

## Shear Bond Strength of Chemical and Light Cured Glass Ionomer Cements Bonded to Resin Composite

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### Key words

shear bond strength, sandwich techniques, glass ionomer cements

### Abstract

The purpose of this study was to compare the shear bond strength of chemically cured (Conventional) glass ionomer cement and light cured (Resin modified) glass ionomer cement to resin composite and to evaluate the effect of acid etching of the glass ionomer cements on the shear bond strength.

Forty acrylic molds were prepared, a hole (6×2) mm was prepared in each mold to retain the glass ionomer cements (GICs). The samples were divided into two main groups. The first group were filled with Conventional GIC and the second group were filled with Resin modified glass ionomer cement (RMGIC), then each group were subdivided into two subgroups, the first subgroup were acid etched and the second subgroup were left without etching. The bonding agent applied to the demarcated bond area on the GIC surface, the composite resin cylinders were built up over the GIC base. The samples were stored for one week in deionized water then thermocycled. The samples then tested for shear bond strength (SBS) using universal testing machine.

The result shows that Independent samples T-test used for statistical analysis. The result showed that RMGIC significantly had higher SBS than conventional GIC. No statistical difference was shown in SBS between subgroup etched and without etching for RMGIC, but the conventional GIC showed significantly higher SBS in subgroup without etching than with etching.

This study Conclude that the SBS of RMGIC to resin composite was significantly higher than that of conventional GIC. Acid etching the GIC surface did not improve the SBS of GICs to resin composite.

### Introduction

Glass ionomer cement (GIC) was developed and first presented by Wilson and Kent in 1972<sup>(1)</sup>. GICs exhibit several clinical advantages such as physico-chemical bonding to tooth structures<sup>(2)</sup>, fluoride release<sup>(3)</sup>, and low coefficient of

thermal expansion<sup>(4)</sup>. However, these materials have some clinical limitations, such as prolonged setting time, moisture sensitivity during initial setting, dehydration, and rough surface texture, which can hamper mechanical resistance<sup>(5)</sup>. Resin-modified glass ionomer (RMGIC) has been developed to overcome the problems of moisture sensitivity and low initial mechanical

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strengths typical for conventional glass-ionomers.<sup>(6)</sup> In addition to the conventional GIC formulation, RMGICs contain polymerizable monomers and photo initiators<sup>(7)</sup>. RMGICs were basically formed by adding methacrylate components to the polyacrylic acid, which are polymerizable by light-curing supplementing the fundamental acid-base reaction<sup>(8)</sup>. The mechanical properties and esthetic appearance still limit its clinical use. Thus, the so-called sandwich restoration or "composite-laminated GIC" technique has been used by clinicians to preserve the fluoride release mechanism and the chemical bond to tooth structure provided by the GIC and RMGIC, and to improve the esthetic and mechanical properties using a resin composite laminate<sup>(9)</sup>. The purpose of this study was to compare the shear bond strength of chemically cured (conventional) glass ionomer cement and light cured (Resin modified) glass ionomer cement to resin composite, and to evaluate the effect of acid etching of the glass ionomer cements prior to the application of a bonding agent and composite resin on the shear bond strength (SBS) at the glass ionomer cement/composite resin interface.

## Materials and Methods

Two glass ionomer cements used in this study: chemically cured glass ionomer cement (conventional GIC) (Meron, VOCO, Cuxhaven, Germany) and light cured glass ionomer cement (Resin modified glass ionomer cement (RMGIC)) (Vivaglass Liner, Ivoclar Vivadent) using the same bonding agent (Retensin Plus adhesive, Sofa Dental) and composite resin (Te-Econom Plus, Ivoclar vivadent). Forty acrylic molds (2×2.5) cm were prepared from cold cure acrylic resin. A hole of 6 mm in diameter and 2mm depth was prepared at the center of each acrylic mold. Forty samples were prepared and divided into two main groups of 20 specimens each: The first main group used conventional GIC and second main group used RMGIC, then each main group subdivided into two subgroups each of 10, in the first subgroup, the surface of GICs

