

Shear bond strength of fluoride release core materials to dentine

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ABSTRACT

The aims of this study were to determine the mean shear bond strength of fast setting fluoride releasing core materials (vitremer core build up restorative system, compoglass F resin modified glass ionomer, Tetric ceram composite and Definite composite) to dentin and the effect of one hour, 24 hour, and one week storage on mean shear bond strength.

One hundred thirty molar teeth were mounted in a plastic cylinder using self curing resin, then the teeth were prepared to expose flat superficial dentinal surfaces. Each material was mixed according to the manufacturer's instructions. A prefabricated nylon mold was applied to the exposed dentin, filled with the core material, then light cured and stored in distilled water at 37°C for one hour, 24 hours and one week.

The 24 hours and one week storage groups were thermocycled (5°C to 55°C) for 100 cycles before shearing. The specimens were tested with universal compression machine and the mode of failure was observed. The result showed that Vitremer core build up exhibited the greatest bond strength followed by compoglass F and then Tetric Composite, Definite showed the lowest for all storage time.

The differences among time groups were not statistically significant except for vitremer core build up and compoglass F which showed an improvement after 24 hour storage.

The adhesive mode of failure revealed a combination of cohesive adhesive failure and failure for vitremer core build up and compoglass F and adhesive failure for Tetric ceram and Definite composite resin.

Key words: Shear bond strength, resin modified glass ionomer, fluoride releasing core material.

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الخلاصة

ان الهدف الرئيس من الدراسة تحديد معدل قوة الانزلاقي للمواد المستخدمة في بناء الجزء المركزي السريع التصلب والتي لها القابلية على تحرير مادة الفلوريد (فيتريميز، كومبوكلاس ف، نيتريك سيرام وديغنت كومبوسيت) لعلاج السن وكذلك تأثير خزن المادة خلال 1 ساعة، 24 ساعة، واسبوع واحد على معدل الربط الانزلاقي.

تم اعداد مائة وثلاثون عينة بتثبيت الاسنان في اسطوانة بلاستيكية باستعمال مادة الراتنج الاكديلي ذاتي التصلب، وبعد ذلك حضرت الاسنان لكشف الطبقة السطحية من عاج السن، تم تثبيت قالب نايلوني على سطح العاج المكشوف ثم ملأ بالمواد المراد فحصها. وبعد ذلك تم وصلها بواسطة جهاز التصلب الضوئي وحفظت في الماء المقطر بدرجة حرارة 37م لمدة اساعة، 24 ساعة، واسبوع واحد . المجاميع التي حفظت لمدة 24 ساعة واسبوع واحد خصت لعملية التدوير الحراري (5-55)م لمدة 100 مرة قبل الفحص بعد ذلك تم فحص معدل قوة الربط الانزلاقي للنماذج ونوع الفشل. ثم جمعت النتائج وتم تحليلها وتم تحليلها احصائيا. أظهرت النتائج الاحصائية ان الاختلاف بين المجاميع التي حفظت لاوقات مختلفة كانت غير معنوية احصائيا ما عدا مادة الفيتريميزير والكومبوكلاس ف التي أظهرت تحسنا في معدل الربط الانزلاقي بعد 24 ساعة من التدوير الحراري.

أظهرت النتائج أيضا ان مادة فيتريميز اعطت اعلى قوة ربط، تليها مادة كومبوكلاس ف، ثم مادة تترك سيرام. ان مادة ديفينيت كومبوسيت اعطت اقل قوة ربط انزلاقي لكل المجاميع مع اختلاف زمن الحفظ. أظهرت نتائج الفحص لنوع الفشل ان نوع الفشل الحاصل هو فشل مشترك، فشل في الربط وفي مادة الحشو وفشل احادي في الربط لمادة الفيتريميزير والكومبوكلاس ف وكان الفشل احادي في الربط لمادة التترك سيرام ومادة ديفينيت كومبوسيت.

INTRODUCTION

A core restoration is often required in endodontically treated teeth to achieve a satisfactory form of resistance and retention of a cast restoration, it should provide a sufficient strength to resist the intraoral, compressive, shear, and complex forces ⁽¹⁾. Amalgam has been used as a core material with satisfactory result, however its relatively high coefficient of thermal expansion ⁽²⁾, the need for matrix band during condensation, and inability to complete a crown preparation in the same visit may restrict its use in some clinical cases.

