A Comparison of the Effect of Application of Sodium Ascorbate and Amla (Indian Gooseberry) Extract on the Bond Strength of Brackets Bonded to Bleached Human Enamel: An In vitro Study

Abstract

Introduction: Whitening of teeth is a popular choice among dental clinicians and patients. However, the changes in enamel structure and composition induced by the bleaching agents cause a decrease in the shear bond strength of brackets leading to premature bracket debonding. Among several methods to overcome this, the most common is delaying bonding by 2–4 weeks. This waiting period can be eliminated by applying an antioxidant (sodium ascorbate) which causes a reversal in the reduction of bond strength. Aim: This study aims to compare the efficacy of a naturally occurring antioxidant (gooseberry) and sodium ascorbate in normalizing the bond strength of enamel to prebleached levels. Materials and Methods: Seventy-two extracted premolars were divided into 4 equal groups; 1st group - control group - unbleached teeth, bonded directly, 2nd group – bleached with 16% carbamide peroxide (8 h for 1 week), then bonded. 3rd and 4th group – similarly bleached, followed by application of 10% sodium ascorbate and gooseberry extract (3 h respectively), then bonded. Bond strength was checked using Instron Universal Testing Machine. Results: The bond strength of the control group was the highest and that of the carbamide group was drastically reduced. Considerable increase in the bond strength was seen after treatment with sodium ascorbate with negligible difference between sodium ascorbate and control group (P > 0.05). Conclusion: Treatment with gooseberry extract did improve the bond strength but was not as effective as sodium ascorbate postbleaching.

Keywords: Antioxidants, bleaching, gooseberry, shear bond strength, sodium ascorbate

Introduction

Today, with an increased focus on dental esthetics, teeth whitening and bleaching have become the most requested procedure in cosmetic dentistry. However, in the realm of esthetics, there are certain conditions where tooth color is not the sole concern of the patient such as diastema, malpositioned teeth, spacing, rotations, crowding, and other mild irregularities. The patient will require orthodontic treatment or restorative procedures after bleaching to achieve the esthetics that he/she desires.[1-3]

However, the changes in enamel structure and composition induced by these bleaching agents may reduce the shear bond strength (SBS) of orthodontic brackets which can result in premature debonding and compromised treatment.[4]

Recently, it has been shown that reduced enamel-orthodontic bracket bond strength following bleaching is reversed with the use of sodium ascorbate as an antioxidant.[5] Certain naturally occurring antioxidants such as pine bark extract,[6] grape seed extract,[7,9] and rosemary extract[2] have also shown to have a similar effect.

This study aims to find out whether a more easily available naturally occurring substance like Indian gooseberry (amla-phyllanthus embelicus) which is a potent antioxidant[10] can have the same effect of reversing the reduction in bond strength caused by bleaching. Furthermore, in this study, a comparison will be made between a synthetic antioxidant, i.e., sodium ascorbate and a naturally occurring antioxidant like amla (gooseberry) in their efficacy in increasing the bond strength of orthodontic brackets to bleached human teeth.

Materials and Methods

This was an experimental in vitro study cleared by the institutional ethical review board. For reprints contact: reprints@medknow.com

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board (Ref No: MCODS/198/2013). Total sample of 72 noncarious, nonhypoplastic premolars extracted for orthodontic purposes were randomly divided into 4 equal groups of 18 teeth each as follows (confidence interval set at 95%):

1. Group 1: Control group in which the teeth were not bleached and the brackets were directly bonded to the unbleached enamel [Figure 1]

2. Group 2: The teeth were bleached with 16% carbamide peroxide (Prevest DenPro Ltd) after which the brackets were bonded to the enamel

3. Group 3: The teeth were bleached with 16% carbamide peroxide after which they were treated with 10% sodium ascorbate (antioxidant) (Loba Chemie Lab Reagents and Chemicals) after which the brackets were bonded to the enamel

4. Group 4: The teeth were bleached with 16% carbamide peroxide after which they were treated with amla (gooseberry) extract (naturally occurring antioxidant) (Wintrust Pharmaceutical Company Ltd) and then the brackets were bonded to the enamel.

Before beginning the study, all teeth were cleaned with oil-free and fluoride-free pumice and water and polished with a brush on a slow speed handpiece.

