Érica Cappelletto Nogueira Teixeira

EFEITO DE AGENTES CLAREADORES INTERNOS NOS PROCEDIMENTOS RESTAURADORES ADESIVOS EM DIFERENTES INTERVALOS DE TEMPO APÓS O CLAREAMENTO

Dissertação apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas para obtenção do título de mestre em Clínica Odontológica - Área de Dentística.

Piracicaba

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Piracicaba

2002

Ficha Catalográfica

	Teixeira, Érica Cappelletto Nogueira.
T235e	Efeito de agentes clareadores internos nos procedimentos restauradores adesivos em diferentes intervalos de tempo após o clareamento. / Érica Cappelletto Nogueira Teixeira. -- Piracicaba, SP : [s.n.], 2002.
	viii, 80f. : il.
	Orientadora : Prof^a Dr^a Mônica Campos Serra.
	Dissertação (Mestrado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.
	1. Adesão. 2. Dentística. 3. Cisalhamento. I. Serra, Mônica Campos. II. Universidade Estadual de Campinas. Faculdade de Odontologia de Piracicaba. III. Título.

Ficha catalográfica elaborada pela Bibliotecária Marilene Girello CRB/8–6159, da Biblioteca da Faculdade de Odontologia de Piracicaba - UNICAMP.

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A Comissão Julgadora dos trabalhos de Defesa de Tese de MESTRADO, em sessão pública realizada em 12 de Junho de 2002, considerou a candidata ÉRICA CAPPELLETTO NOGUEIRA TEIXEIRA aprovada.

1. Profa. Dra. MÔNICA CAMPOS SERRA ____________________

2. Profa. Dra. IZABEL CRISTINA FRONER ____________________

3. Prof. Dr. MARCELO GIANNINI ____________________

Tocando em Frente

Ando devagar porque já tive pressa
E levo esse sorriso porque já chorei demais
Hoje me sinto mais forte,
Mais feliz, quem sabe,
Eu só levo a certeza
De que muito pouco sei,
Ou nada sei
Conhecer as manhas e as manhãs
O sabor das massas e das maçãs
É preciso amor
Para poder pulsar
É preciso paz para poder sorrir
É preciso chuva para florir
Penso que cumprir a vida seja simplesmente
Compreender a marcha e ir tocando em frente
Como um velho boiadeiro levando a boiada
Eu vou tocando os dias pela longa estrada, eu sou
Estrada eu vou
Todo mundo ama um dia,todo mundo chora
Um dia a gente chega e no outro vai embora
Cada um de nós compõe
A sua própria história
E cada ser em si
Carrega o dom de ser capaz
De ser feliz

Renato Teixeira e Almir Sater

DEDICATÓRIA

Ao Meu Companheiro

Fabrício

.... que mostrou ser possível exercer o amor em todos os atos, sendo marido, amigo, e professor.

Aos Meus Pais

Edson e Marina

.... que me deram a vida ensinando-me a viver com dignidade e iluminaram os caminhos obscuros com afeto e dedicação.

Aos Meus Irmãos

Tila, Diogo, Liz

e Toda Família

.... pela presença em minha vida

À Deus

.... que compreendeu os meus anseios e meu deu a necessária coragem para atingir mais esse objetivo.

AGRADECIMENTO ESPECIAL

À Minha Orientadora

Profa. Dra. Mônica Campos Serra

.... que mesmo distante se fez presente, exemplo de perseverança e conquista profissional, muito obrigada!

"Não basta saber, é preferível saber aplicar. Não é bastante querer, é preciso saber querer."

Goethe

AGRADECIMENTOS

À Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas, na pessoa de seu diretor, Prof. Dr. Antônio Wilson Sallum.

À Profa. Dra. Altair Antoninha Del Bel Cury, coordenadora geral do curso de pós-graduação da FOP/UNICAMP.

À Profa. Dra. Brenda Paula F. de Almeida Gomes, coordenadora do curso de pós-graduação em Clínica Odontológica da FOP/UNICAMP.

Ao Prof. Dr. Luiz André Freire Pimenta e Profa. Dra. Giselle M. Marchi Baron, pela colaboração e confiança.

Aos Professores Dr. Luis Roberto Marcondes Martins, Dr. José Roberto Lovadino, Dr. Luis Alexandre M. S. Paulillo e Dr. Marcelo Giannini, da área de Dentística.

Aos estimados amigos Anderson, Ciça, Paty e Ana Cecília pelo apoio, convivência e amizade.

Aos colegas do curso de pós-graduação em Clínica Odontológica, especialmente da área de Dentística, incluindo as colegas de trabalho Larissa e Roberta.

Aos funcionários da Disciplina de Dentística pelo auxílio em meus trabalhos diários.

À todos os professores da FOP/UNICAMP, pelos ensinamentos, dedicação e exemplo.

À todos que de alguma forma contribuíram para a realização deste trabalho.

SUMÁRIO

RESUMO

A descoloração de um dente não vital é uma alteração estética que normalmente necessita de tratamento. Visando o restabelecimento da cor original do elemento dentário, o clareamento dental interno pode ser considerado uma alternativa conservativa, segura e econômica em relação a tratamentos invasivos. Porém, o uso de agentes clareadores pode interferir nos procedimentos restauradores subseqüentes. Entretanto, o tempo necessário após o clareamento para que os produtos dessa reação não afetem a adesão dos materiais restauradores, ainda é objeto de controvérsias, principalmente em se tratando de agentes clareadores para uso interno. Este estudo, composto por quatro artigos, teve como objetivos: 1. Avaliar a interferência dos agentes clareadores internos nos procedimentos restauradores adesivos; 2. Analisar o efeito do tempo de espera (0, 7, 14, e 21 dias) entre o procedimento clareador e restaurador, através de testes de resistência ao cisalhamento em esmalte e dentina e de microinfiltração de restaurações da abertura coronária; 3. Discutir, através de um caso clínico, a utilização do peróxido de carbamida a 37% na técnica *walking bleach*. Nos estudos laboratoriais, foram utilizados três agentes clareadores internos: perborato de sódio e água destilada, perborato de sódio e peróxido de hidrogênio a 30%, peróxido de carbamida a 37%, e um controle (água destilada), sendo aplicados em dentes bovinos por um período de 28 dias, com trocas a cada 7 dias. Pode-se concluir que, na dependência do substrato e do tipo de teste (cisalhamento e microinfiltração), os agentes clareadores e o tempo de espera proporcionam diferentes efeitos sobre os procedimentos restauradores adesivos. Conhecendo-se as indicações e riscos/benefícios do clareamento interno, o peróxido de carbamida a 37% mostrou ser uma opção para a técnica *walking bleach*.

ABSTRACT

Discoloration of a pulpless tooth is an esthetic problem which requires treatment. The nonvital bleaching is considered a conservative, safe and low cost alternative to reestablish the original tooth color compared to invasive treatments. The use of bleaching agents could influence the restorative bonding procedures. However, the role of the elapsed time following bleaching is still controversial, mainly regarding internal bleaching agents. This study, composed of four manuscripts, had the objectives: 1. To evaluate the influence of internal bleaching agents on restorative bonding procedures; 2. To analyze the effect of elapsed time (0, 7, 14, and 21 days) between the bleaching treatment and restorative procedure, through the shear bond strength on enamel and dentin, and microleakage of coronal access restorations; 3. To discuss in a case report the use of 37% carbamide peroxide in the walking bleach technique. For the *in vitro* studies, three different internal bleaching agents were used: sodium perborate with distilled water, sodium perborate with 30% hydrogen peroxide, 37% carbamide peroxide, and one control (distilled water). These agents were placed in bovine teeth for 28 days, and replaced each 7 days. Under the experimental conditions adopted in this study, it was concluded that the different effects caused in the restorative bonding procedures by the bleaching treatment and the time intervals depend on the substrate and the test employed (shear bond strength and microleakage). The 37% carbamide peroxide showed to be an option in the walking bleach technique once the indications and the treatment risk benefits are known.

1. INTRODUÇÃO GERAL

Um dos fatores que mais contribuem para um sorriso insatisfatório é o escurecimento de um ou mais dentes (BARATIERI *et al.*, 1995[1]). Para minimizar a diferença de cor podem ser realizados procedimentos restauradores tradicionais. Contudo, essas técnicas são consideradas invasivas e onerosas, necessitando de maior manutenção (LIEBENBERG, 1997[13]). Apesar de possibilitarem um bom resultado estético, nem sempre reproduzem a aparência natural da estrutura dental (CAUGHMAN *et al.*, 1999[4]).

A causa mais comum de descoloração em dentes desvitalizados ocorre em conseqüência de injúria ou decomposição do tecido pulpar (FEINMAN, 1991[5]). Devido ao rompimento de vasos sangüíneos, os eritrócitos penetram nos túbulos dentinários. Um dos produtos finais da decomposição da hemoglobina é o ferro que, combinado com o sulfeto de hidrogênio forma o sulfeto ferroso, responsável pela pigmentação escurecida do dente (ROTSTEIN *et al.*, 1993[16], 1991[17]). O clareamento dental pode ser considerado uma alternativa conservativa, segura e econômica para o restabelecimento da estética (CAUGHMAN *et al.*, 1999[4]; LIEBENBERG, 1997[13]).

Tradicionalmente, uma solução aquosa de peróxido de hidrogênio associado ao emprego de calor eram utilizados para o clareamento dental interno (WALTON& TORABINEJAD,1989[27]). SPASSER[19] (1961) reportou com sucesso o uso do perborato de sódio com a água destilada, aplicados e mantidos no interior da câmara pulpar entre sessões clínicas, procedimento mais conhecido como técnica *walking bleach*. NUTTING & POE[14] (1963) modificaram essa técnica, substituindo a água pelo peróxido de hidrogênio 30%, com intuito de obter uma potencialização da ação clareadora.

O perborato de sódio associado tanto à água destilada quanto ao peróxido de hidrogênio são considerados agentes clareadores eficazes (WARREN *et al.*,1990[28]). HO & GOERIG[11](1989) relataram bons resultados estéticos através da associação entre o perborato de sódio e peróxido de hidrogênio a 30%. Entretanto, o clareamento dental interno com peróxido de hidrogênio a 30% tem sido relacionado a presença de reabsorção cervical externa (FRIEDMAN *et al.*, 1988[7]; GIMLIN&SCHINDLER, 1990[8]; GOON *et al.*, 1986[9]; LATCHAM *et al.*, 1986[12]; ROTSTEIN *et al.*, 1993[16]).

Na busca de um agente clareador seguro e eficaz, estão sendo realizadas combinações entre técnicas de clareamento dental (NUTTING&POE, 1963[14]; WALTON&TORABINEJAD, 1989[27]). Agentes clareadores indicados para uso externo, como o peróxido de carbamida nas suas mais variadas concentrações, estão sendo utilizados dentro da câmara pulpar, mostrando resultados esteticamente satisfatórios (CAUGHMAN *et al.*, 1999[4]; LIEBENBERG, 1997[13]).

A maioria dos agentes clareadores promovem o clareamento através de um processo de oxidação, decorrente da liberação de radicais livres; provenientes da decomposição do peróxido de hidrogênio; que reagem com as macromoléculas responsáveis pelos pigmentos (FEINMAN, 1991[5]; FRECCIA *et al.*, 1982[6]; HAYWOOD, 1992[10]). A principal substância ativa é o peróxido de hidrogênio, que é liberado tanto na decomposição do perborato de sódio (WALTON&TORABINEJAD, 1989[27]) como na do peróxido de carbamida (HAYWOOD, 1992[10]). Apesar dos benefícios obtidos pela recuperação da estética, alguns estudos apontam para a interferência do oxigênio residual em procedimentos restauradores adesivos, subseqüentes ao clareamento (BARKHORDAR *et al.*, 1997[2]; SHINOHARA *et al.*, 2001[18]; STOKES *et al.*,1992[20]; SUNG *et al.*,1999[21]; TITLEY *et al.*, 1988[23]; TORNECK *et al.*, 1990[24], 1990[25]; VAN DER VYVER *et al.*, 1997[26]).

Foi demonstrado *in vitro* que o tratamento prolongado com peróxido de hidrogênio a 35% pode alterar a morfologia do cemento, dentina e esmalte (TITLEY *et al.*, 1988[22]). Além disso, pode prejudicar o desempenho de materiais utilizados para restauração de dentes clareados e influenciar na técnica restauradora adesiva a ser empregada após o tratamento clareador (SUNG *et al.*, 1999[21]; TITLEY *et al.*, 1988[22]; VAN DER VYVER *et al.*, 1997[26]).

