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An Evaluation of Different Materials for Surface Treatment on Microleakage of Repaired Composite Resin Restoration

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ABSTRACT

Aims: To evaluate the effect of different surface treatment on the microleakage of repaired CI V composite resin restoration. **Materials and methods:** This study was performed in vitro on 20 caries free premolar teeth. Standardized class V cavity preparation on buccal and lingual surfaces of each tooth was done, forty cavities cleaned with distilled water and dried, then the cavities were filled with the composite. After that, all teeth were stored in normal saline for 3 months, so that the filling become old then remove 1mm of composite from all cavities. The cavities were divided into four groups. The first two groups were treated with 37% phosphoric acid. The other groups treated with 9% hydrofluoric acid the groups II and IV were treated with silane coupling agent, then all cavities were filled with composite after 5th generation bonding agent were applied .The teeth were stored for one week after that the Samples were thermocycled and immersed in methylene blue dye, The samples were sectioned, and examined using stereomicroscope. **Results:** Samples treated with silane coupling agent showed less microleakage than those without silanation. There was highly significant difference between samples acid etched using hydrofluoric acid with those etched with phosphoric acid. **Conclusions:** Silane coupling agent and the hydrofluoric acid significantly decreased microleakage of repaired CI V composite resin restoration.

Key words: silane coupling agent**,** hydrofluoric acid, phosphoric acid.

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INTRODUCTION

The introduction of composite based resin technology to the restorative dentistry was one of the most significant contributions in the last century [1].

The composite restorative materials were introduced to the dental profession by Bown in 1962, as an effort to improve the physical characteristics of unfilled acrylic resin and silicate cement [2-4].

Tooth colored restorative materials have increasingly been used to replace the missing tooth structure and to modify tooth color and contour, thus enhancing facial aesthetic [5].

Patient demand for esthetic restoration increased the use of composite resin and stimulates many investigations in order to improve the composite resin restoration techniques and clinical performance of newer dental composites which have been significantly improved over the past decade to provide adequate strength and resistance in order to withstand the force of mastication [4,5].

As time passes composite resin restoration are subject to failure, the most common failure are secondary caries , marginal staining , discoloration and cohesive fractures occurring in the incisal angle restoration [6].

Due to the properties of the composite material failure of a composite resin restoration does not necessarily require removal of the entire restoration or even the preparation of under cuts for mechanical retention.

Complete removal will therefore inevitably lead to larger cavities with further loss of tooth substance. For this reason, repair of an existing restoration would always be preferable to replacement providing that the repaired restoration is clinically satisfactory[4–7].

The new generations of adhesive systems are multipurpose systems capable of bonding composite to various substrates (enamel, dentin, metal and porcelain) [6].

Silane coupling agent presses a general formula of: X – (CH2)3 – Si – (OR)3 they are bifunctional molecules one of them is reactive with various in organic materials such as glass, metals, silica. While the other molecule react with various kind of organic materials or synthetic resin, for this reason silane coupling agent can be used to repair ceramic as well as composite fracture or defect [8].

Hydrofluoric acid is a solution of hydrogen fluoride in water. Together with hydrogen fluoride, hydrofluoric acid is a valued source of fluorine

Hydrofluoric acid is best known to the public for its ability to dissolve glass by reacting with SiO_2 [9,10].

The aim of this in vitro study was to evaluate the effect of different surface treatment on the microleakage of repaired CI V composite resin restoration.

MATERIALS AND METHODS

This study was performed in vitro on 20 caries free premolar teeth, the teeth were examined using fiber optic light and exclude any crack in enamel with effect on dry penetration, the teeth were stored in the normal physiological saline before cavity preparation, after that standardized class V cavity preparation on the buccal and lingual surfaces of each tooth was done in the gingival third.

The cavities were 3mm wide, 5mm length, 2mm depth (the cavities not beveled and not extend to the cementum), Figure (1).

Figure (1): Cl V cavity in the buccal surface of premolar.

