

EFFECT OF SOLVENT OF ONE-STEP SELF-ETCH ADHESIVES ON THE MARGINAL INTEGRITY OF RESIN COMPOSITE TO ENAMEL AND DENTIN

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ABSTRACT

The aim of this study was to evaluate the marginal integrity of a solvent-free one-step self-etch adhesive (Bond 1SF) and to compare it with ethanol-water based adhesive (Single Bond Universal (SB)) and acetone-water based adhesive (G-aenial Bond (GB)), at different storage times. Class V cavities (2×3.5×2.5 mm) were prepared on the buccal aspects of 90 human molars. The adhesives were applied to the cavities then the specimens were restored with A2 shade of Z250XT composite resin. Each group was evaluated for dye penetration under a stereomicroscope at X32 after one day, one month, and six months. Statistical analyses were carried out. In addition, in each experimental group, one specimen were prepared for analysis under SEM.

Results: There were a significant differences in microleakage between the three adhesives at one day, Bond 1SF (B1SF) was the highest one. Whereas, there were no significant differences at six months. There were a significant differences in microleakage between the occlusal and gingival margin microleakage. Gingival margin microleakage was higher than that of occlusal margin.

Conclusion: Storage time has adverse effect on the marginal integrity of solvent containing one-step self-etch adhesive while has no adverse effect on one-step solvent-free self-etch adhesive, microleakage increase obviously at the gingival margin, the type of solvent has a positive effect on the marginal integrity, ethanol-water based one step self-etch adhesives showed superior marginal integrity

INTRODUCTION

As a result of aging, gingival recession, and dentin exposure, the cervical defects and root caries have become more prevalent. Despite the use of composite resins as a material of choice in such cavities, relevant drawbacks, such as

inherent polymerization shrinkage may cause microleakage ⁽¹⁾. Recently, a typical type of degradation of one bottle self-etch adhesives was reported at the adhesive-composite resin interface. Large amounts of water and/or solvent decrease viscosity, leading to transport of oxygen to the surface of the cured adhesive layer and the

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deep uncured layer with the use of one-bottle adhesives, which might be more severe than that with hydrophobic adhesives. Inadequate polymerization of this hydrophilic polymer results in rapid deterioration by environmental water; therefore, it is susceptible to interfacial attack by water ⁽²⁾. Therefore, water is not a proper solvent for organic compounds (such as monomers), because they are usually relative hydrophobic. The difficulty can be resolved by incorporating a secondary solvent, such as ethanol and acetone. Consequently, in some adhesive systems, ethanol and/or acetone is also incorporated to increase solubility of resin monomers ⁽³⁾. In self-etch adhesives, the solvent keeps the ingredients in solution; however, once the adhesive is applied, the solvent evaporates, triggering a phase-separation reaction, as a result of which numerous droplets are formed. If the curing process of the adhesive is accomplished before the separation reaction is

terminated, i.e. before the droplets are completely removed, the droplets remain in the adhesive layer. Moreover, if the solvent in the bonding system is entrapped beneath the hybrid layer, the bond will have a poor quality⁽⁴⁾. The use of solvent-free adhesives may enhance the tooth adhesion free from the residual solvent. Because these adhesives are hydrophobic and dense, these have less water sorption and solubility than solvated resin blends ⁽⁵⁾. Therefore, the purpose of this study was to evaluate marginal sealing and microscopic characteristics of Bond 1SF (B1SF), which is referred to as a solvent-free adhesive and to compare it with ethanol-water based adhesive (Single Bond Universal (SB)) and acetone-water based adhesive (G-aenial Bond (GB)).

MATERIALS AND METHODS

All the materials compositions are listed according to the manufacturers' profile.

TABLE (1): Materials used in this study;