Há relatos de que o pré-tratamento com substâncias a base de peróxidos pode afetar a qualidade da adesão do material restaurador ao esmalte (STOKES *et al.*,1992[20]; SUNG *et al.*,1999[21]; TITLEY *et al.*, 1988[22], 1988[23]; TORNECK *et al.*, 1990[25]; VAN DER VYVER *et al.*, 1997[26]) ou à dentina (TORNECK *et al.*, 1990[24]). Esse efeito depende do agente clareador utilizado, do tempo de exposição ao mesmo, das condições de armazenagem dos espécimes (TORNECK *et al.*, 1990[25]) ou ainda do tratamento restaurador (SUNG *et al.*, 1999[21]).

Sabe-se que o clareamento externo realizado previamente à procedimentos restauradores pode reduzir a força de adesão entre o material utilizado e a superfície dental STOKES *et al.*,1992[20]; SUNG *et al.*, 1999[21]; VAN DER VYVER *et al.*, 1997[26]). Talvez, a realização de um clareamento interno influenciasse, da mesma maneira, as propriedades adesivas do material restaurador na substituição de uma de restauração esteticamente comprometida envolvendo tanto esmalte como dentina. Além disso, poderia existir um tempo necessário após um longo período de clareamento, para que os subprodutos da ação clareadora não interferissem na adesão dos materiais restauradores. Esses questionamentos foram discutidos nos trabalhos "Effect of non-vital bleaching on resin/enamel shear bond strength" e "Effect of post-bleaching times on dentin bond strength" (capítulos 1 e 2).

TITLEY *et al.*[23] (1988) observaram redução das forças de tração e cisalhamento em esmalte bovino exposto ao peróxido de hidrogênio a 35%. BARKHORDAR *et al.*(1997)[2], mostraram aumento na microinfiltração da interface dente/restauração após alguns dias de clareamento com perborato de sódio e peróxido de hidrogênio a 30%. A perda na qualidade do selamento marginal (BARKHORDAR *et al.*, 1997[2]; SHINOHARA *et al.*, 2001[18]), pode ocasionar a penetração de fluidos na câmara pulpar clareada e restaurada (BARATIERI *et al.*,1995[1]; BARKHORDAR *et al.* 1997[2]; BOKSMAN *et al.*, 1983[3]), que contribuiria para o insucesso do tratamento (RIVERA *et al.*, 1997[15]; WILCOX&DIAZ-ARNOLD, 1989[29]).

Para o controle da microinfiltração, foi sugerido maior tempo de espera na execução do procedimento restaurador em dentes clareados externamente, devido a menor quantidade de subprodutos da degradação do peróxido presentes na estrutura dental (BARATIERI *et al.*,1995[1]; HAYWOOD,1992[10]). Possivelmente, o mesmo seja observado em dentes submetidos ao clareamento interno. Espera-se que a interferência do oxigênio residual seja reduzida ou eliminada em função do tempo de espera, contribuindo com a melhora da qualidade do procedimento restaurador adesivo subseqüente (BARATIERI *et al.*,1995[1]; HAYWOOD,1992[10]). Além disso, a obtenção de um adequado selamento marginal pode estar relacionada ao tipo de agente clareador empregado. Com intuito de responder esses questionamentos, o estudo "Effect of nonvital tooth bleaching on microleakage of coronal restorations" foi delineado e realizado (capítulo 3).

Havendo evidências dos efeitos de diferentes agentes clareadores internos nos procedimentos restauradores adesivos e considerando o grande emprego clínico da técnica *walking bleach*, seria importante discutir não somente seu protocolo clínico, como os aspectos pré e pós-tratamento. Desse modo, desenvolveu-se o capítulo 4: "Use of the 37% carbamide peroxide in the walking bleach technique: a case report".

2. PROPOSIÇÃO

O presente trabalho, através de quatro capítulos, teve como objetivos:

1. Avaliar a influência da aplicação de diferentes agentes clareadores através da técnica *walking bleach*, por um período de 28 dias, na resistência ao cisalhamento de um sistema restaurador adesivo ao esmalte e à dentina e na microinfiltração de restaurações da abertura coronária.

2. Verificar o efeito de diferentes intervalos de tempo (0, 7, 14, e 21 dias) entre o término dos tratamentos clareadores e a realização do procedimento restaurador.

3. Apresentar e discutir as indicações, limitações e procedimentos clínicos do emprego do peróxido de carbamida a 37% na técnica *walking bleach*

3.1 CAPÍTULO I

Effect of non-vital tooth bleaching on resin/enamel shear bond strength

Enviado para publicação para Journal of Adhesive Dentistry

Effect of non-vital tooth bleaching on resin/enamel shear bond strength

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Abstract

Purpose: This study evaluated the effect of non-vital tooth bleaching on shear bond strength (SBS) of the composite resin/bovine enamel interface at different post-bleaching periods of time. *Materials and Methods*: Three hundred twenty teeth were randomly divided into four groups: SPH - sodium perborate + 30% hydrogen peroxide; SPW - sodium perborate + distilled water; CP - 37% carbamide peroxide; and CON - distilled water (control). The bleaching agents in the pulp chambers were replaced every 7 days, over 4 weeks. The groups previously mentioned were randomly divided into four subgroups (n=20) to measure the SBS, according to the post-bleaching periods of time: 0 (baseline), 7, 14, and 21 days. At the respective time, enamel slabs were embedded in polyester resin and flattened. Composite resin cylinders (Z100/ Single Bond-3M) were bonded to the enamel surface and submitted to the SBS test using a universal testing machine. *Results:* The ANOVA showed statistically significant differences between the bleaching agents only at the baseline as identified by Tukey's test (α=0.05): CON=CP=SPW>SPH. The SPH group, showing the lowest mean value, differed significantly from the other groups. At 7, 14, and 21 days, no significant differences were observed. *Conclusion:* The non-vital tooth bleaching could affect the resin/enamel SBS values when sodium perborate mixed with 30% hydrogen peroxide was used.

Introduction

Discoloration of non-vital teeth is an esthetic problem, which requires an effective treatment. The most common cause of tooth discoloration is intra-coronal blood decomposition, but iatrogenic procedures, such as filling material or necrotic tissue left in the pulp chamber, could also contribute to this process[20].

Internal bleaching of these discolored pulpless teeth has offered a conservative and economical solution to this problem[5,10]. Traditionally, an aqueous solution of 30- 35% hydrogen peroxide and heat, called the thermocatalytic technique, were used[11]. However, some studies associated this technique with radicular resorption[3,4,6].

The most popular bleaching technique is the walking bleach that uses a paste of sodium perborate mixed with either hydrogen peroxide or water, which is placed in the pulp chamber and sealed for dental appointments[10,13]. This technique is widely used in dentistry because less clinical time is required. An additional advantage is the safety of this procedure[11].

Some investigations have focused on the effect of peroxide bleaching on the properties of dental materials used in esthetics restorations[8,14,15,16,19]. Interaction between residual peroxide or peroxide-related substances and the restorative material could interfere with its adhesion to enamel[14,15,16,17,19].

Several studies have shown that exposure to hydrogen peroxide causes a substantial reduction in the adhesiveness of the enamel[15,16], an effect which may be reversed by leaching the enamel[18]. However, the influence of sodium perborate, 37% carbamide peroxide, and even hydrogen peroxide placed in the pulp chamber for bleaching on postoperative restorations is unknown. Therefore, these materials need further evaluation. In the present study, the walking bleach technique was used to analyze the duration of these possible effects after non-vital tooth bleaching. The purpose of this study was to assess the effect of three bleaching agents on composite resin/enamel shear bond strength at different post-bleaching periods of time.

Materials and Methods

Experimental Design

The factor under study were:

1. Bleaching treatment at four levels: sodium perborate + 30% hydrogen peroxide (SPH); sodium perborate + distilled water (SPW); 37% carbamide peroxide (CP); and one control (CON-distilled water).

2. Time intervals: 0 (baseline), 7, 14 and 21 days after bleaching.

The experimental sample comprised 320 specimens, randomly divided into four groups according to the bleaching treatment, and four subgroups (n=20) according to the elapsed time between bleaching and restoration. The response variable was shear bond strength (SBS) in MPa.

Tooth Preparation

Endodontic access cavities were prepared in 320 bovine incisor teeth, using a diamond cylinder conical end point (n? 4124- KG Sorensen, São Paulo, SP, Brazil). The pulp was debried with a dental explorer. The roots were sectioned 2mm below the cementoenamel junction (Fig. 1) with a double-face diamond disk (KG Sorensen, São Paulo, SP, Brazil) and sealed with composite resin.

Bleaching Procedure

The non-vital bleaching was performed after the teeth were randomly divided into four groups (n=80): SPH - sodium perborate + 30% hydrogen peroxide; SPW - sodium perborate + distilled water; CP - 37% carbamide peroxide, and CON - distilled water (control).

A mixture of 2g of sodium perborate with 1mL of 30% hydrogen peroxide solution (Farmavip Ltd., Piracicaba, SP, Brazil) was used as the bleaching agent for the SPH group, and, in the same ratio 2:1 (g/mL), sodium perborate and distilled water for the SPW group. These pastes were prepared on a glass slab using a metal spatula for a 30-second period. A commercially available 37% carbamide peroxide gel (Whiteness – FGM Ltd., Joinville, SC, Brazil) was used as the bleaching agent for the CP group, and a cotton pellet embedded in distilled water for the control group (CON).

The bleaching agents or the cotton pellets were placed in the pulp chambers and sealed with Cavit (Espe - Germany). These agents were replaced with fresh preparations every 7 days, according to the walking bleach technique. The pulp chamber was washed with distilled water and dried with compressed air. This procedure was repeated over 4 weeks until the bleaching treatment was concluded (Fig. 2). Throughout the entire experimental period, the teeth were kept in artificial saliva, as proposed by Featherstone *et al*[2] and modified by Serra & Cury[12].

Specimen preparation and bonding procedure

Following the bleaching treatment, the groups were randomly divided into four subgroups (n=20) to measure the SBS, according to the post-bleaching periods of time: 0 (baseline), 7, 14, and 21 days. For the baseline group, specimen preparation and bonding procedure were done immediately after the bleaching treatment. The other specimens were stored in artificial saliva at 37°C for 1, 2, and 3 weeks.

For the shear bond test, a piece (5mm high and 5mm wide) from the incisal portion of each crown (Fig. 3) was placed in a ¾ inch diameter PVC ring. These fragments were embedded in self-curing polyester resin (Fig. 4) (Cromex, Piracicaba, SP, Brazil) and flattened through a wet grinding using 320, 400, 600-grit Al_2O_3 abrasive paper (Carborundum Abrasivos, Recife, PE, Brazil). After the polishing, the enamel surfaces were demarcated with a piece of vinyl tape, in which a 3mm-diameter hole had been made (Fig. 5).

The enamel was etched with 35% phosphoric acid (3M Co., St. Paul, MN, USA) and rinsed with tap water for 15s. Afterwards, the enamel was slightly air dried for 5s and two consecutive adhesive coats (Single Bond, 3M Co., St. Paul, MN, USA) were applied using a saturated brush tip and light cured for 10s, after 5 seconds of air-drying.

A 3mm-diameter Teflon ring mold (5mm high) was placed against the fragment to receive the composite resin (Z100, 3M Co., St. Paul, MN, USA). The filling material was inserted in two increments (2.5mm high), all of which were light cured (Optlux 401, Demetron, Kerr Corp., Danbury, CT, USA) for 40s each (Fig. 6-7).

Shear Bond Test

Each specimen was mounted in a custom-made jig and placed in a universal testing machine (DL 500, Emic Ltda., São José dos Pinhais, SP, Brazil). A steel knife-edge was placed parallel to the specimen surface so that the shear force applied the load directly to the bond interface, using a cross-head speed of 0.5mm/min (Fig. 8). The SBS was measured in MPa.

Failure Mode Analysis

Three examiners analyzed the fractured surfaces of the specimens with a stereomicroscope (EMZ-TR, Meiji Techno Co. Ltd., Tokyo, Japan) at a 25x magnification, in order to classify the types of failure. They could be: adhesive-A (cohesive in adhesive interface failure); cohesive in enamel-CE (enamel substrate failure), cohesive in resin-CR (resin composite failure); or mixed-M (cohesive and adhesive failure).

Statistical Analysis

Data were subjected to a one-way analysis of variance (ANOVA) and the Tukey's multiple comparison test at 5% level of significance. ANOVA was applied to each experimental time interval: 0 (baseline), 7, 14, and 21 days. The SAS (6.12) software was used for the statistical analysis.

Results

The mean values and the standard deviations obtained through the SBS test for each subgroup are listed in Table 1. The one-way ANOVA showed statistically significant differences among the bleaching agents only for the baseline group. In addition, Tukey's test ($p \leq 0.05$) revealed a lower SBS mean value for the SPH group, immediately after the non-vital tooth bleaching.

The other periods elapsed between bleaching and bonding procedures (7, 14, 21 days) showed no significant differences among the SBS values due to the different bleaching agents used.

The type of failure for each specimen was chosen in agreement with the three examiners. Table 2 shows the percentage of failure.