were etched with 37% phosphoric acid for 15 seconds while in the second subgroup, the surface of GICs were not etched. The hole was then filled with glass ionomer cement mixed according to the manufacturers instructions, and covered with a glass microscope slide to produce smooth surface and to permit for curing the material<sup>(9,10)</sup>. The chemical cure GIC had already set, the setting time is 5-7 minutes, whereas the RMGIC was light cured for 30 seconds according to the manufacturer's instructions using a conventional QTH (Astralis, VIVADENT, Austria). Then the glass slide was carefully removed, ensuring that the smooth surface was not pitted. A circular area 4mm in diameter was demarcated at the center of the GIC surface through the application of an adhesive tape with a circular hole 4mm in diameter on the prepared GIC surface, the demarcated GIC surface was then treated with a layer of adhesive resin bonding agent, thinned with a gentle air blast and light cured for 20 seconds according to the manufacturers' instructions, the subgroups which were acid etched, the demarcated GIC surfaces were etched with 37% phosphoric acid gel for 15 seconds then washed with water spray for 30 seconds and dried with oil free air. Rubber mold with (4×4) mm internal hole diameter was applied over the adhesive tape that was placed over the GIC surface so that the hole in the rubber mold was positioned over the hole in the adhesive tape and attached in its positions by two points of wax to the acrylic block. The mold was split vertically in one place through its entire thickness using a surgical blade so that the later removal from around the composite was facilitated without putting undue stress on the composite sample. Resin composite was then packed against the demarcated GIC surface through the rubber hole with ash plastic instrument in 2 increments, 2mm thickness of each increment, each increment light cured vertically for 40 seconds, the composite cylinders cured for 20 seconds horizontally on each side at 90 angles to ensure complete curing of the material. As shown in Figure (1). The samples stored in deionized water at 37C° in an incubator for

7 days, then thermocycled for 60 cycles between  $5\pm 1^{\circ}\text{C}$  and  $55\pm 1^{\circ}\text{C}$  with a dwell time of 30 seconds<sup>(11)</sup>. Shear bond strength of each samples was measured using a universal testing machine (Soil Test Co., Inc., USA). A shear load was applied to the glass ionomer/composite interface with a knife-edged rod of 0.5 mm width at a crosshead speed of 0.5mm/min<sup>(6,11,12)</sup>. The bond strength at failure was calculated as the recorded failure load divided by the surface area of the bonded surface ( $12.56\text{mm}^2$ ) and expressed in Megapascal. The GIC/composite interface was examined with stereo microscope at 40X magnification to determine the fracture modes.

## Results

Descriptive statistic including the mean shear bond strength (SBS) in Mega Pascal, standard deviation (SD), standard error (SE), minimum (Min) and maximum (Max) values of SBS and number of samples (N) for each groups are shown in Table 1 and Table 3. The mean shear bond strength (SBS) in Mega Pascal for each group was shown in Figure (2). Independent samples T-test (Table 2 and Table 4) was performed for statistical analysis. All statistical analyses were considered significant at  $P\leq 0.05$ . The result (Table 2) showed that the RMGIC had significantly higher SBS to resin composite than conventional GIC. For conventional GIC, the result (Table 4) showed that the group which was acid etched significantly had lower SBS to resin composite than the group which was not acid etched. While for RMGIC, (Table 4) showed no significant difference in SBS to resin composite between the group which was acid etched and the group which was not acid etched.

### Mode of failure

The failure mode classified as follow:  
1-Cohesive failure within material,  
2-Adhesive failure of the bond and  
3-Mixed (adhesive and cohesive failure).  
(Figures 3,4,5 and 6).

## Discussion

Although the cement is applied beneath a restoration, the cement layer is exposed to stress through the restoration during chewing. Therefore, the mechanical properties of cements, as well as their adhesive properties, are important factors that influence the durability of restorations in the oral cavity<sup>(13)</sup>. According to the result of this study, the RMGIC exhibited higher SBS to resin composite than conventional glass ionomer cement, Vivaglass liner which used in this study contain HEMA and Dimethacrylate which bond with composite resin. RMGIC has a better bonding to composite resin than the conventional GIC, This is due to a similar chemistry between RMGIC and the composite resin, which allows the strong bonding of RMGIC to composite resin. Both RMGIC and the resin composite are cured by a free radical initiator system, which provides a potential for the chemical bonding between these two materials. Moreover, hydroxyethyl-methacrylate (HEMA) incorporated into the glass ionomer cement, forms a chemical bond with the resin of the composite<sup>(9)</sup>. Increased availability of unsaturated double bonds in the air inhibited layer of the RMGICs may assist in the chemical bonding to the resin bonding agent and resin composite. Unpolymerized HEMA on the surfaces of RMGIC increases the surface wetting capability of the bonding agent and could increase the bond strength when polymerized<sup>(14)</sup>. The bond strength between conventional GIC and the composite resin is reduced by the low cohesive strength of GIC and by minimal chemical bonding, due to the different chemical reactions of these materials<sup>(15)</sup>.