The teeth of Group 2, 3, and 4 were then arranged on the acrylic trays in order to be bleached. The bleaching agent used was 24 Karat (16%) carbamide peroxide gel (Prevest DenPro Ltd.). A small amount of this bleaching gel was dispensed on the buccal surface of each tooth and spread evenly to cover the entire buccal surface [Figure 2]. The bleaching gel was applied and kept for 8 h daily. Then, all the teeth were cleaned and stored in distilled water. This procedure was carried out every day for 1 week.

Once the bleaching process was over, the teeth of Groups 3 and 4 were treated with their respective antioxidants. Group 3 specimens were treated with 10% solution of sodium ascorbate by keeping the teeth immersed in the solution for 3 h for 1 day. Group 4 specimens were treated with a solution of amla (gooseberry) extract (WinTrust pharmaceutical company Ltd). The extract was poured into the acrylic tray and the teeth were kept immersed in it for 3 h for 1 day [Figure 3]. Once the antioxidant treatment was done, the Group 3 and Group 4 specimens were cleaned and washed with distilled water.

Meanwhile, the Group 1 and Group 2 specimens were bonded with orthodontic brackets. The buccal surfaces of these teeth were etched using 37% phosphoric acid etchant for 15 s. The etchant was then washed off with water for 10 s, and the tooth surface was air dried until a frosty white appearance was noted. A small quantity of primer was then applied to the tooth surface. Orthodontic brackets (Ormco premolar brackets of 022 slot size and MBT prescription) were then bonded to the tooth surface using Transbond XT composite material. Similarly, once the antioxidant treatment of Group 3 and Group 4 specimens was finished, they too were bonded using the method described above. Once all the teeth were bonded, their SBS was tested using the Universal Testing Machine (Instron 3366 k6571, Instron European Headquarters, Bucks, England). The crosshead speed was kept at 1 mm/min.[11] A computer, electronically connected to the Instron Universal Testing Machine, recorded the results of each test. The total duration of the study was approximately 2 weeks.

Results

The test results obtained from the Blue hill software of the Instron Universal testing machine were statistically analyzed using Statistical Package for Social Sciences (SPSS version 13, SPSS Inc., Chicago, IL ,USA). Independent *t*-test was performed to evaluate the comparison between
the control and the study groups. The mean bond strengths of the various groups have been summarized in Table 1. The mean for Group 1 (unbleached) was 13.18 Mpa whereas the mean for Group 2 (bleached sample without antioxidant treatment) was 8.18 Mpa with \( P > 0.001 \). The comparisons of the various groups have been summarized in Table 2 which shows that there is a significant difference between Group 2 and 4 with \( P > 0.001 \), but there was no statistically significant difference between unbleached group (13.18 gp1) and group bleached followed by treatment with sodium ascorbate (12.88 gp3) with \( P > 0.001 \). The mean bond strength of Group 3 (sodium ascorbate) was 12.88 Mpa and Group 4 (amla) was 11.73 Mpa showed a significant difference with \( P > 0.001 \).

### Discussion

Vital tooth bleaching is a well-tolerated, completely safe, and well-accepted procedure for the removal of surface as well as extrinsic stains of the teeth. The most commonly used method for vital tooth bleaching is home bleaching which was originally proposed by Haywood and Heymann in 1989.\(^{[12]}\) The main active ingredient in all whitening systems is hydrogen peroxide.\(^{[4]}\) Literature reveals that when bleaching of teeth is done before application of resin-bonded fixed appliances, the bond strength of teeth is significantly reduced.\(^{[13-15]}\) The most commonly suggested method to regain bond strength is to delay the bonding procedure after the last bleaching session for a period of 2 days to 4 weeks to allow the bond strength to return to normal.\(^{[4,5]}\) The primary aim of this study was to check if the application of antioxidants have an effect on restoring the bond strength of the bleached teeth done using chemical (e.g., sodium ascorbate) and natural (gooseberry/ amla extract) sources.

