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 the clinical studies in the scientific literature that has been published. The presentation has been divided into eight sections. They are:

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

Introduction

-Why learn about tooth whitening?
--Restorative Dentistry is changing. "The more we cut tooth, the more we weaken tooth."
--We have been trained mostly in "mechanical dentistry" however now we must also become trained in "chemical dentistry".
-How do we present it to our patients without insulting them?
--To promote bleaching have posters, offer staff bleach or discuss color at restorative appointment. Ask "How do you like your teeth?" or "Are you pleased with the color of your teeth".
--Listen, evaluate, discus bleaching with patients. Beware of patients with unrealistic expectations.
-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.
-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 is lightened in color?
--Tooth whiteners penetrate tooth surface to affect the color inside the tooth.

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. Objectively a colorimeter or spectrophotometer is used calculating L*, a*, b* and Delta E.
--As we age our teeth become darker, more yellow and slightly more red.
Odioso, Compendium 21:S35-S41;2000
-Are the methods accurate?
--Subjective methods depend on the skill of the examiner and the environment.
--Objective methods are very accurate if machine is calibrated correctly.
-Are the methods comparable?
--If the same subjective and objective instruments are used by the same people they are comparable.

Systems used in Tooth Whitening

-How many systems are there for whitening teeth?

--There are four major systems, three are At-Home systems and one an In-office system.

-What are the advantages and disadvantages of each system?

--At -home in a custom tray bleaching

---Advantages-Less tooth sensitivity, more effective.

---Disadvantages-Not predictable, takes longer.

---What is important in fabricating and delivering a custom tray?

----Procedure for making tray:

-----Make stone model (vacuum spatulate, or vibrate stone)

-----Reduce to approximately one cm past tooth

-----Place resin using palm method

-----Vacuum form plastic sheet to model

-----Gross reduction on model

-----Carefully lift tray off model

-----Trim to cervical margin (indicated by transparent area)

-----Reverse directions on trimming

----Instructions at delivery:

-----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 in morning

--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 (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.

-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 May 2008

-What do other major health organizations recommend to dentists regarding tooth whitening agents?
--Scandinavian Institute of Dental Materials has also recommended "to avoid using concentrations higher than 10% carbamide peroxide".
Dahl & Pallesen, Crit Rev Oral Biol Med 14:229;2003
--European Commission's Scientific Committee on Consumer Products (SCCP)
---Use of products up to 0.1 HP is safe.
---Use of products from 0.1-6% is safe with approval of dentist.
---There is an absence of studies on adverse effects in mouth.
---Over-the-counter products should not be available.
http://europa.eu.int/comm/health/ph_risk/committees/04_sccp/docs/sccp_o_022.pdf
--International Organization for Standardization (ISO)
---Peroxide concentration
---Surface microhardness
---Surface erosion
---Tooth bleaching efficacy

Material Considerations --Dental Restorative

-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
-Is there a change in micromorphology when tooth whitening agents are placed on dental materials?
--A SEM evaluation of 6% hydrogen peroxide whitening gel on dental materials in vitro.
Schemehorn et al. J Dent 32:35;2004

Material Considerations -- Bleaching Agent

-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
-What percentage of agent is used in the actual tooth whitening process?
--Loss of recoverable agent is due to the following factors: absorbent tooth (13%); physical loss of agent (14%), anti-oxidant degradation/Increased temperature/chemical degradation (42%)
*Matis, Compendium 24(SI 4A):354-362;2003
-Do higher concentrations of carbamide peroxide degrade at the same rate as lower concentrations?
--Different concentrations degrade at the same rate at least at 2 hours.
Matis et al., Op Dent 27:12;2002
-Does pellicle affect rate of degradation?
--The removal of pellicle does not affect tooth whitening potential of agent
Wattanapayungul et al., Quint Int 30:737;1999

-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

-Is concentration accurate on the label?

--Some tests were run on samples sent to Indiana University School of Dentistry

Matis, Compendium 24:352;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) 427:2007

--Why not place resin immediately after bleaching?

Cannot bond properly because of oxygen inhibition internally.

Cannot color match because color reversal will occur.

--There is no loss of adhesion to dentin after bleaching.

Freitas et al., JDR 80:247(Abst 1691) 2001

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

-Is there a loss of microhardness?

--Studies differ in loss of microhardness. Some good studies show loss of microhardness and changes in micromorphology, some show none, WHY?

