

# Tooth Whitening Evaluated Through Clinical Studies

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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 six sections. They are:

Introduction

Material concerns

Tooth concerns

Pulpal concerns

Effectiveness of systems

Clinical Cases

## Introduction

- The practice of dentistry is changing as we are now emphasizing less invasive dentistry. 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 teeth?” or “Are you pleased with the color of your teeth”.
- How does tooth whitening work?
  - Peroxide alters conjugated 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, The bleaching of teeth: A review of the literature. Journal of Dentistry 2006;34:412-419
  - Example of a conjugated double bond molecule, crocin having a dark red color being perceived as colorless upon using peroxide Thompson et al. Mechanism of Bleaching by Peroxides Part 2. Kinetics of Bleaching of Alizarin and Crocin by Hydrogen Peroxide at High pH. Journal of the Chemical Society, Faraday Transactions 1993; **89**:4035-4043.
- What are the two kinds of stains that develop?
  - Extrinsic—Stain, which is deposited on the outside surface. Whiteners will alter the color of calculus and the subsurface structure.
  - Intrinsic—Stain, which is incorporated into the tooth structure before or after eruption.
- There are six major systems, three are At-Home and three are In-office systems.
  - At-home bleaching (overnight and daytime) in a custom made tray
    - Advantages-Lower tooth sensitivity, less peroxide ingestion.
    - Disadvantages-Takes longer to lighten teeth, takes time to fabricate tray.
  - At-home with over-the-counter bleaching kits. Examples Whitestrips, Whitening Wraps, Tray-in-tray, Paint-On
    - Advantages-Less expensive, no doctor visits
    - Disadvantages-Not as effective, higher ingestion of peroxide, higher concentration than recommended
  - In-office bleaching “power bleaching”. Some use halogen, LED or proprietary lights.
    - Advantages-Rapid initial tooth whitening; no gel ingested.
    - Disadvantages- Greater sensitivity; rapid reversal of tooth whitening; “burning” of soft tissues if agent reaches gingiva.
  - In office bleaching of discolored spots “microabrasion”
    - Advantages-No gel ingested, no tooth sensitivity
    - Disadvantages- Must use rubber dam as agent is caustic (removes from 8-22 microns per application), works only on superficial stains

- In office bleaching single dark colored tooth “walking bleach”
  - Advantages-No gel ingested, no tooth sensitivity
  - Disadvantages-Need to see patients several times, difficult to seal lingual, requires entry into the pulp chamber plus 2mm into canal space

### Material Concerns

- American Dental Association has an acceptance program for materials.
  - First guideline on safety and efficacy of bleaching agents was 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](http://www.ada.org/ada/seal/adaseal_consumer_shopping.pdf) 4/11/11
- Hydrogen peroxide is active agent. Breakdown: 10% CP=3.3% HP+6.7% Urea;  
HP=Oxygen + Water; Urea=Ammonia + Carbon Dioxide
- How long is the carbamide peroxide bleaching gel active after placement?
  - 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 (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

### Tooth Concerns

- Is there loss of adhesion 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):427-436;2007
  - Study *in situ* showed shear bond strength returned in seven days.  
Bittencourt, et al. J Am Dent Assoc 141:300-306;2010
  - The reason is “oxygen inhibition” that occurs with Bis-GMA resins.
- Is there a loss of microhardness?
  - Study *in vivo* shows no changes in microhardness after bleaching for two weeks.  
Metz et al., Op Dent 32(5):427-436;2007
  - Review of 55 scientifically valid studies on microhardness recently published.  
Attin et al., Den Mat 25:143-157;2009

- Are there morphological changes on tooth surface?
  - No effect on enamel micromorphology when 38% HP 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 30:265-270;2005

### Pulpal Concerns

- 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, Op Dent 29:363-368;2004
- What can be done to reduce tooth and tissue sensitivity?
  - Tooth sensitivity
    - To reduce tooth sensitivity
      - Use 10% CP for shorter time periods can decrease tooth sensitivity. Cardoso et al. J Am Dent Assoc 141:1213-1220;2010
      - Have patient begin using toothpaste for “sensitive teeth” two weeks before initiation of bleaching.
      - Use agent with potassium nitrate after bleaching for 10-30 minutes. Haywood, Quint Int 32:105-09;2001
  - Tissue sensitivity
    - To reduce tissue sensitivity, have patient more effectively remove excess bleaching agent that comes out of the tray during placement and insure tray trimmed shy of cervical collar of gingiva.

### Effectiveness of various systems

- 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 systems
 

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

      - CRA Newsletter 27(3):3;2003
    - At-home systems will boost in-office systems
      - \*Matis et al. Op Dent 34;142-149;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**.
  - There are three 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

-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

-Summary of effectiveness

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

---At-home nighttime in tray with reservoirs is most effective system.

---At-home daytime in tray is next most effective system.

---Over-the-counter is next most effective system.

---In-office bleaching the least effective system.

Matis et al. Op Dent 34:230-235;2000

-Bleaching is polydirectional

--Tooth under veneer can be lightened

Haywood, Quint Int 30:743-747;1999

-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.

CRA Newsletter 21(4):2;1997

--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

### **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?

--Depends on the person

### **Clinical Cases**

53 year old male that bleached for 2 weeks and followed for 7 years who only bleached the maxillary arch.

19-year-old male, endodontically treated tooth #8, 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 #8, no periapical pathology, bleached 6 weeks. Followed for 4 months post-bleaching

28-year-old male, semi-professional football player/student, canal in tooth #9 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 tooth #9 on 66-year-old female. Followed for 4 months post-bleaching

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

Fluoride stain removal on a 28 year old.

-Tetracycline stain removal in a study accomplished in the China

--Not all tetracycline staining can be bleached

--Cervical area stain removal most challenging to remove

Matis et al., Quint Int 33:645;2002

## **Never promise results but help patients understand possibilities!**

### **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 use it until you have completed nursing. (There is no evidence it would harm the newborn, but no studies have 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.**

### **Tray Fabrication Exercise**

A well fitting tray is important to the bleaching process and the health of the patient.

#### **The instructions for making a model and fabricating a tray follow:**

Obtain correct size tray for the arch and place adhesive in tray

Place alginate in tray and on occlusal and buccal surfaces of teeth

Place tray intraorally and allow material to set

Remove tray, keep impression moist and pour within 30 minutes

Mix stone under vacuum

Vibrate stone into impression and allow stone to set

Trim away base of model to within 5mm from the cervical area of the teeth

Remove globs of stone, if there are any, from model

Place ½ mm thick light activated resin on facial surfaces of anterior and bicuspid teeth to within one mm of mesial, cervical and distal areas of each tooth and polymerize resin. Wipe off oxygen inhibited layer of resin.

Vacuum form tray material onto model (if platform vacuum former is used do not allow sheet to droop more than 1 cm below level of sheet holder before lowering it onto model)

Do gross reduction of excess tray

Lift tray off model carefully

Trim tray to gingival tissue side of clear cervical rainbow outline in tray

#### **The instructions for delivering the tray follow:**

Thoroughly brush teeth

Express a line of agent inside of tray from incisal to cervical on cheek side

Seat tray and express excess

Brush off excess

Rinse with water twice

Retire with tray in mouth

In morning remove tray and brush inside of tray to remove remaining gel