Comparative evaluation of shear bond strength of composite resin to bleached enamel treated with two antioxidants – an Invitro study

Dr. Divyashree D Dandavati[1], Dr. Madhu Pujar[2]
Assistant Professor[1], Professor and Head[2]
Department of Conservative & Endodontics, SDM College of dental sciences, Dharwad[1]
Maratha Mandal's NGH Institute of Dental Sciences, Belgaum[2]

Abstract:
Background and objectives: As there is a saying "The principles of true art is not to portray but to evoke", esthetic dentistry is nothing less than art. Vital bleaching has received widespread arena of possibilities in the field of cosmetic dentistry. In order to avoid waiting period of 1-3 weeks for composite restoration after bleaching, antioxidant application can be done. Grape seed extract (Oligomeric Proanthocyanidin) and green tea extract are beneficial in removing the free radicals, thereby increase the shear bond strength of composite resin. This in-vitro study evaluates bleaching with application of grape seed extract and green tea extract followed by composite build up done immediately and after a delay of 1 week. **Materials and methods:** Sixty maxillary anterior teeth were divided into 3 groups. **Group1(n=20)**Bleaching,no antioxidant treatment.**Group2(n=20)**-Bleaching followed by treatment with 6.5% proanthocyanidin.**Group3(n=20)-**Bleaching followed by treatment with 5% green tea extract. These groups were further divided into subgroups based on composite build up done immediately (subgroupA) or after a delay of 1 week (subgroupB). Shear bond strength of the specimens was tested under universal testing machine. **Statistical analysis**: Data were analysed using One-Sample-Kolmogorov-Smirnov test,One way ANOVA,Tukeys multiple posthoc test. **Results:** The mean bond strength of Group2B_2 was significantly higher(168.7±16.4) which indicated that application of proanthocyanidin showed higher bond strength($P<0.05$). **Conclusion** Within the limitations of this study,it can be concluded that application of antioxidants on bleached enamel reversed the compromised bond strength of composite restoration. The application of proanthocyanidin proved superior followed by green tea extract.
Keywords: 1. Antioxidant;2.Proanthocyanidin;3.Green tea extract;4.Shear bond strength;5.Bleached enamel

Introduction:
The aesthetics of anterior teeth is an important consideration in modern dentistry. Introduction to vital bleaching opened up new horizons in aesthetic dentistry. For the discoloured teeth,vital bleachingisconsidered as a safe, popular, conservative, and well-accepted procedure.[1]The procedure involves lightening of the colour of a tooth through the application of a chemical agent which oxidizes the organic pigmentation in the tooth.[4] Hydrogen peroxide and carbamide peroxide have been used effectively for many years to achieve lighter and more desirable tooth color.[5]
However, bleaching treatment has some deleterious effects on the enamel and dentin surface[4]which includedecreased bonding ability, changes in the morphology of the enamel and dentin surface, increased enamel porosity and changes in the enamel and dentin mechanical features, such as fracture toughness which eventually reduces the tooth fracture resistance and strength.[6]
One amongst these is the decreased bond strength of composite resin restorationdoneimmediately after using bleaching agent.[6]This is attributed to the presence of oxygen ions that interfere with the polymerization of composite resin present on bleached enamel. Oxygen is released at a time interval, i.e. from 24 hours to 2-4 weeks; then the resin composite restores its shear bond strength again. Hence, it is recommended to place composite resin after a delay of 1-3 weeks of bleaching treatment.[1]

There are various techniques that are employed to improve the bond strength of resin composites after bleaching process, such as the removal of the superficial surface of tooth, the application of adhesives encompassing organic solutions, alcohol or antioxidant agents on the bleached enamel surface.In order to fulfill patient requirement of aesthetics at the earliest, the application of antioxidants to the bleached enamel, has been found to be more effective.[1]It was reported that application of antioxidants had beneficial effects on bond strength of resin composite restoration to the bleached enamel by its activity of scavenging of free radicals. Several studies have proposed the use of antioxidant agents such as Grape seed extract that contains 98% oligomeric proanthocyanidin (OPCs) [1]which is obtained from natural sources such as grape seed extract, cocoa beans, pine bark extract, cranberries, lemon tree bark, and hazelnut tree leaves. The other natural antioxidant is the green tea extract whose activity is related to flavanols.Theseare two natural antioxidants which are found to be effective on bleached enamel.[4]

Immediate application of antioxidant on bleached enamel has been reported to be effective in reversing the compromised bond strength of resin. And as per the literature, composite restoration is done 1-3 weeks post bleaching.
In this study the effectiveness of grape seed extract and green tea extract on shear bond strength of composite resin to bleached enamel immediately and post 1 week antioxidant treatment was evaluated.

