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Original Article

The effect of surface treatment methods of tooth colored Restorations on shear bond strength

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Abstract

Introduction: Due to undeniable effect of surface treatment on restoration bond strength, this study was conducted to measure and compare the shear bond strength of hybrid ionomer and compomer using the three different methods of surface conditioning.

Methods: In this in vitro experimental study, 72 samples were prepared from hybrid ionomer (Vitremer-3M) and compomer (Compoglass-Vivadent) restoration materials on the basis of three methods of surface conditioning (etching with 37% phosphoric acid/using silicon carbide paper/micro abrasion with 50 μmaluminum oxide particles). After thermo cycling and simulating the oral environment, maximum shear bond strength of samples was measured by instron machine at a crosshead speed of 0.5 mm per minute on mega Pascal. The data were analyzed by SPSS software and ANOVA completely randomized design and two independent samples t-test. This significance level was considered $p<0.05$.

Results: There was statistically significant difference between the shear bond strength of two types of restoration material, acid phosphoric and silicon carbide, after the different surface treatments ($p=0.016$ and $p=0.002$). In micro abrasion surface preparation method, no statistically significant difference was found in restoration shear bond strength. The shear bond strength of compomer group was also significantly more than hybrid ionomer group ($p=0.015$).

Conclusions: Reconstruction capability of Compoglass was better than Vitremer.

Keywords: Compomer, Hybrid ionomer, Restoration and reconstruction capability, shear bond strength, Surface treatment.

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Introduction

The science of dental materials has a special position in dentistry. Without the knowledge of materials and their applications, it is practically impossible to do treatments and make restorations in a

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correct and eligible manner. Patients expect contemporary dentistry to provide excellent aesthetics for anterior tooth restoration. The restoration material should reproduce natural beauty, color, transparency and texture of the tooth. Also, it must have enough strength and resistance against abrasion, marginal integrity, good seal and biocompatibility and must be insoluble (1). In recent years, efforts to discover an ideal conservative aesthetic tooth restoration, resulted in considerable developments of methods and materials. Examples of such materials include: resin modified glass ionomer cements (hybrid ionomer) and poly acid modified composites (compomer). Both materials were demonstrated to dominate common glass ionomer problems such as: low primary strength, moisture susceptibility in early setting stages, poor esthetic, retention loss and fracture in class II cavities (2).

Resin reinforced glass ionomer (hybrid ionomer) hardens by resin part of this material, but polyacid-modified composite (compomer) is a kind of composite that is hardened in a period of time after hydration and activation with light polymerization by acid-base reaction between the filler and matrix (3).

According to the results of preclinical evaluations, compomers with one-bottle adhesive system have been vastly used, and it seems that the dentin-bonding property of these systems is clinically suitable and there is no need of creating undercuts during tooth preparation. Currently, compomers are proper materials to substitute other dental materials in anterior and posterior primary teeth due to their great clinical success (2).

Tooth colored restorations release fluoride and adhere to enamel and dentine; therefore, they are vastly used as tooth restorations especially in cervical cavities (4). Sometimes it is necessary to reconstruct the tooth colored restorations due to over finishing, fracture, contour loss, erosion, voids, material and marginal discoloration (3, 5).

The advantages of repair of local defects include: preservation of tooth structure, increased longevity, and low cost. This could be more preferable than replacing the whole restoration.

Restoration replacement results in cavity extension, and loss of sound spots, which do not have direct effect on the lesion. Since the differentiation between tooth and restorative material is difficult, the loss of tooth structure is more observed in tooth colored restorations. Reconstruction could be a considerable substitute for restoration replacement on the purpose of preservation of tooth structure (1, 6).Numerous studies have been conducted to evaluate the effect of surface treatment methods on shear bond strength of these restorations.

Swift et al. (7) evaluated the application of sandblast and etching with hydrofluoric acid. They concluded that sandblasting by removing some of the surface matrix, and exposing surface fillers, created a stronger bond as compared to the use of hydrofluoric acid. In 30 seconds, 9.5% hydrofluoric acid solves excessive surface fillers, softens the matrix, and penetrates into composite. They also studied the effect of silan on sandblasted composite, and concluded that silan had low effect on the bond strength of sandblasted composite.

In the study performed by Tata et al. (8), the bond strength of sandblasted composite, using 50 μmaluminium oxide particles at 60 psi followed by application of 35% phosphoric acid for 30 seconds was compared to the bond strength of sandblasted composite with 50 μmaluminium oxide particles at 60 psi followed by application of 9.5% hydrofluoric acid for 30 seconds. They concluded that the application of phosphoric acid after sandblasting created a stronger bond compared to hydrofluoric acid.

Trajteberg et al. (9) evaluated the effect of two methods of surface treatment (using air abrasion with 50 μmaluminium oxide, and etching with 8% hydrofluoric acid) and three different methods of using primer/resin /resin and primer on three types of composite (Artglass, Targis, Sculpture), and concluded that 8% hydrofluoric acid and air abrasion along with the use of resin and primer, created the strongest bond (36.9-39.6 Mpa).

In present study, according to broad use of hybrid ionomer and compomer, the importance of fluoride release and the anti-caries nature of these materials, the effect of three surface conditioning methods including 1.etching with 37% phosphoric acid 2.using silicon carbide paper 3.micro abrasion with 50 μmaluminum oxide particles, on these restorations was analyzed with measurement of shear bond strength.

Methods

In this in vitro experimental study, we used resin modified glass ionomer (Vitremer-3M) and polyacid modified resin composite (Compoglass-Vivadent). Seventy two samples with the length of 25 mm were cut from a solid acrylic tube with 13 mm diameter. A cavity with 3mm depth and 6mm diameter was prepared on the head of every tube. Thevitremer powder and liquid were mixed according to the manufacturer's instructions and each layer was cured for 40 seconds with low power light cure (Astralis 7). A transparent matrix bond was placed on the last layer to remove the material excess and complete the setting process. In Compoglass, the setting process was similar to Vitremer and in two layers. The exposed surfaces of Vitremer and compoglass were covered with a margin bond respectively, and resin was cured for 40 seconds. The samples were immediately placed in distilled water in incubator at 37 degrees centigrade for two days. They were put for 30 seconds in thermo cycling machine in hot and cold water for 500 cycles from 5 to 55 degrees centigrade. The samples were maintained in distilled water in incubator at 37-degrees centigrade for 3 months since the beginning of repair. After this period of time, each group of material was randomly divided into 3 parts, so that each sample group contained a total of 12 samples:

Group 1: The exposed surfaces were treated with 37% phosphoric acid for 15 seconds, irrigated for 30 seconds and gently air dried for 5 seconds. Mono bonds (Vivadent) were applied on all surfaces and were air-dried after 1 minute. Then, low viscose resin (Margin bond) was applied on all surfaces and was cured after 40 seconds, considered as our control group.

Group 2: Surface treatment was done by 800 grit silicon carbide paper for 10 times, instead of acid etching. The other steps were the same as the first group.Group 3: Surface conditioning was done using micro abrasion instrument with 50 µmaluminum oxide particles at 80 PSI for 2 seconds, and the other steps were repeated the same as the first group. Hollow cylindrical plastics with 2mm diameter and 2mm height were placed in the center of previous restorations. These cylinders were filled with two layers of restorative material; each layer was cured for 40 seconds. Then the bonded samples were placed in a test jig to ensure that the force was parallel to the bonded surface.

The samples were put in Instron Universal Testing Machine model 1195 at the speed of 0.5 mm/minute crosshead, and the maximum shear strength of the samples at Megapascal (Mpa) and according to internal surface area (πr^2) and the force was measured as force divided by area. Shear bond strength (Mpa)= Force (N)/ surface area (mm^2)After data collection, evaluation and analysis were done by SPSS software and ANOVA completely randomized design and two independent samples T-test.

Results

In this in vitro experimental study, the total mean of shear bond strength of resin modified glass ionomer (hybrid ionomer) was 11.987±3.240 Mpa and the mean shear bond strength of Compoglass (compomer) was 16.808±5.927 Mpa.

The statistical difference between these two materials was significant (p=0.015). The difference between methods 1 and 2 (phosphoric acid and silicon carbide paper) was not significant. The difference between methods 1 and 3 (phosphoric acid and micro abrasion) was statistically significant (p=0.004). Also there was no statistical difference between methods 2 and 3.

Table 1. The mean and standard deviation of shear bond strength of studied samples modified by restorative material according to surface conditioning method (Megapascal)

Surface Conditioning Method Restorative Material	Phosphoric acid (1)	Silicon carbide paper (2)	Micro abrasion (3)
Hybrid ionomer	9.29±3.32#	12.34±1.54*	14.33±2.45***
Compomer	14.60±3.89	17.78±6.58	18.05±6.73
Total	11.94±4.46	15.06±5.44	16.19±5.31**
pvalue	0.002	0.016	NS

* p<0.05 in comparison with group 1 — # p<0.05 in comparison with group 2
** p<0.01 in comparison with group 1 — ## p<0.01 in comparison with group 2
*** p<0.001 in comparison with group 1 — ### p<0.001 in comparison with group 2

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The total mean standard deviation of shear bond strength of studied samples modified surface conditioning method (megapascal) was 11.94±4.46 for phosphoric acid, 15.06±5.44 for silicon carbide paper, and 16.19±5.31 for micro abrasion.

There was significant difference in both kinds of restorative materials in both methods of surface treatment (1. phosphoric acid and 2.silicon carbide paper) (p=0.002 and p=0.016 respectively); but in micro abrasion surface treatment (third kind), there was no significantly difference between the two restorative materials (table 1).

Discussion

Hybrid ionomer and compomer are common restorative materials used as tooth colored restorations in pediatric dentistry. In most cases, due to the patients' tendencies to repair posterior teeth with tooth colored materials, and their low strength compared to amalgam, there is always a need of repair. Therefore, in the present study, the effect of surface treatment methods of tooth colored restorations on shear bond strength was evaluated.

During the study, to stimulate the oral environment for the restorations, primary prepared samples were kept in thermal conditions (thermo cycling to stimulate the oral environment), followed by humid conditions (maintained in distilled water for 3 months) to evaluate water absorption. Afterwards, the surface conditioning and repair were performed.

In the present study, the mean of shear bond strength in hybrid ionomer group was significantly less than Compoglass (compomer) group (p=0.015). In other words, Compoglass (compomer) created a stronger bond compared to hybrid ionomer, which could be a result of dominant polymer matrix in compomers compared to hybrid ionomers (6). To compare the effects of surface conditioning methods on shear bond strength, in hybrid ionomer group, etching with phosphoric acid created the least bond strength, whereas, bond strength was much higher in the other two groups (silicon carbide paper and micro abrasion), however, in Compoglass group there was no significant difference in this aspect.

It seems that sandblasting by removing some of the surface matrix, and exposing surface filler particles of previous restoration, created a stronger bond as compared to other methods of surface treatment. Moreover, the use of phosphoric acid due to its more surface destruction resulted in the least bond strength. The other studies showed different results.

Yap et al. (10) studied the effect of different methods of surface treatment on shear bond strength of polyacid (Dyract) modified composite samples, and concluded that 6 months after using sandblast, stronger shear bond strength was achieved compared to etching with maleic acid and polyacrylic acid. Charlton (11) compared the effect of surface conditions including: smooth and non-etched, smooth and etched, rough and non-etched, and rough and etched before repair on the bond strength of poly alkonyat glass type 2 which is a kind of hybrid ionomer, concluded that the best and strongest bond was observed in smooth, non-etched surfaces. Under a light microscope, tooth surface has natural roughness that could provide the necessary undercuts for the retention of the restoration, whereas the use of acid, somehow destructs this roughness. Ozcan et al. (12) evaluated the effect of the three surface treatment methods on shear bond strength improvement of composite resin, concluded that the strongest bond was the result of application of silicate ceramic sediment, micro abrasion, and acid etch, respectively.

The results of the study performed by Cesar et al. (13) showed that the mechanical methods of using silicon carbide paper, diamond bur, and micro abrasion did not make specific difference in the bond strength of artglass restoration, while the use of acid, somehow, destructed the topography obtained by mechanical methods. Bouuschlicher (14) evaluated the strength bond of Portac, Hybrid, and Silux Plus restorations using the different methods of surface treatment (diamond bur, micro etching with 50 μmaluminum oxide particles, and micro etching using silicate ceramic particles at low pressure), and demonstrated that the strongest bond was the result of micro etching with silicate ceramic particles.

