Influence of Non-thermal Ambient Plasma, Grape Seed Extract, With Bromelain on Quick Composite Bonding to Bleached, And Microabraded Surfaces

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Abstract

Background: Microabrasion changes the enamel surface, lowering the binding strength of composites. Numerous surface treatments were applied on the enamel surface to increase the binding strength of the composites. The purpose of this study was to determine the effect of non-thermal atmospheric plasma (NTAP), grape seed extract (GSE), and bromelain affected the composite/'s shear bond strength (SBS) after bleaching and microabrasion. **Materials and Procedures:** Eighty extracted human maxillary anterior teeth were used in this study. These teeth were distributed into two groups. Groups 1 and 2 were bleaching and microabrasion, accordingly. Tooth whitening methods including bleaching and, and were further separated into four subgroups ($n = 10$) depending on the type of surface treatment used. No surface treatment in Group A, bromelain in Group B, GSE in Group C, and NTAP in Group D. The labial surface was coated with composite resin and placed in artificial saliva for 24 h. All of the samples were submitted to SBS testing. Statistical Analysis: Two-way analysis of variance and *post hoc* Tukey's test were used during the analysis, with P 0.05 regarded statistically significant. The highest bond strength (35.4 Mpa) was found in Group 1D, whereas the least bond strength values were found in Group 1A. (15.7 Mpa). With the exception of Groups 1A and 1B ($P = 0.972$), there had been a significant difference between the bleaching groups. There is also a significant difference between Group 2A and 2D ($P = 0.0001$), Group 2B and 2D ($P = 0.0010$), and Group 2C and 2D ($P = 0.0001$) in the microabrasion group. Conclusions: After bleaching, the SBS of composite resin was significantly improved using NTAP and GSE. The use of NTAP on microabraded surfaces improved composite resin bond strength.

Keywords: Ambient Plasma, Grape Seed Extract, Bromelain

Introduction

Intrinsic enamel flaws like opacities and brown pigmentations can wreak havoc on the hue and translucency of enamel. Various treatment techniques, such as bleaching, microabrasion, veneers, and crowns, are used depending on the severity of the problems.[1] Bleaching, on the other side, remains the most common treatment for intrinsic stains. The bleaching agent progressively reacts with stains within the tooth's superficial layers, lightening the tooth surface.[2] When a composite is bonded immediately to the bleached surface tooth sensitivity, external cervical resorption, and a decrease in composite bond strength are the common side effects of hydrogen peroxide (H_2O_2). These problems can be overcome by delaying bonding for up to 4 weeks after bleaching.[3] Immediate bonding after bleaching procedures is possible by surface treatment of enamel. Various surface treatment procedures have been offered, including superficial tooth reduction, alcohol application before bonding, acetone-based adhesives, and antioxidants such alpha-tocopherol and sodium ascorbate[4] (mention about Surface treatment procedures).

GSE is a natural antioxidant with 98% oligomeric proanthocyanidin complexes (OPCs). OPCs have hydroxyl sites that attach to free radicals and act as electron donors. They remove free radicals trapped in the enamel as a result of H_2O_2 deterioration. The effect of applying these antioxidants to bleached surfaces should be compared to other surface

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treatment.[4] Enamel deproteinization before etching improves the retentive surface of the enamel to 94.47%, according to Espinosa *et al*.[5] Bromelain as well as other deproteinizing enzymes remove supporting collagen, increasing dentin permeability, and boosting monomer diffusion. Bromelain has been shown to decrease nanoleakage after collagen removal.[6]

Plasma has become significantly important in the medical field in recent years. Plasma is the fourth state of matter and is a partially ionized gas. Non-thermal atmospheric plasma (NTAP) is a low-temperature, vacuum-free gas that is generated intentionally.[7] Proteolytic enzymes, antioxidants, and NTAP have now been shown to improve the bond strength of composite resin to the tooth surface in various investigations. However, there is lack of literature that is there on the impact of bromelain and NTAP on the shear bond strength (SBS) of composite to the tooth surface after bleaching.

Microabrasion is a mixture of abrasion and erosion that reduces the surface enamel and leaves a compact, prism-free layer. A highly compacted prism less layer replaces dense mineralized tissue in an organic matrix. As a result, changing the enamel surface affects the bond strength of the composites.[8] According Opinya *et al*.,[9] the binding strength of composites can be improved by removing the compact mineralized layer. Hence, there is a need to study the effect of various surface treatments on microabraded surfaces. The present work aimed to assess the impact of bromelain, GSE, and NTAP on the SBS of composite resin following bleaching and microabrasion.

Materials and Methods

Eighty human maxillary anterior teeth (n = 80), extracted for various causes, were chosen for the study after obtaining ethical clearance from the Institutional Ethics Committee (Pr. 139/IEC/SIBAR/2018). The materials were cleaned carefully and were placed in plastic casts with self-curing acrylic resin until the cementoenamel junction was reached. Pumice slurry has been used to clean the tooth surfaces on the face. The samples were divided into two groups (n = 40 each) depending on the teeth whitening systems.

