

Bond Strength Between Resin Composite and Glass Ionomer (An in Vitro Study)

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الخلاصة

الاهداف: تهدف الدراسة الى ايجاد قوة الربط الانزلاقي لمادة الراتنج المركب مع السمنت باستخدام انواع مختلفة من المواد اللاصقة للحشوة. **المواد وطرائق العمل:** ستون قاعدة من مادة التفلون (5ملم قطر وارتفاع 4ملم) مملوءة بمادة السمنت GIC ذاتي التفاعل. وقد قسمت إلى مجموعتين رئيسيتين الاولى بدون معاملة (قياسيه) والمجموعه الثانيه عوملت باوكسيد الالمنيوم. ثم قسمت كلتا المجموعتين الرئيسيه الى مجموعتين فرعيتين الاولى بدون معاملة (قياسيه) والمجموعه الثانيه عوملت ب 37٪ من حامض الفوسفوريك. ثم وضعت المادة اللاصقه على السطح المعامل لجميع المجموع. ووضع الجزء الثاني من قالب تفلون (3ملم قطرها وارتفاع 4ملم) فوق القالب الاول و قسمت كلتا المجموعتين الفرعيتين الاولى والثانيه إلى ثلاث مج اميع جديدة: الاولى ملأت بمادة ال tg microhybrid، الثانيه ملأت بمادة ال tg fine glass، والثالثه ملأت بمادة ال Ceram X1. اختبرت العينات بماكئة الاختبار العالميه وفحص نمط الفشل باستخدام ال stereomicroscope. **النتائج:** اختلافات كبيرة للغاية بالنسبة لجميع المتغيرات عند المستوى 1% من الاختلاف باستثناء حامض الفوسفوريك. أوكسيد الالمنيوم كعلاج للسطح اظهر تفوق لقوه الربط (2,3,4) MPa ومادتي ال tg micro hybrid and Ceram X أظهرتا أعلى قيمة لقوه الربط. **الاستنتاجات:** حامض الفوسفوريك لم يظهر أي تحسين على قيمة لقوه الربط في حشوة ساندويتش في حين استخدام أكسيد الألومنيوم للمعالجة السطحية ومادتي ال tg micro hybrid and Ceram X اعطت تحسنا على قيمة لقوه الربط في حشوة ساندويتش. الفشل بشكل رئيسي تماسكي في GIC باستثناء tg fineglass اظهرت فشل تماسكي في ماده الحشوه بخد ذاتها.

ABSTRACT

Aims: The aim of this study was to evaluate the shear bond strength of the resin composite to glass ionomer cement (sandwich technique), using different types of bonding agents. **Materials and Methods:** Sixty Teflon mold of (5mm in diameter and 4mm in height) filled with a based type of light cured glass ionomer cement, cured for (40 seconds), randomly assigned into three groups (n=20) for bonding with different adhesive materials, (Single Bond, i- bond, and TE-Econom) . The bonding applied for (15 seconds). Second split of Teflon mold (3mm in diameter and 4mm in height) placed on to the prepared specimen filled with a Tetric Ceram composite resin (shade A2) , cured for (40 seconds), the samples stored in distilled water at 37°C for 24h ,then thermocycled water for (300 cycles) at (55±2°C and 5±2°C) with a dwell time of (30 seconds). The bond strength measured by using Universal Testing Machine with a Knife edge head placed at the interface between glass ionomer cement and composite at a cross head speed of 0.5mm/min. The modes of fracture were examined by a stereomicroscope at 20X magnification. **Results:** The data were analyzed using (ANOVA) followed by Duncan's Multiple Range Test at 5% .The Single bond total-etching adhesive material showed superior bond strengths than all the other materials tested . i- bond is statistically different and showed intermediary values. The TE-Econom showed the lowest shear bond strength rates and was inferior to the Single bond one. The failures were mainly adhesive fracture for both TE-Econom and Single bond adhesive materials, except for i-bond that showed 60% mixed failure. **Conclusions:** With the limitation of this in vitro study, the high bond strength for the total- etch (Single Bond) bonding agent not mean that self- etch adhesive systems inferior to total -etch bonding, so further studies are needed to agree that total- etch bonding agents was the better form the clinical point of view. The failures were mainly adhesive for Single Bond and TE-Econom bonding agents and mixed failure for i-bond self- etch bonding systems and this dependent on the types of different bonding agents were used in the present study.

Key words: bond strength, adhesive material, glass ionomer cements, resin composite.

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INTRODUCTION

Some dental researchers and clinicians have advocated the use of glass-ionomer cement as a lining under resin composite restorations⁽¹⁾

Much attention has been focused on the development of adhesive systems that will effectively bond resin composite to dentin⁽²⁾. Several dentin bonding adhesives have been developed for the restoration of lost tooth structure^(3,4). The major goals of using dentin bonding agents are to enhance the bonding strength between the resin and the tooth structure, increase the retention of the restoration, reduce the microleakage across dentin-resin interface, and scatter the occlusal stress⁽⁵⁾.

