

Received: 11th May 2014 Accepted: 15th August 2014 Conflict of Interest: None

Original Research

Source of Support: Nil

An In Vitro Comparative Study of Shear Bond Strength of Composite Resin to Bleached Enamel using Synthetic and Herbal Antioxidants

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How to cite the article:

Suneetha R, Pavithra, Thomas J, Nanga GS, Shiromany A, Shivrayan A. An *in vitro* comparative study of shear bond strength of composite resin to bleached enamel using synthetic and herbal antioxidants. J Int Oral Health 2014;6(6):77-81.

Abstract:

Background: The bond strength to bleached enamel is reduced, if adhesive restorations are carried out immediately. So the purpose of this *in vitro* study was an attempt to regain the lost bond strength, for which, the comparison of shear bond strength of composite resin to bleached enamel was carried out using various antioxidants: 10% Sodium ascorbate, Rosemary extracts, Pedicularis extracts.

Materials and Methods: Fifty human extracted single rooted teeth were collected. They were decoronated and coronal portions were embedded in self cure acrylic resin with their buccal surfaces facing upwards. The samples were randomly divided into positive, negative control groups and three experimental groups ($n = 10$). In positive control group, specimens were not bleached, before bonding procedure. In negative control group, bleaching was done with 10% carbamide peroxide and bonding was carried out immediately. In experimental groups, following antioxidants were used after bleaching: Group A: 10% Sodium ascorbate, Group B: Rosemary extracts, Group C: Pedicularis extracts. Then the bonding procedures were carried out in all the groups and were subjected for shear bond strength analysis.

Results: Results clearly showed that groups A and B were effective in reversal of bond strength immediately.

Conclusion: 10% sodium ascorbate solution and rosemary extracts were effective in reversal of shear bond strength immediately after bleaching.

Key Words: Artificial saliva, 10% carbamide peroxide, shear bond strength, 10% sodium ascorbate

Introduction

Ask the average person how they would most like to improve their smile and the answer most often is.....white and symmetrical teeth.¹

A professional response to the unrelenting quest for whiter teeth dates back at least 2000 years. Discolored anterior teeth may be treated with partial veneers (composite/ceramics; laminates, lumineers) or full veneers (all ceramic/porcelain fused metal) to restore esthetics.

Vital tooth bleaching is a safe and well accepted procedure for the treatment of surface and intrinsic staining of teeth. At times, bleaching alone may not be sufficient to achieve required esthetics, need for other procedures such as composite veneers, laminates, etc. may be required.

Previous literature demonstrated that the bond strength of adhesive restorations to dentin and enamel is reduced immediately after bleaching. Previous studies suggested, waiting from 24 h to 3 weeks before carrying out a restorative procedure regains the lost bond strength.²⁻⁴ Such waiting period may not be feasible in cases of immediate esthetic requirements, such as diastema closure after bleaching. Considering this, various methods proposed to avoid clinical problems-related to compromised bond strength after bleaching such as:

- Removal of the superficial layer of enamel.
- Pre-treatment of bleached enamel with alcohol.
- Use of adhesives containing organic solvents.
- Use of anti-oxidant agents before the bonding process can reverse the compromised bonding to bleached enamel.^{3,5}

Among all the methods, the antioxidant treatment using sodium ascorbate has shown immediate improvement in bond strength values, whereas the other methods showed conflicting results in regaining the bond strength values.⁶⁻⁸

Ascorbic acid and its sodium salts are potent antioxidants with the capacity to quench reactive free radicals in biological systems.⁶

However even sodium ascorbate was ineffective in a complete reversal of compromised bond strength. In the quest to search for an effective and safe antioxidant, a novel attempt has been done to use natural antioxidants, which have been used in medical research for their strong antioxidant property.

Hence, the purpose of this *in vitro* study was an attempt to regain the lost bond strength, for which, the comparison of shear bond strength of composite resin to bleached enamel was carried out using various antioxidants: 10% sodium ascorbate, rosemary extracts, pedicularis extracts.

Materials and Methods

Preparation of specimens

Fifty non-carious extracted human single-rooted teeth collected and used in the study. After extraction, the residue on the teeth was removed and washed away with tap water. Then, they were stored in sterile normal saline solution until required. The roots were removed from the crowns at the cemento-enamel junction using slow speed diamond saw under copious water spray. The teeth were mounted in an aluminum holder filled with cold-cure acrylic resin, with the buccal surfaces facing upwards. Then, the central portion of the embedded tooth was ground flat with 200-grit silicon carbide paper. A uniform area of 5 mm² of enamel was created by covering the adjacent areas with nail varnish.

