

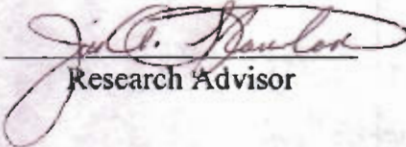
**Effectiveness of a Professional
Bleaching Product on the
Four Shade Ranges of Teeth Enamel**

by

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**A Research Paper
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ABSTRACT

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| <u>Effectiveness of a Professional Bleaching Product on the Four Shade Ranges of Teeth Enamel</u> (Title) |
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The research was done to explore which shade of teeth enamel was most effective for bleaching. There are four basic shades of teeth enamel and they vary in lightness to darkness within each shade. The four shades are brown, grey, yellow, and brown-grey-red mixture.

The subjects were 18-62 years of age and consisted of 6 males and 10 females with varied shades of teeth enamel. The subjects were good candidates because of good oral hygiene, no anterior restorations, limited use of chromogenic agents, no prior history of bleaching, no gingival recession and no intrinsic stain.

For the study, the subjects had their teeth professionally polished, the teeth enamel shade was taken both before and after the bleaching process, instructions were given, and the bleaching material was distributed. The bleaching material was a professional strength strip based bleaching of 6.5% hydrogen peroxide in a concentrated gel. The material was to be used for 30 minutes twice daily for the 14 day study.

The results of the research indicate the brown shade group was the most effected by the use of the bleaching material. This shade had a mean of six units increase in lightness of the teeth enamel among the subjects.

As a result, of this research, dental practitioners will be better prepared to determine the success of the bleaching procedure based on the initial shade range of teeth enamel.

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Chapter One: Introduction

The dental patient asks professionals daily about the possibility of whiter teeth. The popularity for whiter teeth has increased greatly over the last several years. The ethics of the dental profession dictate that dental professionals respond with sound advice to the needs of the patient. This advice would include advising the patient on the probable outcome of using teeth whitening products and its effects on individual shade ranges of enamel.

Background

Historically, and even today there has been a desire for whiter teeth enamel. The Egyptians in 2000 B.C. made chew sticks from reed, pumice stone and vinegar (Marples, 2004). The Roman's made toothpaste from human urine (Marples, 2004).

The French bacteriologist, Louis Pasteur, established the science of microbiology and declared the germ theory of disease in the early 1900's (Allen & Bird, 1997). Pasteur's identification led to the understanding of bacteria existing in the oral cavity naturally and those bacteria increase from food and beverage ingestion. The connection of chromogenic or pigment producing bacteria and the shades of teeth enamel has been questioned since the early 1900's (Ring, 1985). The procedure of dental prophylaxis or teeth cleaning that removes exogenous stains, pellicle, material alba, calculus and oral debris became popular in the early 1900's. This procedure was introduced with the establishment of dental hygiene schools at about the same time (Ring, 1985). The cause and effect of chromogenic bacteria and teeth pigmentation became a concern to the general public. The possibility of whiter teeth after extrinsic stains are removed was beginning to be examined.

Quite by accident in the late 1960's, William Klusmier, an orthodontist in Fort Smith, Arkansas discovered a process that led to the home bleaching technique. Klusmier instructed one of his patients to use a clear gel called glyoxide. The patient had reported tissue irritation and this gel facilitated tissue healing. The gel contained hydrogen peroxide. After using the product, Dr. Klusmier noticed the patient's teeth around the tissue that was irritated were significantly lighter in color as well as the tissue being healthier (H. Heymann, personal communication, October 2, 2004).

Today, teeth bleaching products of hydrogen peroxide are used (Cleveland Clinic). The bleaching techniques that are used today are in two main forms of application. One utilizes the bleaching agent in a gel form that is applied to the teeth through the use of custom made mouth trays similar to a mouth guard used in sports. Haywood and Heymann, respected researchers in the field, have been credited with this teeth bleaching technique (Basting, Rodrigues, & Serra, 2003). The other technique is the use of prefabricated strips. These strips contain the bleaching agent, hydrogen peroxide, in a gel that is on the strip which is preformed to adapt to the teeth.

A professional strip contains 200 mg. gel and 6.5% hydrogen peroxide which results in 13 mg. of hydrogen peroxide per strip. When applied to teeth enamel metallic ions boost oxygen and water release and oxidation occurs. This results in teeth enamel whitening (H. Heymann, personal communication, October 2, 2004). Bleaching popularity in the last several years has risen with an increased demand from the consumer. The professional systems are all successful. Heymann stated that "bleach is bleach is bleach", it takes time and dose as directed (H. Heymann, personal communication, October 2, 2004).

Statement of the Problem

The problem to be studied was which shade of teeth enamel bleaches most effectively. The efficacy of bleaching products has been identified by the dental professionals. However, the research related to the effectiveness of professional strength hydrogen peroxide on specific teeth an enamel shade range has not yet been done. The shades of teeth enamel vary considerably. No research was found for the specific teeth enamel shade ranges and which shade range would yield the most desirable result.

Purpose of the Study

The purpose of this study was to analyze the effects of professional strength strip based bleaching of hydrogen peroxide with a concentrated gel on the four different shade ranges of teeth enamel. Based on the results of the research, the dental professional would be better able to offer sound consultation and to predict the final results of bleaching based on the patients beginning enamel shade ranges.

Research Questions

It was hypothesized that there is a difference in the effectiveness of professional bleaching material on the four different enamel shade ranges. The null hypothesis was that there is no difference on the effectiveness of the bleaching materials for the specific shade ranges of teeth. These various opinions come from clinical experience among the dental professionals.

