ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 8, Issue – 4, July – 2025, Page No. : 155 - 161

Impact of Bioactive Glass and Epigallocatechin Gallate Remineralisation on Shear Bond Strength of Composite Resin to Enamel – Post Aerated Drink Exposure

[1]Dr.Christline Sneha Crasta, Third Year PG Resident, Department of Conservative Dentistry and Endodontics, Krishnadevaraya College of Dental Sciences & Hospital, Bangalore, Karnataka

[2]Dr. Jayalakshmi K.B, HOD, Department of Conservative Dentistry and Endodontics, Krishnadevaraya College of Dental Sciences & Hospital, Bangalore, Karnataka

[3]Dr.Sujatha Bhat, Professor, Department of Conservative Dentistry and Endodontics, Krishnadevaraya College of Dental Sciences & Hospital, Bangalore, Karnataka

[4]Dr. Subindas, Third Year PG Resident, Department of Conservative Dentistry and Endodontics, Krishnadevaraya College of Dental Sciences & Hospital, Bangalore, Karnataka

Corresponding Author: Dr.Christline Sneha Crasta, Third Year PG Resident, Department of Conservative Dentistry and Endodontics, Krishnadevaraya College of Dental Sciences & Hospital, Bangalore, Karnataka

Citation of this Article: Dr. Christline Sneha Crasta, Dr. Jayalakshmi K.B, Dr.Sujatha Bhat, Dr. Subindas, "Impact of Bioactive Glass and Epigallocatechin Gallate Remineralisation on Shear Bond Strength of Composite Resin to Enamel – Post Aerated Drink Exposure", IJDSIR- July – 2025, Volume – 8, Issue – 4, P. No. 155 – 161.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim and Objective: To evaluate and compare the shear bond strength of composite resin to enamel following remineralization with Bioactive Glass (BAG) and epigallocatechin gallate (EGCG).

Materials and Methods: Thirty extracted human maxillary premolars were selected and randomly divided into two experimental groups and one control group (n = 10 per group). All samples were demineralized by immersion in a carbonated soft drink for 5 minutes twice daily for 7 days. Group I served as the control and received no remineralization treatment. Group II underwent remineralization with Bioactive Glass, while Group III was treated with EGCG. All specimens were stored in artificial saliva. After the remineralization phase, the labial surfaces of the teeth were etched with phosphoric acid, bonded with adhesive, and restored with composite resin using a Teflon mold (4 mm diameter × 3 mm height). The shear bond strength was then tested using a universal testing machine.

Results: Multiple comparisons of mean differences between groups showed that Group II (Bioactive Glass) demonstrated the highest mean shear bond strength, followed by Group I (control) and Group III (green tea), which showed the lowest bond strength.

Conclusion: Bioactive Glass (BAG) can be considered an effective remineralizing agent for erosive enamel lesions, as it significantly increased the shear bond strength of composite resin restorations in this study. Although the remineralization potential of green tea extract (EGCG) is well recognized, the present findings suggest it may have a detrimental effect on bond strength when used alone. Therefore, adjusting the etching time or modifying the application protocol may be necessary when using EGCG to optimize adhesion to eroded enamel.

Keywords: Erosion, remineralization, shear bond strength, bioactive glass, EGCG, herbal remineralization.

Introduction

Tooth enamel is an epithelium-derived mineralized structure composed primarily of hydroxyapatite crystals[1]. Enamel loss may occur due to dental caries, tooth wear, or trauma[2]. Saliva acts as a natural remineralizing agent, as it contains calcium and phosphate ions, buffering agents, and fluoride, which together promote the early remineralization of incipient carious lesions[3]. Remineralization is the process by which calcium and phosphate ions from an external source are deposited into demineralized enamel, resulting in a net mineral gain [4]. Acidic beverages are a major cause of tooth demineralization, alongside dental caries, and can lead to dental erosion. Dental erosion is defined as the loss of dental hard tissues through chemical processes that do not involve cariogenic bacteria [5].

