Effect of different concentrations of carbamide peroxide and green tea extract on the color and shear bond strength of enamel – an in vitro study


1Professor and HOD, PMNM Dental College and Hospital, Bagalkot, Karnataka. 2PG Student. 3Professor and HOD, 4Reader, 5Senior Lecturer, Sri Sai College of Dental Surgery, Vikarabad, Telangana.

Corresponding Author:
E-mail: patildjayaprakash@gmail.com

Abstract:
Aim: The aim of this in vitro study is to evaluate the change in color and shear bond strength of enamel bleached with different concentrations of carbamide peroxide and green tea extract solution.

Materials and Methods: The specimens are grouped as follows: Group – A: 16 % carbamide peroxide, Group – B: 16% carbamide peroxide & green tea extract, Group – C: 21% carbamide peroxide, Group – D: 21% carbamide peroxide & green tea extract. Specimens are tagged and colors are recorded using Vita classic shade guide. Two concentrations of carbamide peroxide gels are applied onto the enamel fragments of extracted human teeth of respective groups. Green tea extract, an antioxidant is later applied on bleached specimens of group B and group D. These specimens are then stored in artificial saliva for 24 hrs. Surfaces of all the specimens are examined for color using shade guide followed by shear bond strength test.

Results: At the end of the whitening process, no change was seen in the value of the shade before and after treatment with carbamide peroxide gel and green tea extract, but a significant difference in the shade was seen in group D after the application of carbamide peroxide gel and green tea extract. The ANOVA did not show differences in shear bond strengths with the various treatment agents. No statistically significant difference was seen between all the four treatment groups, but the groups B and D in which antioxidant was used, showed slightly higher bond strength when compared to groups A and group C.

Conclusion: Within the limitations of this study, though increase in the concentration of carbamide peroxide improves the lightening of enamel surface, it affects the bond strength of the specimens bonded immediately with the adhesive resin.

Key words: Carbamide peroxide, Green Tea extract, Enamel, Color, Shear bond strength.

Introduction
Nowadays people are looking for an esthetically pleasing smile. In order to obtain such a smile, dental bleaching is a very useful and non invasive treatment modality. Currently, there are two main whitening techniques: in-office (professional) and at-home bleaching. When performed correctly, both techniques are efficient and safe.1

The at-home bleaching technique for teeth with vital pulp has been used for many decades, however, it was only in 1989 that Haywood and Heyman presented the whitening method with 10% carbamide peroxide gel. The at-home technique has the advantages of self- administration by the patient, less in-office time, high safety, low adverse effects and low cost. 

It is known that bleaching is based on a complex oxidation reaction in which oxygen-free radicals, due to their low molecular weight, infiltrate through the enamel and dentin substrates. During the whitening process, the agents can cause morphologic alteration of mineralized dental structures. In enamel, the alterations are caused by calcium and phosphate loss and the modification that occurs in surface crystals.2

Variety of antioxidant agents, such as 10% sodium ascorbate, catalase, peroxidase, glutathione, sodium bicarbonate, and grape seed extract were used to help in immediate bonding. Green tea is made from the Camellia sinensis plant and contains mainly flavanols or catechins, such as epigallocatechin gallate (EGCG), epigallocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC). Green tea catechins have been shown to possess potent antioxidant activity several times higher than that of vitamin C and vitamin E.2

Hence the aim of this in vitro study is to evaluate the change in color and shear bond strength of enamel bleached with different concentrations of carbamide peroxide and green tea extract combinations.

Materials and Methods

Bleaching Procedure:
Twenty maxillary lateral incisor teeth were taken for the study. The roots of the teeth were embedded in self cure acrylic resin block till the cemento-enamel junction, keeping only the coronal portion exposed.

The specimens were randomly grouped as follows:
GROUP A: 16% carbamide peroxide gel  
GROUP B: 16% carbamide peroxide gel & green tea extract  
GROUP C: 21% carbamide peroxide gel  
GROUP D: 21% carbamide peroxide gel & green tea extract.

Firstly all the teeth were tagged as A1-A5, B1-B5, C1-C5, D1-D5 and the baseline shades were recorded using a VITA classic shade guide. Then, the carbamide peroxide gel of respective concentration was applied to the enamel fragments of the teeth of the respective groups according to the manufacturer’s instructions.

Two concentrations of carbamide peroxide gel were used: (Figure 1)  
a) 16% carbamide peroxide gel (POLA NIGHT)  
b) 21% carbamide peroxide gel (D-Tech EZ-WHITE).

Preparation of green tea extract:  
3gm of organic pure green tea extract in the form of powder was added to 100ml of distilled water and stirred for 1 minute and then the solution was filtered. (Figure 2) Later the prepared green tea solution was applied to the specimens of GROUP B and GROUP D and then washed off with distilled water after 1 hour.