Material specification	Brand name	Composition	Manufacture, website and Batch no.
Single Ethanol - water based one step self-etch adhesive system	Bond Universal	MDP [#] phosphate monomer Dimethacrylate resins, HEMA, Vitrebond Copolymer, filler, initiators, silane, ethanol water.	3M ESPE St. Paul, MN, USA 606115 http://www.3m.com
Acetone - water based self-etch adhesive system	G-aenial Bond	4-META, anhydride 5-10%, acetone 30-40%, water 15-20% Dimethacrylate 15-20% phosphoric acid ester monomer 15-20%, silicon dioxide 1-5%, photo initiator	GC CORPORATION, Tokyo, Japan 1410101 http://www.gcamerica.com
Solvent free, one step self-etch adhesive	Bond-1 SF	Mixture of UDMA, TEGDMA, HEMA & 4-META resins, silane-treated bariumborosilicate glasses, silica with initiator, stabilizers and UVabsorber, organic and/or inorganic pigments, and opacities	Pentron Clinical, Orange, CA, USA 5603010 http://www.pentron.com
Composite resin	Filtek Z250 XT	Filler: zirconia/silica (60vol %) Its matrix is composed of Bis GMA, UDMA, and Bis-EMA. The filler is zirconia /silica with particle size range of 0.01 μm to 3.5 μm .	3M ESPE St. Paul, MN, USA 692513 http://www.3m.com

II. Methods:

Selection of teeth and grouping of specimens:

A total number of 90 freshly extracted, sound human molar teeth, free from caries, extracted for pathologic reasons were collected to be used in this study. The selected teeth were divided into three main equal groups (30 teeth each) according to the type of one step self-etch adhesive systems; Group (A1) used Bond-1SF (solvent free adhesive). Group (A2) used Single Bond Universal (ethanol water based adhesive). Group (A3) used G-aenial Bond (acetone water based adhesive). Each group was subdivided into two equal subgroups (15 teeth each) according to the site of leakage as follows: Subgroup (L1) at the occlusal margin; Subgroup (L2) at the gingival margin. Each subgroup was further subdivided into three divisions of (5 teeth each) according to the storage times; (S1) one day, (S2) one month and (S3) six months

Preparation of the specimens;

A standardized class Class V cavities (2×3.5×2.5 mm) were prepared on the buccal aspects of each tooth. The cervical margins of the cavity preparations were placed 1 mm apical to the CEJ. The gingival and occlusal walls were kept parallel to each other.

Each adhesive agent and composite resin was applied according to manufacturer instruction. The teeth were stored in distilled water at 37°C in an incubator with 100% humidity at different storage time (one day, one month, and six months) until time of testing. Through the period of each storage time, the specimens were thermocycled between 5°C and 55°C for 100 cycles (one minute for each).

Microleakage testing:

At the end of the aging period of each group, the teeth were removed from the water and dried. Then a soft brush was used to coat the crown and the root of each tooth with clear nail varnish except for the restoration and away one 1mm. all around the margins of the cavity, the nail varnish was left to

dry completely. After sealing of the restored teeth, they were immersed in 2% methylene blue dye solution for 12 hours at room temperature. The teeth were removed and washed under running water to removed excess dye and dried then the teeth were sectioned longitudinally in buccolingually direction through the middle of the restoration using a fine diamond disc at low speed. Both tooth halves were examined under stereo microscope at X32 magnification and photographs of specimens were taken by a digital camera connected to the stereomicroscope. For each tooth, the extent of leakage at the occlusal and the gingival margins were evaluated and the microleakage was assessed by scoring the degree of dye penetration in the tooth restoration interface according to the following;

Score 0 = No dye penetration

Score 1 = Dye penetration along enamel (or cementum) wall only.

Score 2 = Dye penetration along enamel and dentin wall but not reach axial wall.

Penetration reaching axial wall Score3= Dye

The obtained data were presented as frequencies and percentages. Chi-square (χ^2) test was used to compare between the groups

Scanning electron microscope examination:

Finally, (random specimens) one tooth from each group that used for marginal adaptability study at the end of storage time (one day and six month) were used for scanning electron microscope examination to evaluate resin-dentin interfaces.

RESULTS

I-The effect of adhesive system on the marginal adaptations:

A) At the occlusal margins:

After 1 day, there was a statistically significant difference between the three groups. Ethanol water

based self-etch adhesive (Single Bond Universal Adhesive) showed the highest percentage (90%) of score 0, followed by acetone water based self-etch adhesive (G-aenial Bond) (70%). The solvent free self-etch adhesive (Bond-1 SF) showed the lowest percentage (50%) of score 0.

After 1 month, there was no statistical difference between the three groups. Ethanol water based self-etch adhesive (Single Bond Universal Adhesive) showed the percentage of microleakage (60%) and (40%) of the specimens manifested score 0 and score 1 respectively. For acetone water based self-etch adhesive (G-aenial Bond), the percentage of microleakage revealed that (30%), (50%), and (20%) of the specimens manifested score 0, score 1, and score 2 respectively. For solvent free self-etch adhesive (Bond-1 SF), the percentage of microleakage revealed that (30%), (50%), and

(20%) of the specimens manifested score 0, score 1, and score 2.

