The Benefits and Risks of Light Augmented vs. Conventional Tooth Bleaching Systems Used in Dental Offices

Micheal Farhadian, B.A.
Christa Favot
Nassi Figdor, B.A.
Vishal Gandhi, B.Sc.
Gabriella Garisto, B.Sc.
Nilava Ghatak
Raktim Ghatak
Mollie Tova Goldstein, B.Sc.
Ryan Lindo, B.Sc.

University of Toronto, Faculty of Dentistry
124 Edward Street
Toronto, Ontario
M5G 1G6, Canada

Contact information
Nilava Ghatak
79 Blackfriar Avenue
Toronto, Ontario
M9R 3S8, Canada
Phone: 416-242-8281
Fax: 416-674-6409
Email: nilava@hotmail.com

Text Word Count: 1534
Manuscript Word Count: 2145

ABSTRACT

This is an evidence-based review of the scientific literature relating to the benefits and risks of in-office, light-augmented tooth bleaching. The evidence is based on searches of several electronic bibliographic databases and a review of the references of the relevant articles. A total of 786 citations were gathered. Of these, three articles were deemed relevant after being critically appraised using the "Efficacy of Therapy or Prevention" checklist developed by Leake[1]. The three studies present strong evidence as they earned minimum scores of 11.5 out of 16. These studies varied in terms of the whitening system used, treatment design and inclusion criteria applied, making comparison of the results problematic. This study has found the following: i) conflicting evidence on whether light truly augments tooth whitening; ii) consensus that light does not cause additional harm to gingiva or tooth. More standardized studies are required as the present evidence available on this subject is limited.

Keywords:

Tooth Bleaching

Tooth Whitening

Light

In-Office

The Benefits and Risks of Light Augmented vs. Conventional Tooth Bleaching Systems Used in Dental Offices

INTRODUCTION

The demand for tooth whitening has existed for more than 125 years with the management of discoloured dentition first reported in 1877. The dentition may discolour due to the effects of aging, chromogenic foods, endodontic treatments, tetracycline use, fluorosis or the exploitation of tobacco products.[2] Today, tooth bleaching has become the most popular elective procedure in dentistry, as it is an easy, effective, non-invasive, and inexpensive method to cosmetically enhance one's appearance.

Tooth bleaching is delivered in three forms: in-office, dentist-prescribed-home-applied and over-the-counter. When choosing among the different modalities, consideration must be given to factors such as time for colour rebound, intensity of stain that can be removed, potential for tooth sensitivity, soft tissue irritation, systemic effects and pulpal damage.[3] In-office whitening products generally utilize 15-35% hydrogen peroxide (H_20_2), which is unstable and decomposes into water and an active intermediate (i.e. oxygen or free radicals). Here, the bleaching agent is the oxidated species, reduced by the stain in the tooth.[4] Home-applied products use similar chemistry; however, 10-15% carbamide peroxide is employed, which decomposes into approximately 3.5% H_20_2. Dentist-prescribed products are generally applied at home using custom-made trays or filmstrips. Over-the-counter products, such as bleaching strips and whitening dentifrice, although less effective in terms of whitening capability, are extremely popular since they are inexpensive, use milder chemistry, and can be used daily.

In-office agents are often selected to obtain a more profound whitening of difficult stains in a shorter period of time. In addition to highly concentrated chemicals, in-office systems also incorporate catalysts. These chemical catalysts accelerate the decomposition of H_20_2 thereby accelerating the bleaching reaction. The catalysts may be activated by either heat or light resulting in the rapid decomposition of H_20_2. Due to the use of more potent chemicals, in-office agents predispose the dentition to adverse effects, such as tooth sensitivity and gingival irritation. These dentist-supervised systems are also more expensive than other bleaching methods.

OBJECTIVE

This paper presents a systematic review of articles comparing the benefits and risks of light augmented vs. conventional tooth bleaching techniques. The null hypothesis is that there is no difference between the two modalities of whitening. A summary of the strongest sources of evidence for this comparison is presented.

METHODS

All studies cited were searched for, selected and appraised by employing a systematic approach.

