The Effect of Air-Inhibited Layer on the Shear Bond Strength of Immediate and Delay Repaired Light-Cured Composite Restoration.

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Abstract

The goal of this study was to determine how air-inhibited layer and time affect the interfacial bond strength when immediate and delay light cure composite repair was done using micro filled composite (helioprogress kit, viva dent, Germany).

In group A there was no air-inhibited film on the surface of the initial layer of restoration, while in group B an air-inhibited layer was present. In both groups the surface layer was abraded and divided into further subgroups.

Sub-group I: repair was done immediately after storage in distilled water of 37^{o}C for 15 min, whereas in Sub-group2: delay repair was done after storage for 1 week.

Result showed significant difference between the immediate and delay sub-group in both groups, while there was no significant difference with or without air-inhibited layer when immediate and delay repair was done.

Key words: shear bond strength, air inhibited layer, light cure composite, and repair.

Introduction

The general reductions of dental caries and increase patient interest in dental esthetic have resulted in the development of new restorative materials and techniques. Composite materials and adhesive techniques have become the foundation of modern restorative dentistry. [1]

Composite restoration is sometimes considered unsatisfactory for so many reasons, in such instances the usual recourse is either repair or replaces the restoration. [2, 3] For reasons of finance, technology, psychology, and time , it may find it is difficult to remove the restoration and redo the job, but confronted with the problem of repairing the composite material.[4]

The strength of the repaired resin ranged from one fifth to one half of the un repaired composite resin, such a repair may be clinically satisfactory, although mechanical retention may be needed where there is exposure to biting force [5]

One measure of the reparability is the development of excellent bond at the interface between the initial and repaired surfaces of the restorations, and usually referred to as the interfacial bond strength [2].

For various composite resins, it has been found that the interfacial bond strength of the repaired restoration is clearly affective by the age of the initial layer and by the quality of the surface layer [5,6] .

Air-inhibited layer is a thin viscous layer comprising unreacted methacrylate group that formed on the cured layer during polymerization because of the inhibition by oxygen, this layer can be prevented when curing done through a plastic strip [5, 7, and 8]

The purpose of this study was to determine how an air-inhibited layer and time affect the interfacial bond

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strength when immediate and delay light-cure composite repair was done.

Materials and methods

The commercial composite resin used in this study, was microfilled composite(Helioprogress, Vivadent, Germany).Forty blocks of (25,25,10 mm) were constructed from cold–cure acrylic resin containing a cylindrical hole of (6 mm diameter and 3 mm depth) in the center of one of its square surfaces . After complete polymerization of the acrylic resin, the acrylic block was placed in boiling water for 1/2 hr to get rid of the free monomer. Then the samples were divided into two groups (A and B) evenly.

Microfilled composite resin was applied in each hole according to the manufacturer instruction using a plastic instrument. For group A the light curing done through a plastic strip covered with a glass slide for 40 sec. Figure 1.

While for group B the curing was done directly for 40 sec while the surface layer exposed to air to form air-inhibited layer on the surface.

The surface layer of the composite resin of each specimen was abraded by finishing disc (1 coarse soflex disc used for each 5 samples). The tested surface rinsed with water for 20 sec to clean the abraded surface. Each group was subdivided into two further subgroups

Subgroup 1: The 10 composite resin samples were repaired after storage in deionized distilled water in a constant temperature oven at 37^{o}C for 15 min to represent (immediate repair).

Subgroup 2: The 10 composite resin samples were repaired after storage in deionized distilled water in a constant temperature oven at 37^{o}C for one week to represent a delay repair. [3, 5, 11]

Repair procedure:

The surface layer treated with 37% phosphoric acid gel for 15 sec , rinsed with air-water spray for 15 sec and dried by oil free air, then heilobond applied on the surface and cured with visible light for 20 sec, then a (3 mm diameter and 6 mm length) cylindrical piece of standardized translucent plastic straw filled with heiloprogress composite placed directly on the composite resin in a vertical position and cured for 40 sec from four directions after removing the excess material from the periphery with a probe. All the specimens stored in distilled water in oven at 37^{o}C for 1 day before testing. [12] Figure 2 & 3.

For the shear bond strength testing, a special designed stainless steel chisel-shaped rod and a universal zwick testing machine was used with displacement speed of 5mm/min. The resultant force obtained in Newton was divided on the surface area (7.065 mm^2), Figure 4.

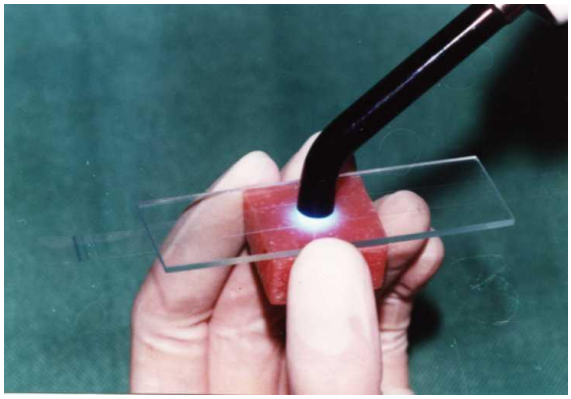


Figure 1

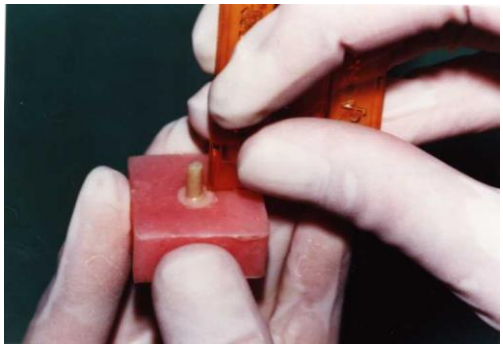


Figure 2

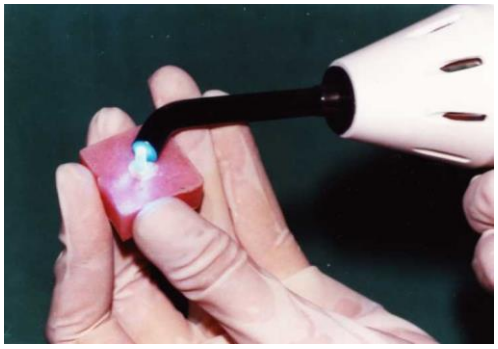
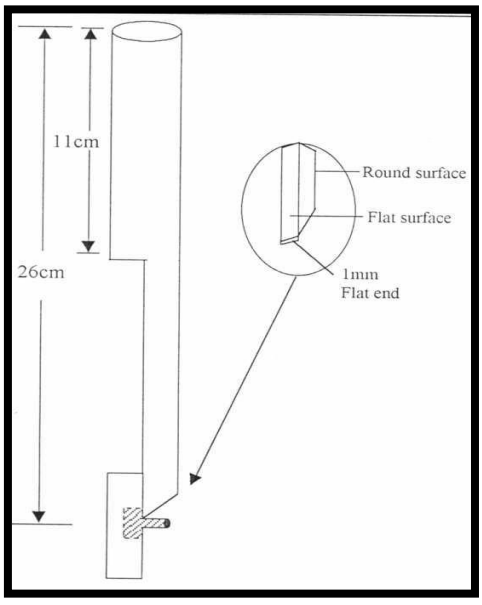


Figure 3



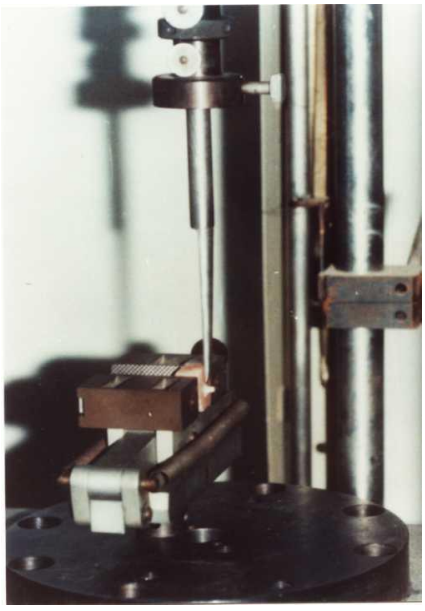


Figure 4

Result

The data obtained in MPa represents shear bond strength and mean value of different subgroups shown in (table 1& figure 5).

The results were statistically analyzed using one way analysis of variance (ANOVA test) and t-test. The ANOVA test for group A and B showed statistically significant difference at P<0.05 level and (total F=4.069) (table 2).

T-test was done between subgroups shows significant difference between subgroups A1&A2, B1&B2, A1&B2 and A2& B1 But there were no significant difference between A1&B1 and A2&B2 (table 3).

Table 1: The shear bond strength and mean in MPa values of immediate and delay repaired light cured composite resin with and without air-inhibited layer.

specimen	Group A		Group B	
No	Subgroup 1	Subgroup 2	Subgroup 1	Subgroup 2
1	6.836	6.369	5.590	5.520
2	5.944	7.784	6.510	2.193
3	4.033	4.317	3.201	9.184
4	6.680	4.133	30182	6.340
5	5.987	4.430	7.700	7.313
6	11.181	3.326	5.502	5.777
7	13.446	1.670	12.882	2.001
8	8.917	2.661	9.921	5.529
9	11.606	1.684	7.011	2.678
10	6.836	4.616	9.020	2.299
mean	8.1466	4.098	8.051	4.881
SD ±	3.0162	1.930	3.946	2.478

A1: Immediate repair of composite surface without air-inhibited layer.
A2: Delay repair of composite surface without air-inhibited layer.
B1: Immediate repair of composite surface with an air-inhibited layer.
B2: Delay repair of composite surface with an air-inhibited layer.