After 6 month, there was no statistical difference between the three groups. For ethanol water based self-etch adhesive (Single Bond Universal Adhesive), the percentage of microleakage revealed that (20%), (40%), (30%), and (10%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively. For acetone water based self-etch adhesive (G-aenial Bond), the percentage of microleakage revealed that (10%), (30%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively. For solvent free self-etch adhesive (Bond-1 SF) the percentage of microleakage revealed that (20%), (20%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively.

TABLE (2): The frequencies, percentages and results of chi-square test for the comparison between the three groups at occlusal margins:

Storage time	AS Score	Single Bond Universal		G-aenial Bond		Bond-1 SF		P-value
		Frequency	%	Frequency	%	Frequency	%	
1 day	0	9	90	7	70	5	50	0.007*
	1	1	10	3	30	5	50	
1 month	0	6	60	3	30	3	30	0.603
	1	4	40	5	50	5	50	
	2	0	0	2	20	2	20	
6 month	0	2	20	1	10	2	20	0.899
	1	4	40	3	30	2	20	
	2	3	30	3	30	3	30	
	3	1	10	3	30	3	30	

*: Significant at $P \leq 0.05$

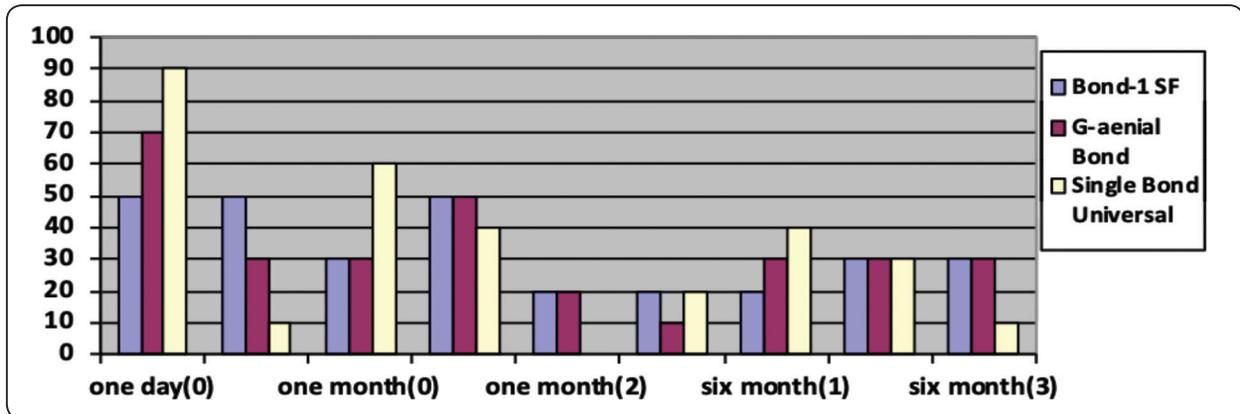


Fig. (1): Bar chart showing the results of chi-square test for the comparison between the three groups at occlusal margins

B) At the gingival margins

After 1 day, there was a statistically significant difference between the three groups. Ethanol water based self-etch adhesive (Single Bond Universal Adhesive) showed percentage (70%) and (30%) of the specimens manifested score 0 and score 1 respectively, followed by acetone water based self-etch adhesive (G-aenial Bond) (40%) and (60%) of the specimens manifested score 0 and score 1 respectively. The solvent free self-etch adhesive (Bond-1 SF) showed the lowest percentage (30%) and (70%) of the specimens manifested score 0 and score 1 respectively

After 1 month, there was no statistical difference between the three groups. Ethanol water based self-etch adhesive (Single Bond Universal Adhesive) showed the percentage of microleakage (50%) and (50%) of the specimens manifested score 0 and score 1 respectively. For acetone water based self-etch adhesive (G-aenial Bond), the percentage of microleakage revealed that (20%), (50%), and (30%) of the specimens manifested score 0, score 1, and score 2 respectively. For solvent free self-etch adhesive (Bond-1 SF), the percentage of microleakage revealed that (60%), and (40%) of the specimens manifested score 0, and score 1.