An effort has been made to develop fast setting core materials that will enable us to do the core and crown preparation in one appointment. Composite resin represent an improvement over unfilled resins but still have many disadvantages, these include a polymerization contraction and relatively highly coefficient of thermal expansion which results in a poor adaptation of resins to the tooth structure and subsequent leakage at the margin ⁽³⁾. The alteration of the tooth structure by the acid etching and the use of the bonding agent can improve to a certain degree the seal of composite to the tooth ⁽⁴⁾.

Glass ionomer cements introduced by Wilson and Kent (1972) which have chemical bond to enamel and dentin ⁽⁵⁾, fluoride release ⁽⁶⁾ and a coefficient of thermal expansion that is similar to that of dentin ⁽⁷⁾, However their low wear resistance, low tensile strength and

brittleness restrict their use as core materials⁽⁸⁾.

The addition of metal alloy to strengthen the glass ionomer material so that it could be used as a core build up⁽⁹⁾. Recently, new core materials were introduced, light-cured resin modified glass ionomer and fluoride release composite resins, which can be also bonded to dentin through its universal bond primer and adhesive, and has a significantly greater compressive and flexural strength⁽¹⁰⁾.

The study was designed to determine

- 1- The shear bond strength of fluoride release core materials to dentin.
- 2- The effect of 1 hour, 24 hour and 1 week storage time on the shear bond.
- 3- The effect of 4th generation (Syntac multistep) and 5th generation (Syntac single component) on shear bond strength of Tetric composite to dentin.

MATERIALS AND METHODS

Two types of resin modified glass ionomers (Vitremer core build up restorative system and Compoglass F) and two types of composite resins (Tetric ceram and Definite) were used in this study, the batch numbers are shown in table (I).

Table (I) Materials used in the definitive study

Material	Manufacture	Batch Number
Vitremer core build up /restoration system	3m, dental product, St.paul,MN 55144	33031
Compoglass F	Vivadent , Schaan / liechtenstein Fi-9494	B10384
Tetric cream compisiteresin	Vivadent , schaan/Leichtenstein Fi-9494	B36278
Definite composite resin	Degussa-atuls AG	039817
Syntac single_component	Vivadent , schaan/ liechtenstein Fi-9494	Bo2o95
Etching gel	Vivadent , schaan /liechtenstein fi-9494	B09250
Syntac primer	Vivadent , schaan/ liechtenstein fi-9494	B05896
Syntac adhesive	Vivadent , schaan /liechtenstein Fi-9494	B03882
Helio Bond	Vivadent , Schaan / liechtenstein Fi-9494	B05853
Etch and prime catalyst	Degussa-ituls AG	099814
Etch and prime universal	Degussa-ituls AG	069811

One hundred thirty permanent molar teeth were selected, scaled with non-fluoridated pumice, randomly divided into four groups and 13 subgroups were in turn distributed of ten teeth each they were stored in distilled water and refrigerated until used for no more than three months⁽¹¹⁾. The teeth were mounted in upright position in poly vinyl chloride plastic ring of 2.5cm in diameter in such away that the crown portion of the tooth was protruded. A soft mixture of cold cure acrylic resin was poured around the tooth, after setting the mold was transferred into a container with distilled water to avoid dehydration. The teeth were prepared by cutting the occlusal enamel with diamond bur (Black diamond Inc. USA) then was ground wet with 400 grit abrasive paper followed by 600 grit abrasive paper to expose the underlying superficial dentin the ground dentin surface were examined with reflecting microscope (corlzeis, Germany) at X50 magnification to ensure no enamel remnant left. Then the tooth was thoroughly washed and dried with oil free compressed air.

A circular hole, 4.5mm in diameter was punched in adhesive tape, which was positioned on the ground dentin to demarcate the bonding region. The bonding region was treated according to the manufacturer's instructions of each material used in table II.

A cylindrical nylon tube of 2mm height 5mm diameter was placed on the bonding side and stabilized with sticky wax. Then an increment of the core material used was introduced into the tube with a plastic instrument and adapted to avoid air entrapment until the tube filled, a glass slide was placed over the top of the tube and a 200 gram weight was placed over the glass slide through which the tip of curing light could be applied to cure the material⁽¹²⁾ Figure (1). The curing of the material was done using light cure unit (Dentsply, USA) for forty seconds. The specimens were stored in distilled water at 37°C in an incubator (Galbn Kamp, England). The specimens were subjected to an alternating manual thermocycle of 5±2°C and 55±2°C for 100 cycles, the dual time at each temperature was 30 seconds and the transport time between the water baths was 15 seconds.