Search Strategy

An initial search for relevant papers was performed via electronic bibliographic databases using the following key words: tooth whitening or tooth bleaching, heat, radiation, ultraviolet or UV, laser, and power bleaching. The keyword “light” was not entered as it generated an overabundance of search results considered irrelevant to the topic at hand. The databases explored and their respective number of articles yielded were as follows: Medline (1966 – January 2005) with 73 articles, Medline (in process) with zero, the Cochrane Library with seven, EBM-Database with zero, and Google Scholar with 512. The relevance of these articles was

assessed using predetermined inclusion criteria. The titles of studies found in the reference lists of the six articles that met the criteria were then reviewed as additional potentially relevant articles. Of the 194 references surveyed, 183 were deemed irrelevant based on title, while inclusion criteria were applied to the abstracts of nine. Ultimately, two of the references were considered relevant and selected for validity scoring; however, both were duplicate articles from the original search.

Determination of Relevance

The relevance of an article was established with the following inclusion criteria: 1) the article was written or translated into English and was available in local holdings at the University of Toronto or could be acquired through contact with the authors, 2) the basis of the article was research performed on human models, 3) the article reports on an in vivo study, 4) the study involved only vital teeth and not endodontically treated teeth or an intracoronal bleaching technique, 5) the article reported bleaching of extrinsic stains as opposed to intrinsic staining such as that caused by tetracycline or fluorosis, 6) the bleaching system employed in the study used augmentation via light, heat, radiation, or laser technology, 7) The bleaching method discussed in the article was an "in-office" technique, not dentist-prescribed for home use.

Of the 796 citations garnered through the electronic database and article reference searches, 774 did not meet the inclusion criteria. 693 were eliminated based on title alone and 81 were rejected based on the abstract. Here, five duplicate citations were eliminated and one article[5] was excluded as it could not be obtained. Six relevant articles remained.

Validity Instrument

The quality of five of the six relevant articles was assessed using a "checklist to assess evidence of efficacy of therapy or prevention" developed by Leake[1]. Each article was scored by

three independent reviewers (Figdor N., Ghatak N., and Ghatak R.) and could receive a maximum score of sixteen. The sixth article by Yarborough[7] was a review and was therefore scored by the three reviewers against a "checklist for a review article" by Leake[1] with a maximum score of ten. When a discrepancy in the study score of two or more points was demonstrated, a final score was determined after discussion between all three reviewers.

All studies receiving a score of 65% and above (corresponding to 11 out of 16 for the efficacy checklist and 6.5 out of 10 for the review checklist) were retained.

RESULTS

Of the six articles that were reviewed, two[6,7] did not receive a high enough score on the checklist to be considered compelling evidence and were excluded in the review of study outcomes and the conclusions. Upon full reading of the text, one additional article[8] did not meet the inclusion criteria. The remaining three articles were control trials which all presented relatively strong evidence.

The 3 relevant studies presented evidence that scored between 11.5 and 14.5 out of 16. Tavares *et al*. presented the strongest evidence. Their results indicate a significant average increase in tooth whitening with the addition of light by 1.93 shades. Papathanasiou *et al*. and Hein *et al*. employed a split-arch technique and found that light does not significantly enhance whitening dentition with bleach. While there is conflicting evidence presented on the benefit of light for augmenting tooth whitening with bleach, all three papers indicate that light does not cause additional harm to the pulp or gingival nor does it increase tooth sensitivity.

DISCUSSION

According to the systematic review of articles, the findings pertaining to in-office tooth whitening systems cannot be compared due to differences between study designs. Specifically,

the various in-office whitening systems examined vary by the hydrogen peroxide concentration and bleach pH, the type of light being used as well as the wavelength, the number of treatments required and individual exposure times (Table 1).

Two different shade guides were used to evaluate baseline shades in the studies. In the studies by Papathanasiou, *et al*. and Tavares *et al*. the Vita Shade Guide was used and Hein, et al used the Vitapan 3D-Master Shade Guide. The interpretations from the shade guides were subjective and there were related confounding variables. For instance, the number of examiners and their rater reliability, the teeth being rated and their position and inclination in the arch should be considered. In addition, it would be valuable to note whether a standard full-spectrum operatory light was used for the visual shade evaluation. The minimum baseline also varied and in two studies was not mentioned at all. These variables could have affected the assignment of a baseline shade and thus may have affected whether a significant difference was found between treatments. Pretreatment preparation of the teeth included pumice, prophylaxis, or nothing at all and may have influenced how the whitening systems were able to interact with the tooth surface.