Grouping of specimens

Groups (n=10)	Antioxidant
Positive control	Unbleached
Negative control	Bleached
Group A	10% Sodium ascorbate
Group B	Rosemary extracts
Group C	Pedicularis extracts

Bleaching procedure

In all the groups (except negative control), 10% carbamide peroxide (opalescent, ultradent) gel was placed on the flattened enamel surface for 8 h/day (Figure 1). The specimens were partially immersed in artificial saliva at 37°C in a tray in such a way that only the enamel surfaces that were coated with a bleaching gel, did not contact the saliva. After completion of the daily bleaching procedure, specimens were thoroughly rinsed with air/water spray and air-dried. For the remaining hours in the day, specimens were stored in artificial saliva in an incubator at 37°C. The procedure was continued for 1 week.

Antioxidant treatment

After the bleaching treatment, antioxidant treatment was done. 10 ml of antioxidant solution was applied to the enamel surfaces as an irrigating solution for 10 min with a flow rate of 1 ml/min. After antioxidant treatment, the enamel surface was thoroughly rinsed with distilled water for 30 s and subjected to bonding procedures.

Bonding procedure

A piece of adhesive tape with a 2 mm diameter hole was punched and securely adapted to the center of the flattened portion of the labial enamel. Then, 37% phosphoric acid gel (3 M ScotchBond) was applied to the demarcated area for 15 s, rinsed with air/water syringe for 15 s and dried

with compressed air for 5 s. Then (single bond, 3M) 2-3 consecutive coats of bonding agent was applied to the enamel surface and gently dried and cured for 10 s using a blue phase light curing unit with an intensity output of 400-500 mWcm². A cellophane tube with 2 mm in diameter and 4 mm in depth was positioned over the hole in the adhesive tape. Two



Figure 1: 10% carbamide peroxide gel placed over the flattened enamel surface embedded in self-cure resin block.

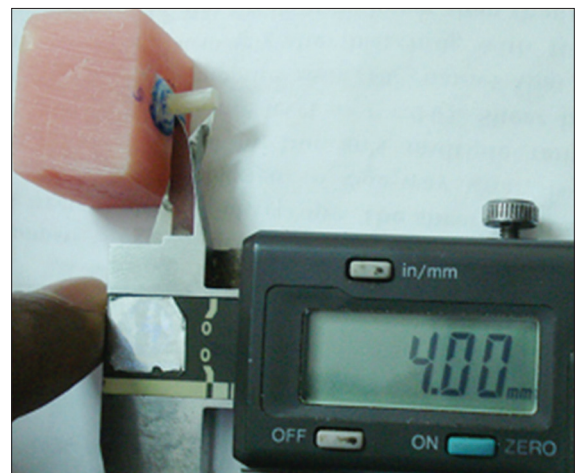


Figure 2: Composite resin cylinder of 4 mm height and 2 mm depth built after bleaching procedure.



Figure 3: SHIMADZU Universal testing machine.

increments of composite resin (Z 350, shade A2) was placed, and each one was light cured with 40 s. Each specimen was cured for 80 s. Then, the specimens were stored in distilled water at 37°C for 24 h.

Analysis of shear bond strength

The height and diameter of composite cylinders were reconfirmed by digital vernier calliperse (Figure 2). The shear bond strength was measured with a shimadzu universal testing machine (model AG-50 kNG) (Figure 3). A knife edge shearing rod with a crosshead speed of 0.5 mm/min was used (Figure 4). The load at failure was recorded by lab tech notebook software version 6.3. The shear bond strengths of the specimens were calculated and expressed in MPa.

Statistical analysis

The shear bond strength data of the groups was subjected to ANOVA, and then Duncan’s multiple range tests for comparison of specific mean values.

Results

The study results are represented in Table 1.