Discussion

Some experiments have shown the detrimental effect of hydrogen peroxide released from bleaching agents on the adhesion of light-cured resins to enamel[16]. Since non-vital bleaching is generally followed by replacement of esthetic restorations, concerns have developed about the bond between the tooth and restorative material after bleaching[9].

For non-vital discolored teeth, the walking bleach technique is efficient and requires less office time. In dental clinics, bleaching agents are replaced at an interval of 3 to 7 days to preserve the agent's oxidation[11]. When stains are normally related to intra-coronal blood decomposition, the treatment may lighten teeth in 3 or 4 weeks[20]. For this reason, the bond values evaluated in this work were tested after 28 days of tooth exposure to the bleaching agents.

In a previous study, SEM investigations of specimens treated with hydrogen peroxide indicated an inability of bonding resin to adhere properly to enamel surface[15,16], interfering with resin attachment and inhibiting resin polymerization[17]. An interaction with peroxide or peroxide related substances may also cause an alteration in resin[19].

The exposure of peroxide-treated enamel to water for a prolonged period eliminates the reduction in bond strength that attends the immediate application of resin to peroxide-bleached enamel[18]. However, in daily practice this is not an effective procedure to be used against the residual peroxides, which could be a possible cause for the SBS reduction. Probably, the delay in restoring or the use of different agents after bleaching could show similar effects.

The elapsed time between bleaching and bonding procedures in this study was based on investigations that evaluated the leaching of hydrogen peroxide immediately[1] or 7 days after bleaching[18]. Considering, the effect on bond strength as dependent on hydrogen peroxide time exposure[19], the 14 and 21 day periods were evaluated to verify the SBS values resulting from a long period of bleaching treatment.

The lowest values for SBS were observed immediately after bleaching in the SPH group, probably due to a significant amount of active oxygen in the 30% hydrogen peroxide solution. It is likely that the residual oxygen diffusion ranges from the pulp chamber to the enamel, affecting the bond. Although, SPW and CP are known to release hydrogen peroxide[5,21], the values for SBS showed no alteration.

The initial purpose of the present study was to evaluate the influence of SBS on bleaching treatment correlated to time. However, since the CON group showed no constant behavior over the time intervals, comparisons of time intervals with each bleaching agent were not considered. Because a control group was used for each experimental time, an individual analysis could be conducted. As a result, the possible influence of three different internal bleaching agents on resin/ bovine enamel shear bond strength was verified. The failure type percentage revealed different variations. Furthermore, the mixed failure was more frequent in all groups due to a satisfactory enamel shear bond strength[7].

This investigation showed that at 7, 14, and 21 days after non-vital bleaching, the SBS of bovine enamel was not significantly altered even for the SPH group. It was hypothesized that the exposure of a bleached tooth to saliva may leach out peroxide absorbed by enamel during bleaching and reestablish the bond potential.

To sum up, the deleterious effect of hydrogen peroxide on resin adhesion reported in previous studies may be reversible or not significant, depending on the bleaching agent used. Throughout this investigation the effects of peroxide bleaching agents on bond strength at different post-bleaching times could be compared. However, more studies are necessary to establish an ideal time for performing restorative procedures.

Acknowledgments

The authors gratefully acknowledge the valuable advice provided by Prof. Antonio Luiz Rodrigues Junior from the School of Medicine of Ribeirão Preto – USP, in the statistical consideration of the data. Thanks are also extended to Whiteness- FGM Corporation- Joinville-S.C., Brazil for supplying the carbamide peroxide agent.

References

1. Adibfar A, Steele A, Torneck CD, Titley KC, Ruse D. Leaching of hydrogen peroxide from bleached bovine enamel. *J Endod* 1992; 18:488-491.
2. Featherstone JD, O' Reilly MM, Shariati M. Enhancement of remineralization *in vitro* and *in vivo*. In: Leach, S.A. *Factors Relating & Demineralization and Remineralization of the teeth*. Oxford: Oxford, IRL 1986: 23-34.
3. Gimlin DR, Schindler WG. The management of post bleaching cervical resorption. *J Endod* 1990; 16:292-297.
4. Harrington GH, Natikin E. External resorption associated with bleaching of pulpless teeth. *J Endod* 1979; 5:344-348.
5. Haywood Van B. History safety, and effectiveness of current bleaching techniques and applications of the night-guard vital bleaching technique. *Quint Int* 1992; 23:471-488.
6. Lado E.A, Stanley HR, Weisman MI. Cervical resorption in bleached teeth. *Oral Surg Oral Med Oral Pathol* 1983; 55:78-80.
7. Pashely DH, Sano H, Ciucchi B, Yoshiyama M, Carvalho RM. Adhesion testing of dentin bonding agents: a review. *Dent Mater* 1995; 11:117-125.
8. Perdigão J, Francci C, Swift EJ, Ambrose WW, Lopes M. Ultra-morphological study of the interaction of dental adhesives with carbamide peroxide-bleached enamel. *Am J Dent* 1998; 11:291-301.
9. Rivera EM, Vargas M, Williamson LR. Considerations for the aesthetic restoration of endodontically treated anterior teeth following intracoronal bleaching. *Pract Periodontics Aesthetic Dent* 1997; 19: 117-128.

10. Rotstein I, Lehr Z, Gedalia I. Effect of bleaching agents on inorganic components of human dentin and cementum. *J Endod* 1992; 18:290-293.

11. Rotstein I, Mor C, Friedman S. Prognosis of intracoronal bleaching with sodium perborate preparation in vitro: 1-year study. *J Endod* 1993; 19:10-12.

12. Serra MC, Cury JA. The in vitro effect of glass-ionomer cement restorations on enamel subjected to a demineralization and remineralization model. *Quintessence Int* 1992; 23:143-147.

13. Spasser HF. A simple bleaching technique using sodium perborate. *N. Y. State Dent J* 1961; 27:332-334.

14. Stokes NA, Hood, JAA, Dhariwal D, Patel, K. Effect of peroxide bleaches on resin-enamel bonds. *Quintessence Int* 1992; 23:769-771.

15. Titley KC, Torneck CD, Ruse ND, Krmec D. Adhesion of a resin composite to bleached and unbleached human enamel. *J Endod* 1993; 19:112-115.

16. Titley KC, Torneck CD, Smith DC, Adibfar A. Adhesion of composite resin to bleached and unbleached bovine enamel. *J Dent Res* 1988; 67:1523-1528.

17. Titley KC, Torneck CD, Smith DC, Chernecky R, Adibfar A. Scanning electron microscopy observations on the penetration and structure of resin tags in bleached and unbleached bovine enamel. *J Endod* 1991; 17:72-75.

18. Torneck CD, Titley KC, Smith DC, Adibfar A. Effect of water leaching the adhesion of composite resin to bleached and unbleached bovine enamel. *J Endod* 1991; 17:156-160.

19. Torneck CD, Titley KC, Smith DC, Adibfar A. The influence of time of hydrogen peroxide exposure on the adhesion of composite resin to bleached bovine enamel. *J Endod* 1990; 16:123-8.

20. Walton RE. Bleaching Discolored Teeth: Internal and External. In: Walton RE, Torabinejad M. *Principles and practice of endodontics*. Philadelphia: WB Saunders, 1989; 385-397.

21. Weiger R, Kuhn A, Löst C. Effect of various types of sodium perborate on the pH of bleaching agents. *J Edodon* 1993; 19:239-241.

Tables

Table 1- Means and standard deviations of shear bond strength test values (MPa) according to the experimental groups.

Groups	Baseline	n	7 days	n	14 days	n	21 days	n
SPH	19.61(4.11)^{b}	20	24.59(6.10)^{a}	19	20.50(4.42)^{a}	20	24.08(3.43)^{a}	19
SPW	21.15(3.50)^{a}	19	26.39(5.48)^{a}	19	20.06(5.09)^{a}	20	22.68(5.57)^{a}	19
CP	22.26(3.51)^{a}	20	28.42(5.08)^{a}	18	20.85(4.55)^{a}	19	23.92(4.84)^{a}	20
CON	23.44(4.71)^{a}	19	28.06(4.30)^{a}	18	21.39(4.88)^{a}	19	24.37(5.37)^{a}	18

? Statistical differences are expressed by different letters in columns ($p < 0.05$)

? SPH- sodium perborate + 30% hydrogen peroxide; SPW- sodium perborate + distilled water; CP- 37% carbamide peroxide; and CON- distilled water.

Table 2- Percentage of failure mode

Groups	Baseline				7 days				14 days				21 days			
	Failure mode															
	A	M	CR	CE	A	M	CR	CE	A	M	CR	CE	A	M	CR	CE
SPH	30.0	40.0	20.0	10.0	38.8	50.0	-	11.1	21.0	63.1	15.7	-	10.5	52.6	31.5	-
SPW	26.3	42.1	21.0	10.5	36.8	42.1	15.7	5.2	47.3	47.3	5.2	-	31.5	42.1	16.3	-
CP	20.0	45.0	5.0	30.0	16.6	33.3	33.3	16.6	31.5	36.8	15.7	15.7	15.0	65.0	10.0	5.0
CON	31.5	36.8	26.3	5.2	44.4	44.4	11.1	-	20.0	55.0	-	25	5.5	66.6	22.2	5.5

? A-adhesive; M-mixed; CR-cohesive in resin; CE-cohesive in enamel.

? SPH- sodium perborate + 30% hydrogen peroxide; SPW- sodium perborate + distilled water; CP- 37% carbamide peroxide; and CON- distilled water.

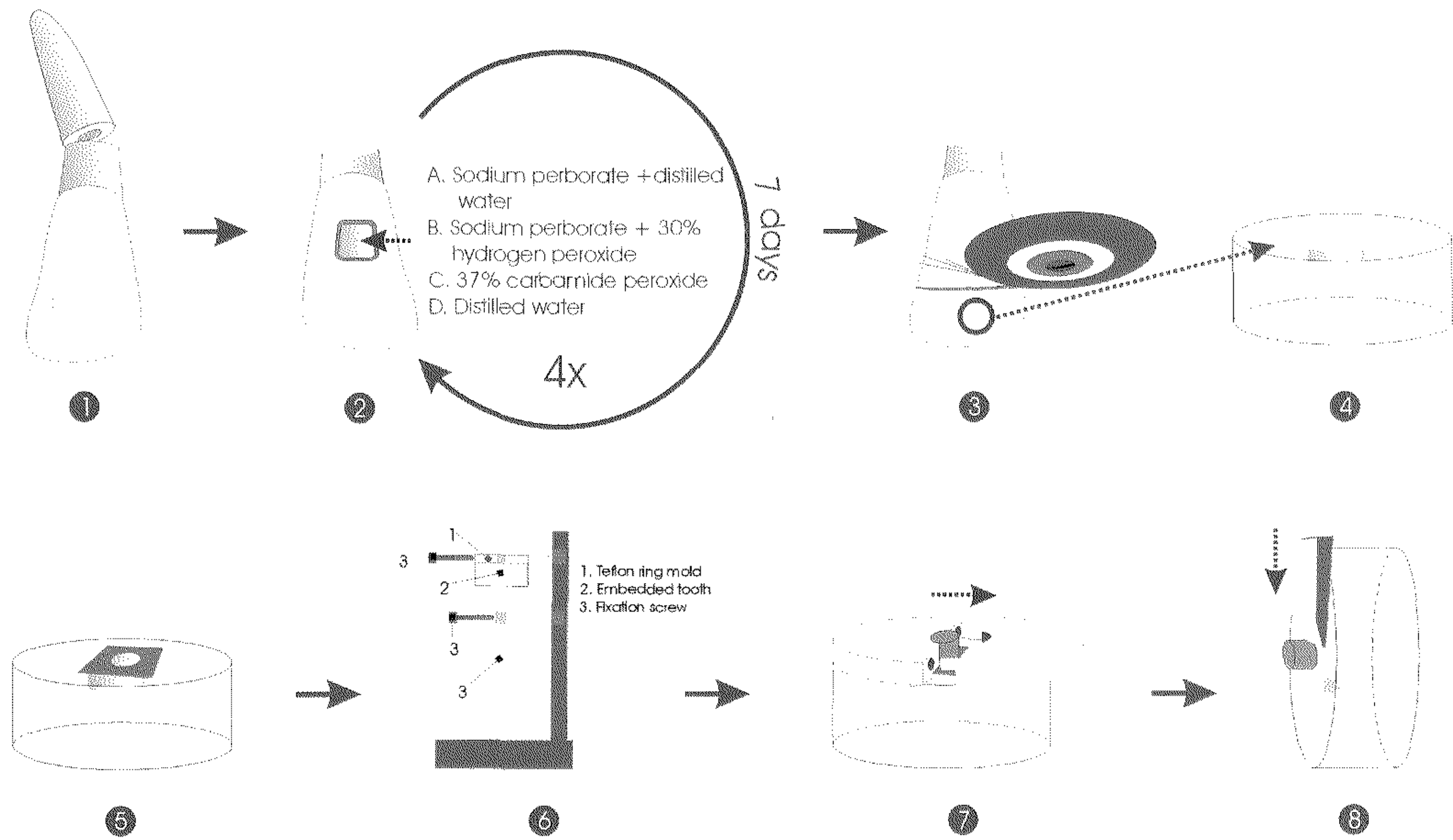

Fig.1- Sectioning 2mm below the cementoenamel junction.
Fig.2- Bleaching treatment.
Fig.3- Obtainment of enamel fragments.
Fig.4- Embedded tooth fragment.