Figure 1- Sample with composite build up

Materials and Methods:
Sixty freshly extracted human permanent maxillary anterior teeth were obtained from the Department of Oral and Maxillofacial Surgery.The teeth were cleaned, rinsed with water, and stored in saline.

Specimen Preparation
The roots of teeth were embedded in self-cure acrylic resin (DPI-RR Cold Cure) block till cementoenamel junction. Labial surfaces were flattened with 600-grit silicon carbide paper. The samples were divided into three major groups (1, 2, 3) of 20 teeth each then further divided into subgroups (A_1, B_1, A_2, B_2, A_3, B_3) of 10 teeth each. Before application of bleaching agent, it was activated according to manufacturer's instructions. Each tooth was treated with 40% hydrogen peroxide for 40 minutes (Two applications for 20 minutes each) according to manufacturer's instructions and then rinsed off with water. Then composite build up was done in incremental technique (1mm) with the use of Teflon mold of height of 2mm and diameter of 2mm was cured for 40 seconds. After the composite build up was completed, all the specimens were stored in distilled water at room temperature for 24 hours.Shear bond strength was measured using universal testing machine.

Preparation of Antioxiant Solutions:

1. About 6.5g of grape seed extract powder (Parshwa enterprises) was collected and dissolved in 100ml of distilled water to obtain 6.5% proanthocyanidin solution.
2. 5g of green tea extract powder (Nutrislim) was dissolved in 100ml of distilled water to obtain 5% green tea extract solution.

Evaluation of Shear Bond Strength:
The specimens were then mounted on the Universal testing machine for the evaluation of shear bond strength. The knife edge of indent of universal testing machine was loaded at the interface between the composite and enamel surface. The bond strength was measured at a crosshead speed of 0.5 mm/min until fracture occurs. The bond strength of all groups were recorded in Newton (N) and converted into megapascal (MPa) using formula shear bond strength (Mpa) = F (N)/πr^2 .

Statistical Analysis: Data were analysed using One-Sample-Kolmogorov-Smirnov test,One way ANOVA,Tukeys multiple posthoc test.P < 0.05 was considered as statistically significant.

Figure 2- sample testing with universal testing machine

Results
As shown in Table 1 there was a stastical difference between groups with p <0.05. The mean bond strength of Group $2A_2$i.e. bleached with application of grape seed extractimmediately (143.42± 19.8) was higher than other experimental groups. As shown in Table 2 the bond strength of Group $2B_2$ i.e. bleached with application ofgrape seed extract after a delay of 1 week was(168.73 ±16.42) which was highest among all the groups and mean shear bond strength value of control group $1A_1$i.e., bleaching without antioxidant immediately was least (35.90 ±5.7)There was a statistically significant difference present among groups (p< 0.05).

Table 1: Mean shear bond strength comparisons of three groups (Immediately)

Groups	Interval	N	Minimum	Maximum	Mean	Std. Deviation	Std. Error	95% confidence for mean	
								Lower bound	Upper bound
no antioxidant	SBS(Mpa) immediately (Group $1A_1$)	10	30.50	46.90	35.9020	5.70174	1.80305	31.82	39.98
grape seed	SBS(Mpa) immediately (Group $2A_2$)	10	121.80	181.97	143.4210	19.80604	6.26322	129.25	157.58
green tea	SBS(Mpa) immediately (Group $3A_3$)	10	64.80	95.40	80.0810	10.10339	3.19497	72.85	87.3

Table 2: Mean shear bond strength comparisons of three groups (After A week)