All the samples were stored in artificial saliva for a period of 24hrs. After rehydration a new shade assessment was made using Vita classic shade guide in natural light against a black background.

Shear bond strength test:  
In groups A and C, the samples were etched with 37% phosphoric acid and light cure composite resin (Filtek Z350) was bonded using an adhesive system according to the manufacturer’s instructions and light cured after finishing bleaching protocol whereas in groups B and D the same procedure was followed after the specimens were washed of green tea extract solution.

Testing procedure:  
Each specimen was loaded in an universal testing machine for shear bond strength testing. The long axis of the specimen was kept perpendicular to the direction of the applied forces. The knife edge was loaded at the interface between the composite and the enamel surface. The shear bond strength was measured in shear mode at a crosshead speed of 1 mm/min until fracture occurred. (Figure 3)

Results  
All the analysis was done using SPSS version 14. A p-value of <0.05 was considered statistically significant. Comparison of mean values was done using ANOVA with post-hoc Tukey’s test.

A summary of results is given in Table-1, Table-2, Table-3, Graph-1 and Graph-2.

At the end of the whitening process no statistically significant difference was seen in the shade of the teeth of groups A (1.20±.45, 2.00±1.73), B (3.00±4.47, 1.80±.84) and C (6.40±4.56, 2.80±2.05) between baseline and follow up. However a significant change was seen in the shade from baseline to follow up in group D (1.20±.45, 2.80±1.30) treated with the combination of 21% carbamide peroxide and green tea extract.

The ANOVA did not show differences in shear bond strengths with the various treatment agents. No statistically significant difference was seen between all the four treatment groups, but the group B (313.641±80.971) and group D (329.575±32.451) in which antioxidant was used, showed slightly higher bond strength when compared to group A (250.178±77.299) and group C (257.600±25.901).

Discussion  
Bleaching agents release free radicals as nascent oxygen and hydroxyl (OH-) or perhydroxyl ions when they are applied to the dental structure. A free radical is any molecule with one unpaired electron, imparting high reactivity. These molecules are able to react with the electron rich regions of pigments inside the dental structure, breaking down large pigmented molecules into smaller, less pigmented ones.  

Many of the newer systems contain carbamide peroxide in various concentrations, with carbopol as a thickening agent to improve tissue adherence and allow for time or sustained release of the whitening agent. After the use of bleaching material for 2 to 6 weeks, teeth are usually significantly lighter than before bleaching. The physical alterations that can be seen in enamel after bleaching with carbamide peroxide are increased porosity of enamel which is manifested as over etched appearance with loss of prismatic structure and alterations in the organic substance. An important complication following bleaching procedure is the decrease in bond strength of composite resin to enamel which is due to the presence of oxygen ions which interfere with the resin polymerization. This reduced bond strength can be reversed by the use of various antioxidants such as sodium ascorbate, proanthocyanidin and lycopene.

This in vitro study evaluated the effect of various concentrations of carbamide peroxide on the color and shear bond strength of enamel treated with green tea extract. Green tea catechins have been shown to possess potent antioxidant activity several times higher than that of vitamin C and vitamin E. The strong anti oxidant properties of green tea have been attributed to catechins of epigallocatechin...
Effect of different concentrations of carbamide peroxide and green tea extract on the color and shear bond strength of enamel – an in vitro study

gallate(EGCG) and epigallocatechin(EGC). The catechins can donate hydrogen ions from the hydroxyl groups in their structure, by their free radical scavenging ability.

In this study the teeth became lighter from their original baseline shades after treatment with carbamide peroxide at 16% and 21% concentrations as well as in the groups treated with green tea. This would indicate that, although practitioners cannot expect all patients to experience faster whitening with the higher concentration Carbamide peroxide, some patients probably will obtain faster results. In this study two concentrations of carbamide peroxide were used i.e. 16% and 21% percent along with green tea extract to know whether it can affect the bond strength of enamel.

In a study by Dildeep Kaur et al, it has been reported that following bleaching with 10% carbamide peroxide, there has been an increase of upto 30% of fracture susceptibility of the tooth, failure of bond with resin, decrease in microhardness and pulpal irritation. A study by Vasundhara Shivanna et al stated that carbamide peroxide is unstable and immediately dissociates into constituent parts on contact with tissue, saliva or moisture.

Ten percent carbamide peroxide is the most frequently used concentration for at home bleaching, as described by Haywood and Heymann. In this study, though specimens treated with green tea showed higher bond strengths, there was no statistically significant difference in the shear bond strength between the four treatment groups. The decomposition products of carbamide peroxide i.e. hydrogen peroxide and urea, are obtained after the dissociation of the bleaching agent in contact with saliva and oral fluids. Urea is degraded into ammonia and carbon dioxide.