Discussion

Attractive white teeth have always been typical patient’s prime concern. For the appropriate patient, with careful diagnosis, case selection, treatment planning and attention to technique,

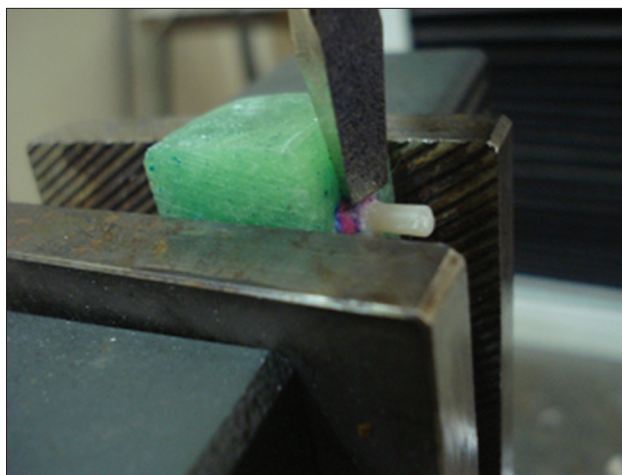


Figure 4: Knife edge shearing rod (0.5 mm) at composite enamel interface.

Table 1: Mean shear bond strength values of composite resin to bleached enamel

Groups	Mean (Mpa)	n	SD	Minimum (Mpa)	Maximum (Mpa)
PC	30.14	10	2.51	26.89	34.40
NC	14.12	10	3.02	11.61	20.52
Group A	25.81	10	2.05	22.63	28.56
Group B	28.71	10	2.16	21.43	28.98
Group C	23.69	10	1.97	19.56	25.11

Mean shear bond strength values in megapascals (MPa). SD: Standard deviation, PC: Positive control, NC: Negative control

bleaching can be the simplest, least invasive and least expensive approach for brighter teeth.⁹

At times, bleaching alone may not fulfill the objective of achieving esthetics in scenarios such as a diastema, malposed teeth, etc., which demands other esthetic procedures such as composite restorations, veneers, laminate, lumineers, etc. Furthermore, prerestorative bleaching facilitates the use of lighter restorations with decreased amounts of opacifier within the composite or porcelain veneer, thus allowing for a more natural translucent appearance. It can modify individual shade discrepancies and allows minimal tooth preparation for composites, in situations such as, recontouring of canines to occupy the position of lateral incisors, diastema closures etc.

Long-term clinical success of bonded restorations relies on adequate adhesion to tooth structure. Any factor compromising adhesion can affect esthetics and longevity of a bonded restoration.¹

Reports in the literature suggested that bleaching with peroxides reduces enamel adhesion strengths. It is a concern in esthetic dentistry and orthodontics, since previous studies suggested to wait from 1 day to 3 weeks to proceed with an adhesive procedure.^{7,8}

Such waiting period may not be feasible in cases of immediate esthetic requirements. Considering this, various studies were undertaken to regain the reduced bond strength values and hence that immediate esthetic corrections by using adhesive technology could be carried out.

Among all the methods, the antioxidant treatment using sodium ascorbate has shown immediate improvement in bond strength values to an extent, whereas the other methods showed conflicting results in regaining the bond strength values. In contrast, few studies showed that sodium ascorbate is ineffective in reversing reduced bond strength.

Hence, this study was undertaken to evaluate and compare the shear bond strength of composite resin to bleached enamel using 10% sodium ascorbate, pedicularis extracts^{10,11} and Rosemary leaf extracts.¹²

In the pursuit of identifying the factors that may account for the reduced bond strength after bleaching, it has been proposed most commonly that residual peroxide from bleaching agent inhibited resin polymerization. Some electronic and optical microscopic studies showed that the resin tags in the bleached enamel were sparse, short, poorly defined, structurally incomplete and, in some areas, completely absent.^{13,14} It is supposed that the bonding agent applied on the etched enamel is not completely polymerized, impairing the mechanical retention and decreasing the bond strength. Bubble-like structures and voids were observed inside the adhesive layer,

suggesting that the oxygen released by the hydrogen peroxide is trapped within the adhesive during light-activation.¹⁵

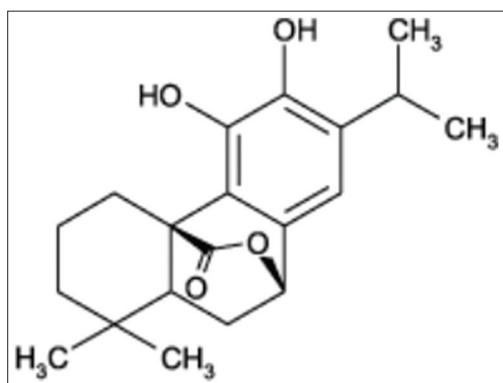
Hence, the present study used antioxidants which have been intended to remove the oxygen trapped inside the dental hard tissues and the potency of the antioxidant was judged how effectively it removed oxygen radicals, thereby completely reversing the compromised bond strength. When traced the chemical structure of the antioxidant, it was found that the antioxidant activity is related to their hydroxyl group and the presence of second hydroxyl group in the ortho or para position is known to increase the antioxidant activity due to additional resonance stability and O-quinone and p-quinone formation.¹⁶