Groups	Interval	N	Minimum	Maximum	Mean	Std. Deviation	Std. Error	95% confidence for mean	
								Lower bound	Upper bound
No antioxidant	SBS(Mpa) (Group $1B_1$) after a week	10	42.30	57.80	49.2490	5.55511	1.75668	45.27	53.22
Grape seed	SBS(Mpa) (Group $2B_2$) after a week	10	142.90	192.34	168.7370	16.42469	5.19394	156.98	180.48
Green tea	SBS(Mpa) (Group $3B_3$) after a week	10	87.90	110.34	100.9680	9.00344	2.84714	94.52	107.4

Discussion

Dentists have been perplexed with the difficulties of tooth discolouration over past 200 years. Various methods were introduced to overcome these problems. Although many methods were tried, the results were unpredictable and unsuccessful. Through the introduction of vital bleaching new horizons opened up in this aspect.[34] Vital bleaching is considered to be the safe, conservative and well accepted treatment modality. The chemical agents used include hydrogen peroxide and carbamide peroxide. These are the oxidants that release free radicals i.e, nascent oxygen and hydroxyl ions when applied over the tooth structure, that are responsible for the bleaching process.[1]

Bleaching acts as a two way sword - with all the benefits that it provides, it also has some deleterious effects on enamel and dentin. The main disadvantage of bleaching that poses a great task to the dentist is the decreased bond strength of composite. The shear bond strength (SBS) of composite resin bonded to the tooth surface decreases dramatically right after bleaching treatment.[17]

Dishman and Covey[36] (1994) evaluated that resin tags were short, sparse, poorly defined, structurally incomplete, or completely absent, when restored with composites immediately after bleaching enamel.[5]

Nair et al suggested that the decreased bond strength of composite resin can be improved by delaying its placement for 1–3 weeks following the bleaching procedure.There are various techniques employed to remove these free radicals such as removing superficial enamel and application of adhesives which contain organic solutions, alcohol, or antioxidants. Application of antioxidants was reported to restore the decline of SBS of composite resin to bleached enamel as it removes the free radicals.[17]

In recent years interest in antioxidants of plant origin has greatly increased. Grape seed extract is an antioxidant that is of plant origin. It contains 98% oligomeric proanthocyanidin complexes (OPCs). Proanthocyanidin is found in sources such as grape seed extract, cocoa beans, pine bark extract, cranberries, lemon tree bark, and hazelnut tree leaves. OPCs possess properties such as antibacterial, antiviral, anticarcinogenic, anti-inflammatory, and anti-allergic. Nair et al in 2018 evaluated that, immediate application of 6.5% grape seed extract showed reversal of bond strength which was superior to other antioxidants used.[1]

In the present study, 6.5% grape seed extract along with another antioxidantgreen tea extract were used in the study.Green tea extract is derived from Camellia sinensis. Green Tea Catechins (GTCs) consists of four major epicatechin (EC) derivatives; EC – 6.4%, epigallocatechin (EGC – 19%), EC gallate (ECG – 13.6%), and EGC gallate (EGCG – 59%).[30]Sharafeddin F et al in 2016 showed that using green tea extract had significant increase in shear bond strength of resin composite to enamel bleached with38% hydrogen peroxide gel but had no significant effects on the SBS of resin composite to enamel bleached with 15% carbamide peroxide gel.[6]

In the present study, the ability of grape seed extract to reverse the shear bond strength of bleached enamel was evaluated which showed significant increase in shear bond strength with composite restoration done after a delay of 1 week, followed by immediate application. This may be because of the increased reduction in free radicals with combined effect of antioxidant after 1 week.

However, green tea extract also showed significant increase in shear bond strength after a delay of 1 week but it was lower than that of grape seed extract.From the study, it can be determined that, grape seed extract and green tea extract are effective in reversing the shear bond of bleached enamel. Grape seed extract is more effective after a delayed application (1 week), more than the immediate application. However, clinical studies are required to bring these antioxidants into practice.

Conclusion

Within the limitations of the present study, it can be concluded that

1. Bleaching with 40% hydrogen peroxide reduced the bond strength of composite to enamel.
2. Antioxidant agents were able to reverse the bond strength of composite resin to bleached enamel immediately and after 1 week.
3. Both the antioxidants(6.5% grape seedextract and 5% green tea extract) reversed the reduced shear bond strengthof composite resin to bleached enamelimmediately and after 1 week.
4. Among the two antioxidants, the use of 6.5% grape seed extract showed significantly greater shear bond strength of composite to bleached enamel than that of 5% greentea extract.