Another study by Khamverdi Z et al showed that the use of epigallocatechin gallate on tooth structure after bleaching might neutralize the effect of oxygen free radicals retained in tooth structure and improve the bond strength of composite resin to tooth structure.

When esthetic restorations are needed, they should be placed using a bonding technique, however, it is unknown whether immediate bonding of resin after bleaching procedures decreases the bond strength of some of these restorative materials. The residual peroxide and the oxygen have both been claimed as factors that affect the polymerization of the adhesive systems and composite resins. In products with higher concentrations of carbamide peroxide, higher concentrations of hydrogen peroxide are released, possibly providing a reduction of the adhesive system's shear bond strength immediately after bleaching procedures which can be explained by physical and chemical alterations in enamel. Although the roughness of the surface and an increase in porosity caused by the loss of mineral content might eliminate the effects of a decrease in adhesiveness, it is suggested that the quality of the composite bond is compromised through a decreased number of resin tags, owing to the polymerization inhibition taking place and the relative amount of Ca on the enamel surface which affects bonding.

The loss of minerals during bleaching procedures has also been suggested as a possible cause for a decrease in adhesiveness. A delay in bonding procedures should be considered to avoid the problems in enamel bonding procedures that generally follow a bleaching treatment. In this study, groups B & D where specimens were treated with the antioxidant have shown slightly higher bond strength when compared to the other two groups. Green tea, through free radicals, is able to remove the residual oxygen that is contained in the enamel after bleaching, which interferes with resin bonding and inhibits resin polymerization, enabling the adhesive procedure to be performed immediately after bleaching. Thus, this effect may have occurred in the groups treated with green tea, where there was improvement in the values of bond strength.

Conclusion

It can be concluded that though increase in concentration of carbamide peroxide showed improvement in lightening the enamel surface, it effected the bond strength of those specimens when bonded immediately with adhesive resin. Treatment with green tea extract after above bleaching regimen though led to darker specimens, have showed an improvement in immediate shear bond strength with adhesive resin and composite.
Effect of different concentrations of carbamide peroxide and green tea extract on the color and shear bond strength of enamel – an in vitro study

Table 1

<table>
<thead>
<tr>
<th>Sample</th>
<th>Baseline shade</th>
<th>Score</th>
<th>Shade change</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>A1</td>
<td>2</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>A3</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>A4</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>A5</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>B1</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>B2</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>B4</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>B5</td>
<td>B3</td>
<td>11</td>
<td>B2</td>
<td>3</td>
</tr>
<tr>
<td>C1</td>
<td>B1</td>
<td>1</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>B3</td>
<td>11</td>
<td>A2</td>
<td>5</td>
</tr>
<tr>
<td>C3</td>
<td>A3</td>
<td>9</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>C4</td>
<td>A3</td>
<td>9</td>
<td>A2</td>
<td>5</td>
</tr>
<tr>
<td>C5</td>
<td>A1</td>
<td>2</td>
<td>B1</td>
<td>1</td>
</tr>
<tr>
<td>D1</td>
<td>A1</td>
<td>2</td>
<td>B2</td>
<td>3</td>
</tr>
<tr>
<td>D2</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>D3</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>D4</td>
<td>B1</td>
<td>1</td>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>D5</td>
<td>B1</td>
<td>1</td>
<td>A2</td>
<td>5</td>
</tr>
</tbody>
</table>

Shade assessment

Table 3

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>A</td>
<td>1.20</td>
<td>.45</td>
<td>2.00</td>
</tr>
<tr>
<td>B</td>
<td>3.00</td>
<td>4.47</td>
<td>1.80</td>
</tr>
<tr>
<td>C</td>
<td>6.40</td>
<td>4.56</td>
<td>2.80</td>
</tr>
<tr>
<td>D</td>
<td>1.20</td>
<td>.45</td>
<td>2.80</td>
</tr>
</tbody>
</table>

Wilcoxon Signed Rank Test to compare inter-group mean shade change values

Table 4

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>250.178</td>
<td>77.299</td>
<td>313.641</td>
<td>80.971</td>
<td>257.600</td>
</tr>
<tr>
<td>SBS</td>
<td>250.178</td>
<td>77.299</td>
<td>313.641</td>
<td>80.971</td>
<td>257.600</td>
</tr>
</tbody>
</table>

ANOVA with post-hoc Tukey’s test was done to compare inter-group mean shear bond strength values
Effect of different concentrations of carbamide peroxide and green tea extract on the color and shear bond strength of enamel – an in vitro study

Chart 1

Chart 1:

Baseline
Follow-up

Chart 2

Chart 2:

Figure 1
Effect of different concentrations of carbamide peroxide and green tea extract on the color and shear bond strength of enamel – an in vitro study

Materials used in the study

Specimen loaded in the Universal Testing Machine

References:


