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THE SHEAR BOND STRENGTH OF FRESHLY ADDED COMPOSITE RESIN TO A REPAIRED CHEMICALLY BLEACHED COMPOSITE

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ABSTRACT

Objective: This in-vitro study was done to evaluate the shear bond strength (SBS) of a repaired chemically bleached composite using a freshly added composite material.

Materials and Methods: Forty composite disk specimens were prepared using a (8X3mm) Teflon mold. All specimens were immersed in saline solution for 2 months. Afterwards, the specimens were equally divided into four groups (10 each) depending on the instance of new composite addition. A Teflon mold (5X3mm) was used for adding the new composite disk by packing of the new composite to the previously cured disk. Group A (the control group) new composite was added to non-bleached composite samples. While group B fresh composite was added immediately after bleaching, group C it was added 1 week after bleaching, and group D it was added 2 weeks after bleaching. Bleaching was done utilizing chemical bleaching technique. The SBS between the two composite disks was measured using Instron universal testing machine.

Results: A highly statistically significant difference was revealed by using of ANOVA test between the four groups ($p<0.001$), with the highest mean shear stress values noted in group A followed by D then group C, while the lowest recorded in group B. A High statistically significant difference between group B vs. A and D ($p<0.001$*) was shown by using of Pairwise Posthok test, denoting the lower shear bond stress values of group B versus both these groups. Furthermore, a significant statistical difference was noted between groups A & B versus C. While, non-significant differences were recorded between groups A&C versus group D.

Conclusions: Teeth bleaching significantly decreases SBS in composite repair procedures, despite using ethanol based adhesives. In addition, postponing the composite repair after bleaching procedure has a major role in regaining the desired SBS.

KEY WORDS: Shear Bond Strength (SBS), Bleaching, Composite

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INTRODUCTION

Aesthetic dentistry is not only related to teeth Caries or destruction but also undesirable teeth color [1]. Discoloration of teeth necessitates effective treatment [2]. This in turn needs accurate diagnosis to find out a suitable line of treatment. Conservative treatment is required. Bleaching is a non-invasive method which might be an effective treatment method, micro abrasion is another line of treatment considered as a minimal invasive procedure, in addition composite resin restorations or porcelain veneers are considered invasive techniques [3].

Bleaching is a comparatively simple process [4]. Vital bleaching is safe, popular and well accepted line of treatment for discolored teeth [5].

To define bleaching the ADA considered this process as a procedure that changes the tooth color by products containing peroxides helping to remove internal and / or external stains.Restored teeth appears lighter after bleaching thus restoring or repairing composite restorations to match the new teeth color is mandatory [6].

Classification of bleaching includes in-office bleaching which may be light activated or chemically activated, and home bleaching which is chemically activated[7].

Hydrogen peroxide with higher concentrations is mainly used in an in-office bleaching procedures for chemically activated systems[8]. While. carbamide peroxide (25%-38%) is mainly used for home bleaching [9].

In office chemical bleaching is simply the application of a bleaching agent to the teeth for a certain time period, usually three applications of 20 minutes each, so it is considered. the most economic and widely used technique. [10]

The decrease of the bond strength of composite restorations is considered the major drawback of bleaching .[11] Multi-directional functional forces such as compressive stresses, tensile stresses and shear stresses are important stresses which might affect such bond in oral environment.[12]

The maximum stress that a material can withstand before failure in a shear mode of loading is defined as Shear bond strength (SBS) .[13]

Ethanol-based adhesives is recommended, by Jacobsen and Soderholm in 1995, to be used in a trial to overcome the problem of reduced bonding to the bleached teeth, .[14]

So the purpose of the current was to evaluate the SBS of a newly added composite to old composite restoration bleached using a chemical bleaching procedure.

MATERIALS AND METHODS

Materials:

The used materials in the present study were (AELITE™ Aesthetic Enamel Nanofil Composite, All Bond Universal, Self-etch adhesive and WHITEsmile™ Power WhiteningYF). (Table 1) illustrates the chemical composition, manufacturer and web site of each material.

Methods:

This study was conducted as an in-vitro study. The Research Ethics Committee of the Faculty of Dentistry; Pharos university approved this experimental study. Forty composite disk specimens were prepared using a (8mmX3mm) Teflon mold. A plastic filling instrument was used to apply the composite resin by packing the first composite increment in the mold. Light curing of that layer is done by using of LED Light curing unit (MiniS, Woodpecker, Guilin, Guangxi, China) with light intensity 1000 mW/cm^2 at a curing distance of 1 mm, curing was done under pressure using a glass transparent piston for 40 seconds pressing the composite increment in the Teflon mold. Light curing of the final layer is done through a transparent microscopic glass slide to get a flat surface of the composite disk. Afterwards to ensure complete polymerization of the composite disk further multi-directional curing was done. Finishing of the disk was done using no. 12 scalpel blade (Suzhou Kyuan Medical Co, Jiangsu, China). All composite discs

TABLE (1) Chemical composition, manufacturer and web site of tested materials used in the study

Material	Chemical Composition	Manufacturer	Web-site
AELITE™ Aesthetic Enamel Nanofil Composite	Reinforced Nanofil composite shade A1: Matrix: Bis-GMA, UDMA, Bis-EMA Filler: 0.04-5 μm glass and silica with filler load of (73% wt.)	BISCO, Schaumburg, USA	www.global.bisco.com
All Bond Universal, Self-etch adhesive	10-MDP Monomer, 2-HEMA, BisGMA, Ethanol, Water, Initiator	BISCO, Schaumburg, USA	www.global.bisco.com
WHITEsmile™ Power WhiteningYF	Chemically activated bleaching system 40% hydrogen peroxide (32% mixed)	Birkenau, Germany	www.whitesmile.com

TABLE (2) Study design

Specimens (n=40)			
Group A (n=10)	**Group B (n=10)**	**Group C (n=10)**	**Group D (n=10)**
Control group (without bleaching).	New composite was added immediately after bleaching.	New composite was added 1 week after bleaching.	New composite was added 2 weeks after bleaching

were then dipped in a saline solution in a closed glass container and stored for 2 months.

Afterwards, the specimens were equally and randomly divided into four groups (10 specimens each) according to the instance of fresh composite addition after bleaching. Group A (the control group) new composite was added to non-bleached composite. Group B the new composite was added immediately after bleaching. While group C the new composite was added 1 week after bleaching, and group D the new composite was added 2 weeks after bleaching as shown in (Table 2).

Bleaching procedure:

The bleaching procedure was done utilizing chemical bleaching technique in three successive sessions by spreading of the agent all over the composite disk using a disposable dental brush and waiting for 20 minutes per application. After each session, a disposable suction tip was used to eradicate the bleaching gel and the each disk was washed with a spray of tap water and oil free air. Then dried with a compressed oil free air as the final session following the manufacturer's recommendations.

Procedure of Adding of fresh composite:

The cured composite surface of each disk is roughened using round end diamond bur (#881, DIASWISS, Switzerland) in high speed contrangle handpiece revolving at 400,000rpm, followed by marking the area for bonding using a pencil then an eugenol free separating medium is applied all around the excluded area of the composite disk. A Teflon mold (5mmX3mm) was used for adding the new composite disk .First application of 2 coats of the bonding agent was done, using a disposable micro- brush, and light cured for 20 second, followed by packing of the new composite using the previously used composite packing instrument. Light curing was done under pressure for 40 seconds using a transparent glass rod. The last layer of composite was compressed and light cured through microscopic glass slide. Multi directional curing was done to insure complete polymerization. Removal of the composite fleshes was done using a sharp scalpel blade no. 12.

To evaluate the SBS between the two composite disks, an Instron universal testing machine (Instron, MA, USA) with cross head speed: 0.5mm/min was used. The SBS values were recorded and calculated using the following equation: Stress in MPa = load in newton / surface area (r^2)

The quantitative data were recorded, tabulated and analyzed statistically using ANOVA test. Pairwise Post Hok Tukey test was used for paired group comparison. All tests were done utilizing the software Statistical Package for Social Science (SPSS) (SPSS, Chicago, IL, USA) version 29 computer software.

RESULTS

As shown in (Table 3) and (Figure 1), ANOVA statistical test showed a highly significant difference between the four groups respectively ($p<0.001$), with the uppermost mean shear stress values at maximum load recorded in group A (16.48) followed by group D (15.49) then group C (12.22) and the lowest values recorded in group B (7.19) where the composite was added immediately after bleaching.

Pairwise Posthok test presented in (Table 4) was then performed to analyze the multiple means in pairs between each two groups together. It revealed highly statistically significant difference between group B vs. A and D ($p<0.001$*), denoting the lower shear bond stress values of group B versus both these groups. Furthermore, statistically significant differences were found between groups A & B versus C ($p=0.009$*&0.002*) respectively. Non-significant differences were recorded between groups A&C versus group D ($p=0.861$ & 0.063) respectively.

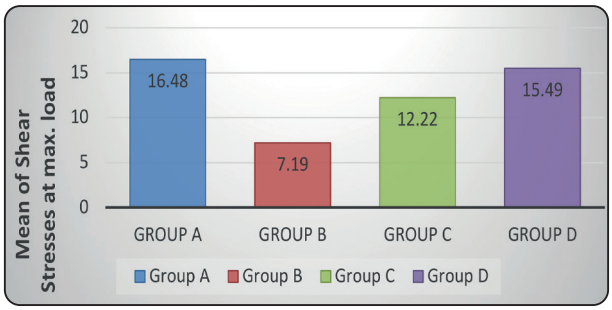

Fig (1) Mean Shear stress values at maximum load [MPa] of the four groups

TABLE (3) Comparison between the mean values of SBS of the four groups.