The goal of remineralization is to restore mineral ions to demineralized enamel, rebuilding the hydroxyapatite crystal lattice[6]. Various strategies for tooth remineralization have been developed and continue to evolve. Bioactive Glass (BG) has gained popularity over the last decade as a potent remineralizing agent. Any material capable of forming a hydroxyl-carbonate apatite (HCA)-like layer in a biological environment is classified as bioactive. Bioactive Glass, composed of calcium sodium phosphosilicate, can form an HCA-like layer when in contact with an aqueous medium such as saliva [7].

Recently, naturally occurring plant-based compounds found in vegetables and other food products have gained attention for their health benefits. Plant-derived antimicrobial compounds are being explored as alternatives to chemical agents for preventing dental diseases and controlling dental plaque [8]. Tea (both green and white) contains catechins such as epigallocatechin gallate (EGCG) [9]. In dentistry, tea has demonstrated various benefits due to its high fluoride content, which inhibits caries activity and supports enamel remineralization, contributing to caries prevention and plaque control [10].

The acidic environment created by carbonated beverages or other dietary acids results in enamel erosion due to mineral loss, altering the surface properties of enamel and compromising bond strength [11]. However, limited research exists on the shear bond strength of composite resin restorations following pretreatment with remineralizing agents. Therefore, this in vitro study aimed to evaluate the shear bond strength (SBS) of composite resin to enamel after exposure to an aerated drink, with and without the application of remineralizing agents.

Aim and objectives

- To evaluate the shear bond strength of composite resin on enamel following exposure to an aerated drink with and without application of remineralizing agent.
- To compare the shear bond strength of composite resin following exposure to an aerated drink on enamel following remineralization with bioactive glass and epigallocatechin gallate.

Methodology

The study methodology was divided into the following steps:

A. Sample Preparation

B. Grouping of Samples

C. Demineralization of Enamel

D. Remineralization

E. Composite Resin Restoration

F. Shear Bond Strength (SBS) Testing

Sample Preparation: Thirty extracted human maxillary premolars were collected, cleaned of debris ultrasonically, and polished for 30 seconds using a non-fluoridated, oil-free pumice slurry. The inclusion criteria were intact human maxillary and mandibular premolar teeth extracted for orthodontic purposes. Teeth that were carious, restored, or developmentally malformed were excluded. The samples were thoroughly rinsed with deionized water to remove any residual debris or tissue remnants.

Grouping of Samples

The prepared samples were randomly divided into three groups:

- **Group 1(n = 10):** Control group (no remineralization)
- **Group 2 (n = 10):** Remineralization treatment with Bioactive Glass (BAG)
- **Group 3 (n = 10):** Remineralization treatment with Epigallocatechin Gallate (EGCG)

Demineralization of Enamel: All tooth samples (n = 30) were immersed in 5 ml of Coca-Cola for 5 minutes twice daily for 7 days, once in the morning and once in the evening at the same time each day. After each immersion cycle, the specimens were rinsed with distilled water, gently dried with gauze, and stored in artificial saliva at 37 °C until the next cycle.

Remineralization

Preparation of 10% EGCG: A 10% green tea extract solution was prepared by dissolving 10 g of NutriJa Green Tea Extract powder in 100 ml of distilled water.

Remineralisation cycle:

Group 1: Samples received no remineralizing treatment.

Group 2: The buccal surfaces were covered with a thin layer of BAG gel (Prevest DenPro Bioenamel Remineralizing Gel) for 5 minutes twice daily for 7 days, once in the morning and once in the evening at the same times each day.

Group 3: Samples were immersed in 100 ml of 10% EGCG solution for 5 minutes twice daily for 7 days, once in the morning and once in the evening at the same times each day.

After each application, the samples were gently wiped and stored in artificial saliva.

Composite Resin Restoration: After completion of the remineralization cycle, all samples were etched with 37% phosphoric acid gel for 30 seconds, rinsed for 15 seconds, and air-dried for 10 seconds. A bonding agent (3M Single Bond Universal) was applied to the etched surfaces with a disposable microbrush and light-cured for 20 seconds. For composite resin build-up, translucent cylindrical molds (4 mm in diameter and 3 mm in height) were fixed onto the sample surfaces. A light-cured nanohybrid universal composite resin (Filtek Z250, 3M ESPE) was placed into the molds and light-cured for 20 seconds. After removal of the molds, the samples were stored in distilled water at room temperature for 24 hours.