Significance of the Study

The significance of the study is that it is well known that dental professionals differ widely on the effectiveness of professional bleaching products on the shade ranges of teeth enamel. Bleaching results for individual patient shade ranges has not yet been identified. According to Tim Johnson owner of a dental lab in a metropolitan city, the shade guide used to

determine the enamel shades is universally accepted throughout the dental profession (T. Johnson, personal communication, June 7, 2004). This shade guide is the reference tool used to compare shade ranges of teeth enamel. The efficacy of using professional strength strip based bleaching of hydrogen peroxide with a concentrated gel has been established. Complete results can sometimes be achieved in as little as a week (Fillon, 2004). The bleaching techniques produce results (Wagner, 1999). However, the bleaching result of individual shade ranges has not been studied. As a result of this research, the dental community will have greater insight into the expected result of individual shade ranges of teeth enamel and therefore can advise patients with more accurate potential results. The researcher is an experienced registered dental hygienist. The researcher fields questions on a daily basis regarding the potential results of the teeth bleaching procedure. Hopefully, this research will enable the patient to make a more informed decision on whether to undergo the procedure of bleaching their teeth.

Definitions of Terms

Aesthetic: Appreciative of the beautiful (Merriam Webster, 1994, p. 30). This term is used in the dental profession to describe a beautiful smile.

Anterior: Toward the front (Short, 2002, p. 7).

Bleach (whitening material): Hydrogen peroxide is the main ingredient in the teeth bleaching process (Pointer, 2000).

Calculus: Mineralized bacterial plaque, hard tenacious mass that forms on teeth (Woodall, 1993, p. 249).

Carbon Dioxide: Colorless, odorless gas formed during organic decomposition (Merriam Webster, 1994, p. 171). This gas is a byproduct of the bleaching process.

Ceramic: "Glass or clay earthenware using kaolin and feldspar and fusing particles together" (Fujimoto, Land, & Rosenstiel, 1995, p. 526). This material is used to restore teeth.

Chroma: Intensity of color, light to dark (Winkelmann, 2005).

Chromogenic: Producing color or pigment (Wilkins, 1999, p. 286).

Dental Prophylaxis: Removal of exogenous stain, pellicle, material alba, oral debris, bone measurement, tissue examined for oral cancer and caries detection (Wilkins, 1999, p. 264).

Dentin: "Light yellow substance that is more radiolucent than enamel, constitutes the largest portion of the tooth, is harder than bone but softer than enamel and calcium and phosphorus are the chief inorganic components" (Melfi, 1994, p. 113).

Efficacy: Intended effects (Merriam Webster, 1994, p. 244).

Enamel: The hardest structure in the body and covers the entire crown of the tooth (Halstead & Phinney, 2000, p. 756).

Extrinsic: Outside (Wilkins, 1999, p. 286).

Exogenous: Produced from external causes such as coffee that stains teeth enamel (Wilkins, 1999, p. 286).

Gingival Recession: Migration of the gum tissue around teeth.

Hue: Actual color (Winkelmann, 2005).

Hydroxyapatite: A complex phosphate of calcium that occurs as a mineral and is the chief structural element of teeth and bone (Merriam Webster, 1994, p. 567).

Intrinsic: Belonging to the essential nature or constitution of a thing (Merriam Webster, 1994, p. 613).

Materia alba: "White or cream colored cheesy mass that can collect over bacterial plaque on neglected teeth; it is composed of food debris, mucin and bacteria"(Wilkins, 1999, p. 265).

Microbiology: Branch of biology dealing with microscopic forms of life (Merriam Webster, 1994, p. 463).

MSDS: Material Safety Data Sheets that accompany dental materials (MSDS 2003)

Mucin: Secretion of mucous found in saliva (Wilkins, 1999, p. 929).

Over-the-Counter Products: Purchase without a prescription (Wilkins, 1999, p. 88).

Patient: A person who seeks healthcare from a professional.

Pellicle: "Tenacious membranous layer that is amorphous, acellular, and organic and that forms over exposed tooth surfaces, restorations and dental calculus" (Wilkins, 1999, p. 264).

Pigment: A coloring matter (Merriam Webster, 1994, p. 879).

Professional Observation: To take careful notice.

Professional Strength: Percentage of a material used that is only available through a professional

Pumice: "Highly siliceous volcanic glass that when ground is useful as a polishing agent in prophylactic paste" (Craig, O'Brian, & Powers, 1996, p. 100).

Range: Proper order, sequence or scale between limits (pg. 964 Merriam Webster)

Resin: Composite acrylic polymer and monomer material used to restore teeth (pg.658 Fujumoto, Land, Rosenstiel)

Restoration: Something that has been restored (Merriam Webster, 1994, p. 627).

Root Exposure: The additional root surface that is visible due to gingival recession.

Shade: Degree of color (Winkelmann, 2005).

Specialties: “The areas of dentistry that have an ethical limited practice, these would include orthodontic for straightening teeth, oral surgery for the removal of teeth and surgical procedures, oral pathology the examination under microscope of dental specimens, prosthodontics which is the replacement of teeth in either removal or fixed appliances, pedodontics which is working with children, public health which is as it states, and endodontics which is removing diseased pulp tissue and surgical procedures related to the pulp chamber”(Halstead & Phinney, 2000, p. 8).

Subjects: Human beings participating in a study.

Tetracycline: “Broad-spectrum antibiotic affecting a wide range of microorganisms. Their adverse effects on developing teeth are well known” An adverse effect is teeth enamel intrinsic staining (Holroyd & Requa-Clark, 1995, p. 115).

Urea: A soluble weakly basic nitrogenous compound (Merriam Webster, 1994, p. 1296).

Value of Color: Dull or brilliance of color, amount of gray (Winkelmann, 2005).

Virgin: Free from stain (Merriam Webster, 1994, p. 813).