The bleaching agent used in this study was 16% carbamide peroxide gel which is the most commonly used bleaching agent at home bleaching. During the bleaching process, carbamide peroxide reacts with water to release hydrogen peroxide, which further breaks down into water and nascent oxygen.\(^{[16]}\) It has been established that on treating an enamel surface with a bleaching agent, significant amount of reduction in the bond strength is seen in case of resin-based adhesives. A scanning electron microscopy study was done by Titey et al. in 1991 which showed that in unbleached enamel, the resin tags could be clearly seen penetrating the enamel whereas it was very few resin tags penetrating the bleached enamel with reduced depth of penetration of the tags.\(^{[13]}\) Potocnik et al. studied the effect of carbamide peroxide bleaching gel and showed that the bleached enamel had eroded prism cores and striae of Retzius which were changes similar to the structural changes caused due to caries. The concentrations of calcium and phosphorous were lowered in bleached enamel which confirmed the demineralizing effect of the bleaching gel.\(^{[17]}\) This reduces the surface energy of the enamel leading to reduced bond strength.\(^{[18]}\) It was also postulated that there are alterations that occur in the organic matrix of the enamel that lead to a reduced resin bond strength. Furthermore, the residual oxygen released from the bleaching agent could interfere with the resin infiltration into the bleached enamel and inhibit resin polymerization.\(^{[4]}\) Furthermore, for the bonding procedure, when the bleached enamel was etched, the usual keyhole appearance was not seen, rather an overetched appearance with loss of prismatic structure was observed. Numerous voids and bubble-like structures were seen inside the adhesive layer which suggested that the oxygen released by the decomposition of hydrogen peroxide was trapped within the adhesive during light activation.\(^{[2,3,19]}\) These findings are in concurrence with the results obtained in this study where there was a significant reduction in bond strength of the teeth postbleaching.

Ascorbic acid and its compounds are derivatives of Vitamin C and are well-known antioxidants. They have been shown to have the ability to quench the reactive free radicals in biological systems.\(^{[6]}\) Lai et al. hypothesized that application of an antioxidant may inhibit the incorporation process of the peroxide ions itself, thereby limiting the structural aberrations. The antioxidant (sodium ascorbate) restores the altered redox potential of the oxidized bonding substrate thereby reversing the compromised bonding. Thus, the main purpose of antioxidant treatment of the teeth postbleaching is to eliminate any residual oxygen trapped inside the dental hard tissues, thereby neutralizes the oxidizing effects of the bleaching agent.\(^{[19]}\) Thus, the results obtained in this study are in agreement with these findings as the bond strength of the teeth treated with sodium ascorbate postbleaching was found to be increased significantly.

An attempt was made to find a naturally occurring alternative to sodium ascorbate that will similarly reverse the compromised bond strength postbleaching. Several naturally occurring antioxidants have been used in the past such as rosemary leaf extract, grape seed extract, and pine bark extract. In this study, gooseberry (amla) was

### Table 1: Mean of bond strengths of the different groups

| Group          | Description                          | n  | Mean (MPa) |
|----------------|--------------------------------------|----|------------|
| Group 1        | Control (unbleached)                  | 18 | 13.18      |
| Group 2        | Bleached and without any antioxidant treatment | 18 | 8.18       |
| Group 3        | Bleached and sodium ascorbate treatment | 18 | 12.88      |
| Group 4        | Bleached and amla (gooseberry) treatment | 18 | 11.73      |

### Table 2: Comparison of various groups

| Group compared | \( P \)   | Significance     |
|----------------|----------|------------------|
| Group 1 and 2  | <0.001   | Statistically significant |
| Group 2 and 3  | <0.001   | Statistically significant |
| Group 2 and 4  | <0.001   | Statistically significant |
| Group 1 and 3  | >0.001 (0.317) | Not statistically significant |
| Group 1 and 4  | <0.001   | Statistically significant |
| Group 3 and 4  | 0.001    | Statistically significant |
chosen as in addition to being a potent antioxidant, it is also very easily available and is highly economical. Plus, it is completely safe, nontoxic, and has numerous medicinal properties as it mainly increases the defense of the body against disease due to the high concentration of Vitamin C, tannins, and flavonoids present in it which makes it a strong antioxidant.[20] According to the results obtained in our study, treatment of the bleached teeth with gooseberry did significantly increase their SBS, but it did not match the level of bond strength obtained after treatment with sodium ascorbate. Hence, in the comparison of the efficacy of sodium ascorbate and gooseberry in reversing the compromised bond strength after bleaching, sodium ascorbate proved to be a better alternative.