Chen et al. J of Dent 36:718-725;2008

--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 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

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

-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. Masters Thesis IUSD 2002

-What effect does heat have on the pulp?
--The effect of intrapulpal temperature rise on vitality of pulp in Rhesus monkies.
Zach et al., O Surg, O Med, O Path 19:515-530;1965
--How much temperature rise occurs on gel and intrapulpal area during light enhanced bleaching?
Baik et al. J Esthet Restor Dent 13:370;2001
-Will discomfort occur during tooth whitening?
--Patient may have one of two different kinds of discomfort: Tooth or Gingival sensitivity.
---Tray alone causes tooth sensitivity in 15-20% of patients, add placebo agent and 20-30% report tooth sensitivity, add active agent instead of placebo and 55-75% report tooth sensitivity.
Haywood, J Dent Res 79:519(#3001);2000
-What can be done to reduce tooth and tissue sensitivity?
--Tooth sensitivity
---To reduce tooth sensitivity
----Have patient begin using toothpaste for sensitive teeth two weeks before initiation of bleaching.
----Have patient use agent with potassium nitrate after bleaching for 10-30 minutes.
----Have patient use agent less often.
----Have patient wear the tray for a shorter period of time.
Haywood, Quint Int 32:105-09;2001
---Potassium nitrate gel faster acting than toothpaste.
Haywood, Dental Products 43;82:2000
---Sodium Lauryl Sulfate may cause gingival irritation and apthous ulceration in some patients. Potassium nitrate alone does not cause sensitivity.
---Relatively new product is now available, MI Paste (Tooth Moose)
PF and CPP-ACP are equally effective desensitizing agents.
Duan et al. Quint Int (submitted for publication)
--Tissue sensitivity
---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 gingiva.
-How common is severe sensitivity?
--Few people experience severe sensitivity and those that do only have it for a very short time.

Effectiveness of various concentrations and systems

-How effective are the In-office systems?
--*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
--Does light use improve the effectiveness of the In-office systems?
---Effectiveness of In-office products evaluated with and without use of light.
Opalescence Xtra Boost PolaOffice Rembrandt Lighten Plus

LumaArch Niveous LaserSmile Zoom!

One-week recall shows that light use does not increase whitening over non-light use.

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

--How does the effectiveness of an In-office system compare with the overnight tray system?

--ADA accepted In-office product used in a study with an ADA accepted At-home product.

*Zekonis et al., Op Dent 28:114-121;2003

--Is an At-home system recommended after an In-office system?

---It is always recommended as it will further increase the lightening of the tooth.

Matis et al. Op Dent 34:142;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.

Matis et al.29:555;1998.

--Efficacy of 10% CP used for two weeks shows 20% large change, 50% moderate, 20% slight and 10% none.

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

--Here 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.

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

--There are two kinds of Over-the-counter products, whitening toothpaste and whitening gels.

---Whitening toothpastes found over-the-counter

----ADA Seal of Acceptance means that side is lighter that is brushed vs the side that is not brushed. Usually those toothpastes have enzymes and a better abrasive.

----Toothpaste will not internally lighten a tooth unless it has peroxide in it.
----A toothpaste with peroxide in will keep teeth lighter longer.
----Whitening toothpaste decreases reversal of color that happens after vital tooth bleaching.
Matis, Indiana Dent J 77(3):27-32;1998

---Whitening gels found over-the-counter
----Gels do not have concentrations on labels because they are considered cosmetic. Whitestrips have products with 6.0%, 6.5, 10.0% and 14% HP.
----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
----Whitening wraps were more effective than Whitestrips Premium.
*Matis et al., Op Dent 30:588;2005
----Paint-on least effective tooth whitening because it does not stay on the tooth very long.

-Summary of 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

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 happy after 7 year post bleaching
Leonard et al., J Esthet Rest Dent 15:142-152;2003
-Can a patient over bleach—if so, when do you stop bleaching?
--We cannot conduct studies to determine this as the first principle if research is “Do no harm”. Therefore when cuspids become as light as the central and lateral incisors I tell patients it is time to stop bleaching.
-Are there any contraindications to bleaching?
--The contraindications to bleaching are patients with resin or peroxide allergies and pregnant or lactating women.

-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)

--Use of peroxide does not cause oral cancer.

Munro et al., J Esthet Rest Dent 18:119;2006.

-Are there any contraindications for tooth whitening?

-- Patients with resin allergies, peroxide allergies and pregnant or lactating patients.

-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

-Are there other excellent sources of information on tooth whitening?

--Excellent article entitled "Biological Properties of Peroxide-containing Tooth Whiteners" is available.

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 who fell down, traumatizing deciduous central incisors, which were bleached for a total of 47 hours.

Brantly et al. Ped Dent 23:514;2001

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

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

--Not all tetracycline staining can be bleached

--Cervical area stain removal most challenging to remove

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

--Clinical cases of Bleaching Tetracycline Stained Teeth

1) Homogenous Staining	Right 15%-Left 20%
2) Incisal Staining	Right 10%-Left 20%
3) Cervical Staining	Right 20%-Left 15%
4) Bands of Staining	Right 20%-Left 15%

Never promise results but help patients understand the possibilities!

End of Course Thank you for your attention

* 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 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.