Limitations

The study is limited to the individual color interpretation of the professional and light source for the observer. In addition, the study is limited to the subjects adherence to the guidelines of the study which include the discontinued use of chromogenic causing agents such as tobacco, coffee and tea, dark colas, dark fruit and their juices or red wine to name a few, during the bleaching procedure. The study is further limited by the fact that enamel thickness varies per subject. The thickness depends on the pattern of the enamel rods that are laid down during tooth development. The thicker the enamel, the greater amount of time it could take to bleach. The thinner enamel bleaches more rapidly. The use of human beings as subjects includes

the limitation of their compliance of the use of the bleaching product. During the study, these subjects were expected to adhere to strict oral hygiene habits which includes tooth brushing twice daily and the use of dental floss and oral rinses. If the habit was not carried out, the study would be further limited.

Timeline of Research Paper

| | |
|----------------|---|
| September 2004 | Take research course, choose an advisor, complete survey test and obtain certificate, obtain graduate packet, take 5 additional credits |
| October 2004 | Distribute questionnaire to Dentists at the ADA convention in Orlando, Florida., attend convention lecture with Dr. Heymann for research information and for independent study of research for thesis |
| November 2004 | Register Plan B and three additional credits |
| December 2004 | Complete Chapters 1-3 of thesis, contact advisor, complete coursework for current semester |
| January 2005 | Obtain IRB approval, secure typist, apply graduation |
| February 2005 | Conduct research, complete chapters 4 & 5 of thesis, deliver paper to the advisor |
| March 2005 | Make any necessary changes to paper |
| April 2005 | Complete coursework, distribute paper to typist, complete any details |
| May 2005 | Graduate |

Chapter Two: Review of Literature

Historically, there has always been, what appears to be a vanity issue among human beings associated with the color of their teeth. Many cultures have tried home remedies to try to improve their smiles. The Egyptians in 2000 B.C. made chew sticks from reed, pumice stone and vinegar (Marples, 2004). The Roman's made toothpaste from human urine (Marples, 2004).

Modern dentistry continually improved and the question of enhanced whitening began to be addressed when the professionals connected the proverbial dots of the relationship between what people ingest and the stains on their teeth. It is known that a person can improve their teeth color somewhat with good oral hygiene and by having regular dental prophylaxis. As dentistry has continued to move forward, the possibility that teeth could be even whiter to further enhance the smile continues to be explored.

In the 1980's, bleaching products, to be used under the supervision of dental professionals, were introduced. The efficacy of the professional products was not questioned. The consensus among dental professionals is that all bleaching systems work, supporting the idea of "bleach is bleach is bleach" (H. Heymann, personal communication, October 2, 2004). The procedure does work (Kimmes, 2004). The desire for whiter teeth has become quite popular. The demand by patients seeking advice and consultation on professional bleaching is a daily occurrence in the dental office. It is at a level now that almost everyone wants whiter teeth. The demand for tooth whitening has increased 300% over the last five years (Feinman, personal communication, September 13, 2004). A recent study found that 98% of dental offices in the United States offer whitening advice and procedures (Feinman, personal communication, September 13, 2004). In reading a recent article the statement appeared "Chiclet white is what people are asking for" (Harms, 2004, p. 1D).

Enamel is the calcified substance that covers the entire anatomical crown of the tooth and protects the dentin. Dentin is the light yellow substance that is more radiolucent than enamel, is very porous, constitutes the largest portion of the tooth, is harder than bone but softer than enamel. Calcium and phosphorous are its chief inorganic components (Melfi, 1994). Enamel is the hardest tissue in the body and consists of ninety-six percent inorganic minerals, 1% organic components and 3% water. Calcium and phosphorous, in the form of hydroxapatite, are the main inorganic components. Structurally enamel is composed of millions of enamel rods or prisms. Each rod begins at the dentinoenamel junction, which is the junction formed between the enamel and dentin, and extends to the outer surface of the crown (Melfi, 1994). The number of rods varies from person to person, and the thickness of the enamel varies as well.

When hydrogen peroxide is applied to the enamel, the ends of the rods change chemically from the crystals in the hydrogen peroxide and allow the material to enter the hollow rods (Pointer, 2000). The bleaching of the teeth enamel is underway.

Bleaching is oxidation of organic pigment in a tooth (H. Heymann, personal communication, October 2, 2004). The peroxide has a low molecular weight therefore it can pass through the dentin and enamel easily (Wagner, 1999). The chemical process is oxidation by which organic materials are eventually converted to carbon dioxide and water. The use of sodium hypochlorite or household bleach on clothing stain removal is an example of the oxidation process. The chemical process can be stopped when a desired effect is achieved in both cases.

Bleaching is oxidation - a reduction process or a redox reaction. In a redox reaction, there is an oxidizing agent containing free radicals with unpaired electrons which it gives up readily, thus causing it to be reduced. These electrons are taken up by the reducing agent, the substance

being bleached, causing it to be oxidized. The peroxide is the oxidizing agent that produces two free radicals, oxygen and water. The pH of this solution affects its strength. In its pure aqueous form, peroxide is weakly acidic and produces more of the weaker oxygen free radical. The solution is buffered to a higher pH in order to promote the production of a higher percentage of the stronger free radicals (Wagner, 1999). Bleaching material diffuses laterally when applied to the teeth therefore it reaches all the surfaces for an even distribution (H. Heymann, personal communication, October 2, 2004).

Organic materials can interfere with the bleaching process. The presence of decomposition catalysts and enzymes can change the reaction so that no free radicals are produced. The success of the bleaching treatment is based on the ability of the bleaching agent to permeate tooth structure. It is therefore very important that teeth be dry and cleaned of debris before any bleaching agent is applied. The solution must penetrate the surface of the teeth. In dental bleaching, the peroxide diffuses through the organic matrix of the enamel and the dentin, emitting its free radicals (Wagner, 1999).