Fig.5- Demarcation of the area to bonding procedure.
Fig.6- Specimen preparation device.
Fig.7- Removal of the Teflon ring mold.
Fig.8- Shear bond test.

3.2 CAPÍTULO II

Influence of post-bleaching times on dentin shear bond strength

Enviado para publicação para Journal of Esthetic and Restorative Dentistry

Influence of post- bleaching times on dentin bond strength

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Influence of post- bleaching times on dentin bond strength

Abstract

Purpose: Bond strength of resin to tooth structure can be reduced when the bonding procedure is carried out immediately after the bleaching treatment. This study evaluated the effect of non-vital tooth bleaching on shear bond strength (SBS) of composite resin/bovine dentin interface and the influence of delaying the bonding procedures for different time intervals following bleaching. *Materials and Methods*: According to a randomized block design, composite resin cylinders (Z100/ Single Bond-3M) were bonded to the flattened dentin surface of two hundred fifty six teeth which had previously been subjected to four different treatments: SPH - sodium perborate + 30% hydrogen peroxide; SPW - sodium perborate + distilled water; CP - 37% carbamide peroxide; and CON - distilled water (control), each one followed by storage in artificial saliva for 0 (baseline), 7, 14, and 21 days after bleaching (n=16). The bleaching agents in the pulp chambers were replaced every 7 days, over 4 weeks. The SBS test of the sixteen blocks was done, using a universal testing machine. *Results:* The ANOVA showed that there was no significant interaction between time and bleaching agents ($p > 0.05$), and that the factor time was not statistically significant ($p > 0.05$). For the factor bleaching treatment, the Student's t-test showed that CON=CP>SPW=SPH. The non-vital tooth bleaching could affect the resin/dentin SBS values when sodium perborate mixed with 30% hydrogen peroxide or water was used, independently of the elapsed time following the bleaching treatment.

Clinical Significance

In a non-vital tooth bleaching, the delaying in the bonding procedures after the bleaching treatment did not influenced the reduction in dentin bond strength caused by sodium perborate mixed with 30% hydrogen peroxide or water.

Introduction

Esthetic treatment is a current interest, but since 1800s tooth bleaching has been a part of dentistry[1,2]. The tooth bleaching can avoid more costly and invasive dental treatment, preserving tooth structure[2,3].

In an endodontically treated tooth, the intracoronal bleaching technique called walking bleach has proved popular. This technique is performed by using a paste of sodium perborate mixed with either hydrogen peroxide or water, which is placed in the pulp chamber and sealed for several days[3,4,5]. Once the bleaching process is complete, the pulp chamber must be restored, and the replacement of esthetics restorations may be necessary, in order to match the color of the bleached tooth. In general, composite resins associated with a dentin bonding system are used[6].

Although tooth bleaching presents satisfactory esthetics results, some investigations have shown a deleterious effect of peroxide bleaching on the adhesion of composite resins to tooth structure[7,8,9,10,11,12,13]. That has become a concern in esthetic dentistry.

It has been shown that exposure to hydrogen peroxide causes a substantial reduction in the adhesiveness of composite resin to the enamel[8,9,10]. However, the influence of some bleaching agents, like sodium perborate and 37% carbamide peroxide, placed in the pulp chamber for bleaching on dentin prior to bonding procedures is unknown.

In the present study, an experimental bleaching procedure was used to analyze the duration of these possible effects after non-vital tooth bleaching. In this way, this *in vitro* study was designed to assess the effect of bleaching agents on composite resin/dentin shear bond strength at different post-bleaching periods of time.

Materials and Methods

Experimental Design

The factor under study were Bleaching treatment: sodium perborate + 30% hydrogen peroxide (SPH); sodium perborate + distilled water (SPW); 37% carbamide peroxide (CP); and control (CON-distilled water) and Time intervals: 0 (baseline), 7, 14 and 21 days after bleaching. The experimental units were 256 bovine incisors teeth (n =16), divided into 16 groups (4 bleaching treatments x 4 Time intervals). This study used a randomized complete block design, having 16 blocks. Within each block, the order used to apply the different bleaching treatments was randomly determined. The response variable was shear bond strength (SBS) in MPa.

Tooth Preparation

Endodontic access cavities were prepared in 256 bovine incisor teeth, using a diamond cylinder conical end point (n? 4124- KG Sorensen, São Paulo, SP, Brazil). The pulp was debried with a dental explorer. The roots were sectioned 2mm below the cementoenamel junction with a double-face diamond disk (KG Sorensen, São Paulo, SP, Brazil) and sealed with composite resin.

Bleaching Procedure

The non-vital bleaching was performed according to four treatments: SPH - sodium perborate + 30% hydrogen peroxide; SPW - sodium perborate + distilled water; CP - 37% carbamide peroxide, and CON - distilled water (control).

A mixture of 2g of sodium perborate with 1mL of 30% hydrogen peroxide solution (Farmavip Ltd., Piracicaba, SP, Brazil) was used as the bleaching agent for the SPH group, and, in the same ratio 2:1 (g/mL), sodium perborate and distilled water for the SPW group. These pastes were prepared on a glass slab using a metal spatula for a 30-second period. A commercially available 37% carbamide peroxide gel (Whiteness – FGM Ltd., Joinville, SC, Brazil) was used as the bleaching agent for the CP group, and a cotton pellet embedded in distilled water for the control group (CON).

The bleaching agents or the cotton pellets were placed in the pulp chambers and sealed with Cavit (Espe - Germany). These agents were replaced with fresh preparations every 7 days, according to the walking bleach technique. The pulp chamber was washed with water and dried with compressed air. This procedure was repeated over 4 weeks until the bleaching treatment was concluded. Throughout the entire experimental period, the teeth were kept in artificial saliva[14,15].

Bonding procedure and shear bond Test

For the shear bond test, a piece of the central area of the facial crown of each tooth (5mm high and 5mm wide) was placed in a ¾ inch diameter PVC ring. These fragments were embedded in self-curing polyester resin (Cromex, Piracicaba, SP, Brazil) and flattened through a wet grinding using 320, 400, 600-grit Al_2O_3 abrasive paper (Carborundum Abrasivos, Recife, PE, Brazil), in order to expose the outer dentin. After polishing, the dentin surfaces were demarcated with a piece of vinyl tape, in which a 3mm-diameter hole had been made.

The dentin was etched with 35% phosphoric acid (3M Co., St. Paul, MN, USA) and rinsed with tap water for 15s. Afterwards, the dentin was slightly air dried for 5s and two consecutive adhesive coats (Single Bond, 3M Co., St. Paul, MN, USA) were applied using a saturated brush tip, air-dried for 5 seconds and light cured for 10s.

A 3mm-diameter Teflon ring mold (5mm high) was placed against the fragment to receive the composite resin (Z100, 3M Co., St. Paul, MN, USA). The filling material was inserted in two increments (2.5mm high), both were light cured (Opitlux 401, Demetron, Kerr Corp., Danbury, CT, USA) for 40s.

Each specimen was mounted in a custom-made jig and positioned in an Instron testing machine (4411, Instron Corp., England). A steel knife-edge was placed parallel to the specimen surface so that the shear force applied the load directly to the bond interface, using a cross-head speed of 0.5mm/min. The SBS was measured in MPa.

Statistical Analysis

Data were subjected to a two-way analysis of variance (ANOVA) and the Student's t-test at 5% level of significance. The SAS (6.12) software was used for the statistical analysis.

Results

The two-way ANOVA showed that there was no interaction between Time and Bleaching treatment (p_{value}=0.90). There were statistically significant differences among the Bleaching treatments (p_{value}=0.001) (Table1), but no among the Time intervals (p_{value}=0.84)

(Table 2). Student's t-test ($p \leq 0.05$) revealed lower SBS mean values for the SPH and SPW groups in comparison to the CON and PC values.

Discussion

Since the walking bleach was proposed for Spasser[5], some modifications have been described in the literature[1,16]. The use of sodium perborate mixed with hydrogen peroxide demonstrated successful results, as well as its combination with water[11]. The use of 10% carbamide peroxide was also suggested, in a modified walking bleach technique called inside/outside bleaching[17]. However, it has been shown that 10% carbamide peroxide was less effective than 30% hydrogen peroxide mixed with sodium perborate[18]. Therefore, in this study a 37% carbamide peroxide agent, a more concentrated gel, was used.

All those bleaching agents have the hydrogen peroxide as the active substance. The mechanism of action of these agents consists of a strong oxidizing reaction, which removes stain within the enamel and dentin, releasing free oxygen radicals[1,2,19]. Some investigations showed side effects of the bleaching reactions on the adhesion of light-cured resins to enamel[8,9,10] which might be related to the presence of residual hydrogen peroxide.

Although prolonged *in vitro* water exposure reversed the deleterious effect of residual bleaching peroxides on the SBS of composite resin to enamel[20], this method was not effective for a rapid neutralization of the hydrogen peroxide[21]. The use of an enzyme called catalase, was also suggested[21], however the effects of this substance on the restorative procedure are unknown. The delay in the subsequent restorative procedures has been consider a reasonable approach to improve the adhesion between the resin and tooth interface[2]. Therefore, in this study, the shear bond strength was evaluated immediately, 7, 14 and 21 days after an experimental bleaching procedure that had been performed closer to clinical conditions.

This study showed lower SBS values for the composite resin to the dentin surface in the SPW and SPH group. This reduction was independent of the time elapsed between the placement of the composite resin and the end of the bleaching procedure. The delay in bonding did not result in higher SBS values on resin/dentin interface. Probably, the hydrogen peroxide elimination in the dentin tubules was not enough to modify this result. The lower SBS values may have been caused by significant structural changes[10]. Previous reports hypothesize that changes in the dentin could contribute to the loss in adhesiveness[12]. In addition, the hydrogen peroxide in higher concentrations may cause an alteration in the organic and inorganic components of the dentin and the cementum[3].

Titley *et al.* (1991)[11] suggested that a change in surface chemistry and/or structure was responsible for the reduction in bond strength to bleached enamel. Ruse *et al.* (1990)[22], argued that the reduction in bond strength caused by bleaching is not-related to peroxide-induced changes in the elemental composition of enamel surface, however, this does not imply that a change in surface chemistry do not occur[11]. Rotstein *et al.* (1996)[23], by means of a histochemical analysis, observed a decreased in the Ca/P ratio after the bleaching procedure, which was more significant in the cementum and dentin than in the enamel.

Although SEM investigations indicated an inability of bonding resin to adhere properly to enamel surface of specimens bleached with hydrogen peroxide for a short-term[9,10], recent literature has shown that the use of acetone-based adhesives may reverse the effects of vital bleaching, without the need of delay in restoring[24]. This is different from the effect of hydrogen peroxide on the dentin, as its *in vitro* adhesion is more uncertain than on enamel and a permanent alteration could be occurred to this substrate. The surface alterations may interfere with the formation of bonding and could be responsible for the decrease of adhesion[12,25].

The main factor in the results was the bleaching treatment. The CP group showed results similar to the CON group, probably due to the action mechanism that offers a slower release of hydrogen peroxide[2,19]. Although the sodium perborate associated with water was also claim to have a slow release of hydrogen peroxide[19], this group differed from the control. Another factor that may have influenced our results was the cleaning of the pulp chamber after the bleaching treatment. It was more difficult to wash the sodium perborate than the carbamide peroxide, which is soluble in water. In the SPH group a lower SBS value was noticed possibly because of the higher amount of hydrogen peroxide and the swift action mechanism[19]. In this study, the adverse effects observed on the outer dentin were presumably a result of bleaching agents diffusion via the dentinal tubules.

Under the experimental conditions adopted in the present study, it was possible to conclude that sodium perborate associated with water or hydrogen peroxide caused lower SBS values of composite resin to dentin surface. The 37% carbamide peroxide did not affect the SBS values. This investigation suggests that the shear bond strength of composite resin on the bleached dentin surface may be acceptable, when the carbamide peroxide is used as the internal bleaching agent, independently the post-bleaching intervals.

Disclosure and acknowledgments

This paper is part of a thesis submitted by the first author in the Piracicaba School of Dentistry, State University of Campinas, in-partial fulfillment of the requirements for the MSc degree in Clinical dentistry. Thanks to the Dental Materials Area of the Piracicaba School of Dentistry for assistance with the universal testing machine.