Shear stress at maximum load [MPa]	Group A (n=10)	Group B (n=10)	Group C (n=10)	Group D (n=10)	ANOVA (F)	p-value
Min. – Max.	13.50 – 19.60	5.50 – 9.0	7.40 – 17.60	9.70 – 20.50		
Mean ± SD.	16.48 a ± 2.33	7.19 c ± 1.23	12.22 b ± 3.10	15.49ab ± 3.91	22.057*	<0.001*
Median	16.45	7.10	12.80	16.25		

Pairwise Post Hok Tukey test between each two groups.

Significance at<0.05*Different manuscript letter indicate significance between groups.

TABLE (4) Pairwise Post Hoc Tukey test between each two groups together

Groups	Group A	Group B	Group C	Group D
Group A	---------	0.001*	0.009*	0.861
Group B	0.001*	----------	0.002*	0.001*
Group C	0.009*	0.002*	----------	0.063
Group D	0.861	0.001*	0.063	----------

DISCUSSION

The contact of the bleaching agent with organic and inorganic content of the resinous restoration may lead to clinical deterioration [15]. So the clinical evaluation of the preexisted bleached composite resin restoration is mandatory [16]. The bleaching agent penetrates the resin matrix content in a longer period depending on its density [17].

Alteration of the surface hardness of the composite resin restoration may be occurred after the bleaching process. [16]

Some studies evaluated the effect of blenching material on the physical properties of different composite versions.

Debated outcome was obtained: certain researches have stated a reduction, other noted an augmentation, and others recounted no major alteration in the hardness of the composite[18]. Ferrari et al.[19] measured the outcome of internal bleaching on shear bond strength of composite-to-composite bond. They stated that the bond strength was improved upon using of sodium perborate mixed with water or three percent H_2O_2. These results may be referred to the using of certain whiting material and also the different method of bleaching.

Zakavi et al [20] described that no major disturb of the bond strength between freshly added composite to a bleached preexisted composite.

They also reported that this bond strength has a relation to the type of the used composite illustrating that the use of Hybrid and microhybrid composites result in satisfactory repair bond strengths. However the recorded result showed that the use of nanofilled composite reduced the repair bond strengths.

Matter of fact, the bond strength of newly added composite is debilitated upon repairing process of the preexisted one.[12,13] For appropriate adhesion between the timeworn and freshly added composite restoration an oxygen-inhibited layer (a non-polymerized layer of resin) is needed .[12,13] This weak oxygen-inhibited layer can reduce the amount of unsaturated double carbon = carbon bonds, cause water access between the inorganic fillers and resin matrix, and may affect the surface accuracy [12,13].

A significant reduction in the bond strength of freshly added composite to the bleached one was noticed in this study between the 3 tested groups and the control one.

This result was in covenant with Zakavi et al [20] who concluded that a major reduction of the bond strength occurred between the bleached composite and the freshly added one upon using of a nanofilled type while an acceptable bond strength was noticed upon using hybrid and microhybrid composite resin.

In the current study an ethanol based adhesive system was used, based on the conclusions of Barghi and Godwin [21].of the ability of ethanol to spread adhesive system more effectively into dentinal tubules and improve the bond strength.

Currently, the highest mean SBS value was recorded with the unbleached composite than those of the bleached composite groups even after 2 weeks of the whitening process.

This was in contract with Carlos et al [22] as they noticed that adding of composite to a preexisted one without bleaching showed higher bond strength than that added momently after bleaching. They also referred that to the absence of residual oxygen inhibited layer. They also added that postponing the adhesion to a bleached composite by a period ranged from one day to three weeks is recommended to act against this problem.

Treatment of the bleached enamel with alcohol was mentioned as a method of other several one to overcome the problem of reduction of the adhesive bond strength after bleaching. Also reduction of the superficial layer of enamel, application of organic solvent and the use of antioxidants were mentioned, reporting that improvement in SBS values, occurred only upon using of antioxidants [7,8].

In the current study it was found that Group C where composite was added 1 week after bleaching

exhibited lower mean SBS compared to Group D where composite was added 2 week after bleaching.

Topcu et al [23] reported that application of composite restorations on a bleached enamel surface should be postponed for at least 2 weeks after the blanching procedure.

CONCLUSION

Under the restrictions of this in-vitro study, the following might be concluded:

1. Teeth bleaching significantly decreases shear bond strength in composite repair procedure.
2. Ethanol based adhesives application has no significant effect on increasing the shear bond strength of composite to composite after bleaching.
3. Postponing the composite repair after bleaching procedure has a major role in regaining the desired shear bond strength.
4. Waiting for 2 weeks in addition to use of ethanol based adhesive system seems to reach satisfying result compared to the non-bleached group (control group).

RECOMMENDATIONS

Developing on the outcomes of this in-vitro study, the following points could be recommended:

1. Increase number of specimens used.
2. Further investigations could be done using other surface treatment procedures that may counteract the contrary effect of bleaching during composite repair as the use of catalase enzyme to effectively eliminate the residual hydrogen peroxide or calcium hydroxide to attack the free radical.
3. More studies could be done on the effect of bleaching solution on other available types of composites to find out if the type of composite has an effect on shear bond strength of freshly added composite resin to a preexisted one.

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Conflicts of interest

There are no conflicts of interest.

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