After 6 month, there was no statistical difference between the three groups. For ethanol water

based self-etch adhesive (Single Bond Universal Adhesive), the percentage of microleakage revealed that (10%), (40%), (30%), and (20%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively. For acetone water based self-etch adhesive (G-aenial Bond), the percentage of microleakage revealed that (0%), (20%), (30%), and (50%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively. For solvent free self-etch adhesive (Bond-1 SF) the percentage of microleakage revealed that (10%), (20%), (30%), and (40%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively.

2. The effect of storage times on the marginal adaptations

A) At the occlusal margins

In the Single Bond Universal Adhesive

The percentage of microleakage scoring after one day revealed that (90%) and (10%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (60%) and (40%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (20%), (40%), (30%), and (10%) of the specimens manifested score 0, score 1, score 2, and score 3.

- ***In the G-aenial Bond:*** The percentage of microleakage scoring after one day revealed that (70%) and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (30%), (50%), and (20%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (30%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3.
- ***In the Bond-1 SF:*** The percentage of microleakage scoring after one day revealed that (50%) and (50%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (30%), (50%), and (20%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (20%), (20%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3.

B) At the gingival margins:

In the Single Bond Universal Adhesive: The percentage of microleakage scoring after one day revealed that (70%) and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (50%) and (50%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (40%), (30%), and (20%) of the specimens manifested score 0, score 1, score 2, and score 3.

In the G-aenial Bond: The percentage of microleakage scoring after one day revealed that (40%) and (60%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (20%), (50%), and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of scoring after six months that

(0%), (20%), (30%), and (50%) of the specimens manifested score 0, score 1, score 2, and score 3.

In the Bond-1 SF: The percentage of microleakage scoring after one day revealed that (30%) and (70%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (60%), (40%), and (0%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (20%), (30%), and (40%) of the specimens manifested score 0, score 1, score 2, and score 3

3- The effect of margins site on the marginal adaptations:

I- In the Single Bond Universal Adhesive: Shows the frequencies, percentages and results of chi-square test for the effect of time at the gingival and occlusal margin. Through all storage times, there was no statistically significant difference between occlusal and gingival leakage.

- ***A) At the occlusal margins:*** The percentage of microleakage scoring after one day revealed that (90%) and (10%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (60%) and (40%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months revealed that (20%), (40%), (30%), and (10%) of the specimens manifested score 0, score 1, score 2, and score 3 respectively
- ***B) At the gingival margins:*** The percentage of microleakage scoring after one day revealed that (70%) and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (50%) and (50%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (40%), (30%), and (20%) of the specimens manifested score 0, score 1, score 2, and score 3.

II- In the G-aenial Bond shows the frequencies, percentages and results of chi-square test for the effect of time at the gingival and occlusal margin. Through all storage times, there was no statistically significant difference between occlusal and gingival leakage.

A) At the occlusal margins: The percentage of microleakage scoring after one day revealed that (70%) and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (30%), (50%), and (20%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (30%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3.

B) At the gingival margins: The percentage of microleakage scoring after one day revealed that (40%) and (60%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (20%), (50%), and (30%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (0%), (20%), (30%), and (50%) of the specimens manifested score 0, score 1, score 2, and score 3

III- In the Bond-1 SF: Shows the frequencies, percentages and results of chi-square test for the effect of time at the gingival and occlusal margin. Through all storage times, there was no statistically significant difference between occlusal and gingival leakage.

A) At the occlusal margins: The percentage of microleakage scoring after one day revealed that (50%) and (50%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (30%), (50%), and (20%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage

scoring after six months that (20%), (20%), (30%), and (30%) of the specimens manifested score 0, score 1, score 2, and score 3.

B-At the gingival margins: The percentage of microleakage scoring after one day revealed that (30%) and (70%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after one month revealed that (60%), (40%), and (0%) of the specimens manifested score 0 and score 1 respectively. The percentage of microleakage scoring after six months that (10%), (20%), (30%), and (40%) of the specimens manifested score 0, score 1, score 2, and score 3

Scanning electron microscope (SEM) observations

A-Scanning electron microscope (SEM) observations after one day

The result of SEM observations of the current study after one day demonstrated that, the thickness of the hybrid layer varied among these different adhesive systems.