Swift et al. (7) evaluated the application of sandblast and hydrofluoric acid etching in Herculite XR restorations, concluded that sandblast created a stronger bond compared to its combination with hydrofluoric acid. Also, Tata et al. (8) compared the bond strength between two composites using 50 μmaluminum oxide particles with 35% phosphoric acid or 9.5% hydrofluoric acid. They concluded that the application of phosphoric acid after sandblasting created a stronger bond as compared to hydrofluoric acid. Mitchem et al. (15) evaluated the effect of surface treatment method on shear bond strength of hybrid composites and concluded that shear bond strength between sandblasted hybrid composite and previous composite restoration was nearly equal to the composite strength, whereas the bond strength in the use of hydrofluoric acid was 35% of sandblast bond strength.

In this regard, Miranda et al. (6) concluded that the use of abrasive paper with 220µm particles along with 37% phosphoric acid etching for 1 minute, and enamel bond would create bond strength as strong as 50% of composite mass between the two layers of previous and new restorations, and this strength was clinically approved.

With an overview of the conducted studies in this field, we find out that the applied materials and used methods in the mentioned studies are not similar to our study; therefore, further investigations on these materials should be conducted.

According to the higher shear bond strength of compomer group compared to hybrid ionomer group, reconstruction capability of Compoglass is better than vitremer.

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References

1. Meerbeek B Van,Inoue S, Perdigao J, Lambrechts P, Vanberle G. Enamed and Dentin Adheesion In: Summitt JB, Robbins JW, Schwartz RS, santo jose dos. Fundamentals of Operative Dentistry: A Contemporary Apporach. 2nd ed. Chicago: Quintessence publishing Co, Inc; 2001. P. 224-28.
2. Krämer N, Frankenberger R. Compomers in restorative therapy of children: a literature review. Int J Paediatr Dent 2007; 17: 2-9.
3. Yap AU, Quek CE, Kau CH. Repair of new-generation tooth-colored restoratives: methods of surface conditioning to achieve bonding. Oper Dent1998; 23:173-8.
4. Shaffer RA, Charlton DG, Hermesch CB. Repairability of three resin-modified glass-ionomer restorative materials. Oper Dent 1998; 23:168-72.
5. Flores S, Charlton DG, Evans DB. Repairability of polyacid-modified composite resin. Oper Dent 1995; 20:191-6.
6. Miranda FJ, Duncanson MG Jr, Dilts WE. Interfacial bonding strengths of paired composite systems. J Prosthet Dent 1984; 51: 29-32.
7. Swift EJ, Jr, Brodeur C, Cvitko E, Pires JA. Treatment of composite surfaces for indirect bonding. Dent Mater 1992; 8: 193-6.
8. Tate WH, De Schepper EJ, Powers JM. Bond strength of resin cements to a hybrid composite. Am J Dent 1993; 6:195-8.
9. Trajtenberg CP, Powers JM. Bond strengths of repaired laboratory composites using three surface treatments and three primers. Am J Dent 2004; 17:123-6.
10. Yap AU, Sau CW, Lye KW. Effects of aging on repair bond strengths of a polyacid-modified composite resin. Oper Dent 1999; 24: 371-6.
11. Charlton DG, Murchison DF, Moore BK. Repairability of type II glass polyalkenoate (ionomer) cements. J Dent 1991; 19: 249-54.
12. Ozcan M, Alander P, Vallittu PK, Huysmans MC, Kalk W. Effect of three surface conditioning methods to improve bond strength of particulate filler resin composites. J Mater Sci Mater Med 2005; 16: 21-7.
13. Cesar PF, Meyer Faara PM, Miwa Caldart R, Gastaldoni Jaeger R, da Cunha Ribeiro F. Tensile bond strength of composite repairs on Artglass using different surface treatments. Am J Dent 2001; 14: 373-7.
14. Bouschlicher MR, Reinhardt JW, Vargas MA. Surface treatment techniques for resin composite repair. Am J Dent 1997; 10:279-83.
15. Mitchem, JC, Feracane, JL, Gronas, DG. The etching of hybrid compositresin. J Operative Dentistry 1996; 21: 249-56.