Conclusion

The SBS of brackets reduced significantly after treatment with 16% carbamide peroxide, and hence, application of certain antioxidants must be done to reverse this reduction, especially if bonding needs to be done immediately. Treatment of the bleached teeth with sodium ascorbate yielded positive results as unbleached enamel even though the SBS did not reach up to the level of the unbleached enamel; the difference between them was not significant. On treating the bleached teeth with gooseberry (amla) extract, the bond strength of the teeth increased but fell significantly short of the unbleached level. Thus, gooseberry (amla), a readily available natural source, was not as effective in reversing the reduction in bond strength as compared to sodium ascorbate. This study proved that if the bleached teeth were treated with 10% sodium ascorbate, bonding of the teeth could be done immediately, and thus, the waiting period could be eliminated.

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Conflicts of interest

There are no conflicts of interest.

References

1. Samorodnitzky-Navéh GR, Geiger SB, Levin L. Patients’ satisfaction with dental esthetics. J Am Dent Assoc 2007;138:805-8.
2. Suneetha R, Pavithra S, Thomas J, Nanga GS, Shromany A, Shivrayan A, et al. 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;6:77-81.
3. Türkün M, Kaya AD. Effect of 10% sodium ascorbate on the shear bond strength of composite resin to bleached bovine enamel. J Oral Rehabil 2004;31:1184-91.
4. Gungor AY, Ozcan E, Alkis H, Turkkahraman H. Effects of different bleaching methods on shear bond strengths of orthodontic brackets. Angle Orthod 2013;83:686-90.
5. Bulut H, Turkun M, Kaya AD. Effect of an antioxidantizing agent on the shear bond strength of brackets bonded to bleached human enamel. Am J Orthod Dentofacial Orthop 2006;129:266-72.
6. Aksakalli S, Ileri Z, Karacan N. Effect of pine bark extract on bond strength of brackets bonded to bleached human tooth enamel. Acta Odontol Scand 2013;71:1555-9.
7. Vidhya S, Srinivasulu S, Sujatha M, Mahalaxmi S. Effect of grape seed extract on the bond strength of bleached enamel. Oper Dent 2011;36:433-8.
8. Abraham S, Gholam WN, Saujanya KP, Jaju N, Tambe VH, Yawalikar PP, et al. Effect of grape seed extracts on bond strength of bleached enamel using fifth and seventh generation bonding agents. J Int Oral Health 2013;5:101-7.
9. Subramonian R, Mathai V, Christaine Angelo JB, Ravi J. Effect of three different antioxidants on the shear bond strength of composite resin to bleached enamel: An in vitro study. J Conserv Dent 2015;18:144-8.
10. Mayachiew P, Devahastin S. Antimicrobial and antioxidant activities of Indian gooseberry and galangal extracts. LWT Food Sci Technol 2008;41:1153-9.
11. Ireland AJ, Sherriff M, McDonald F. Effect of bracket and wire composition on frictional forces. Eur J Orthod 1991;13:322-8.
12. Haywood VB, Heymann HO. Nightguard vital bleaching. Quintessence Int 1989;20:173-6.
13. 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;17:72-5.
14. García-Godoy F, Dodge WW, Donohue M, O’Quinn JA. Composite resin bond strength after enamel bleaching. Oper Dent 1993;18:144-7.
15. Miles PG, Pontier JP, Bahiraei C, Close J. The effect of carbamide peroxide bleach on the tensile bond strength of ceramic brackets: An in vitro study. Am J Orthod Dentofacial Orthop 1994;106:371-5.
16. Güler E, Gönülol N, Özyılmaz ÖY, Yücel AÇ. Effect of sodium ascorbate on the bond strength of silorane and methacrylate composites after vital bleaching. Braz Oral Res 2013;27:299-304.
17. Potocnik I, Kosec L, Gaspersic D. Effect of 10% carbamide peroxide bleaching gel on enamel microhardness, microstructure, and mineral content. J Endod 2000;26:203-6.
18. Kunt GE, Yılmaz N, Sen S, Dede DÖ. Effect of antioxidant treatment on the shear bond strength of composite resin to bleached enamel. Acta Odontol Scand 2011;69:287-91.
19. Lai SC, Tay FR, Cheung GS, Mak YF, Carvalho RM, Wei SH, et al. Reversal of compromised bonding in bleached enamel. J Dent Res 2002;81:477-81.
20. Madhuri S, Govind P, Verma Karuna S. Antioxidant, immunomodulatory and anticancer activities of emblica officinalis: An overview. Int Res J Pharm 2011;2:38-42.