B-Scanning electron microscope (SEM) observations after six month: The result of SEM of the current study after one year shows that, all the resinous materials have gaps along the resin dentin interface.

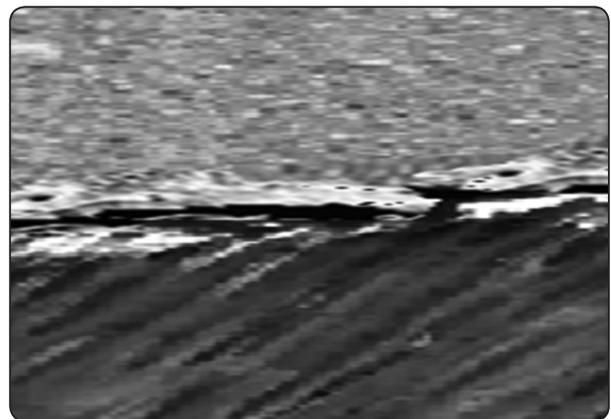


Fig. (2): Scanning electron photomicrograph for the resin dentin interface (at 1500X) using solvent free one step self-etch adhesive after six months of storage showing gaps at the interface .

DISCUSSION

1- Effect of solvent on the marginal adaptation

Solvent free self-etch adhesive: The results of the present study (table 2) revealed that, solvent containing self-etch adhesives provided lower initial micro leakage than solvent free self-etch adhesive system. This can be explained by that, the presence of water as solvent in the composition of self-etch systems is necessary to ionize the acidic monomers and trigger the demineralization process. While the other co-solvents like ethanol are added to form an azeotropic mixture with water and thus accelerate the water remove by means of air syringe drying, and also promote the diffusion of monomers into the dentin ⁽⁶⁾. On the other hand the solvent free adhesive system failed to penetrate in-between dentin structures and to form sufficient hybrid layer, which affected the bond quality of resin composite to dentin so affect negatively on microleakage ⁽⁷⁾.

This is confirmed with the results obtained by previous studies⁽⁸⁾, which concluded that, elimination of the solvent from self-etch adhesive systems may be decrease or hindered the infiltration of adhesive components into dentin, which lead to debility of hybrid zone formation and eventually to a decrease of the bond strength to the dentin. The results of this study disagree with previous study⁽⁹⁾, which evaluated the bond strength of solvent free self-etch adhesive system and two solvent containing self-etch adhesives, and found that, there is no significant difference between solvent free and solvent containing self-etch adhesives. This controversy may be due to differences in the materials or methods that were used.

Solvent containing self-etch adhesives:

The results of the current study (table 2) revealed that the ethanol based adhesive (Single Bond Universal adhesive) showed lowest initial micro leakage compared to the other tested groups (acetone-water based and solvent free adhesives).

This result may be due to its high hydrogen (H) bonding capacity which is higher than that of dried collagen, this allow ethanol to dehydration and stiffening of the matrix without allowing interpeptide H-bonding to collapse. While acetone that found in acetone –water based adhesives (G-aenial Bond) has lower H bonds, so it is not able to expand the shrunken demineralized collagen. It also has higher vapor pressure than ethanol. As the solvent evaporates, the viscosity of the bonding system increases, which decreases the ability of the bonding system to penetrate around the exposed collagen fibers and the opened dentinal tubules producing poor and incomplete hybrid layers ⁽¹⁰⁾.

This is in agreement with previous study ⁽¹¹⁾; which evaluated the effect of HEMA and the type of solvent on the tensile bond strength. They concluded that, the HEMA-rich and ethanol-water-based self-etch adhesives are the “golden standard” in terms of bond strength.

This disagrees with the results obtained by previous study ⁽¹²⁾. Which explain is, the presence of HEMA could allow, in association with ethanol, high bond strength values to dentin, but the association with water as solvent together with ethanol, may interfere and provide an incomplete polymerization. While GB is HEMA free, the strong air blowing of the primed surface is requested to accelerate the evaporation of the solvent and water droplets. This controversy may be due to differences in the materials or methods that were used.

2- Effect of the microleakage site on composite leakage

The data in tables 2 of the current study revealed that the gingival margin leaked more than the occlusal margin. This can be explained by the fact that, the occlusal margin has enamel / dentin but the gingival margin has cementum / dentin therefore affect the marginal seal. However, the cervical dentin is a less favorable bonding substrate than the coronal dentin. This is confirmed with the

results obtained by Civelek A et al in 2003⁽¹³⁾, who concluded that the enamel better seal than dentin.