Shear Bond Strength (SBS) Measurement: The shear bond strength was measured using a universal testing machine with a steel parallel blade (1 mm in diameter) at a crosshead speed of 0.5 mm/min, applied at the composite-enamel interface until bond failure occurred. The force required to dislodge each composite cylinder was recorded.

Results

The data obtained was then subjected to Statistical tests. One way ANOVA and Tuckey's post-hoc tests were used. The test results demonstrate that the mean Shear Bond Strength for Group 1 was 15.57 ± 1.01, Group 2 was 19.88 ± 2.03 and Group 3 was 12.95 ± 0.78 as depicted in Table 1. This mean difference in the Shear Bond Strength between 3 groups was statistically significant at $p<0.00$.

Multiple comparison of mean differences between all 3 groups showed that Group 2 exhibited with significantly highest Shear Bond Strength as compared to Group 1 and Group 3 and the mean differences were statistically significant at $p<0.001$ respectively as depicted in Table 2. This was then followed next with Group 1 which showed significantly higher mean Shear Bond Strength as compared to Group 3 and the mean difference was statistically significant at $p=0.001$. This infers that the mean Shear Bond Strength was significantly highest in Group 2, followed by Group 1 and least in Group 3

Table 1: Comparison of mean Shear Bond Strength (in Mpa) between 3 groups

Comparison of mean Shear Bond Strength (in Mpa) b/w 3 groups using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	p-value
Group 1(control group)	10	15.57	1.01	14.1	17.2	<0.001*
Group 2 (BAG Group)	10	19.88	2.03	17.4	23.4	
Group 3 (EGCG Group)	10	12.95	0.78	11.7	14.2	

* - Statistically Significant

Figure 1: Mean Shear Bond Strength (in MPa) between 3 groups

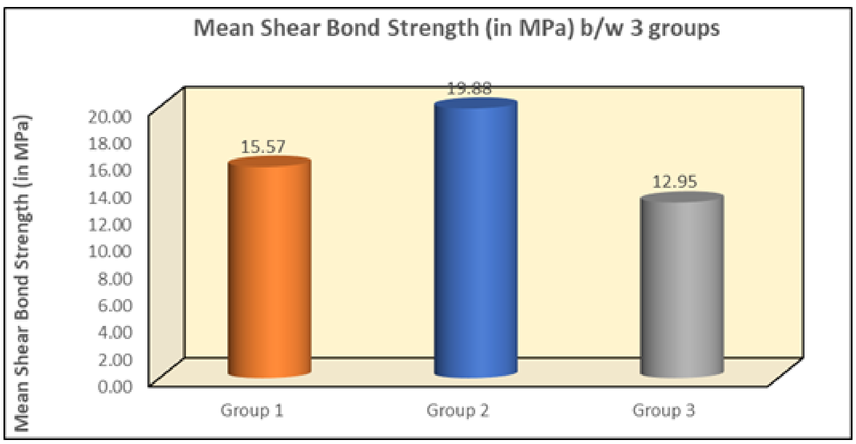
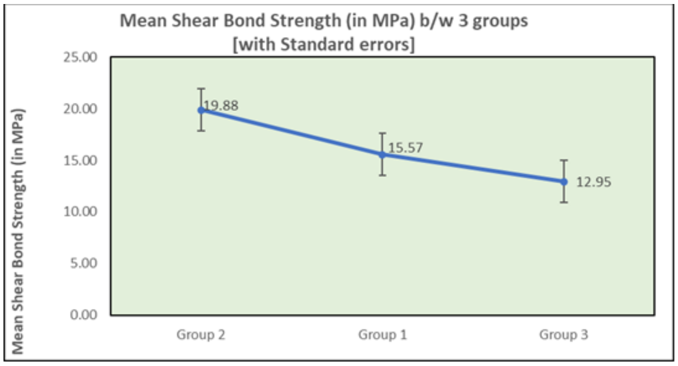