Group 1 (n = 40): The labial tooth surfaces were dried before using teeth whitening products. The plunger is drawn back to release pressure and extrude the contents into the pot supplied by the manufacturer using a Pola Office syringe (SDI limited, Australia) are taken, contents into the manufacturer's pot. Using an applicator tip for 8 min, a generous amount of this gel is applied to the labial surface. After that, the bleaching gel is rinsed and blotted dry.

Group 2 (n = 40): A fine grit diamond bur with coolant is utilized to partially remove the labial surface superficially to commence micro reduction in the Opalustre (Ultradent, USA) syringe that was fitted with a plastic mac tip provided by the manufacturer. On the labial surface of the tooth, a 1 mm thick layer is applied uniformly. At 400 RPM, a micromotor handpiece with Opal prophy cups was utilized for 2 min on the enamel surface. After that, distilled water has been used to rinse the teeth.

The groups were separated into four categories based on the type of surface treatment used: A, B, C, and D, respectively.

Subgroup A (n = 10): There is no surface treatment (control group).

Subgroup B (n = 10): Washed with distilled water after 10 min in a 5% bromelain solution.

Subgroup C (n = 10): Washed with distilled water after 10 min in a 5% GSE solution.

NTAP was exposed for 15 sec in Subgroup D (n = 10).

Preparation of solutions

5% bromelain solution + proteolytic enzyme -5 gramme bromelain (India: Meteoric Exim Pvt. Ltd.) diluted in 100 ml distilled water 5% GSE solution as an antioxidant - 5 g GSE diluted in 100 mL distilled water (All pure organics, India).

Implementation of non-thermal atmospheric plasma

The plasma jet was created using pressurized He gas with a pulsing head of 2 GHz and a volume of 3.25 standard liters. The NTAP was administered at a pressure of 2 Pascals and a power of 2 Watt. For each sample, the application was performed in an isolated closed chamber at a distance of 5–6 mm from the tooth surface for 15 s, with a 3-s activation and resting period. A thermocouple was used to check the temperature on the tooth surface, which ranged from 27 to 29.4°C and is experienced by pulpal tissues.

The composite was placed immediately after surface treatment in all groups. The labial surfaces of the tooth were coated with self-etch adhesive (Solare Universal Bond, GC, India). A 3 mm diameter and 3 mm height cylindrical plastic matrix were created. The matrix was adhered to the labial surface, and the composite resin (Spectrum, Dentsply, USA) was gradually condensed. After that, it was photopolymerized in both directions for 60 s using a light-emitting diode light-curing device (Orikam Eighteenth Curing Pen, India). Following polymerization, the matrix was carefully removed. After that, the samples were immersed in artificial saliva for 24 h at 37°C. The Universal Testing Machine (UTM) was used to conduct SBS testing on all samples (Instron, Model 8801). At a speed of 1 mm/min, each sample was secured in UTM with the leading edge of the plunger positioned at the interface between composite and labial surface. It was determined how much force was required to remove the composite material. N/mm^2 (peak load value/composite base area) was used to compute the SBS.

Statistical analysis

SPSS software version 20.0 was used to analyze the data (Statistical Package for the Social science, IBM Corp. Ltd., Armonk, NY, USA). The overall significant values of all the groups were determined using a two-way analysis of variance test, while intragroup and intergroup comparisons were done using *post hoc* Tukey's testing with $P < 0.05$ which was considered as statistically significant.

Results

Group 1D had the highest bond strength (35.4 Mpa) of all the groups, whereas Group 1A had the weakest bond strength values (15.7 Mpa). Except for Groups 1A and 1B ($P = 0.972$), there were substantial differences between the bleaching groups [Table 1]. Significant differences were found between Group 2A and 2D ($P = 0.0001$), Group 2B and 2D ($P = 0.0010$), and Group 2C and 2D ($P = 0.0001$) in the microabrasion group [Table 2].

Discussion

The bleaching treatment may have obvious negative impacts on the enamel. A decrease in surface microhardness, as well as morphological and chemical alterations, were among them.[10] When applied immediately after bleaching, these alterations may compromise the bonding of restorations to enamel. Tooth bleaching, according to the research, may lower the binding strength of composites placed to bleached enamel. In bleached enamel, Smith *et al*. stated that in bleached enamel and that there was a significant surface structural alterations. They postulate that fundamental changes are to blame for the bonding strength decline.[11] The link between bleaching agents and alterations in the chemical or morphological structures has been observed in several studies.

The least bond strength was found in the present study when bleaching was followed by immediate bonding of composite resin with no surface modifications. This finding is comparable to that of Nimet *et al*. have found that using 35% H_2O_2 reduced the composite's mean bond strength by half.[13] The decrease in enamel bond strength was most likely caused by physical changes in the tooth structure following bleaching. Cinthia *et al*. and Khamverdi *et al*. both showed a decrease in binding strength.[14,15] This decrease in binding strength could be attributed to bleached teeth having insufficient, tiny, and poorly distinguishable resin tags. According to Titley *et al*., research's the prominence of these resin tags, their frequency, and their depth of penetration affect the bond strength of composite to enamel.[11] Dishman *et al*. found similar short, sparse, structurally defective, or completely absent resin tags in bleached enamel.[16] Torneck *et al*. discovered that once enamel was exposed to HO_2, the adhesive binding strength of composite resin was significantly reduced.[17] The bond failure that occurred at the resin-enamel interface was caused by residual peroxides on the enamel surface. Only the surface enamel (0.5–5 nm) is affected by the remaining H_2O_2 washout.[18] The decreased binding strength could have been caused by leftover free radicals trapped deep within the enamel. There are two strategies to reverse the decreased bond strength. The first is caused by a time-dependent delay in composite implantation, while the second is caused by surface treatments such as alcohol, acetone-based adhesives, and antioxidants applied to bleached enamel.