There is a point called saturation where the lightening ceases (Wagner, 1999). The bleaching process therefore, reaches a plateau. The teeth may darken slowly over a period of time therefore after two years or so the bleaching process can be redone with several applications to brighten the teeth once again.

According to the directions supplied with dental whitening products, patients that would be favorable candidates of teeth enamel bleaching would possess the following traits: The patient must demonstrate excellent oral hygiene; good habits encompass brushing teeth twice daily, as well as the daily use of dental floss and oral rinses. The patient should not use excessive

chromogenic producing substances such as tobacco of any kind, tea, coffee, colas, red wines, dark fruit and its juices. Patients that possess anterior restorations cannot be considered; these restorations are generally resin or ceramic and do not bleach. Resin is the material primarily used for the restorations of anterior teeth where aesthetics is a primary concern (T. Johnson, personal communication, June 7, 2004). The outcome would therefore not be even. Patients that have gingival recession root exposure should be cautioned because the root structure could become sensitive to the materials used in the bleaching process. Patients that possess intrinsic stain from tetracycline antibiotic use, trauma to teeth, root canal procedures, old age or excessive fluoride would have limited results (Cleveland Clinic, 2003).

The patient should use the bleaching material following a prophylaxis. It was stated earlier that for the best results teeth need to be debris free. The dentist would do an exam to check for any needed dental treatment. The patient would be given the bleaching material and instructions.

The procedure for whitening would begin with checking the patient's enamel shade. Color is a mental interpretation by the observer as light rays are returned to the observer from the object. Three things are necessary to achieve this: an observer, an object, and a light source (T. Johnson, personal communication, June 7, 2004). The shade guide is a reference tool used in the dental field to compare the shade ranges of teeth enamel. It is called the VITA shade guide designed by Dr. Hollenbeck, a dentist from Germany. The shade guide was further developed by the VITA Zahnfabrick company also in Germany (H. Heymann, personal communication, October 2, 2004). The shade guide has 16 plastic tooth shaped tabs that slide in and out of a holder. The tabs represent the four shades of teeth enamel and the different chroma within those

shades. The shade ranges of teeth enamel is represented by letters for the hue. The hue is the actual color itself. The numbers in each hue represent the chroma.

The chroma are the range of the colors. The colors therefore have a range of shade from lighter to darker within each grouping. For example, the color red is an actual color and pink or ruby red would be chroma within the color red. The chroma for pink is light and the chroma for ruby red is darker. The value of color is the dullness or brilliance (Winkelmann, 2005).

The shade guide used universally in the dental profession is broken down by hue and chroma in Table 1 below. The bases are the four basic hues. They are "A" representing brown base, "B" representing yellow base, "C" representing gray base and "D" representing a mixture of red, gray and brown. The "D" hue is not very often found in teeth enamel. The chroma or light to dark is represented by numbers.

Table 1

The Shades of Teeth Enamel Based on Hue and Chroma

VITA Shade Guide

| | | | | | |
|------------------------------|-----------|-----------|-----------|-------------|-----------|
| Brown Base | A1 | A2 | A3 | A3.5 | A4 |
| Yellow Base | B1 | B2 | B3 | | B4 |
| Gray Base | C1 | C2 | C3 | | C4 |
| Red, gray, brown base | | D2 | D3 | | D4 |

The shade guide in Table 2 represents the hue and chroma with arrangement of light to dark.

Table 2

VITA Shade Guide Representation of Hue and Chroma in Arrangement of Lightest to Darkest

| | | | | | | | | | | | | | | | | |
|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|-----------|-----------|-----------|----------------|
| Lightest | | | | | | | | | | | | | | | | Darkest |
| B1 | A1 | B2 | D2 | A2 | C1 | C2 | D4 | A3 | D3 | B3 | A3.5 | B4 | C3 | A4 | C4 | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |

The concern that exists among dental professionals is that many dental professionals have widely different opinions concerning the result of professional bleaching products on specific shade ranges of teeth enamel. The shade ranges of teeth differ like skin and hair color differ among human beings. Patients will get different results from professional bleaching products depending on their shade (Kimmes, 2004). In an interview by the researcher with Ronald Feinman, D.D.S. who has a dental practice in Atlanta, Georgia, who is known for his extensive use of whitening products in his practice, stated, "we all know that yellow bleaches better than gray" (R. Feinman, personal communication, September 13, 2004). However, some dentists the researcher interviewed expressed that in their clinical experience brown or gray bleaches best. Addressing these differences of opinions needs to happen so that the patient can obtain a better indication of results that would be expected with the bleaching procedure. The information given to patients by professionals should be consistent and accurate with the interpretation of shade ranges of teeth enamel.

A survey was conducted and questionnaires were distributed by this researcher to 50 dentists at the Annual Convention of the American Dental Association in Orlando, Florida in October of 2004. These 50 dentists attended a dental fraternity meeting that the researcher also attended. These dentists were asked to indicate the teeth enamel shade on the questionnaire (Appendix A) that in their professional opinion whitened the best. With 100% return, it was concluded by this researcher that there exists vast confusion on the interpretation of bleaching material results on shade ranges of teeth enamel. The results of the survey showed that the dental professionals who completed the questionnaire had differing opinions. The results were the "A" shade range or brown had 23 votes, the "B" shade range or yellow had 19 votes, the "C" shade range or gray had 7 votes and the "D" shade range or red, gray and brown had 1 vote.

Significance

The dental professionals are bombarded daily with questions from the dental patient. Most patients want whiter teeth. The professionals need to deliver this care to be competitive. The delivery of care must be done in conjunction with the education of the product as well as the anticipated results. Therefore, the results of the study will hopefully help the dental professional to feel more confident in their delivery of professional bleaching materials.