Table 2: Multiple comparison of mean diff. in Shear Bond Strength (in Mpa) between 3 groups

Multiple comparison of mean diff. in Shear Bond Strength (in Mpa) b/w 3 groups using Tukey's Post hoc Test					
			95% CI for the Diff		
(I) Groups	(J) Groups	Mean Diff.(I-J)	Lower	Upper	p-value
Group 1	Group 2	-4.31	-5.84	-2.78	<0.001*
	Group 3	2.63	1.09	4.16	0.001*
Group 2	Group 3	6.94	5.40	8.47	<0.001*

* - Statistically Significant

Graph 1: Mean Shear Bond Strength (in MPa) between 3 groups



Discussion

Lifestyle changes and the increased consumption of soft drinks and acidic foods are well-documented factors contributing to the rising incidence of dental erosion among young individuals. In the present study, a cola drink was used as the erosive agent due to its high erosive potential and low pH [12]. This protocol simulated the clinical scenario of frequent intake of aerated beverages, placing individuals at higher risk for dental erosion.

When enamel is exposed to acidic challenges, mineral loss occurs, leading to initial surface softening [13]. With continued exposure, this softening progresses deeper into the enamel, eventually resulting in substantial enamel loss. This may occur through direct chemical dissolution or by mechanical wear, such as tooth brushing and mastication, which further removes the softened enamel and justifies restorative treatment for such a substrate [14]. However, studies show that the bond strength of composite resin to eroded enamel surfaces is low, compromising retention and longevity [15]. Therefore, pretreatment with remineralizing agents has been suggested to enhance bond strength [16]. In this study, Bioactive Glass (BAG) and epigallocatechin gallate (EGCG) from green tea extract were used for this purpose.

The results demonstrated that pretreatment with BAG significantly increased the shear bond strength of composite resin, consistent with findings by Mona et al. [17]. This effect can be attributed to the formation of an octacalcium phosphate (OCP) phase, which acts as a precursor for hydroxyapatite formation [18]. OCP is valued for its remineralization potential as it can incorporate fluoride, promoting transformation to apatite and the formation of an acid-resistant fluoridated apatite layer.

Conversely, pretreatment with 10% EGCG showed lower shear bond strength compared to BAG, which may be explained by its lower pH [19]. Additionally, in this study, samples were exposed to EGCG at 37 °C. However, in practice, green tea is often consumed at higher temperatures (near 50 °C), which may further affect the bonding effectiveness and should be explored in future research [20].

Conclusion

Within the limitations of this study, BAG showed improved bond strength of composite resin to eroded enamel surfaces compared to EGCG remineralizing agent.

Although remineralization using EGCG (green tea extract) is accepted in literature, results of the present study show detrimental effect on bond strength of composite resin with eroded enamel. Further studies are recommended to explore the effect of different concentrations, application protocols, and intraoral conditions to optimize clinical outcomes.

References

1. Lacruz RS, Habelitz S, Wright JT, Paine ML. Dental Enamel Formation And Implications For Oral Health And Disease. Physiol Rev. 2017 Jul 1;97 (3):939-993. doi: 10.1152/physrev.
2. Abbas Rizvi, Muhammad S. Zafar, Yasser Al- Wasifi, WamiqFareed, ZohaibKhurshid .Role of

enamel deminerlization and remineralization on microtensile bond strength of resin composite. 2016 European Journal of Dentistry.