References

1. Walton RE. Bleaching Discolored Teeth: Internal and External. In: Walton RE, Torabinejad M. *Principles and practice of endodontics*. Philadelphia: WB Saunders, 1989; 385-397.
2. Haywood Van B. History safety, and effectiveness of current bleaching techniques and applications of the night-guard vital bleaching technique. Quint Int 1992; 23: 471-488.
3. Rotstein I, Lehr Z, Gedalia I. Effect of bleaching agents on inorganic components of human dentin and cementum. J Endod 1992; 18: 290-293.
4. Rotstein I, Mor C, Friedman S. Prognosis of intracoronal bleaching with sodium perborate preparation in vitro: 1-year study. J Endod 1993; 19: 10-12.
5. Spasser HF. A simple bleaching technique using sodium perborate. N. Y. State Dent J 1961; 27: 332-334.
6. Rivera EM, Vargas M, Williamson LR. Considerations for the aesthetic restoration of endodontically treated anterior teeth following intracoronal bleaching. Pract Periodontics Aesthetic Dent 1997: l9; 117-128.
7. Perdigão J, Francci C, Swift EJ *et al.* Ultra-morphological study of the interaction of dental adhesives with carbamide peroxide-bleached enamel. Am J Dent 1998; 11: 291-301.
8. Stokes AN, Hood JAA, Dhariwal D *et al.* Effect of peroxide bleaches on resin-enamel bonds. Quintessence Int 1992; 23: 769-771.
9. Titley KC, Torneck CD, Ruse ND *et al.* Adhesion of a resin composite to bleached and unbleached human enamel. J Endod 1993; 19: 112-115.

10. Titley KC, Torneck CD, Smith DC *et al.* Adhesion of composite resin to bleached and unbleached bovine enamel. J Dent Res 1988; 67: 1523-1528.

11. Spyrides GM, Perdigão J, Pagani C, Araújo MAM, Spyrides SMM. Effect of whitening agents on dentin bonding. J Esthet Dent. 2000; 12:264-270.

12. Titley KC, Torneck CD, Smith DC, Applebaum NB. Adhesion of a glass ionomer cement to bleached and unbleached bovine dentin. Endod Dent Traumatol. 1989; 5:132-128.

13. Toko T, Hisamitsu H. Shear bond strength of composite resin to unbleached and bleached human dentine. Asia J Aesthetic Dent. 1993; 1:33-36.

14. Featherstone JD, O' Reilly MM, Shariati M *et al.* Enhancement of remineralization *in vitro* and *in vivo*. In: Leach, S.A. *Factors Relating & Demineralization and Remineralization of the teeth.* Oxford: Oxford, IRL 1986; 23-34.

15. Serra MC, Cury JA. The in vitro effect of glass-ionomer cement restorations on enamel subjected to a demineralization and remineralization model. Quintessence Int 1992; 23: 143-147.

16. Nutting EB, Poe GS. A new combination for bleaching teeth. J South Calif Dent Assoc 1963; 31:289-291.

17. Liebenberg WH. Intracoronal lightening of discolored pulpless teeth: a modified walking bleach technique. Quintessence Int. 1997; 28:771-7. Review.

18. Perrine GA, Reichl RB, Baisden MK, Hondrum SO. Comparison of 10% carbamide peroxide and sodium perborate for intracoronal bleaching. General Dentistry 1998; May/June: 264-270.

19. Weiger R, Kuhn A, Lost C. Effect of various types of sodium perborate on the pH of bleaching agents. J Endod. 1993; 19:239-41.

20. Torneck CD, Titley KC, Smith DC *et al.* Effect of water leaching the adhesion of composite resin to bleached and unbleached bovine enamel. J Endod 1991; 17: 156-160.

21. Rotstein I. Role of catalase in the elimination of residual hydrogen peroxide following tooth bleaching. J Endod. 1993; 19:567-569.

22. Ruse ND, Smith DC, Torneck CD, Titley KC. Preliminary surface analysis of etched, bleached, and normal bovine enamel. J Dent Res. 1990; 69:1610-3.

23. Rotstein I, Dankner E, Goldman A, Heling I, Stabholz A, Zalkind M. Histochemical analysis of dental hard tissues following bleaching. J Endod 1996; 22:23-26.

24. Sung EC, Chan SM, Mito R, Caputo AA. Effect of carbamide peroxide bleaching on the shear bond strength of composite to dental bonding agent enhanced enamel. J Prosthet Dent 1999; 82:595-599.

25. Torneck CD, Titley KC, Smith DC, Adibfar A. Adhesion of light-cured composite resin to bleached and unbleached bovine dentin. Endod Dent Traumatol. 1990; 6:97-103.

Table

Table 1- Means and standard deviations of shear bond strength test values (MPa) according to the experimental groups.

Groups	CON	n	CP	n	SPW	n	SPH	n
Means(SD)	6.55(3.18)[a]	62	6.68(3.24)[a]	61	5.33(3.17)[b]	61	4.79(2.76)[b]	59

Table 2- Means and standard deviations of shear bond strength test values (MPa) according to the time intervals after bleaching.

Time	Baseline	n	7 days	n	14 days	n	21 days	n
Means(SD)	5.98(1.17)[a]	63	5.91(1.35)[a]	62	5.93(0.77)[a]	58	5.53(0.72)[a]	60

? Statistical differences are expressed by different letters ($p < 0.05$)

? CON- distilled water; CP- 37% carbamide peroxide; SPW- sodium perborate + distilled water; and SPH- sodium perborate + 30% hydrogen peroxide.

3.3 CAPÍTULO III

Effect of nonvital tooth bleaching on microleakage of coronal access restorations

Enviado para publicação para Journal of Oral Rehabilitation

Effect of nonvital tooth bleaching on microleakage of coronal access restorations

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Abstract

This study evaluated the effect of nonvital tooth bleaching on microleakage of composite resin/bovine tooth interface at different post-bleaching times. Three hundred twenty teeth were cleaned. A pulp chamber access cavity was made at the lingual surface of each tooth. The teeth were randomly divided into four groups: SPH- sodium perborate + 30% hydrogen peroxide; SPW-sodium perborate + distilled water; CP- 37% carbamide peroxide and CON- distilled water (control). The bleaching agents were replaced each 7 days, over 4 weeks. Following bleaching procedures, the groups were divided into four subgroups (n=20), according to the post-bleaching times: 0 (baseline), 7, 14 and 21 days. After that, the cavities were restored with an adhesive system (Single Bond/3M) and a composite resin (Z100/3M). The specimens were thermocycled, stained with 2% methylene blue solution (pH 7), and sectioned longitudinally. The teeth were evaluated blind and independently by three previously calibrated examiners, to provide representatives scores. The data were submitted to Kruskal-Wallis and Multiple Comparison tests (α=0.05). At baseline and 7 days, SPH group showed a higher degree of dye penetration than CON (p=0.04). At 14 and 21 days, there were no differences among groups. The association of sodium perborate with 30% hydrogen peroxide or with water may affect the sealing ability of composite resin restorations performed up to 7 days after bleaching procedures.

Introduction

Nonvital tooth bleaching is a conservative esthetic treatment for endodontically treated discolored teeth, as it offers advantages over full coverage restorations. It is simple, effective and is of a relatively low cost (Baratieri *et al.* 1995, Haywood 1992, Rotstein, Mor, Friedman 1993).

The walking bleach technique stands out among others reported for internal bleaching treatment. It consists of placing caustic agents, such as sodium perborate associated with water or hydrogen peroxide, in the pulp chamber between dental appointments (Baratieri *et al.* 1995, Nutting, Poe 1963, Spasser 1961). *In vitro* studies have reported that both combinations were equally effective in bleaching discolored teeth (Rotstein *et al.* 1993). Satisfactory esthetic results have also been obtained when carbamide peroxide is used for intracoronal bleaching (Haywood 1992, Caughman, Frazier, Haywood 1999, Perrine *et al.* 1998).

Otherwise, previous studies have shown changes in the tensile and shear bond strength of resin composites to bleached teeth (Titley *et al.* 1988, Titley *et al.* 1993, Torneck *et al.* 1990a,b, Torneck *et al.* 1991, Van Der Vyer, Lewis, Marais 1997). Although there are no clear explanations why this should occur, some studies suggested the interference of residual oxygen in the resin-bonding restorative procedure that follows the bleaching process (Titley *et al.* 1988, Titley *et al.* 1993, Torneck *et al.* 1990a, Van Der Vyer, Lewis, Marais 1997).

The marginal seal of restorations could also be affected by the bleaching reactions (Haywood 1992, Barkhordar, Kempler, Plesh 1997, Shinohara, Rodrigues, Pimenta 2001), increasing the microleakage of oral fluids and bacteria into the restored pulp chamber (Haywood 1992, Barkhordar *et al.* 1997) and contributing to the failure of the treatment (Rivera, Vargas, Williamson 1997, Wilcox, Diaz-Arnold 1989). In order to avoid these undesirable effects, has been indicated to wait for a certain period of time between bleaching and restorative procedures (Haywood 1992). It is hypothesized that this elapsed time could be an important factor to obtaining a satisfactory sealing after bleaching, probably eliminating traces of bleaching reactions.

The aim of this study was to evaluate the effect of bleaching agents on microleakage of coronal access restorations placed at different time intervals after bleaching.

Methods and Materials

Experimental Design

The factors under study were bleaching treatment and time intervals at four levels in each one. The experimental sample comprised 320 specimens, randomly assigned to four groups, according to the bleaching treatment, and four subgroups (n=20), according to the elapsed time between bleaching and restorative procedures. The qualitative response variable was the score of dye penetration, evaluated blind and independently by three calibrated examiners, using an ordinal scale from 0 to 2.

Tooth Preparation

Endodontic access cavities (5mm x 5mm) were prepared in 320 bovine incisors teeth, using diamond burs, (n? 4124- KG Sorensen, São Paulo, SP, Brazil). The pulp was debried with a dental explorer. The root was sectioned 2mm below the cementoenamel junction with a double-face diamond disk (KG Sorensen, São Paulo, SP, Brazil) and sealed with composite and epoxy resin (Araldite Ciba Especialidades Química).

Experimental Bleaching Procedures

The nonvital bleaching was performed after the teeth had been randomly divided into four groups: SPH- sodium perborate + 30% hydrogen peroxide; SPW-sodium perborate + distilled water; CP- 37% carbamide peroxide and CON- distilled water (control).

A mixture of 2g sodium perborate and 1ml of 30% hydrogen peroxide solution (Farmavip Co. Ltd., Brazil) was used as the bleaching agent for the SPH group. The SPW group was bleached with a mixture of 2g sodium perborate and 1ml distilled water. Both pastes were prepared by mixing on glass slab with a metal spatula for 30 seconds. For the CP group a commercially available 37% carbamide peroxide gel (Whiteness – FGM Ltd., Joinville, SC, Brazil) was used as the bleaching agent. The control group (CON) used a cotton pellet embedded in distilled water.

The bleaching agents or the cotton pellet were placed in the pulp chambers and sealed with Cavit (Espe-Germany); they were replaced by fresh preparations after 7 days, according to the walking bleach technique; the pulp chambers were washed with distilled water and dried with compressed air before each replacement. These procedures were repeated 4 times and the sealed teeth were maintained in artificial saliva (Featherstone, O'Reilly, Shariati 1986, Serra, Cury 1992) throughout the entire experimental bleaching period.

Bonding procedures and Thermocycling

Following bleaching treatments the groups were randomly divided into four subgroups (n=20), according to the post-bleaching times: 0 (baseline), 7, 14 and 21 days. The bonding procedures for baseline were done group immediately after bleaching treatment, according to the manufacturer's recommendations. The specimens of the other subgroups were stored in artificial saliva at 37°C for 1, 2 and 3 weeks.

After the elapsed time, the temporary restorations were removed. The cavities were treated with 35% phosphoric acid (3M Co., St. Paul, MN, USA) for 15s and rinsed with water for the same time and slightly air dried for 5s. Two consecutive coats of adhesive (Single Bond, 3M Co., St. Paul, MN, USA) were applied using a saturated brush tip. After gently air drying for 5s, the material was light cured for 10s. The filling material was placed in three increments and each one was light cured for 40s (Optlux 401, Demetron, Kerr Corp., Danbury, CT, USA).

The composite surface was polished with a series of graded Sof-Lex disks (3M Dental Products, St. Paul, MN, USA). The restored teeth were thermocycled in a thermocycling machine (MCT2, Instrumental Instrumentos de Precisão) for 500 times in water baths maintained at 5°C+/-2 and 55°C+/-2. The dwell time in each bath was 1 minute.