Chapter Three: Methodology

Introduction

The problem being studied in this research is that dental professionals have widely different opinions concerning the result of professional bleaching products on specific shade ranges of teeth enamel. The shade ranges of teeth enamel differ just like skin and hair color differs among human beings. Individuals will get different results depending on their shade (Kimmes, pg. 1D). In an interview with Ronald Feinman D.D.S., a practicing dentist from Atlanta, Georgia, he stated, "we all know yellow bleaches better than gray" (R. Feinman, personal communication, September 13, 2004). However, some dentists say that they believe that gray bleaches best. Many dentists are reluctant to give an indication of the results due to extraneous factors such as oral hygiene habits and the use of chromogenic agents (H. Heymann, personal communication, October 2, 2004).

The concern needs to be addressed so that the patient can have a better indication of the results that can be expected with the bleaching procedure. It is this researcher's opinion that the information given to patients by dental professionals should be consistent with the interpretation of shade ranges of teeth enamel.

The clinical study utilized professional strength strip based bleaching of 6.5% hydrogen peroxide in a concentrated gel. The strips were applied to different shade ranges of teeth enamel. The study compared results of which shade ranges of teeth enamel bleaches with the most effective results. This chapter will address the subject selection, description of the study, instrumentation, data collection procedure, data analysis, and limitations.

Subject Selection and Description

The study consisted of 16 subjects, six males and ten females. The age range was from 18-62 years. The seventeenth subject dropped out of the study after two days due to the strict regimen of the study. The subjects had no acute dental treatments or restorative dentistry involving the anterior teeth. The anterior restorations would be resin or ceramic and would not bleach thus ending with an uneven result. The subjects were all patients in the dental practice, in a lake country setting where the study was performed. They came to the dental office for their standard cleaning recall appointment. They were all seeking advice and consultation of the teeth bleaching procedure. As a result of this level of interest, they were invited to volunteer for the study. At no cost to them. The subjects that volunteered were screened for:

- 1) good oral hygiene,
- 2) the limited use of chromogenic agents,
- 3) past use of bleaching products,
- 4) gingival recession,
- 5) intrinsic stain,
- 6) anterior restorations, and
- 7) varying shade range of enamel.

Before the study initiation, the protocol and informed consent procedure were reviewed and approved by an institutional review committee.

There were three office visits for each subject during the study. The first visit included distribution of the professional strength strip based bleaching of hydrogen peroxide with a concentrated gel. Each subject was given 28 strips which would be the supply for the study. The subjects received instructions both verbal and written (Appendix B). These instructions included

the use of product material and study expectations. The study expectations included the continued practice of good oral hygiene habits which is tooth brushing twice daily and the use of dental floss and oral rinses and the discontinued use of any chromogenic agents such as coffee, tea or tobacco products. The subjects were given a journal (Appendix C) specially designed to record their progress. The progress includes the use of the bleaching material, record of oral hygiene practice and any use of chromogenic agents during the study. All study subjects had their teeth professionally polished by the researcher who is a dental hygienist, to remove any existing chromogenic stain. The initial shade assessment was done in natural light using the shade guide. The initial shade is taken to have a comparison at the end of the treatment. The shade guide is the dental reference tool used to compare shade ranges of teeth enamel. It is called the VITA shade guide. The VITA shade guide was specifically designed for this use by Dr. Hollenbeck of Germany and manufactured by the VITA Zahnfabrick company also of Germany. The shade guide has 16 plastic tooth shaped tabs that slide in and out of a plastic holder. The tabs represent the four shades of teeth enamel and the different chroma within those shades. The shades are represented as letters and the numbers in each hue represents the chroma. The recommended process would be to look at the shade guide for ten seconds alternating it to the tooth so that the shade can be easily interpreted and not distorted. The cones of the retina can hold a true color for no more ten seconds. If the subject is wearing a bright color garment they should be draped with a neutral material. A subject wearing lipstick would need to remove it to have a neutral background (T. Johnson, personal communication, June 7, 2004).

These findings were recorded in a specially designed form called the dental log (Appendix D) created by the researcher. This dental log was used by the researcher to record the subject's shades of teeth enamel bleach progress during the study. A new toothbrush and floss

were given to each subject for use during the study. The total treatment phase was 14 days. The application of the material was done at home by the subjects following the detailed instruction. The material was used twice daily for 30 minutes for each application. These treatments were suggested for morning and evening. The subjects were all seen within a two week period of time. Most of the subjects were scheduled with appointments in 15 minute increments back to back on the same day. The researcher did provide other appointment times to accommodate the subjects schedule if necessary. There was a shade assessment on the eighth day, which took five minutes using natural light and the shade guide. The findings were recorded in the dental log and all questions from the subjects were answered.

At the end of the study, the fourteenth day, the final shade was assessed using natural light and the shade guide. The findings were recorded in the dental log. The journal used by the subjects of their product compliance, oral hygiene habits, and use of chromogenic agents were collected. The subjects were thanked for their participation. and invited to read the final results of the study.

Instrumentation

Data collection took place in a dental clinical setting for all subjects. A professional shade guide and log sheet were used for data collection. The dental record log sheet was created especially for the study and was completed specifically for that purpose. The subjects maintained a journal, created for the study of chromogenic agents used during the 14 days. The subjects also recorded their oral hygiene habits and use of bleaching material as instructed in this journal. This journal was collected from all subjects at the last visit and the entries were analyzed.

Data Collection

The dental record was completed for the 16 subjects at each meeting. The shade and the progress of the bleaching material was recorded in the dental log. The journal was completed by the same 16 subjects. The subjects were requested to complete the daily journal of use of chromogenic agents, oral hygiene habits and compliance of the material usage. The journals the subjects completed during the study was collected at the third meeting.