Table-2: ANOVA test of the shear bond strength

Source of variation	SS	df	MS	F-test	P-value
Between groups	105.33	3	35.113	4.069	P=0.016 P<0.05 Significant
Within groups	232.97	27	8.628		
Total	338.310	30			

SS: Sum of square **df**: Degree of freedom **Ms**: Mean of square

Table-3-t test between subgroups

Subgroup	t	Degree of freedom	p-values	Significance
A1 Vs A2	2.774	9	0.022	S
B1 Vs B2	1.864	9	0.049	S
A1 Vs B2	2.139	9	0.041	S
A2 Vs B1	2.455	9	0.036	S
A1 Vs B1	0.113	9	0.913	NS
A2 Vs B2	0.813	9	0.437	NS

S: significant P<0.05

NS: non significant P>0.05

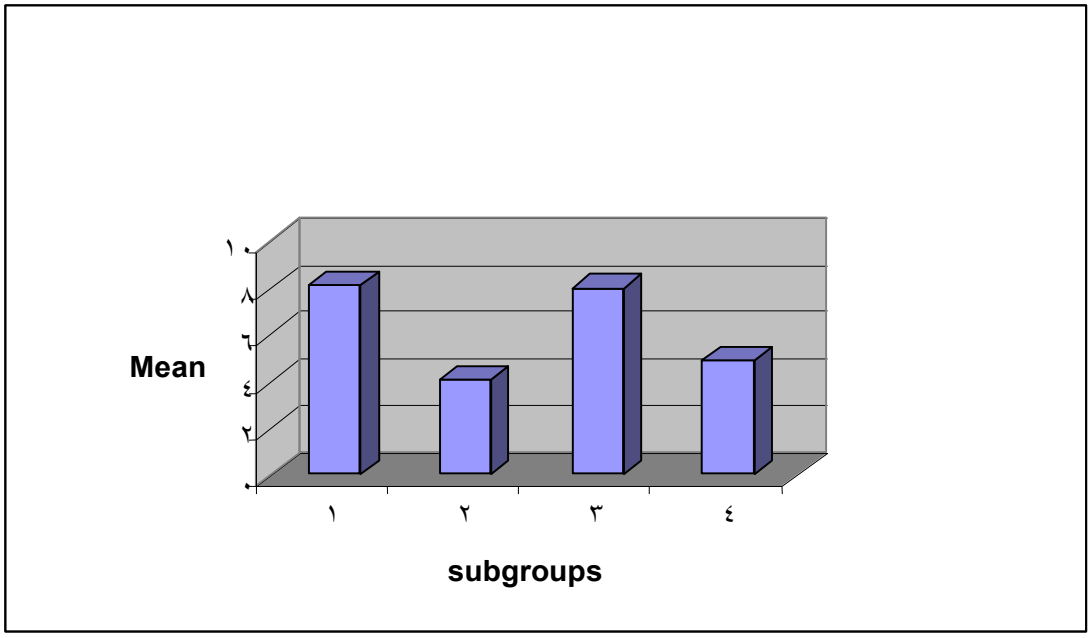


Fig (5) Bar- Chart shows the differences in mean bond strength values between group's and subgroups

Discussion

Technologic break through bonding agent and composite have given a material and techniques that are reliable in long term. Nevertheless, it maybe still confront with fractured composite [4].

The restorative material used in this study was among the newest materials introduced to the market with manufacturers and authors claims of high efficiency especially in composite repair. [13-18]

Although many authors prefer to measure the bond strength in tension [5,1,19] , but still the majority of authors prefer to measure it in shear [8,9,11,12] , to coincide with the fact that tensile bond strength is not a practical measure for brittle material such as dental composite. [7]

The results of this study showed a decrease in bond strength values of both groups by time relapse before repair irrespectively and independently of the surface quality whether the surface being repaired was cured against a plastic strip or containing an air-inhibited layer.

The reduction in bond strength values was attributed to the combined effect of:

1. Reduction in the amount of available bond that aid in repair. [2,20]
2. The effect of water storage that results in hydrated composite not readily wet by new resin material. [2,16]

These results agree with Briane et al 1975 [15], Flores et al 1995 [21], and Shaffer et al 1998 [8].

Further more the result of this study showed non significance difference in bond strength values of immediately and delay repaired light cure composite restoration at P>0.05 when finished surface was initially with or without air-inhibited layer.

In fact, although the air-inhibited layer was a hypothesis by many authors, as an important factor in light cured composite repair,[10,22] assuming that a thin viscous layer comprising unreacted methacrylate groups is

formed on the cured layer that permit further secondary bond formation with the added new material.[2]

This layer is porous, rough, and easily worn away from composite resin surface,[21] thus their benefit restricted in multiple mix restorations that cured in a several layers.[22] Furthermore, other authors suggest that air-inhibited layer reduce the interfacial bond strength.[5,23] They argued, was because of in adequate bonding, which was attributed to the topical reduction of the initiator concentration arising from a diffusion process and copolymerization of the initial film with repair composite.[2]

Conclusions

1. Delaying the repair process result in marked reduction in shear bond strength values irrespectively on the quality of the surface layer of the composite resin being repaired.
2. Air-inhibited layer have a none pronounced effect on the shear bond strength of immediately and delay repaired light cured finished composite resin surface.

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