3. Namrata Patil, Shantanu Choudhari, Sadanand Kulkarni, Saurabh R Joshi. Comparative evaluation of remineralizing potential of three agents on artificially demineralized human enamel: An in vitro study. Journal of Conservative Dentistry | Mar-Apr 2013 | Vol 16 | Issue 2
4. Cochrane NJ, Cai F, Huq NL, Burrow MF, Reynolds EC. Newapproach to enhance remineralization of tooth enamel. J Dent Res2010;89:1187-97.
5. ShashiPrabhaTyagi, ParidhiGarg, Dakshita Joy Sinha, UdaiPratap Singh. An update on remineralizing agents. Journal of Interdisciplinary Dentistry / Sep-Dec 2013 / Vol-3 / Issue-3.
6. Kaur , S., Gupta , S., Mehra, M., Sadana, G., Gupta , T. and Grover , R. (2023) “Remineralization of Tooth: A Literature Review”, Journal of Pharmaceutical Research International, 35(8), pp. 15–22.
7. Farooq I, Ali S, Farooqi FA, AlHumaid J, Binhasan M, Shabib S, Vohra F, Abduljabbar T. Enamel Remineralization Competence of a Novel Fluoride-Incorporated Bioactive Glass Toothpaste-A Surface Micro-Hardness, Profilometric, and Micro-Computed Tomographic Analysis. Tomography. 2021 Nov 9;7(4):752-766.
8. Jawale KD, Kamat SB, Patil JA, Nanjannawar GS, Chopade RV. Grape seed extract: An innovation in remineralization. Journal of conservative dentistry JCD. 2017 Nov;20(6):415
9. Jose P, Sanjeev K, Sekar M. Effect of green and white tea pretreatment on remineralization of demineralized dentin by CPP-ACFP-an invitro microhardness analysis. Journal of clinical and diagnostic research: JCDR. 2016 Apr;10(4):ZC85.
10. Hasan R, Bds A. Effect of Different Tea in Remineralization of Artificially-Induced Initial Enamel Caries of Human Teeth (Study in Vitro) Key words. Tikrit Journal of Dental Sciences. 2011 Jan;1:19-24.
11. Rizvi A, Zafar MS, Al-Wasifi Y, Fareed W, Khurshid Z. Role of enamel deminerlization and remineralization on microtensile bond strength of resin composite. Eur J Dent. 2016 Jul-Sep;10 (3):376-380.
12. de Carvalho Sales-Peres SH, Magalhães AC, de Andrade Moreira Machado MA, Buzalaf MA. Evaluation of the erosive potential of soft drinks. Eur J Dent. 2007 Jan;1(1):10-3.
13. Inchingolo F, Dipalma G, Azzollini D, Trilli I, Carpentiere V, Hazballa D, Bordea IR, Palermo A, Inchingolo AD, Inchingolo AM. Advances in Preventive and Therapeutic Approaches for Dental Erosion: A Systematic Review. Dent J (Basel). 2023 Nov 29;11(12):274.
14. Shellis RP, Featherstone JD, Lussi A. Understanding the chemistry of dentalerosion. Monogr Oral Sci. 2014;25:163–79
15. Hosni et al., “Evaluation Of Shear Bond Strength Of Resin Composite To Enamel Surface Of Permanent Teeth Eroded By Two Carbonated Beverages (In Vitro Study)”, Alexandria Dental Journal. (2019) Vol.44 Pages: 96-100.
16. Belmar da Costa M, Delgado AHS, Pinheiro de Melo T, Amorim T, Mano Azul A. Analysis of laboratory adhesion studies in eroded enamel and dentin: a scoping review. Biomater Investig Dent. 2021 Feb 15;8(1):24-38.

17. Mona Aly Abbassy et al, “Fluoride bioactive glass paste improves bond durability and remineralizes tooth structure prior to adhesive restoration”, Dental Materials, Vol 37, 1, January 2021, 71-80.
18. D’Onofrio, A.; Kent, N.W.; Shahdad, S.A.; Hill, R.G. Development of novel strontium containing bioactive glass based calciumphosphate cement. Dent. Mater. 2016, 32, 703–712.
19. Marudam Usha et al, “Evaluation of Effect of Various Teas on Shear Bond Strength of Composite Restorations: An in Vitro Study”, International Journal Dental and Medical Sciences Research , vol 5, Issue 4, July-Aug 2023 305-309.
20. Cagri Ulusoy, Arzu Mujdeci, Osman Gokay. The effect of herbal teas on shear bond strength of orthodontic brackets; European journal of orthodontics;31(2009)385-389.