Data Analysis

The subjects' enamel hue was assessed using the dental shade guide to establish baseline data. This was recorded in the dental study log. The subjects were assessed the second time, on the eighth day of the study, to determine progress of the bleaching process, compliance of study guidelines and to answer all questions. The results were recorded in the dental log. The subjects were further assessed on the fourteenth day. The assessment included the final results of the bleaching process and the ending shade was recorded. The subjects' compliance journals were collected and reviewed. These findings were also recorded on the dental log. These results were analyzed and developed into tables.

Limitations

The study was limited to the individual color interpretation and light source by the professional observer. In addition, the study was limited by the subjects understanding and adherence to the guidelines, which include the discontinued use of chromogenic agents during the bleaching procedure, good oral hygiene and proper use of the material. The study was further limited to the fact that enamel thickness varies. Another limitation of the study is that it included only sixteen subjects and only one dental practice. Generalizations cannot be made from this small number of participants.

Summary

The concern of the dental professionals is that different opinions exist on the results of professional bleaching products on specific shade ranges of teeth enamel. It is the opinion of the researcher that dental patients should have an idea of the expected result of their bleaching procedure. The study compares the bleaching procedure on the different shade ranges of a selected group of subjects to determine whether or not one shade range of teeth enamel does bleach in a superior fashion with as many variables minimized as possible.

Chapter Four: Results

Home professional strength strip based bleaching with 6.5% hydrogen peroxide in a concentrated gel is a rapidly growing treatment choice for patients who want whiter teeth. Under the supervision of the dental professional the procedure is safe, effective and a conservative approach for whitening. Research shows that the dental professionals generally agree that professional strength strip based bleaching in 6.5% hydrogen peroxide in a concentrated gel is effective however, the professionals disagree on the effectiveness of the professional strength strip based bleaching in 6.5% hydrogen peroxide with a concentrated gel on specific shade ranges of teeth. A completed survey done for this study strongly suggests the null hypothesis. The null hypothesis states that there is confusion, among dental professionals on effectiveness of bleaching material for specific shade ranges of teeth enamel.

The purpose of the study was to analyze the effectiveness of professional strength strip based bleaching of 6.5% hydrogen peroxide in a concentrated gel on the four different shade ranges of teeth enamel. Based on the results of the research, the dental professional would be able to offer more sound consultation with a stronger prediction of the final results of bleaching based on the patients beginning enamel shade ranges.

The study included 16 subjects that were all patients in the dental practice where the study was performed. These people came to the office for their standard cleaning recall appointment. They were all seeking advice and consultation regarding the teeth bleaching procedure. As a result of this level of interest, they were invited to volunteer for the study. The subjects were screened for:

- 1) oral hygiene,
- 2) the use of chromogenic agents,

- 3) past use of bleaching products,
- 4) recession,
- 5) intrinsic stain,
- 6) anterior restorations, and
- 7) varying shade range of enamel.

Before the study initiation, the protocol and informed consent procedure were reviewed and approved by an institutional review committee.

There were three office visits for each subject during the study. The seventeenth subject dropped out of the study after two days. This subject indicated the regimen was too difficult. The first office visit included product distribution. The subjects received instructions both verbal and written. These instructions included the use of product material and study expectations. The study expectations included the practice of good oral hygiene habits and the discontinued use of chromogenic agents. The subjects were given a journal specially designed for the study to record their progress. All subjects had their teeth professionally polished to remove any chromogenic stain prior to use of the bleaching product. The initial shade assessment was done in natural light using the VITA shade guide. The 16 subjects had teeth enamel shades as follows: A shade or brown six subjects, B shade or yellow five subjects, C shade or gray four subjects and the D shade or mix of red, brown and gray only had one subject. The subject that dropped out was also in the "D" hue. This hue is difficult to find subjects because the hue is obscure (Tables 3 and 4). These findings were recorded in a specially designed form called the dental log. A new toothbrush and dental floss was given to each subject for use during the study. The total treatment phase was 14 days. The application of the material was done at home by the subjects following the detailed instruction. The material was used twice daily for 30 minutes for each

application. These treatments were suggested for morning and evening application. There was a shade assessment on the eighth day which took five minutes using natural light and the VITA shade guide. The findings were recorded in the dental log and all questions answered (Table 5).

Table 3

VITA Shade Guide Grouping by Letter Represents the Shade /Hue and #'s for Chroma

A=Brown, B=Yellow, C= Gray and D= Red + Brown + Gray
The numbers 1-4 represent the chroma within each base shade from light to dark

This shade guide is the representation of the shade guide without change.
Each box is a tab or unit

| | | | | | | | | | | | | | | | |
|----|----|----|------|----|----|----|----|----|----|----|----|----|----|----|----|
| A1 | A2 | A3 | A3.5 | A4 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D2 | D3 | D4 |
|----|----|----|------|----|----|----|----|----|----|----|----|----|----|----|----|

This is the same shade guide however it is in order of the lightest shade of teeth enamel to the darkest shade of teeth enamel

Each box is a tab or unit

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|----|----|----|
| B1 | A1 | B2 | D2 | A2 | C1 | C2 | D4 | A3 | D3 | B3 | A3.5 | B4 | C3 | A4 | C4 |
|----|----|----|----|----|----|----|----|----|----|----|------|----|----|----|----|

Table 4

Shade Guide: Lightest Shade of Teeth Enamel to Darkest Shade of Teeth Enamel

Number in the second row represents the number of subjects that had that shade on the first day of the study

Each box is a tab or unit

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|----|----|----|
| B1 | A1 | B2 | D2 | A2 | C1 | C2 | D4 | A3 | D3 | B3 | A3.5 | B4 | C3 | A4 | C4 |
| - | - | 3 | 1 | 2 | - | 1 | - | 2 | - | 1 | 2 | 1 | 2 | - | 1 |

Table 5

Shade Guide: Lightest Shade of Teeth Enamel to Darkest Shade of Teeth Enamel

Number in the second row represents the number of subjects that had that shade of teeth enamel on day 8 of the study