Forty cavities cleaned with distilled water and dried, then the cavities were acid etch with 37% phosphoric acid for 15 seconds then washed with water spray for 15 seconds and dried with cotton leaving moist dentin,then single bond 5th generation (excite bonding agent) (Vivadent, Liechtenstein) applied according to the manufacturer instructions, and light cured for 20 seconds. Then the cavities filled with universal composite (tetric) (Vivadent, Liechtenstein) and light cured for 40 seconds putting the tip of light cure in intimate contact with the surface of cavity after put celluloid strip on the filling.

After that all teeth were stored in normal physiological saline for 3 months, so that the filling become old ,then remove 1mm from the filling surface leaving 1mm thickness of composite in the cavities.

The cavities were divided into four groups according to the surface treatment.

Group I: Ten cavities were acid etch with 37% phosphoric acid for 15 seconds after that washed and dried then single bond 5th generation (excite bonding agent) applied according to the manufacturer instructions, and light cured for 20 seconds. Then the cavities filled with universal composite (tetric) and light cured for 40 seconds.

Group II: Ten cavities were acid etch with 37% phosphoric acid for 15 seconds after that washed and dried then silane coupling agent (MonoBond−S Vivadent, Liechtenstein) was applied according to the manufacturer instructions and allow to react for one minute**.** Single bond 5th generation (excite bonding agent) applied according to the manufacturer instructions, and light cured for 20 seconds. The cavities filled with universal composite (tetric) and light cured for 40 seconds.

Group III: Ten cavities were acid etch with 9% Hydrofluoric acid for 15 seconds after that washed and dried then single bond 5th generation (excite bonding agent) applied according to the manufacturer instructions, and light cured for 20 seconds. The cavities filled with universal composite (tetric) and light cured for 40 seconds.

Group IV: Ten cavities were acid etch with 9% Hydrofluoric acid for 15 seconds after that washed and dried then silane coupling agent (MonoBond−S Vivadent, Liechtenstein) was applied according to the manufacturer instructions and allow to react for one minute**.** Single bond 5th generation (excite bonding agent) applied according to the manufacturer instructions, and light cured for 20 seconds. The cavities filled with universal composite (tetric) and light cured for 40 seconds.

Thermocycling and Dye Application*:*

The teeth were stored in normal physiological saline in an incubator at 37 C^o for one week.

After storage each tooth was mounted in cold cure acrylic resin to the level of cement-enamel junction and the teeth were coated with two layers of nail varnish except the restorations and 1mm around the restorations.

The teeth were thermo cycled for 200 cycles. Thermocycling was done manually between two water baths the temperature of one bath was maintained at 5^{o}C ± 2^{o}C and the other bath at 55^{o}C ± 2^{o}C. The immersion time was for 30 seconds in each bath and 15 seconds intervals between baths [(11,12)].

After thermocycling all teeth were immersed in a freshly prepared solution of 2% methylene blue dye for 24 hours at 37C^o ,washed with tap water and allowed to dry.

Using special diamond disk (Komet, Germany)the specimens were sectioned longitudinally buccolingually thro-ugh the centre of the restoration. [11,12]

The depth of dye penetration was measured using stereomicroscope (Carl Zeiss, West Germany) at a magnification level of x10 and the scoring criterion for the amount of dye penetration was accordingly [(11)]:

Score 0: no dye penetration.

1. Dye penetrates 0.5 mm.
2. Dye penetrates 1mm.
3. Dye penetrates1.5mm.
4. Dye reaches the pulpal floor.

RESULTS

Statistical analysis of data by using the analysis of variance “ANOVA” Table (1) revealed that there was highly significant difference between the different groups indicated that surface treatment of the composite filling with silane coupling agent and with Hydrofluoric acid signifycantly decreased the microleakage of repaired composite,Further investigation using student T-test showed that there were significant differences between groups treated with silane coupling agent with untreated groups, Table (2).

Table (1): ANOVA test between groups.

Source	DF	SS	MS	F-value	*P*-value
Between groups	3	10.075	3.358	9.37	0.000
Error	36	12.900	0.358		
Total	39	22.975			

DF: Degree of freedom; SS: Sum of squares; MS: Mean of squares.

Table (2): The student T-test between groups.

Groups	Mean		T-value	*P*-value	Level of significance
	First	Second			
1&2	1.800	1.000	2.75	0.016	S
1&3	1.800	0.900	2.93	0.0098	H.S
2&4	1.000	0.400	2.71	0.015	S
3&4	0.900	0.400	2.06	0.055	S

Also student T-test showed highly significant and significant differences correspondingly between groups acid etched with hydrofluoric acid with corresponding groups acid etched using phosphoric acid.

Bar chart shows the mean value for all groups, it showed that group treated with hydrofluoric acid and silane coupling agent showed lowest leakage, while the group treated with phosphoric acid and with out silane coupling agent showed the highest level of leakage, as shown in Figure (2).

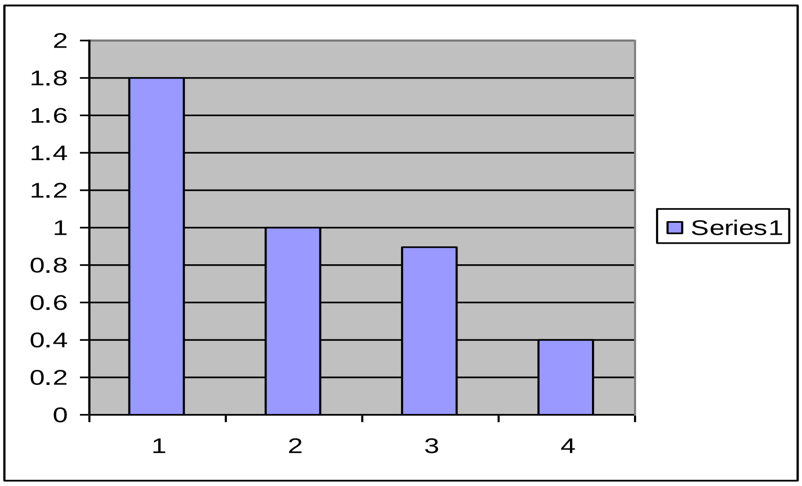

Figure (2): barchart 1:groupI,2:groupie,3:groupIII,4:groIV

DISCUSSION

Effect of silane coupling agent:

Cavities treated with Monobond–S silane coupling agent (Groups II and IV) showed less microleakage scores than those without silane treatment (Groups I and III).

This because Silane coupling agent are bifunctional molecules one of them is react with inorganic materials such as glass, silica and the other react with organic resin (The alkoxysilane group of silane bond with the filler and it bond with the resin by its methacrylate functional group).

Thus, the silane coupling agent is a crucial ingredient in creating long-term bonds of composite repair that could resist the forces of polymerization shrinkage. Thus the silane coupling agent is important in reducing the tendency for pulling back the restoration with its adhesive system away from the cavity wall resulting in less gap formation and reduced microleakage [9,10,13].

The effect of type of acid:

Etching procedures are used to facilitate bonding because it creates a porous surface this porosity lead to increase the retentive bond between the resin and tooth.

In this study the groups treated with hydrofluoric acid produce less leakage than treated with phosphoric acid because hydrofluoric acid produce aggressive effect on the surface contain silica fillers (this is based on the affinity of fluoride to silicon).

$SiO_2 + 6HF \rightarrow H_2[SiF_6] + 2H_2O$

Because composite contain silica fillers so that the hydrofluoric acid is the material of choice in etching the composite surface [10].

Hydrofluoric acid attacks the silica phase of ceramic and composite materials producing a retentive surface for micromechanical bonding [14].

CONCLUSIONS

under the limitation of this study the following conclusion could be drawn silane coupling agent and the hydrofluoric acid significantly decrease microleakage of repaired Cl V composite resin restoration.

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