Dental adhesives are used for a wide variety of applications. They are available as etch-and-rinse systems (also known as "total-etch" systems) and self-etch systems. Both systems result in etching of the tooth surface, and mechanical and/or chemical retention of the restoration or device upon curing of the adhesive. The adhesive system selected has implications for the technique used as well as for the quality of the bonding⁽⁶⁾.

Glass ionomer cements have several advantages such as fluoride release,⁽⁷⁻¹¹⁾ adhesion to mineralized dental tissue,⁽¹²⁾ and a coefficient of thermal expansion comparable to that of tooth structure⁽¹³⁾. Because of these favorable properties, Mclean and Wilson⁽¹⁴⁾ proposed the placement of glass ionomer cement on dentin prior to the application of a resin composite. This restorative method is commonly referred to as the sandwich technique. This procedure makes optimal use of the adhesive properties and biocompatibility of the glass ionomer cement and the desirable surface and esthetic appearance of composite resin.

Among the factors that may affect the bond strength between a resin composite and a glass ionomer cement are the tensile strength of the cement, itself, the adhesive system and the composite resin, employed⁽¹⁵⁾, the type of glass ionomer cement⁽¹⁶⁾, the surface treatment of the cement⁽¹⁷⁾ and shear strength; which defined as the force per unit area that would listed one portion of the material to slide against another portion⁽¹⁸⁾, shear bond strength is

commonly used to test the strength of bonding materials.

Several studies have been done on the effectiveness of self-etching materials on the adhesion of composite to glass ionomer cement. However controversial results have been reported about the bonding performance of adhesives⁽¹⁹⁻²¹⁾. The aim of this study was to evaluate the shear bond strength (using different types of bonding materials), of a resin composite to the glass ionomer cement (sandwich technique).

MATERIALS AND METHODS

Sixty specimens of a light cured base glass ionomer cement (FREEDOM SDI Bayswater, Victoria 3153, Australia) were prepared using Teflon mold, the mold had a central hole measuring (5mm) in diameter and (4mm) in height, each hole was filled with glass ionomer cement using an incremental technique with a plastic instrument and covered with microscopic slid to produce a smooth surface and to facilitate light curing, each specimen was cured for (40 seconds) according to manufacture instruction. Light cure unit (Translux® curing unit. Dental curing light unit, Europe) was used for all curing procedures in the present study.

The samples were randomly assigned to three groups (n=20) for bonding with three different adhesive systems:

Single Bond (3M ESPE ST. PauL. Minn).

i-bond (Heraeus Kulzer, Hanau, Germany).

Te-Econom (Ivoclar – vivadent AG schaan, Liechstein).

Bonding materials was applied and cured for (15 seconds) with light brushing motion according to the manufacturer instructions. Second split of Teflon mold (3mm in diameter and 4mm in height) was placed on to the prepared specimen. A Tetric Ceram composite resin shade A2 (Ivoclar vivadent, AGFL-anau schann/Leichtenstein), was inserted into the mold incrementally, and cured for (40 seconds) (according to the manufacturer's instructions) from the top of the specimens. After curing the second split mold was removed.

The samples were stored in distilled water at 37°C for 24h, thermo-cycled for (300 cycles), each a cycle consisted of 30 seconds at 55±2°C and 5±2°C with a dwell time of 30 seconds⁽²²⁾.

The bond strength between the glass ionomer cement and composite was measured by using Universal Testing Machine with a Knife edge head placed at the interface between glass ionomer cement and composite at a cross head speed of 0.5mm/min⁽²³⁾.

The modes of fracture were examined by a stereomicroscope (Zeiss, MC 63A, Germany) at 20X magnification power.

Data were tabulated and statistically analyzed. They were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test at 5% level of significance to indicate if there were

any statistical difference in shear bond strength of the three groups.

RESULT

Table (1) shows the mean shear bond strengths (in MPa) for the different groups, as well as the results of the Duncan's Multiple Range Test. Figure (1) explain the comparison of mean values between the different groups. The Single Bond total-etching adhesive material showed superior bond strengths than all the other materials tested, i-bond self-etching adhesive is statistically different and showed intermediary values. The TE- Econom (all-in-one adhesive) showed the lowest shear bond strength that inferior to the Single bond one.