The samples were divided into groups

Group A: The teeth were treated with vitremer primer for 30 seconds, air dried for 15 seconds and light cured for 20 seconds. Then powder and liquid of vitremer was mixed, filled and cured for 40 seconds. This group was subgrouped into:

A1: Teeth were tested about one hour after placement of the core material.

A2: Teeth were stored for 24 hours and thermocycled for 100 cycles before testing.

A3: Teeth were stored for one week and thermocycled for 100 cycles before testing.

Group B: The teeth were treated with syntac single component for 20 seconds, light cured for 20 seconds then a second layer of syntac single component was applied, light cured for 20 seconds, then compoglass F was applied and light cured for 40 seconds. This group was subgrouped into:

B1: Teeth were sheared about one hour after placement of the core material.

B2: Teeth were stored for 24 hours and themocycled for 100 cycles before bond testing.

B3: Teeth were stored for one week and thermocycled for 100 cycles before bond testing.

Group C: The teeth were treated with 37% acid gel for 15 seconds, then rinse off the acid with water for 15 seconds and tooth surface was dried with oil free air. Syntac primer was applied for 15 seconds and dried. Then syntac adhesive was applied and allowed to react for 10 seconds and dried for 5 seconds, Then Heliobond was applied and light cured for 20 seconds. Then Tetric ceram composite was applied and light cured for 40 seconds. This group was subgrouped into:

C1: Teeth were sheared after one hour after placement of the core material

C2: Teeth were stored for 24 hours and thermocycled for 100 cycles before testing.

C3: Teeth were stored for one week and thermocycled for 100 cycles before testing.

C4: This subgroup was designed to compare the effect of single component, (one step adhesive) and syntac multi step adhesive on shear bond strength of Tetric ceram to dentin specimen were stored after treatment in a distilled water for 24 hours in an incubator at 37°C and thermocycled for 100 cycles before testing.

Group D: Teeth were treated with two layers Etch and prime 3.0 then the teeth were dried for 5-10 seconds and light cured for 10 seconds then Definite composite was applied and light cured for 40 seconds. This group was subgrouped into:

D1: Teeth were sheared one hour after placement of the core material

D2: Teeth were stored for 24 hours and thermocycled for 100 cycles before bond testing

D3: Teeth were stored for one week and thermocycled for 100 cycles before bond testing.

The bond strength was measured quantitatively with a universal compression machine (Electric compression apparatus, soiltest co. Inc.; USA). The specimen was tested at a cross-head speed of 0.5mm/min. After calculating the area of the bonding in mm² and the magnitude of the loading from the dial gauge in Kgm, the force was divided over the surface area, then the results were recorded in megapascal and the data were statistically analysed.

t-test was used to compare the effect of syntac multistep and syntac single component on the shear bond strength of Tetric composite to dentin.

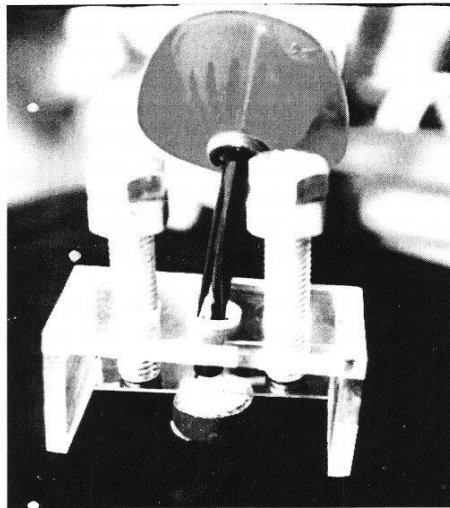


Figure (1) Specimen under load during curing procedure

RESULTS

The results illustrated in Figure (2) and Table (II) show that vitremer resin modified glass ionomer produce significantly the highest shear bond strength for the different storage time used in this study. Definite composite produce the lowest shear bond strength value for all storage groups.

