Not everyone lightened as they had hoped as evidenced by evaluation of clinical photographs. Reversal of color came to a plateau between two weeks and one month postbleaching. Efficacy of 10% CP used for two weeks shows 17% large change, 48% moderate, 21% slight and 14% none after six months.

Matis et al., Quint Int 29:555;1998

--There are three other half-mouth design studies which taught us some important concepts.

---10% CP and 15% CP, overnight. 15% was no different than 10% at the end of one month

Matis et al., Quint Int 31:303-310;2000

---15% CP and 5.5% HP, ½ hour 2X daily showed equal concentrations produced equal results.

Panich, Masters Thesis, IUSD, 1999

---20% CP and 7.5% HP, 1 hour 2X daily showed 20% twice a day was no better than 10% overnight.

Mokhlis et al., J Am Dent Assoc 131:1269-1277;2000

--We can now compare the In-office with three studies using 10% CP overnight in trays with reservoirs. 10% was twice as effective both subjectively and objectively than In-office products.

--Do we need reservoirs in our trays?

---Teeth in the side of the trays with reservoirs were statistically lighter, but not clinically lighter than teeth in side of the trays without reservoirs. More gel is ingested by patients using trays without reservoirs.

Matis et al., Op Dent 27:5;2002

-How effective are the Over-the-counter systems?

--Whitening gels found over-the-counter

---What is their effectiveness in bleaching? For six Vita tab changes; Strips (30 min)=31 cycles At-home (8 hours)=7 cycles, In-office (15 min)= 3 cycles.

Aushill et al., Op Dent 30:156;2005

---Many different products available for purchase with peroxide in them

-Is there one comparison of all the systems effectiveness?

--Nine studies with 26 products with both subjective and objective evaluations

At-home nighttime in tray with reservoir is most effective system

At-home daytime in tray is next most effective system

Over-the-counter is next most effective system

In-office systems is the least effective system

*Matis et al., Op Dent 34:230-235;2009

Summary of Section

- In-office tooth whitening works
- Light use does not speed up whitening
- Microabrasion effective on superficial stains
- “Walking Bleach” sometimes is effective
- At-home twice as effective as In-office
- Bleaching outcome: 20% Hollywood white, 50% pleased, 20% okay, 10% not much happened
- Over-the-counter works
- Effectiveness in order: At-home evening, At-home daytime, Over-the-counter, In-Office

Odds and Ends

- How long do patients use agent?
 - When cuspids become as light as central and lateral incisors.
- Do I deliver both trays at the same time?
 - Deliver maxillary tray first so patients can see the amount of bleaching that has occurred.
- Rebleaching, how often should it be done?
 - When needed, probably every one to three years.
- Does rebleaching take as long as initial bleaching?
 - No it is much faster, one day of rebleaching is usually required for every 5-7 days of initial bleaching.
- Can we guarantee lightness with bleaching?
 - No, but I tell patients I will apply the money it costs to bleach on a discount for veneers or crowns within three months if they are not pleased with the results.
- How long does tooth whitening last?
 - 42% were satisfied after 10 years post bleaching
Leonard et al., J Esthet Rest Dent 15:142-152;2003
- How old should patients be before bleaching?
 - Should not lighten teeth while patient is in mixed dentition.
 - Tooth whitening for individual teeth has a different policy.
Ped Dent 30(7 Sup):61-63;2008
- Can teeth underneath veneers be whitened?
 - It will go around and underneath a resin. Before replacing veneers due to darkened color, bleach from inside.
Haywood, et al. Quint Int 30:743;1999
- Is the use of hydrogen peroxide or carbamide peroxide safe?
 - “All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.”
Paracelsus (1493-1541)
 - Body produces about 6.5 g of peroxide daily in the liver. Oral cavity can decompose 29 mg peroxide in one minute. Approximately 3.5 mg peroxide used per session with 10% CP
Li, Dent Clin N Am 55:255-263;2011
- Are there any contraindications for tooth whitening?
 - Patients with resin allergies, peroxide allergies and pregnant or lactating patients.
- Are there other excellent sources of information on tooth whitening?
 - Excellent article entitled “Biological Properties of Peroxide-containing Tooth Whiteners”.
Li, Food and Chemical Toxicity 34:887-904;1996
 - Excellent book on bleaching entitled “Bleaching Techniques in Restorative Dentistry” by Linda Greenwell, published by Martin Dunitz, London, England.
Matis, Op Dent 27;103;2002 Book reviewed
 - Book entitled “Tooth Whitening: Indications and Outcomes of Nightguard Vital Bleaching”
Van Haywood, Published by Quintessence International

Clinical Cases

4 year old fell down, traumatizing deciduous central incisors, bleached for a total of 47 hours.
Brantly et al. Ped Dent 23:514;2001

83 year old male who bleached for 6 weeks with one-month post-bleaching

19-year-old male, endodontically treated N 11, placed glass ionomer plug, bleached internally and externally for 2 weeks each. Followed for 2 months post-bleaching.

36-year-old female, trauma caused discoloration of tooth N 11, no periapical pathology, bleached 6 weeks. Followed for 4 months post-bleaching

28-year-old male, semi-professional football player/student, canal in tooth N 21 calcified and tooth discolored, bleached for 5 weeks, rebleached after 9 months.

62-year-old female bleached mandibular teeth 6 weeks. Followed for 2 months post-bleaching.

Lightened stained craze line on N 21 on 66-year-old female. Followed for 4 months post-bleaching. Cervical dentin does not usually lighten much with bleaching.

Hypocalcified area was bleached for 14 days, white spot lightened rapidly then returned to original color after cessation of bleaching.

Unhappy person who was dissatisfied with vital bleaching and decided on veneers.

Fluoride stain removal using bleaching on a 28 year old.

Tetracycline stain removal in a study accomplished in the Peoples Republic of China
--Cervical area stain most challenging to remove,
*Matis et al., Op Dent 31(6):643-651;2006

Never promise results but help patients understand the possibilities!

* Articles are available on Dr Matis' web site- www.bamatis.com

Other questions patients often ask and their answers

How long do I use the product?

Usually from 2-4 weeks. (On some teeth that are yellow due to aging, I have used the agents for 2 months. Use it as long as teeth continue to lighten. Dr. Haywood has used agents for 12 months on tetracycline stained teeth.)

When will I notice some effect?

In about three days.

What if I cannot wear the tray all night?

Wearing the tray is usually not a problem. The tray is like a contact lens; it stays in place with the gel. Some people will salivate more the first couple of nights. If you find you cannot sleep with it through the night we will have you wear it in the morning or evening for a couple of hours. That way will just take a little longer .

What happens if I miss a day?

No problem, just wear it the following evening.

Can I rebleach?

Yes, use the same tray. The product is good for 18 months in the refrigerator.

I am pregnant, can I use At-Home whitening agents?

We recommend you not bleach while you are pregnant or use bleaching agent until you have completed nursing. (There is no evidence it would harm the newborn, but no studies have been conducted to determine if it would harm the offspring. This is an elective procedure so it is better to wait.)

Is it true that laser bleaching is more effective than at-home bleaching?

No. (The American Dental Association has stated that laser bleaching is not more effective than at-home bleaching.)

Will it damage my crowns or fillings?

No, it will not damage fillings or crowns. It will not lighten them either. It will discolor some temporary filling materials.

There is an excellent article on my web site by Dr Haywood entitled “Frequently Asked Questions about Bleaching”, which was published in Compendium 24(4A):324-338;2004.