References

1. Nair R, Bandhe S, Ganorkar OK, Saha S, Sial S, Nair A. A comparative evaluation of the three different antioxidant treatments on the bond strength of composite resin to bleached enamel: An in vitro study. Journal of conservative dentistry: JCD. 2019 Jan; 22(1):82.
2. El-Din AN, Miller BH, Griggs JA, Wakefield C. Immediate bonding to bleached enamel. Operative dentistry. 2006 Jan;31(1):106-14.
3. Borges AB, Borges AL, Rocha PI, Rodrigues JR. The influence of bleaching agents on enamel bond strength of a composite resin according to storage time. Journal of Dental Research. 2003 Jun 1:B191-.
4. Vidhya S, Srinivasulu S, Sujatha M, Mahalaxmi S. Effect of grape seed extract on the bond strength of bleached enamel. Operative dentistry. 2011;36(4):433-8.
5. Arumugam MT, Nesamani R, Kittappa K, Sanjeev K, Sekar M. Effect of various antioxidants on the shear bond strength of composite resin to bleached enamel: An in vitro study. Journal of conservative dentistry: JCD. 2014 Jan;17(1):22.
6. Sharafeddin F, Farshad F, Azarian B, Afshari A. Effect of green tea extract as antioxidant on shear bond strength of resin composite to in-office and home-bleached enamel. Journal of dental biomaterials. 2016 Sep;3(3):269.
7. Unlu N, Cobankara FK, Ozer F. Effect of elapsed time following bleaching on the shear bond strength of composite resin to enamel. Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2008 Feb;84(2):363-8.
8. Basting RT, Amaral FL, França FM, Flório FM. Clinical comparative study of the effectiveness of and tooth sensitivity to 10% and 20% carbamide peroxide home-use and 35% and 38% hydrogen peroxide in-office bleaching materials containing desensitizing agents. Operative dentistry. 2012;37(5):464-73.

9. Tezel H, Atalayin C, Erturk O, Karasulu E. Susceptibility of enamel treated with bleaching agents to mineral loss after cariogenic challenge. International journal of dentistry. 2012 Mar 14;2011.
10. Nujella BS, Choudary MT, Reddy SP, Kumar MK, Gopal T. Comparison of shear bond strength of aesthetic restorative materials. Contemporary clinical dentistry. 2012 Jan;3(1):22.
11. Srinivasulu S, Vidhya S, Sujatha M, Mahalaxmi S. Effect of collagen cross-linkers on the shear bond strength of a self-etch adhesive system to deep dentin. Journal of conservative dentistry: JCD. 2013 Mar;16(2):135.
12. Sharafeddin F, Motamedi M, Modiri S. Effect of Immediate Application of Pomegranate Peel, Grape Seed and Green Tea Extracts on Composite Shear Bond Strength of In-Office Bleached Enamel. Research Journal of Biological Sciences. 2013;8(3):83-7.
13. Torres CR, Souza CS, Borges AB, Huhtala MF, Caneppele TM. Influence of concentration and activation on hydrogen peroxide diffusion through dental tissues in vitro. The Scientific World Journal. 2013 Jan 1;2013.
14. Roubickova A, Dudek M, Comba L, Housova D, Bradna P. Effect of postoperative peroxide bleaching on the marginal seal of composite restorations bonded with self-etch adhesives. Operative dentistry. 2013;38(6):644-54.
15. Abraham S, Ghonmode WN, Saujanya KP, Jaju N, Tambe VH, Yawalikar PP. Effect of grape seed extracts on bond strength of bleached enamel using fifth and seventh generation bonding agents. Journal of international oral health: JIOH. 2013 Dec;5(6):101.
16. Sharma P, Nagpal R, Tyagi SP, Singh UP, Manuja N. Adhesion to pulp chamber dentin: Effect of ethanol-wet bonding technique and proanthocyanidins application. Saudi Endodontic Journal. 2015 Jan 1;5(1):38.
17. Sharafeddin F, Farshad F. The effect of aloe vera, pomegranate peel, grape seed extract, green tea, and sodium ascorbate as antioxidants on the shear bond strength of composite resin to home-bleached enamel. Journal of Dentistry. 2015 Dec;16(4):296.