According to result of this study, for conventional GIC (Table 4), the group which was acid etched showed significantly lower SBS to resin composite than the group which was not acid etched, because acid etching leads to a decrease in the strength of the GIC. Besides, dissolution acid etching may also introduce cracks in the GIC<sup>(16)</sup>. Acid etching forms a weak zone in the cement

which can be partially reinforced with the bonding agent. During shear testing, failure occurs at this weakened region<sup>(11)</sup>. Etching GICs immediately after initial set creates a weak mechanical bond and has been shown to have a deleterious effect on the material<sup>(16)</sup>, while waiting for 24 hours prior to etching slightly improves the bond strength, it is impractical as a clinical protocol<sup>(17)</sup>. For RMGIC the result showed no significant difference between the group which was acid etched and the group which was not acid etched. In the resin-modified cements, the acid etching may remove the air-inhibited layer on the surface of the cement and decrease the

potential for chemical bonding to the adhesive system<sup>(14)</sup>.

**Conclusion**

From the result of this study it can be concluded that RMGIC had better SBS to resin composite than conventional GIC and it is the material of choice. In addition the acid etching the GICs prior to placement of bonding agent and resin composite in sandwich restoration did not improve the SBS of GICs to resin composite.

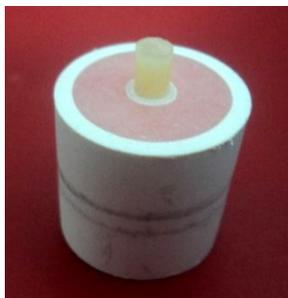


Fig. (1):-The sample.

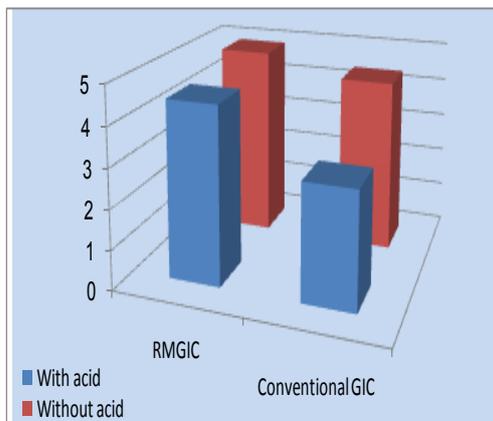


Fig.(2):-The mean SBS of all groups.

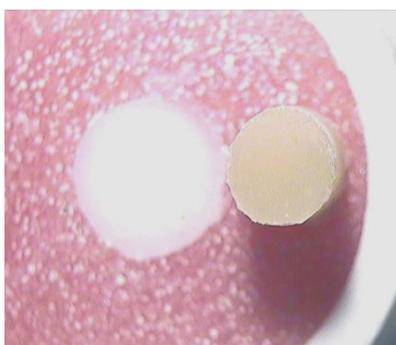


Fig.(3):- Adhesive failure.



Fig.(4):- Cohesive failure within RMGIC.



Fig.(5):- Cohesive failure within conventional GIC.



Fig.(6):- Mixed failure (adhesive and cohesive failure).

Table (1):- The mean (Mpa) and standard deviation(SD) of SBS for conventional GIC and RMGIC.

GIC Types	N	Mean	SD.	SE Mean	Min.	Max.
RMGIC	20	4.6810	0.59136	0.13223	3.74	5.62
Conventional GIC	20	3.6555	0.93515	0.20911	2.06	5.15

Table (2):- Independent Samples T-Test showing the effect of GIC types on the SBS at GIC/ resin composite interface.

Variance	t	df	p-value
GIC types	4.145	38	0.000

Table (3):- The mean (Mpa) and standard deviation of SBS for all groups of conventional GIC and RMGIC.

Materials	Acid etching Presence	N	Mean	SD	SE Mean	Min	Max
RMGIC	With Acid	10	4.4740	0.56469	0.17857	3.74	5.15
	Without Acid	10	4.8880	0.56936	0.18005	4.12	5.62
Conventional GIC	With Acid	10	2.9300	0.61438	0.19429	2.06	3.74
	Without Acid	10	4.3810	0.54684	0.17293	3.28	5.15

Table (4):- Independent Samples T-Test showing the effect of acid etching of GICs on the SBS at GIC/resin composite interface.

Materials	t	Df	p-value
RMGIC	-1.633	18	0.120
Conventional GIC	-5.579	18	0.000

Table(5):- Percentage of mode of failure for RMGIC and conventional GIC.

Materials	Cohesive%	Adhesive%	Mixed%	N
RMGIC	80	10	10	20
Conventional GIC	60	40	0	20

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