The shift exists due to the whitening procedure from darker to lighter

Each box is a tab or unit

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|----|----|----|
| B1 | A1 | B2 | D2 | A2 | C1 | C2 | D4 | A3 | D3 | B3 | A3.5 | B4 | C3 | A4 | C4 |
| 3 | 4 | 1 | - | 3 | 1 | 2 | - | - | - | 1 | - | - | 1 | - | - |

At the end of the study, the final shade was assessed using natural light and the VITA shade guide. The findings were recorded in the dental log. The journal used by the subjects of their product compliance, oral hygiene habits, and use of chromogenic agents was collected. The results of the study are illustrated in table 6 and Figures 1 and 2. The dental journals collected from the subjects were very detailed. The subjects indicated the time of day they used the product, practiced their oral hygiene and recorded the use of any chromogenic agents. The subjects were prompt for all assessment appointments. The subjects were very compliant in all phases of the study.

Table 6

Shade Guide: Lightest Shade of Teeth Enamel to Darkest Shade of Teeth Enamel

Number in the second row represents the number of subjects that had that shade of teeth enamel on the 14th or Final Day of the study

The shift exists due to the whitening procedure from darker to lighter

Each box is a tab or unit

| B1 | A1 | B2 | D2 | A2 | C1 | C2 | D4 | A3 | D3 | B3 | A3.5 | B4 | C3 | A4 | C4 |
|----|----|----|----|----|----|----|----|----|----|----|------|----|----|----|----|
| 4 | 7 | - | - | - | 2 | 1 | - | - | - | 1 | - | - | 1 | - | - |

The subjects that participated had nice results for the 14 days. The A shade or brown shade had the best results. The C shade or gray was second, and the B shade, which most dentists think is the best shade for bleaching, yellow, came in third. The D shade came in fourth. This shade only had one subject because people with this shade of teeth, which is a red, brown, gray combination are difficult to find. The subject that dropped out after two days was also the D shade. The study was successful and the subjects were very pleased with their bright smiles.

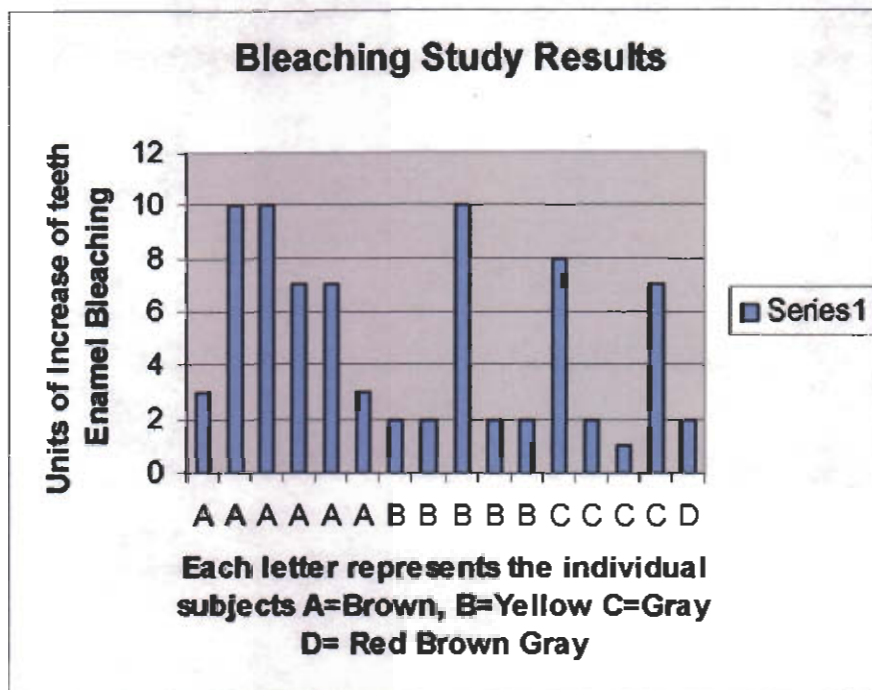


Figure 1. Results of Bleaching Study

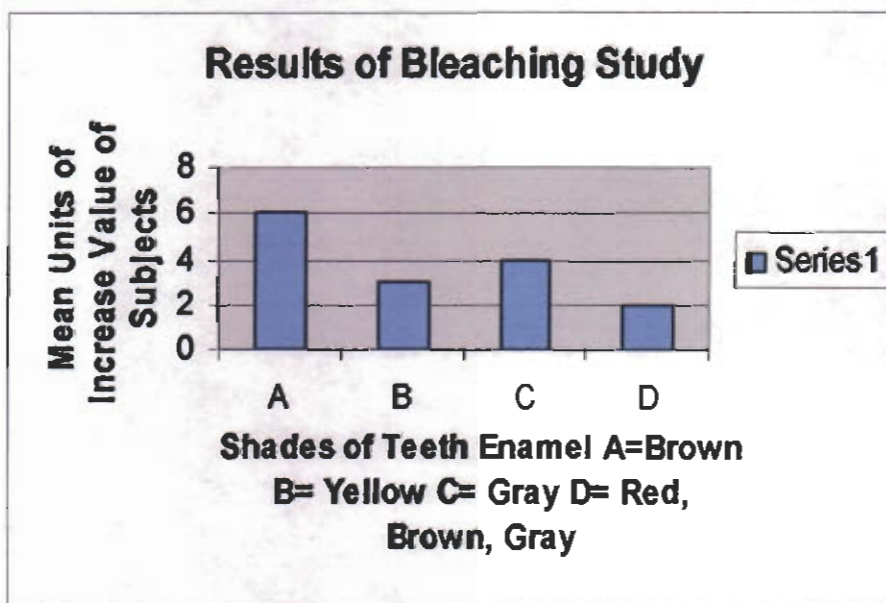


Figure 2. Results of Bleaching Study

Chapter Five: Summary

The results of the study indicate that the bleaching material is effective in bleaching teeth enamel. The subjects bleaching their teeth for 30 minutes twice a day for 14 days yielded positive results. The research was completed on the sixteen subjects and the results quite clearly suggest that the "A" shade ranges of teeth enamel, which is brown based, bleach most effectively.