Table (II) Mean bond strength (mpa) of the fluorides release core materials to dentin for the different storage times

Material	Mean after 1hour	SD	No. of samples	Mean after 24 hours	SD	No. of samples	Mean after 1week	SD	No. of samples
Vitremer core built up	9.50	±1.17	10	12.73	±2.17	10	14.22	±2.42	10
Compoglass	7.89	±1.29	9	11.31	±1.10	10	12.51	±2.35	10
Tetric	8.64	±2.40	9	10.68	±1.6	10	11.15	±2.49	10
Definte	3.17	±0.82	8	3.75	±1.30	10	4.18	±1.70	10

The results showed that the bond strength for the 24 hour and 1 week storage were statistically higher than one hour storage for the vitremer core built up restorative system and compoglass.

There was no statistical difference in bond strength among the three storage time for Tetric composite and Definite composite except after week storage for Tetric which is statistically higher than one hour storage.

The effect of bonding agent. Table III showed that syntac multistep system was produce significantly higher shear bond strength than syntac single component $P < 0.05$.

Table (III) Mean standard deviation and T-test of syntac multi step and syntac single component

Variable	Mean Mpa	S.D	t. test	2-tail significant	P level
Syntac Multi Step	10.68	1.69	3.90	0.004	P<0.05
Syntac Single	7.06	2.34			

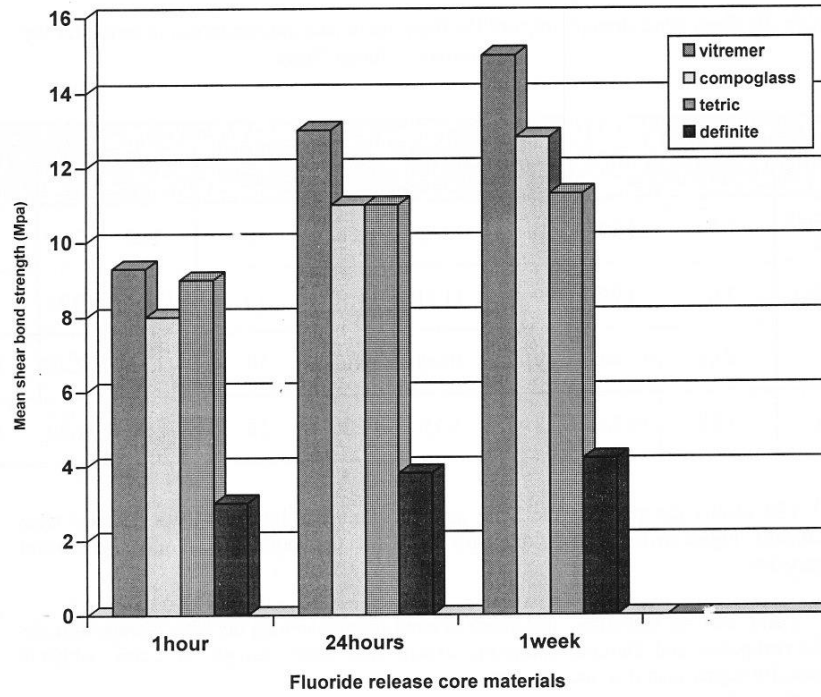
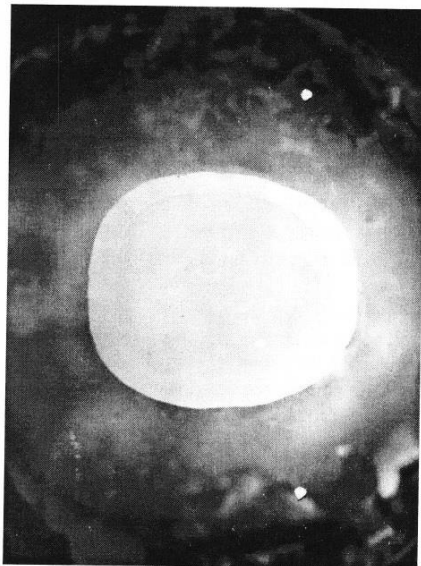


Figure 2. Mean shear bond strength of the fluoride release core materials to dentin for the different storage times