Microleakage Test

Each tooth was coated with nail varnish, except 1mm around the cervical margin of the restoration. The specimens were immersed in a 2% methylene blue dye solution (pH 7) for 4 hours and rinsed under tap water. Afterward, each tooth was sectioned longitudinally through the center of the restoration with a double-faced diamond disk.

The samples were examined visually with a stereomicroscope (EMZ-TR, Meiji Techno Co. Ltd., Tokyo, Japan) at 15x magnification. The evaluation was performed blind and independently by three previously calibrated examiners to classify dye penetration, according to the scores: 0- no dye penetration; 1- dye penetration only in enamel; 2- dye penetration through both enamel and dentin.

Statistical Analysis

A median score of the three evaluators was determined for each specimen. The data were analyzed using Kruskal-Wallis non-parametric tests (? = 0.05). Multiple Comparison tests at 5% level of significance were employed to verify the hypothesis of equality among the groups by means of the least significant difference.

Results

The median dye penetration, the average ranks, and pairwise comparisons for the experimental groups within each time interval are shown in Table 1. Kruskal-Wallis and Multiple Comparison tests showed statistically significant differences among the groups at baseline and 7 days (p=0.04). The CP and SPW groups did not differ from the CON group immediately after bleaching, the SPH group showed higher microleakage than the CON, but was not statistically different from groups SPW and CP.

At 7 days, SPH and SPW groups revealed higher dye penetration than the CON group, whereas CP group did not differ from the other experimental groups. No statistical differences were observed among the groups at 14 (p=0.06) and 21 days (p=0.75)

Discussion

Loss of seal is a very important cause of dentin hypersensitivity, discoloration of the restoration margins, and failure of endodontic therapy (Wilcox *et al.*1989). Although the development of adhesive dental materials has improved their sealing ability at tooth-restoration interface, it has been demonstrated by several reports that bond strength is reduced after bleaching (Titley *et al.*1988, Titley *et al.*1993, Torneck *et al.* 1990a, Van Der Vyer *et al.* 1997). Higher microleakage was reported on class V restorations placed soon after nonvital tooth bleaching (Shinohara *et al.* 2001). Since this treatment is generally followed by adhesive restorations of the coronal access, it seems necessary to evaluate the effect of bleaching agents frequently used in the walking bleach technique, on microleakage of restorations performed at different time intervals after bleaching. This study corroborates to those previous investigations that have shown the adverse effect of dental bleaching reactions at the resin-tooth interface (Titley *et al.* 1988, Titley *et al.*1993, Torneck *et al.* 1990a, Van Der Vyer *et al.* 1997, Barkhordar *et al.*1997, Shinohara *et al.*2001).

Some authors have suggested that the deleterious effects of the bleaching treatment could be caused by residual peroxides and active oxygen, released by bleaching agents, which inhibits resin polymerization (Titley *et al.* 1988, Torneck *et al.* 1991). However, it has been shown that 30% hydrogen peroxide affected the organic and inorganic components of dentin, causing denaturation of proteins (Rotstein, Lehr, Gedalia 1992). These morphologic changes could also reduce the performance of resin bond restorations (Shinohara *et al.* 2001).

It appears that hydrogen peroxide remains active in the pulp chamber or in dentin tubules for a certain period after bleaching. This may be due to its interaction with certain components of the dentin, thus affecting the release of oxygen from the dentin tubules (Torneck *et al.* 1990b, Rotstein *et al.* 1992).

In our study, the unbleached group (CON) showed the least microleakage. The 37% carbamide peroxide results were similar to the control group than the other groups at baseline and 7 days, probably due to the slow release of the oxidizing agent hydrogen peroxide through the dentin and enamel (Haywood 1992). The higher content of hydrogen peroxide in the SPH group would explain the greater dye penetration in that group. The association of sodium perborate either with 30% hydrogen peroxide or water seems to cause more adverse effects on the microleakage than the 37% carbamide peroxide.

The present results showed that the sealing of tooth-resin interface was not affected by the bleaching treatments after 14 and 21 days. Although the dentin acts as an oxygen reservoir (Titley *et al.* 1993), it was hypothesized that the interaction with artificial saliva may leach out all the residual substances. Salivary deposits may also occur when specimens were maintained in artificial saliva (Rotstein *et al.* 1992). However, water storage of *in vitro* specimens can also results in a complete reversal of the reduced enamel bonds (Torneck *et al.* 1991). Following removal of the bleaching agent, this drawback can be reversed (Torneck *et al.* 1991), depending on the time of exposure to hydrogen peroxide (Torneck *et al.* 1990a).

The elapsed time between bleaching and bonding procedure is another important factor to improve sealing ability and to reduce microleakage in adhesive restorations. When using sodium perborate, either with water or with 30% hydrogen peroxide, it would be advisable for resin composite restorations to be done 14 days after bleaching, to minimize microleakage of coronal access restorations.

Although the results of the bleaching product containing 37% carbamide peroxide were closer to those of the control, more studies are necessary to evaluate its clinical effectiveness as an agent for walking bleaching technique. Even though carbamide peroxide has been considered safe as a vital bleaching agent, any association with external cervical resorption has to be evaluated.

References

1. Baratieri, L.N, Ritter, A.V, Monteiro, Jr S, Andrada, M.A.C, Vieira, L.C.C. (1995) Nonvital Tooth Bleaching: Guidelines to the clinician. Quintessence International, 26,597-608.
2. Barkhordar, R.A, Kempler, D, Plesh, O. (1997) Effect of nonvital tooth bleaching on microleakage of resin composite restorations. Quintessence International, 28,341-344.
3. Caughman, W.F, Frazier, K.B, Haywood, V.B. (1999) Carbamide peroxide whitening of nonvital single discolored teeth: Case reports. Quintessence International, 30,155-161.
4. Featherstone, J.D, O' Reilly, M.M, Shariati, M. (1986) Enhancement of remineralization *in vitro* and *in vivo*. In: Leach, S.A. Factors relating to demineralization and remineralization of the teeth, 3-rd ed., p.23-34. Oxford: Oxford, Irl.
5. Haywood, V.B. (1992) History, safety and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. Quintessence International, 23,471-488.
6. Nutting, E.B, Poe, G.S. (1963) A new combination for bleaching teeth. Journal of South California Dental Association, 31,289-291.
7. Perrine, G.A, Reichl, R.B, Baisden, M.K, Hondrum, S.O. (1998) Comparison of 10% carbamide peroxide and sodium perborate for intracoronal bleaching. General Dentistry, 3,264-270.

8. Rivera, E.M, Vargas, M, Williamson, L.R. (1997) Considerations for the aesthetic restoration of endodontically treated anterior teeth following intracoronal bleaching. Pract Periodontics Aesthetic Dentistry; 9,117-28.

9. Rotstein, I, Lehr, Z, Gedalia, I. (1992) Effects of bleaching agents on inorganic components of human dentin and cementum. Journal of Endodontics,18,290-293.

10. Rotstein, I, Mor, C, Friedman, S. (1993) Prognosis of intracoronal bleaching with sodium perborate preparation *in vitro*:1-year study. Journal of Endodontics,19,10-12.

11. Serra, M.C, Cury, J.A. (1992) The *in vitro* effect of glass-ionomer cement restorations on enamel subjected to a desmineralization and remineralization model. Quintessence International, 23,143-147.

12. Shinohara, M.S, Rodrigues, J.A, Pimenta, L.A. (2001) *In vitro* microleakage of composite restorations after nonvital bleaching. Quintessence International,32,413-417.

13. Spasser, H.F. (1961)A simple bleaching technique using sodium perborate. New York State Dental Journal,27, 332-334.

14. Titley, K.C, Torneck, C.D, Ruse, N.D, Krmec, D. (1993) Adhesion of a resin composite to bleached and unbleached human enamel. Journal of Endodontics,19,112-5.

15. Titley, K.C, Torneck, C.D, Smith, D.C, Adibfar, A. (1988) Adhesion of a resin composite to bleached and unbleached bovine enamel. Journal Dental Research, 67,1523-1528.

16. Torneck, C.D, Titley, K.C, Smith, D.C, Adibfar, A. (1990) Adhesion of light-cured composite resin to bleached and unbleached bovine dentin. Endodontic Dental Traumatology, 6,97-103.

17. Torneck, C.D, Titley, K.C, Smith, D.C, Adibfar, A. (1991) Effect of water leaching the adhesion of composite resin to bleached and unbleached bovine enamel. Journal of Endodontics,17,156-60.

18. Torneck, C.D, Titley, K.C, Smith, D.C, Adibfar, A. (1990) The influence of time of hydrogen peroxide exposure on the adhesion of composite resin to bleached bovine enamel. Journal of Endodontics,16,123-128.

19. Van der Vyver, P.J, Lewis, S.B, Marais, J.T. (1997) The effect of bleaching agent on composite/ enamel bonding. Journal Dental Association of South Africa, 52, 601-603.

20. Wilcox, L.R, Diaz-Arnold, A.M. (1989) Coronal microleakage of permanent lingual access restorations in endodontically treated anterior teeth. Journal of Endodontics,15,584-587.

Table 1- Microleakage median scores, average ranks and results of multiple comparisons of experimental groups per time intervals.

Time intervals	Groups	n	Median	Average Rank
Baseline	CON	20	1	31.45[a]
	CP	20	1	36.27[ab]
	SPW	19	1	44.84[ab]
	SPH	20	2	47.67[b]
7 days	CON	20	1	31.20[a]
	CP	20	1	36.10[ab]
	SPW	19	2	46.39[b]
	SPH	20	2	46.62[b]
14 days	CON	20	1	39.50[a]
	CP	19	1	29.81[a]
	SPW	19	1	40.71[a]
	SPH	20	2	47.55[a]
21 days	CON	20	1	36.90[a]
	CP	20	1	38.00[a]
	SPW	19	2	43.52[a]
	SPH	19	1	39.78[a]

? Statistical differences are expressed by different letters for each time intervals.

? Least significant difference (n=19; n=20)=14,35 (n=20; n=20)=14,21

3.4 CAPÍTULO IV

Use of the 37% carbamide peroxide in the walking bleach technique: a case report

Enviado para publicação para Quintessence International

USE OF THE 37% CARBAMIDE PEROXIDE

IN THE WALKING BLEACH TECHNIQUE: A CASE REPORT

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Abstract

Dental bleaching represents an effective, conservative, and relatively low cost method for improving the appearance of discolored pulpless teeth. Among the bleaching techniques, the walking bleach with sodium perborate associated with water or hydrogen peroxide stands out. The authors presented a modified walking bleach technique with the use of 37% carbamide peroxide as the bleaching agent. Additionally, the adverse effects of dental bleaching in the following restorative procedures were discussed, showing the advantages with the use of 37% carbamide peroxide.

Key words: 37% carbamide peroxide, nonvital bleaching, walking bleach, discolored tooth.

Introduction

The presence of discolored teeth is a serious esthetic problem and bleaching is the most conservative technique for improving their appearance[1,2]. Nonvital tooth bleaching is a current procedure in endodontics and esthetic dentistry with a high rate of success[3]. Three techniques have been successfully used in dentistry for many years to reverse stains associated with nonvital teeth: the thermocatalytic, the walking bleach, and the combination of both[4].

The thermocatalytic technique uses 30% to 35% hydrogen peroxide placed in the pulp chamber and activated by heat[4]. This combination appears to be associated with the major concern in nonvital bleaching treatment, the external cervical root resorption[5,6,7,8]. The etiology of this pathology is complex and can also be related to the age of the patient when the tooth became pulpless and the presence of a cervical barrier[6,7].

The most popular bleaching technique is the walking bleach in which many bleaching agents have been used. Generally, a paste of sodium perborate mixed with either hydrogen peroxide or water is sealed in the pulp chamber by a temporary restoration and changed every 3 to 7 days, until a desirable result[1,4,6,9,10]. This technique is widely used in dentistry because less clinical time is required. *In vitro* studies suggested that sodium perborate mixed with water is as effective as it is when mixed with hydrogen peroxide[11,12]. An additional advantage is the safety of this procedure[9,10,13,14].

Recently, a modified walking bleach technique, called inside/outside, was proposed. It consists of the patient administering the 10% carbamide peroxide inside and outside the tooth simultaneously[15,16]. This agent appears to be another option for bleaching a discolored nonvital tooth. However, for internal bleaching, a higher concentration could be necessary to obtain better esthetic results.

The purpose of this article is to discuss the indications, limitations and clinical procedures for nonvital tooth bleaching, with 37% carbamide peroxide.

Clinical application - carbamide peroxide

Historically, carbamide peroxide was used as an oral antiseptic in concentrations of 10 to 15 percent[17] but, since 1989, this material has been commonly used as a whitening agent for nightguard vital bleaching[1,2]. Two primary transient side effects, tooth sensitivity and gingival irritation[18], are related to this procedure. Tooth sensitivity occurred due to the passage of the small hydrogen peroxide molecules through the enamel and dentine to the pulp[1] and gingival irritation resulted because of the excess bleaching solution in the nightguard tray[17].