Table(1) Mean bond strength (± standard deviation) obtained for the different groups and the results of the Duncan test

Shear strength (MPa)			
	SD	Mean	
A	0.11	4.14	Single bond
B	0.23	3.69	i- bond
C	0.03	2.90	TE- Econom

Different letters mean significant difference at $p \leq 0.05$

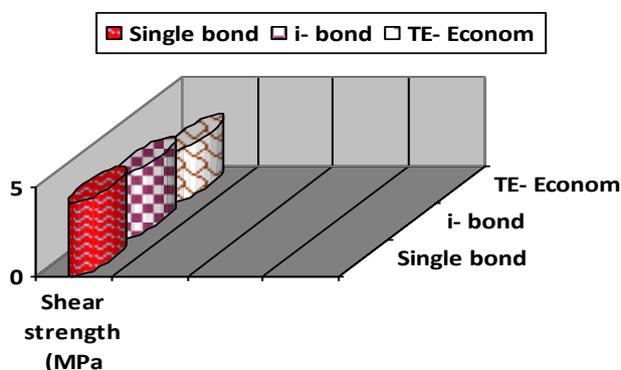


Figure (1): Comparison of mean shear bond strength values among different groups

The mode of failures were mainly adhesive type of fracture for Single Bond and TE- Econom adhesive materials, while

i- bond showed 60% mixed failure, Table (2).

Table(2) Mode of fracture (failure) in percentages for : (Single bond, i- bond,TE- Econom).

Mixed	Adhesive	Adhesive system
20%	80%	Single bond
60%	40%	i- bond
10%	90%	TE- Econom

DISCUSSION

The laminate or "sandwich" technique has been suggested primarily for lessening microleakage. The bond strength between the glass-ionomer cement and resin composite is highly dependent on the adhesive systems used, the methods of handling, types of composite resin and the glass ionomer cement employed.^(1,24,25)

The high bond strength with the total etch Single Bond achieved on the present study, may be due to unfilled nature of the adhesive with lack of nanofillers which may reduce shrinkage and increase rigidity and bonding of the adhesive, thus acting as an intermediate shock absorber that responsible for high bonding. The current study agree with the study by Crim and Deliperi et al., who stated that the unfilled adhesive with lack of nanofillers, responsible for high bonding strength of total- etch adhesive agents^(26,27).

The one- bottle self-etching (i- bond) systems, represents the latest simplification of adhesive systems that showed low bonding strength in the present study comparing to total etch and this may be due to excessive water content of the adhesive system which dilute the primer of the adhesive and reduce its effectiveness. So water-based adhesive systems may result in lower bond strength that is due to incomplete polymerization of the monomers^(28,29).

Self -etching adhesive systems are undergoing rapid advancements and the simplification in the adhesive technique became a major requirements in current practice but, the degree of the bonding ability is still questionable.

Self-etching adhesives, by virtue of their self-etching nature, contain acidic monomers and water. The effectiveness of a self-etch adhesive system depends on multiple factors. The result of this study was in agreement with Moura et al., who demonstrated that self- etch systems showed lower bond strength compared to total-etch bonding agents⁽³⁰⁾.Shinohara et al., concluded that low bond strength with questionable bonding effectiveness was achieved with self-etching adhesive systems⁽³¹⁾. Nakabayashi and Takarada noticed that the hydrophilic nature and evaporable solvent responsible for low bonding ability of the self- etching systems⁽³²⁾.

In the present study, the bond strength of all-in-one adhesive TE-Econom differ significantly from that of self-etching bonding agent and this may be due to the hydrophilic nature of monomers and the presence of evaporable solvent of TE-Econom system⁽³³⁾. Elghandour and Elgezawi demonstrated the same result that were a significant difference in shearing strength between TE- Econom of all-in-one adhesive system and self- etching bonding agents⁽³³⁾.

The failures were mainly adhesive within the TE- Econom and Single bond adhesive materials, except 60% for i- bond self-etching adhesives that showed mixed failure and this can be explained by difference in the composition of the bonding agents and the methodology used as stresses within the bonding interface in shear bond test is highly dependent on test geometry and loading configuration employed . This finding is in agreement with Van Noor et al.,and Borges et al., who concluded that the

adhesive failure occur more frequently with Single Bond and TE- Econom adhesives while failures were mainly mixed for i-bond adhesive^(34,35).

The high bond strength for total- etching agents make it superior to self-etching bonding to be used clinically, but farther studies are needed about microleakage, sealing ability, biocompatibility and acidity.

CONCLUSIONS

1-The limitation of this in vitro study, the high strength was for Single Bond while i- bond and TE- Econom were not differ significantly.

2-The high bond strength for the total-etch (Single Bond) bonding agent not mean that self-etch adhesive systems inferior to total – etch bonding, so further studies are needed to agree that total-etch bonding agents was the better form the clinical point of view.

3-The failures were mainly adhesive for Single Bond and TE- Econom bonding agents and mixed failure for i- bond self-etch bonding systems and this dependent on the types of adhesive bonding agents were used in the present study.

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