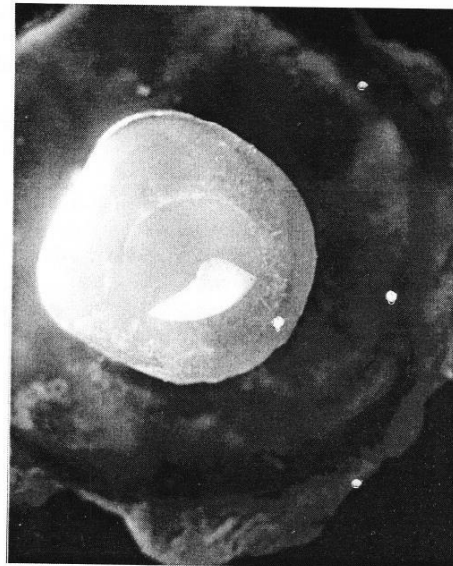
Mode of failure: Microscopic examination with reflecting light microscope of the debonded surfaces exhibited various combination of adhesive and cohesive failure. Table (IV) and Figure (3)

Table (IV): Mean and percentage for each type of failure modes in the four groups of the experiment.

Material	Mean bond strength (Mpa)	Adhesive failure %	Cohesive failure with in material %	Cohesive adhesive failure %	Total %
Vitremer	12.13	40	0	60	100
Compoglass	10.57	44	0	56	100
Tetric	10.16	100	0	0	100
Definte	3.71	100	0	0	100



(A)



(B)

Figure 3 made of failure.

(A)Adhesive failure .

(B)combination of adhesive- cohesive failure

DISCUSSION

The present work shows that the resin modified glass ionomer produce higher bond strength, it is possible that the mechanism of bonding of these glass ionomer to dentin is the cause of these result, vitremer core build up and compoglass F bond chemically to dentin⁽¹³⁾, In addition, the dentin surface was treated with vitremer primer before using vitremer core build up restorative material, and for the compoglass F the dentin surface was treated with syntac single component. Both vitremer primer and syntac single component contain HEMA (2 Hydroxy ethyl melhacrylate) in their composition which improve the wetting of dentin and the bond strength was enhanced.

It seems from the results that Definite composite resin had the lowest bond strength, this finding has come in agreement with Frankenberger and kramer⁽¹⁴⁾. This low bond strength could be attributed to the calcium and phosphate that were desolved from the dentin surface must be suspended in the water which was evaporated during air drying. The concentration of calcium and phosphate tend to limit a further demineralization so, it limit the depth of demineralization, on the other hand it was likely evaporation of water during air drying as well as light cured of Etch and prime 3.0 restrict and inhibit the self Etching effect of Etch and prime 3.0 molecules.

In this study the bond strength of vitremer and compoglass to dentin increased with increasing storage and this finding was in agreement with many investigators^(15,16) this may be due to the fact that the matrices of the vitremer and compoglass consist of a cross - Linked polyalkenoate network resulting of acid - base reaction, the presence of HEMA made the acid base reaction proceeds at a lower rate⁽¹⁷⁾, thus the maturation of polyalkenoate network was continuing with increasing storage time.

For the composite resin no increase in bond strength and this has come in agreement with other studies^(16,18).

The explanation of this finding may be that the polymerization of light activated composite resin took place mainly during the first hour from polymenzation. This finding was in disagreement with previous worker⁽¹⁹⁾ who found a decreasing in the bond strength after seven days of storage.

The group of dentin specimen treated with syntac multistep had a significantly higher bond strength than that treated with syntac single component this finding has come in agreement with previous worker⁽¹⁴⁾. The explanation of this finding may be due to the inadequate resin penetration to dentin of syntac single component when it was compared with syntac multistep.

The mode of failure: Debond surfaces of vitremer and compoglass exhibit more combination of adhesive cohesive failure. This has come in agreement with other study⁽²⁰⁾ which may be due to the development of the ion enriched layer of the cement on the surface of dentin in the retention of glass ionomer cement⁽²¹⁾, so after testing a part of the resin modified glass ionomer stayed on the tooth due to the chemical linked between the HEMA and the polyalkenoate network within the dentin through the methacrylate group. This finding was confirmed by other authors^(22,23).

CONCLUSIONS

From this study it was concluded that:

- 1- The shear bond strength of resin modified glass ionomer to dentin exceed that of

composite resin.

2- Shear bond strength was significantly increase with increasing storage time 1 hour, 24 hour and 1 week for the resin modified glass ionomer.

3- Syntac multistep (4th generation bonding agent) produced significantly a higher shear bond strength to dentin than syntac single component.

4- The mode of failure directed toward a combination of adhesive, cohesive failure and adhesive failure alone for resin modified glassionomer, while composite resin failed adhesively.

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