Bromelain was employed as an experimental surface treatment agent in this investigation. Bromelain is a frequent ingredient in health supplements. Bromelain has a pH ranging from 3 to 6.5. Bromelain components are stable at this pH, and it destroys attached proteins, resulting in stains. According to Aarti *et al*., microleakage increases significantly after 35% H_2O_2 bleaching and is successfully decreased when bleached teeth are treated with bromelain.[19]

However, they used a class V cavity preparation technique on the cervical third of the teeth.

In their investigation, the better results for the bromelain group could be attributed to dentin involvement during cavity preparation, exposing the collagen substrate for the bromelain to act on. Bromelain had no statistical significance in this investigation as compared to the control group. This could be because bromelain affects the protein level of enamel, which is lower.

Vidya *et al*. investigated the usefulness of antioxidants in reversing diminished adhesion to bleached enamel to overcome the failure of instant bonding.[4] Nair antioxidant agents have the capacity to remove free radicals, hence limiting interference with adhesive polymerization, which can increase the binding strength of composites to bleached surfaces, according to Rose *et al*.

Control samples had the weakest binding strength in the microabrasion group. Microabrasion enhances the roughness of the enamel surface and is linked to a decrease in the

Table 1: Comparison of interactions between the four subgroups (A, B, C, and D) with mean shear bond strength using Tukey's multiple *post hoc* test in Group 1

Interactions	Group 1A	Group 1B	Group 1C	Group 1D
Mean	15.7797	18.0378	25.1044	35.4858
SD	2.9608	6.2426	2.9104	5.6864
Group 1A (P)	-	-		
Group 1B (P)	0.9724	-		
Group 1C (P)	0.0024*	0.0466*	-	
Group 1D (P)	0.0002*	0.0002*	0.0005*	-

*Statistically significant, SD: Standard deviation

Table 2: Comparison of interactions between the four subgroups (A, B, C, and D) with mean shear bond strength using Tukey's multiple *post hoc* test in Group 2

Interactions	Group 2A	Group 2B	Group 2C	Group 2D
Mean	18.4272	21.4821	18.5607	31.3465
SD	4.9408	3.7011	4.9607	
Group 2A (P)				
Group 2B (P)	0.8715			
Group 2C (P)	0.9998	0.8953		
Group 2D (P)	0.0002*	0.0011*	0.0002*	

*Statistically significant, SD: Standard deviation microhardness of the enamel. By-products of enamel rod abrasion are formed, which become compacted on the microabraded surface. As a result, the surface is resistant to etching.[8] Because bromelain operates on the protein content, which is lower in enamel, Group 2B exhibited no improvement in mean SBS values. Because no free radicals are produced, even the addition of antioxidants had no effect on bond strength in Group 2C.

Plasma is the fourth state of matter, and it is a highly reactive material made up of charged particles and a strong electric field. Plasma treatment improved the interfacial quality by increasing the hydrophilicity of dental materials on the dentin surface, minimizing interface flaws and voids.[12-21] NTAP treatment to both bleached and microabraded surfaces, that is, Groups 1D and 2D, considerably increased bond strength in the current investigation. This is in line with other studies that show NTAP increases binding strength at the tooth-composite interface by 60%.[22] The bonding at the interface improves the composite resin's resilience, longevity, and performance.[23]

Plasma treatment improves the substrate's wettability and hydrophilicity while also changing its chemical structure by partially exposing and distributing the functional groups. According to Cho *et al*., this leads in enhanced infiltration of the bonding agent into the enamel and increased adhesive bond strength, resulting in bonds that are based on surface chemistry rather than surface porosity.[24] Despite the fact that resin tags do not contribute considerably to bond strength in self-etch adhesives, the improved resin tag generation by NTAP in this study may have contributed to the increase in initial bond strength.[7,21]

NTAP produces chemical changes in enamel, such as decreasing nitrogen and carbon molecules and exposing hydroxyapatite crystals, which improves wettability significantly. Super hydrophilic surfaces are formed when enamel surfaces are subjected to NTAP for only 30 s.[25] To support the current hypothesis, more clinical studies are needed to compare and gather more details about plasma's effects on the organic components of enamel, as well as to analyze the different periods of plasma application and their implications on adhesive properties to bleached and microabraded enamel.

Conclusions

Composite resin application immediately following bleaching and microabrasion showed decreased mean SBS values. Following bleaching, NTAP, and GSE application significantly improved the SBS of composite resin. Following microabrasion, NTAP significantly increased the SBS of composite resin.

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