Discussion

There were 16 subjects that participated in the study. The A shade range included six subjects, the B shade ranges included five subjects; the C shade ranges included four subjects and the D shade range included one subject. It must be understood that the D shade is the most obscure shade and individuals were difficult to locate. The figures shows that there are 16 different shade ranges of teeth enamel. The A shade ranges had a 40 unit overall increase of light value among the six subjects or a mean of six units, the B shade ranges had an 18 unit overall increase of light value among the five subjects or a mean of three units, the C shade ranges had an 18 unit overall increase of light value among the four subjects or a mean of four units and the D shade range had a two unit increase in light value for the one subject.

The subjects submitted their dental journals that recorded oral hygiene habits, their compliance of the bleaching material and the use of chromogenic agents. The subjects were chosen for their excellent oral hygiene habits and their limited use of chromogenic agents. The subjects were extremely compliant in all the areas. The subjects recorded their use of the professional strength strip based bleaching of 6.5% hydrogen peroxide with a concentrated gel for two 30 minutes sessions for the 14 days. The discontinued use of chromogenic materials was not a factor in the study for any of the subjects. This was evidenced by the journal entries the

subjects made and there were no stains evident on the subjects' teeth. The subjects were initially chosen because of their excellent oral habits including tooth brushing twice daily, the use of dental floss daily and the use of an oral rinse. These habits were carried out with all subjects throughout the study.

Conclusion

We already know from the research that teeth enamel bleaching is effective in increasing the lightness or chroma of the hue of a person's teeth. There isn't a great deal of research that looks at the shade ranges and outcomes. The outcome of this study was consistent with the design of the study that suggested that one shade range of teeth enamel might be superior over another. The A shade or brown range had the most effective result with the use of the professional strength strip based bleaching of 6.5% hydrogen peroxide with a concentrated gel. The six subjects as a whole had a 40 unit increase in lightness of shade of teeth enamel. The use of the shade guide in order of lightest to darkest each tab on the shade guide would represent a unit. This would represent a mean of six units increase per subject. The C shade or gray range came in second. This group of subjects had an 18 unit increase in lightness of shade of teeth enamel. This would represent a mean of four units increase per subject. The B or yellow shade came in third. This group of subjects had an 18 unit increase in lightness of shade of teeth enamel. This would represent a mean of three unit increase per subject. The D shade range or red, brown and gray combination was the least effective with teeth enamel bleaching. This subject had an increase of two units.

The study was performed as scheduled and the participants were very compliant. The professional survey that was performed in conjunction with the subject testing was an excellent tool to determine preconceptions because the greatest percentage of dental professionals who

were all dentist did answer with the "A" shade or brown shade providing the best bleaching result. The bleaching specialist professionals, however, stated that that the "B" shade would have the best results. Since this different professional opinion still exists, this research is significant.

Recommendations

On the basis of the study, the following recommendations are made:

1. The study may have been even more effective if there were a greater number of participants, especially in the D range of teeth enamel or combination of red, gray and brown. The study could have been more significant if there were a greater number of subjects with darker values within the shade ranges as well.

2. The cost of the study, because of the bleaching material and the time frame made it difficult to have more subjects. If the research materials could be funded by one of the dental material companies it would allow the researcher to include a greater number of subjects in each shade range of teeth enamel.

3. The results of this study will be shared with the dental professionals which includes dental assistants, dental hygienists and dentists in the Central Wisconsin area where the researcher practices dental hygiene. The results will also be shared with the students and faculty in the dental department at an urban technical college where the researcher is on the faculty.

4. The study will be most likely be submitted to a dental hygiene journal to be reviewed for the consideration of being published.

The research will provide the dental community with greater insight into the expected result of individual shade ranges of teeth enamel with bleaching. The professionals will be better able to give their patients more accurate potential results. The patient will be able to make a more

informed decision on whether to undergo the bleaching procedure based on the initial shade of their teeth enamel and their personal habits.

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Appendix A: Questionnaire

I am doing my master's thesis research and would like your assistance. You are a dentist that practices general dentistry. The research I am doing is regarding the teeth whitening procedure that we use that involves the use of professional white strips. The whitening procedure done on the most favorable candidate with instructions followed properly. In your professional opinion what shade of teeth enamel would yield the most favorable result of bleaching?

Please circle your response:

The "A" shade or **Brown**

The "B" shade or **Yellow**

The "C" shade or **Gray**

The "D" shade or, **Red, Gray & Brown**

Thank you,

Ann Prey C.D.A. R.D.H. B.S.

Appendix B: Research Subjects Instructions

The bleaching project that you are participating in is part of an educational process for me. I really appreciate your participation.

It is very important that you are compliant with the following directions. If you have any questions, please contact me on my cell. The number is (xxx) xxx-xxxx

1. Please continue your great oral hygiene: brush and floss every morning and every evening and use of oral rinses.
2. Please don't drink any (or limit) dark soda, red wine, tea, coffee or dark fruit juices. Don't eat any dark fruit or dark foods during the bleaching process. Please record use on the journal that is attached.
3. Use the bleaching strips everyday for the next 14 days. Apply the bleaching strip on clean teeth for 30 minutes in the morning and 30 minutes in the evening. The strips generally adhere best on dry teeth. Please record the procedure on the journal.
4. We will meet on the 8th day to check your progress and check your progress and on the 14th or final day to check the final shade.