Although 10% carbamide peroxide was first indicated for vital teeth[1,2], the use of this agent was proposed for lightening nonvital discolored teeth, using the inside/outside technique[15,16]. With this technique, the bleaching time range is reduced, usually few days, depending on how severely the discoloration is[16]. However, the pulp chamber is kept open until the final restoration. The risk of coronal microleakage is increased, contributing to the access of fluid and failure of the endodontic treatment[3,4,19,20,21]. In spite of the satisfactory esthetic results obtained with 10% carbamide peroxide in the outside/inside technique[15,16], this material was shown to be less effective than 30% hydrogen peroxide mixed with sodium perborate, as an intracoronal bleaching agent[22].

Ten percent carbamide peroxide breaks down to 3% hydrogen peroxide[22] while of the 37% in a higher amount, it is approximately 11%, the same as for sodium perborate mixed with water[11,12]. The potential side effects of carbamide peroxide are less severe than the complications associated with hydrogen peroxide, since an indirect release of hydrogen peroxide is expected to occur[2,22].

Carbamide peroxide has not been found to be carcinogenic in humans. Carbamide peroxide-containing products were not genotoxic, nor were they any more toxic than dental materials currently in use[23]. Moreover, the transient effects with nightguard vital bleaching do not assist the walking bleach technique.

Special care must be taken for a successful and adequate internal bleaching. Some principles are very important, such as: case selection, the condition of the teeth and mouth, and the individual patient's desires and expectations concerning the esthetic outcome. The choice of the bleaching agent, the clinical protocol, and the time to restore the coronal access or to replace restorations play an important role in the treatment's success.

Case Report

A 43-year-old woman patient presented a single, discolored, maxillary, right lateral incisor (tooth 12)(Fig 1-2). Visual examination and behavioral history revealed the darkened color of the tooth to be the result of a traumatic injury. The tooth was structurally sound and asymptomatic, but associated with a pulp necrosis. Radiographic exam showed a periapical lesion in the lateral incisor apex without root canal therapy (Fig 3). A pulp vitality test was also performed in the adjacent central incisor (tooth 11) to exclude its relation with the lesion, and no alteration was detected.

The endodontic treatment was resumed through a complete and adequate root canal obturation (Fig 4). The patient was given an explanation of the risk, benefits, and limitations of the options available for restoring the esthetics of the tooth. Then, the intracoronal bleaching technique with 37% carbamide peroxide was proposed to and accepted by the patient.

A baseline tooth-shade was recorded, and clinical photographs were taken, providing a reference for measuring the progress of color enhancement. The rubber dam isolation was achieved for the coronal and root canal access (Fig 5). All debris was eliminated and the canal restorative material removed 2mm below the level of the cementoenamel junction, using a rotary instrument. A cervical barrier with 2mm thickness of Cavit (Espe-Germany) was done (Fig 6-7).

The bleaching agent, carbamide peroxide gel 37%, was placed in the pulp chamber with a plastic instrument (Fig 8). The excess gel was removed with a cotton pellet and the tooth was sealed with a temporary restoration (Cavit, Espe-Germany) (Fig 9).

In four clinical appointments, after 1 week each, the tooth-shade was evaluated (Fig 10-11-12). The pulp chamber was irrigated with distilled water, the bleaching agent was replaced and a provisional restoration was made. After 4 weeks, a satisfactory tooth color was obtained, according to the professional criteria and the patient's desires (Fig 13). The coronal access was restored immediately following bleaching with a composite resin (Z100-3M) associated with adhesive system (Single Bond-3M) (Fig 14).

A clinical evaluation 10 months later showed that the lighter shade of the tooth was maintained (Fig 15-16). Radiographic assessment revealed no evidence of external cervical root resorption (Fig 17).

Discussion

In dentistry, bleaching agents usually refer to products containing some form of hydrogen peroxide[1,4,22]. Although not completely clear, the basic mechanism of bleaching agents is oxidation. In contact with the tissue the hydrogen peroxide molecules break up and form oxygen and peridroxil free radicals[1,4].

Sodium perborate is stable when dry, but when combined with water, it decomposes to form metaborate, hydrogen peroxide, and nascent oxygen[9,11,12]. It is more easily controlled and safer than concentrated hydrogen peroxide solutions. This substance breaks up into a less concentrated hydrogen peroxide that, at a second stage, releases active oxygen and initiates the bleaching process. Such combination reduces the aggressive power of 30-35% hydrogen peroxide[11,12].

Another bleaching agent is carbamide peroxide, which has been successfully used, since the advent of nightguard vital bleaching[2]. Materials that contain carbamide peroxide can also elicit the same oxidation reactions that result in bleaching with the application of hydrogen peroxide and sodium perborate[1,2]. Carbamide peroxide, breaks down into urea, ammonia, carbon dioxide, and hydrogen peroxide, which releases more or less nascent oxygen, according to the agent concentration[1,2,6,22].

Some authors suggested the use of calcium hydroxide after the bleaching treatment and prior to the final restoration to prevent the cervical resorption[7,21,24]. However, this material failed to prevent resorption in an animal study[8]. The thermocatalytic technique and the use of hydrogen peroxide, a caustic substance that could cause a drop in pH at a cervical level[25], are associated with cervical resorption[5,6,7]. On the contrary, pH changes could be avoided with the use of sodium perborate[11,12,14,26] or the carbamide peroxide[1,2]. The risk of resorption can be prevented when a cervical barrier is correctly placed. Materials, such as gutta-percha, zinc phosphate, Cavit (Espe), and glass-ionomer materials have been used[13]. The Cavit (Espe) was chosen due to the reduced linear leakage and because it is an easily handled material[25].

The use of 37% carbamide peroxide is a new approach to internal bleaching. The esthetic outcome could be acceptable and the potential for resorption may be minimized. However, the use of any of the current bleaching agents is not completely without risk, and care must be taken with their storage, application, and monitoring[17]. Another important aspect to discuss is the material that should be used after bleaching to maintain the esthetics results.

New composite, resin-bonded, and glass ionomer restorative materials have been developed for restoration of endodontically treated and bleached teeth[20,21]. The material used to restore the bleached tooth in this case report was a hybrid resin composite in association with dental adhesives systems. The restoration aimed to protect the remaining tooth structure, to minimize the risk of fracture, and to seal the coronal access augmenting the new shade, prevent microleakage and recurrent caries. Moreover, the possible interference of the bleaching agents in the following restorative procedures was evaluated.

Some studies have shown significant lower bond strengths obtained when glass-ionomer and composite resins are bonded to dentin and enamel immediately after bleaching with 30% hydrogen peroxide[27,28,29]. Microleakage is also increased around composite resin restorations[19]. This appears to be an effect of residual-peroxides substances and consequence of morphological changes[29,30,31]. Depending on the bleaching agents used, the time elapsed after bleaching is an important factor for obtaining an optimal adhesion[30,32].

In nonvital bleaching with sodium perborate mixed with water or 30% hydrogen peroxide the final restoration at the coronal access should also be deferred for 2 weeks following bleaching treatment[32]. However, 37% carbamide peroxide showed less influence in the adhesive procedures in comparison with these agents[32]. The appliance of carbamide peroxide suggests that a better seal is arranged even immediately after the bleaching procedure[32].

An adequate coronal access restoration is important for the longevity of the bleaching results. It consists not only of the choice of the restorative material that could improve the esthetic appearance, but also prevents microleakage[19,20]. Color regression occurs with the access of fluid into bleached and restored cavity[19]. Although long-term studies of carbamide peroxide application are lacking, studies presented since its use for vital bleaching suggest that this agent could be an option also for nonvital tooth bleaching.

The 37% carbamide peroxide gel is easy to manipulate, to remove from the pulp chamber, and has a pH close to neutral. Its clinical effectiveness, as an agent for the walking bleach technique was satisfactory in the 10 months follow-up.

Conclusion

The clinical result obtained with the use of 37% carbamide peroxide suggests that it could be employed as a bleaching agent in the walking bleach technique, when the indications and the treatment risk benefits are known.

References

1. Haywood VB. History, safety and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. Quintessence Int 1992; 23: 471-488.
2. Haywood VB, Heymann HO. Nightguard vital bleaching. Quintessence Int 1989; 20: 173-176.
3. Abbott PV. Aesthetic considerations in endodontics: internal bleaching. Pract Periodontics Aesthet Dent 1997; 9:833-40.
4. MacIsaac AM, Hoen CM. Intracoronal bleaching: concerns and considerations. J Can Dent Assoc. 1994; 60:57-64.
5. Harrington GH, Natikin E. External resorption associated with bleaching of pulpless teeth. J Endod 1979; 5:344-348.
6. Friedman S, Rotstein I, Liebfield H. Incidence of external root resorption and esthetic results in 58 bleached pulpless teeth. Endo Dent Traumatol. 1988; 4: 23-26.
7. Gimlin DR, Schindler WG. The management of postbleaching cervical resorption. J Endod. 1990; 16:292-7. Review.
8. Rotstein, I., *et al.* Histological characterization of bleaching–external root resorption in dogs. J Endod 1992; 7: 436-41.
9. Spasser HF. A simple bleaching technique using sodium perborate. N Y Dent J 1961; 27:332-334.
10. Nutting EG, Poe GS. A new combination for bleaching teeth. J South Calif Dent Assoc 1963; 31:289-291.

11. Weiger R, Kuhn A, Lost C. Effect of various types of sodium perborate on the pH of bleaching agents. J Endod. 1993; 19:239-41.

12. Weiger R, Kuhn A, Lost C. In vitro comparison of various types of sodium perborate used for intracoronal bleaching of discolored teeth. J Endod 1994; 20:338-41.

13. Hara AT, Pimenta LAF. Nonvital tooth bleaching: A 2-year case report. Quintessence Int 1999; 30:748-754.

14. Teixeira FB, Nogueira EC, Ferraz CCR, Zaia AA. Internal dental bleaching using sodium perborate/distilled water paste. Rev Assoc Paul Cir Dent 2000; 54:315-8.

15. Caughman WF, Frazier KB, Haywood VB. Carbamide peroxide whitening of nonvital single discolored teeth: Case Reports. Quintessence Int 1999; 30:155-161.

16. Liebenberg WH. Intracoronal lightening of discolored pulpless teeth: a modified walking bleach technique. Quintessence Int. 1997; 28:771-7. Review.

17. Lyons K, Ng B. Nightguard vital bleaching: a review and clinical study. N Zealand Dent J 1998; 94:100-105.

18. Rosenstiel SF, Gegauff AG, Johnston WM. Randomized clinical trial of the efficacy and safety of a home bleaching procedure. Quintessence Int 1996; 27:413-424.

19. Barkhordar RA, Kempler D, Plesh O. Effect of nonvital tooth bleaching on microleakage of resin composite restorations. Quintessence Int 1997; 28: 341-344.

20. Rivera EM, Vargas M, Williamson LR. Considerations for the aesthetic restoration of endodontically treated anterior teeth following intracoronal bleaching. Pract Periodontics Aesthet Dent 1997; 9:117-28.

21. Baratieri NC, Ritter AV, Monteiro Jr S, Andrada MAC, Vieira LCC. Nonvital tooth bleaching: Guidelines to the clinician. Quintessence Int 1995; 26:597-608.

22. Perrine GA, Reichl RB, Baisden MK, Hondrum SO. Comparison of 10% carbamide peroxide and sodium perborate for intracoronal bleaching. Gen Dent. 2000; 48:264-70.

23. Woolverton CJ, Haywood VB, Heyman HO. Toxicity of carbamide peroxide products used in nightguard vital bleaching. Am J Dent 1993; 6:310-314.

24. Demarco FF, Freitas JM, Silva MP, Justino LM. Microleakage in endodontically treated teeth: influence of calcium hydroxide dressing following bleaching. Int Endod J. 2001, 34:495-500.

25. Smith JJ, Cunningham CJ, Montgomery S. Cervical canal leakage after internal bleaching procedures. J Endod 1992; 18:476-481.

26. Rotstein I, Friedman S. pH variation among materials used for intracoronal bleaching. J Endod. 1991; 17:376-9.

27. Titley KC, Torneck CD, Ruse ND, Krmec D. Adhesion of a resin composite to bleached and unbleached human enamel. J Endod 1993; 19:112-5.

28. Titley KC, Torneck CD, Smith DC, Applebaum NB. Adhesion of a glass ionomer cement to bleached and unbleached bovine dentin. Endod Dent Traumatol. 1989; 5:132-128.

29. Torneck CD, Titley KC, Smith DC, Adibfar A. Adhesion of light-cured composite resin to bleached and unbleached bovine dentin. Endod Dent Traumatol. 1990; 6:97-103.