The reasons for the tooth staining were not taken into consideration in any of the studies. The study by Hein *et al.* also excluded smokers from the inclusion criteria for possible subjects even though smoking is a major cause of tooth staining. Diet, habits and oral hygiene of subjects was not considered or controlled for between re-evaluation intervals and may have affected the long-term results of the treatments.

Two of the studies were supported financially by companies whose products were being tested. One of these studies done by Tavares *et al.* was the only study that found a significant difference in shade between application with light applied and without light applied.

The teeth being tested varied between studies. One study used only incisors. Two studies used the entire anterior region and one used only premolars. Enamel and dentine thickness differs among teeth, which may account for discrepancies in the results.

The mean age of the subjects varied. As teeth age, the pulp chamber tends to decrease in size leading to a dampening in perceived sensitivity. Pain was evaluated subjectively either by interviewing or surveying subjects. Since pain is perceived differently among subject, it is difficult to determine whether results of sensitivity are valid.

In conclusion, the evidence does not present a consistent effect from the addition of light during tooth bleaching. The studies agree that light does not increase pulp or gingival irritation or tooth sensitivity. Further studies controlling the variables outlined and considering the aforementioned recommendations are required before a recommendation can be submitted.

Table 1. Differences among bleaching systems used in the studies evaluated.

	Tavares M., *et al.*	Papathanasiou A., *et al.*	Hein DK, *et al.*		
System Examined	BriteSmile 2000	Opalescence Xtra	LumaArch	Opalescence Xtra Boost	Zoom!
Concentratio of H202	15%	35%	35%	38%	25%
PH	6.5	/	5.6	7.5	7.9
Light Used	Short-arc gas plasma	Halogen Light	High intensity Xenon halogen Tungsten light	Tungsten Halogen Light	Mercury vapour Metal-halide Plasma arc Lamp
Wavelength (nm)	400--505	/	405--580	440--528	362-587
# of Txs.	3	1	3	4	3

Table 2. Yield of articles for each search engine used.

	Medline (1966-Jan 2005)	Medine (In Process)	EBM – Cochrane…	EBM – Database…	Google Scholar
Number of articles	**73**	**0**	**7**	**0**	**512**
Title rejection	**40**	**0**	**5**	**0**	**459**
Abstract rejection	**30**	**0**	**0**	**0**	**48**
Checklist performed	**3**	**0**	**2**	**0**	**5**

Table 3. Search results from reference list.

Number of articles	194
Title rejection	189
Abstract rejection	3
Checklist performed	2

REFERENCES

1. Dr. JL Leake, Department of Biological and Diagnostic Sciences, Faculty of Dentistry, University of Toronto. Unpublished document. Course notes DENT 1040Y 2001.

2. Papathanasiou A, Kastali S, Perry RD, Kugel G. Clinical evaluation of a 35% hydrogen peroxide in-office whitening system. *Compendium* 2002; 23(4);335-346.

3. Tavares M, Stultz J, Newman M, Smith V, Kent R, Carpino E, Goodson JM. Light augments tooth whitening with peroxide. *J Am Dent Assoc* 2003; 134:167-175.

4. Goldstein GR, Kiremidjian-Schumacher L. Bleaching: Is it safe and effective? *J Prosthet Dent* 1993; 69(3):325-8.

5. Ploeger BJ, Palmer TM, Christensen RP. Does heat and/or light enhance vital tooth bleaching? (IADR San Diego 2002 abstracts) J Dent Res 2002;. 81(March 2002 Special Issue A):A-398 (Abs 3212), 2002.

6. C Chandra S. and Chawla TN. Clinical evaluation of heat method for bleaching of discoloured mottled teeth. Journal of the Indian Dental Association. 46(8):313-8, 1974

7. Yarborough DK. The safety and efficacy of tooth bleaching: a review of the literature 1988-1990. *Compend Contin Educ Dent* 1991; 12(3):191-6.

8. Cohen SC, Chase C. Human pulpal response to bleaching procedures on vital teeth. *J Endod* 1979; 5(5):134-8.

9. Hein DK, Ploeger BJ, Hartup JK, Wagstaff RS, Palmer TM, Hansen LD. In-office vital tooth bleaching what do lights add? *Compendium* 2003; 24(4A):340-352.