3- Effect of storage time on the marginal adaptation

The results that presented in tables(2) of this study revealed that all adhesive systems have relative better marginal adaptation through the 24 hours and one month. The better marginal adaptation through these periods of water storage may be due to the short time that lapse of water storage or may be due to strength of the adhesive system itself through this period and strong hybrid layer therefore, may resist polymerization depending stresses⁽¹⁴⁾. Also in this study showed that the microleakages of all adhesive systems increase after six months. This might be due to hydrolytic degradation of the resin and collagen fibers in the submicron spaces of the hybrid layer increase with increased exposure to water⁽¹⁵⁾.

Solvent free self-etch adhesive:

The solvent free self-etch adhesive (Bond-1 SF) showed no significant increase in the microleakage after aging (one day, one month and six months). This may be due to the unique composition of this adhesive, which contains neither water nor organic solvents in the ingredients in order to eliminate technical issues in terms of evaporation of solvents and concerns for the durability of resin-dentin bond⁽¹⁶⁾.

Another explanation for the relatively stable microleakage of solvent free self-etch adhesive (Bond-1 SF) at six months that, the non-solvated adhesives are less hydrophilic and exhibited lower water sorption, solubility and higher degree of conversion when compared to solvated one⁽¹⁷⁾.

Solvent containing self-etch adhesives:

At one day and one month the solvent containing adhesive agents produced lower microleakage values at one day and one month; this may be due to no long-term water storage for hydrolysis and the initial bond strength values do not always correlate

with the long term bond stability, since degradation throughout the bonded interface does not occur rapidly. At six months all solvent containing adhesive agents produced higher microleakage. This could be attributed to the presence of water, a high concentration of hydrophilic domains and residual solvents affect the polymerization reaction, leading to suboptimal degree of conversion and reduced bond longevity as a result of the elution of unreacted monomers. The final consequence of this process is the formation of a porous structure and permeable membrane. Therefore, simplified adhesives are characterized by increased water sorption, which promotes polymer swelling and other water-mediated degradation phenomena⁽¹⁸⁾.

4- Scanning electron microscope (SEM) observations

The scanning electron microscope used to compare the hybrid layer, and shows the restoration /tooth interface, and evaluation of marginal quality.

After one day: In SEM observations of the current study demonstrated that, significant difference between these different adhesives, the thickness of the hybrid layer varied among these different adhesive systems. The solvent containing adhesive systems appeared to produce a thicker hybrid layer and resin tags seem to be more numerous and longer than solvent free adhesive this might be related to the depth of demineralization that attained with each adhesive. However, solvent free adhesive was unable to penetrate into inter tubular dentin so producing small degree of decalcification after dissolution of the smear layer. The buffer capacity of the smear layer and smear plugs may have limited the degree of penetration of solvent free adhesive more than with solvent containing adhesive⁽¹⁹⁾.

After six month: In SEM observations of the current study demonstrated that, no significant difference between the all adhesive systems. The adhesive systems where solvent containing or solvent free appeared to produce a thinner hybrid

layer and resin tags seem to be less numerous and shorter this might be related to the air drying is not able to accomplish significant solvent evaporation in the solvent containing adhesives. As both acetone and ethanol evaporate faster than water because they have higher vapor pressures. Their evaporation increases the concentration of monomers in the adhesives, which lowers the vapor pressure of the remaining residual solvents, making it impossible to evaporate all solvents during air-drying stage. The residual water and solvents is responsible for producing localized areas of incomplete monomer polymerization which generating porosities within the bonded interfaces, in turn, may permit inward diffusion of water molecules during storage⁽²⁰⁾.

* All groups had not scanning because the one day & one month groups are too close so no change will be happen in these closed periods so there is no need to more scanning and cost.

* The results and discussion are long because this study has a lot of variables so I cannot shortcut it more than that.

CONCLUSION

- 1- Storage time has adverse effect on the marginal integrity of solvent containing one-step self-etch adhesive while has no adverse effect on one-step solvent-free self-etch adhesive.
- 2- Microleakage increase obviously at the gingival margin.
- 3- The type of solvent has a positive effect on the marginal integrity, ethanol-water based one step self-etch adhesives showed superior marginal integrity

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