Natural Antioxidants used in the Study

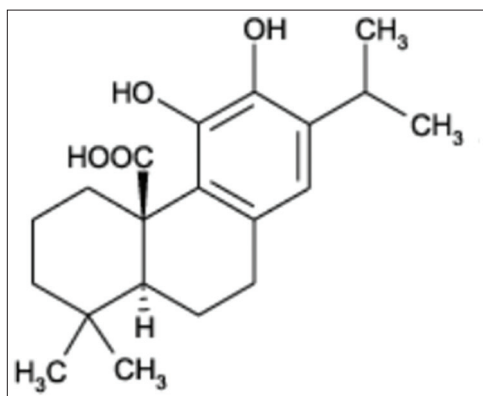
Rosemary extracts

Use of rosemary extracts as antioxidant was first reported by Rac and Ostrich-matijasevic.¹⁷ The principal antioxidative components of the extracts are the phenolic diterpenes carnosol (CAS No 5957-80-2, molecular formula C₂₀H₂₈O₄) and carnosic acid (CAS No 3650-09-7, formula C₂₀H₂₈O₄).^{18,19} Hence, these leaf extracts were used in the present study and these extracts showed more antioxidant activity when compared with synthetic antioxidant sodium ascorbate.

Chemistry of carnosol



Chemistry of carnosic acid

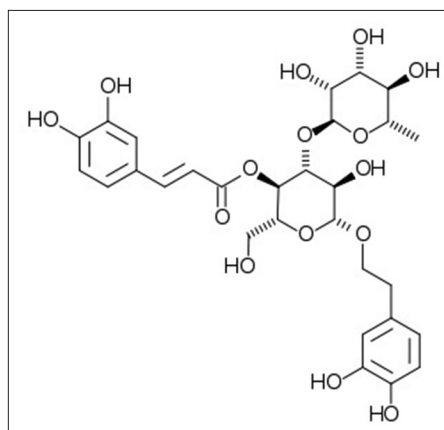


Pedicularis (lousewort) extracts

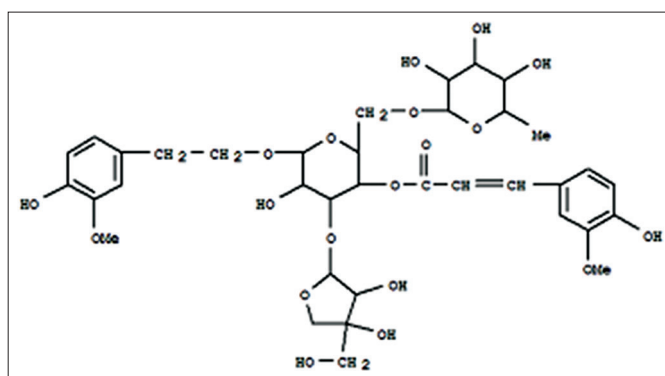
Pedicularis species are traditionally used in India for some clinical disorders such as cold, cough and fever.²⁰ Since these traditional applications can be attributed in part to the antimicrobial and antioxidant activity of the plant, in this study we intended to evaluate experimentally the *in vitro* antioxidant effects of pedicularis extracts on bleached enamel.

The scavenging effects of the phenylpropanoid glycosides possessing two o-dihydroxyl groups were stronger. The antioxidant activity of pedicularis is attributed to the presence of phenylpropanoid glycosides such as verbascoside and pedicularioside A.^{10,11} In spite of its orthohydroxyl groups in phenylpropanoid glycosides the extract was not that much effective in a reversal of bond strength, that could be attributed to the purity of extracts that were used in the present study.

Chemistry of verbascoside



Chemistry of pedicularioside A



Conclusion

The present study showed that rosemary leaf extracts and sodium ascorbate were effective in reversal of bond strength but pedicularis extract was not much effective in reversal of bonding strength.

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