30. Spyrides GM, Perdigão J, Pagani C, Araújo MAM, Spyrides SMM. Effect of whitening agents on dentin bonding. J Esthet Dent 2000; 12:264-270.

31. Cavalli V, Reis AF, Giannini M, Ambrosano GMB. The effect of elapsed time following bleaching on enamel bond strength of resin composite. Oper Dent 2001, 26:597-602.

32. Teixeira ECN, Hara AT, Turssi CP, Serra MC. Effect of post-bleaching times on the microleakage of composite resin restorations. J Dent Res 2002; 81:A76 special issue. Abstract:411.

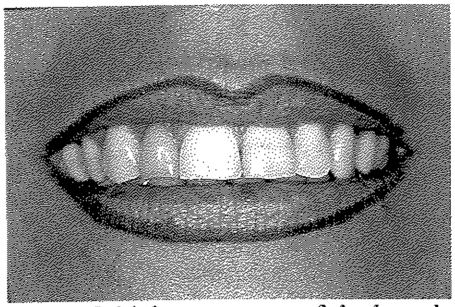

Fig 1 - Initial appearance of the lateral incisor discolored from trauma

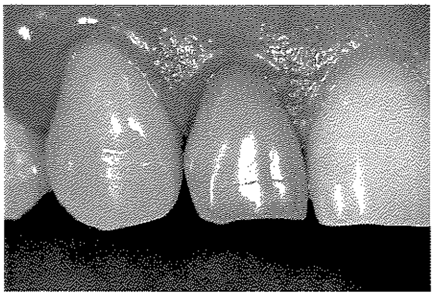

Fig 2 - Nearby view of the lateral incisor

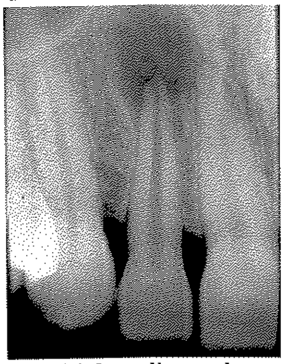

Fig 3 - Initial radiograph reveals a periapical lesion in the tooth 12

Fig 4 - Periapical radiograph, showing the successful endodontic treatment

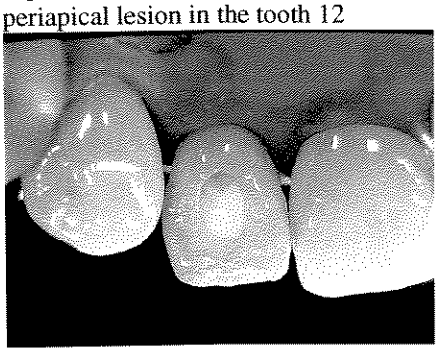

Fig 5 - Lingual view of tooth 12 demonstrating the coronal access. Dental dam isolation facilitates the access to the pulp chamber.

Fig 6 - Placement of the intracoronal isolating base with Cavit (Espe) at the cementoenamel junction

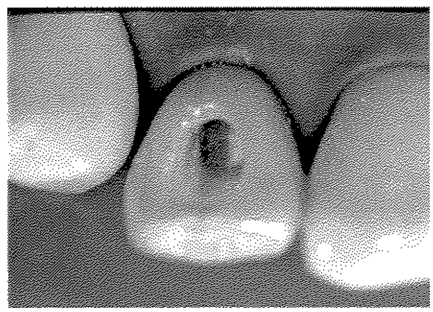

Fig 7 - The pulp chamber without debris and the cervical barrier view

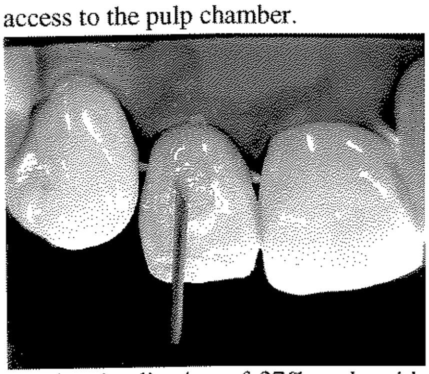

Fig 8 - Application of 37% carbamide peroxide gel

Fig 9 - The pulp chamber is provisional sealed

Fig 10 - Appearance 7 days after the bleaching treatment beginning

Fig 11 - The result after 14 days

Fig 12 - Appearance after 21 days

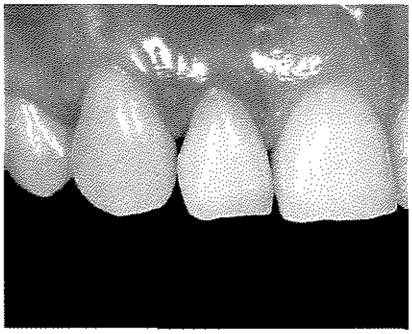

Fig 13 - Post-bleaching result reveals a satisfactory esthetic following 4 weeks

Fig 14 - The bleaching agent was removed the pulp chamber rinsed with water, and the coronal access was restored immediately after bleaching, showing the final tooth shade.

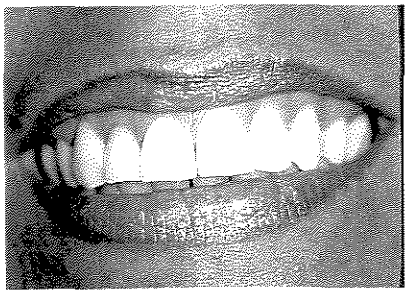

Fig 15 - The results after 10 months are excellent

Fig 16 - Postoperative appearance following 10 months

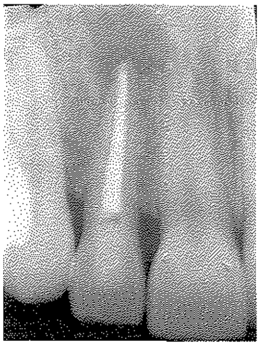

Fig 17 - Periapical radiograph from the 10 months follow-up. There is no evidence of external cervical root resorption

4. CONCLUSÃO GERAL

Nas condições em que estes estudos foram conduzidos, pode-se concluir que:

1. O peróxido de carbamida a 37% mostrou os menores efeitos adversos tanto na resistência adesiva como na microinfiltração.

2. O tempo de espera proporciona diferentes efeitos sobre a interface adesiva, dependendo do substrato, do tipo de teste (cisalhamento e microinfiltração) e do agente clareador.

3. O peróxido de carbamida a 37% pode ser empregado na técnica *walking bleach*, favorecendo a obtenção de um menor tempo clínico e um resultado estético satisfatório.

REFERÊNCIAS BIBLIOGRÁFICAS[*]

1. BARATIERI, L.N. *et al.* Nonvital tooth bleaching: Guidelines to the clinician. **Quintessence Int.**, v.26, n.9, p. 597-608, Sep. 1995.
2. BARKHORDAR, R.A.; KEMPLER, D.; PLESH, O. Effect of nonvital tooth bleaching on microleakage of resin composite restorations. **Quintessence Int.**, v.28, n.5, p.341-344, May. 1997.
3. BOKSMAN, L.; JORDAN, R.E.; SKINNER, D.H. Non-vital bleaching - internal and external. **Aust Dent J.**; v.28, n.13, p.149-152, Jun. 1983.
4. CAUGHMAN, W.F.; FRAZIER, K.B.; HAYWOOD, V.B. Carbamide peroxide whitening of nonvital single discolored teeth: Case reports. **Quintessence Int**, v.30, n.3, p.155-161, Mar. 1999.
5. FEINMAN, R. A. Chemical, optical and physiologic mechanisms of bleaching products: A review. **Pract Periodontics Aesthet Dent**, v.3, n.2, p.32-37, Mar. 1991.
6. FRECCIA, W.F. *et al.* An *in vitro* comparison of nonvital bleaching techniques in the discolored tooth. **J Endod**; v.8, n.2, p.70-77, Feb. 1982.
7. FRIEDMAN, S.; ROTSTEIN, I.; LIEBFIELD, H. Incidence of external root resorption and esthetic results in 58 bleached pulpless teeth. **Endo Dent Traumatol**; v.4, n.1, p. 23-26, Feb. 1988.
8. GIMLIN, D. R., SCHINDLER, W.G. The management of postbleaching cervical resorption. **J Endod**; v.16, n.6, p.292-2977, Jun. 1990.

[*] De acordo com a NBR 6023, de 1989, da Associação Brasileira de Normas e Técnicas (ABNT). Abreviatura dos periódicos em conformidade com o "Medline".

9. GOON, W.W.; COHEN, S.; BORER, R.F. External cervical resorption following bleaching. **J Endod**; v.12, n.9, p.414-418, Sep. 1986.

10. HAYWOOD, V.B. Bleaching of vital and nonvital teeth. **Curr Opin Dent**; v.2, n.3, p.142-149, Mar. 1992.

11. HO, S.; GOERIG, A.C. An *in vitro* comparison of different bleaching agents in the discolored tooth. **J Endod**; v.15, n.3, p.106-111, Mar. 1989.

12. LATCHAM, N. L. Postbleaching cervical resorption. **J Endod**; v.12, n.6, p.262-264, Jun. 1986.

13. LIEBENBERG, W.H. Intracoronal lightening of discolored pulpless teeth: A modified walking bleach technique. **Quintessence Int**.; v.28, n.12, p.771-777. Dec 1997.

14. NUTTING, E.B.; POE, G.S. A new combination for bleaching teeth. **J South Calif Dent Assoc**; v.31, n.9, p.289-291. 1963.

15. RIVERA, E.M.; VARGAS, M.; WILLIAMSON, LR. Considerations for the aesthetic restoration of endodontically treated anterior teeth following intracoronal bleaching. **Pract Periodontics Aesthet Dent**; v.9, n.1, p.117-128, Jan-Feb. 1997.

16. ROTSTEIN, I.; MOR, C.; FRIEDMAN, S. Prognosis of intracoronal bleaching with sodium perborate preparation in vitro: 1-year study. **J Endod**; v.19, n.1, p.10-12, Jan. 1993.

17. ________; TOREK, Y.; MISGAV, R. Effect of cementum defects on radicular penetration of 30-per-cent H_2O_2 intracoronal bleaching. **J Endod**; v.17, n.5, p.230-233, May. 1991.

18. SHINOHARA, M.S.; RODRIGUES, J.A.; PIMENTA L.A. *In vitro* microleakage of composite restorations after nonvital bleaching. **Quintessence Int.**; v.32, n.5, p.413-417, May. 2001.

19. SPASSER, H.F. A simple bleaching technique using sodium perborate. **N. Y. State Dent J**; v.27, p.332-334. 1961.

20. STOKES, A.N *et al.* Effect of peroxide bleaches on resin-enamel bonds. **Quintessence Int.**; v.23, n.11, p.769-771, Nov. 1992

21. SUNG, E.C. *et al.* Effect of carbamide peroxide bleaching on the shear bond strength of composite to dental bonding agent enhanced enamel. **J Prosthet Dent.**; v.82, n.5, p.595-9, Nov. 1999

22. TITLEY, K.C.; TORNECK, C.D.; SMITH, D.C. The effect of concentrated Hydrogen Peroxide Solutions on the surface morphology of human tooth enamel. **J Endod**; v.14, n.2, p.69-74. Jun. 1988.

23. _______.; TORNECK, C.D.; SMITH, D.C.; ADIBFAR, A. Adhesion of a resin composite to bleached and unbleached bovine enamel. **J Dent Res**, v.67, n.12, p.1523-1528, Dec. 1988.

24. TORNECK, C.D.; TITLEY, K.C.; SMITH, D.C.; ADIBFAR, A. Adhesion of light-cured composite resin to bleached and unbleached bovine dentin. **Endod Dent Traumatol**; v.6, n.3, p.97-103. Jun. 1990.

25. _______.; TITLEY, K.C.; SMITH, D.C.; ADIBFAR, A. The influence of time of hydrogen peroxide exposure on the adhesion of composite resin to bleached bovine enamel. **J Edodon**; v.16, n.3, p.123-128, Mar. 1990.

26. VAN DER VYVER, P.J.; LEWIS, S.B.; MARAIS, J.T. The effect of bleaching agent on composite/ enamel bonding. **J Dent Assoc S Afr**; v.52, n.10, p.601-603, Oct. 1997.

27. WALTON, R.E.; TORABINEJAD, M. Principles and pratice of endodontics. Philadelphia: WB Saunders, 1989.

28. WARREN, M.A.; WONG, M.; INGRAM, T.A. An *in vitro* comparison of bleaching agents on the crowns and roots of discolored teeth. **J Endod**; v.16, n.10, p.463-467, Oct. 1990.

29. WILCOX, L.R.; DIAZ-ARNOLD; A.M Coronal microleakage of permanent lingual access restorations in endodontically treated anterior teeth. **J Endod**.; v.15, n.12, p.584-587, Dec. 1989.

ANEXOS

Title: "Effect of non-vital tooth bleaching on resin/enamel shear bond strength"

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