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Original Article

Dentistry Section

Shear Bond Strength Evaluation of Resin Composite Bonded to GIC Using Different Adhesives

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ABSTRACT

Aim: To evaluate the bonding of composite to glass ionomer cement (GIC) using two different bonding systems.

Materials and Methods: The occlusal surface of 30 teeth was flattened and they were divided into three groups. In Group A, composite (Filtek™ Z350 XT, 3M ESPE, USA) was bonded to GIC (Fuji II, GC Corporation, Japan) after initial setting of the GIC being employed as a total-etch adhesive(AdperSinglebond 2, 3M ESPE, USA). In Group B and C, self-etch primer(Adper™ Easy One, 3M ESPE, USA) was employed to bond composite to GIC before and after initial setting of GIC respectively. Shear bond strength and nature of fracture of specimens was determined.

Statistical analysis: One-way analysis of variance (ANOVA) was used.

Results: Group B showed higher bond strength than Group A & Group C ($p<0.01$). Group C showed the least bond strength.

Conclusion: Bond strength of composite to GIC was significantly higher for self-etch primer group employed on unset GIC.

Keywords: Bond strength, Composite, Glass ionomer cement, Self-etch, Total-etch

INTRODUCTION

Adhesive dentistry has gained steady importance in restorative dentistry during past four decades with the chief goal to achieve an adequately strong bonding of the restorative resin to the tooth structure for optimum retention, minimal microleakage, better colour stability and clinical longevity of the restoration [1]. GIC adhesion mechanism to tooth structure, thermal compatibility with tooth enamel, biocompatibility and low cytotoxicity render to GIC an interesting clinical option for restorative treatments [2]. Thus, the so-called sandwich restoration or "composite-laminated GIC" technique has been used by clinicians. This preserves the fluoride release mechanism and the chemical bond to tooth structure provided by GIC, and improve the esthetic and mechanical properties using a resin composite laminate [3]. However, the bond between conventional GICs and resin composite is limited due to a lack of chemical bonding between the two materials and also the low cohesive strength of glass ionomers. This could be attributed to the difference in setting reactions between dental composites and conventional GICs [4].

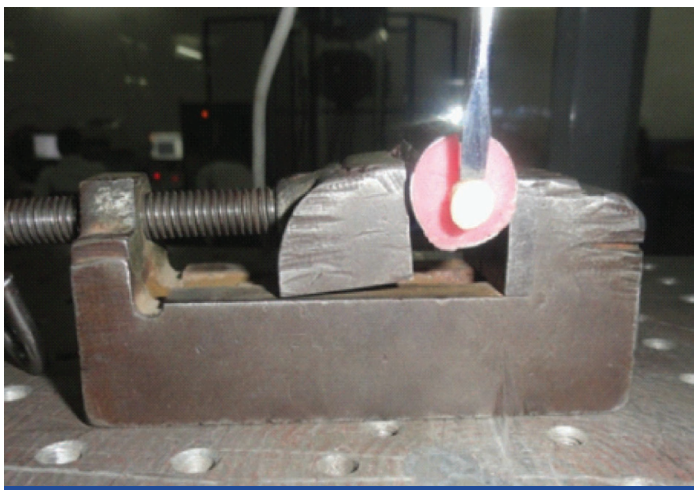
Current strategies in adhesive dentistry involve two methods: the total-etch and self-etch. The total etch bonding technique is characterized by the complexity of its components and of the bonding procedure. Self-etching systems follow a trend towards simplification [5].

Although enamel and dentin pre-treatment before the application of bonding systems and restorative materials is well established in the literature, the need for GIC surface treatment before the placement of composite resin in sandwich restorations still remains debatable [6,7]. McLean et al., pointed out that it is possible to etch the surface of a conventional GIC and develop a mechanical union between the cement and the bonding agent/composite resin similar to that developed between etched enamel and the composite resin [8,9].

However, sensitivity of the GIC to moisture and its progressive loss following acid etching often leads to its failure as moisture contamination during the initial setting of GIC can cause dissolution of the weak calcium- polyacrylate chains, and degrade their physical properties.Moisture contamination during the rinsing procedure can be prevented by waiting for about seven minutes for the initial setting of the GIC to be complete before starting the etch and rinse procedure. Since this procedure requires a waiting period, this technique is not popular among restorative dentists [10].

The recent development of adhesive systems such as self-etch primers might overcome this disadvantage, as they do not require etch and rinse procedure. Self-etching systems are less technique sensitive and require less application time. They do not require etch and rinse phase and combine the functions of primer and adhesive making them more convenient in manipulation. In these systems, there is simultaneous infiltration of the resin with the self-etching process. Studies have proven that self-etch systems produce bond-strength similar to total-etch systems to both dentin and enamel [11,12]. The other advantage of these systems is their feasibility to be employed over unset GIC, as there is no need to rinse the GIC prior to application of the bonding agent, thus preventing moisture contamination or desiccation of the underlying GIC and saving precious chairside clinical time [13].

Adper easy one - one bottle one coat self etch adhesive, Adper ™ Singlebond 2 - total etch adhesive and Filtek™ Z350 XT- composite resin have been recently introduced by 3M ESPE Inc, St Paul, MN, USA. To date, no study has evaluated the bonding ability of these new adhesives for GIC or resin composite. Hence the aim of the



[Table/Fig-1]: Bond strength evaluation of the specimen in Universal Testing Machine

S.No.	Group	Shear Bond Strength (Mean±S.D.)	(*)	Failure Mode
1	A-Total etch	3.28±.2044 MPa	a	2 adhesive, 5 mixed, 3 cohesive
2	B-Self etch before setting of GIC	4.02±.2530 MPa	b	1 adhesive, 2 mixed, 7 cohesive
3	C-Self etch after setting of GIC	3±.2 MPa	a	7 adhesive, 2 mixed, 1 cohesive

[Table/Fig-2]: The mean shear bond strength for different groups, *Different lower case letters in the column indicate significant statistical differences according to One way Anova Test (p<0.01)*

present study was to evaluate the bonding of self-etch adhesive over unset GIC in comparison with set GIC i.e at two time intervals and to determine the bonding of glass ionomer cement with composite resin using total-etch adhesive in comparison with self-etch adhesive, using the recent materials.

MATERIALS AND METHODS

The acrylic resin was filled in iron cylinders upto cement-enamel junction and 30 single rooted premolar teeth were mounted in them. A flat dentin surface at 0.5 mm below the dentino-enamel junction was obtained by grounding the tooth on a water-cooled model trimmer. A layer of glass ionomer cement (Fuji IIGlass ionomer restorative GCCorporation, Tokyo, Japan) of 1 mm thickness was made over the occlusal surface of each sample. The tooth specimens were divided into three groups of 10 samples each on the basis of time of application and the type of the bonding agent used. The composite material (Filtek™ Z350 XT, 3MESPE Inc, St Paul, MN, USA) was applied in a thickness of 2 mm over the GIC and then it was light cured. The GIC surface was not finished to a smooth glass surface to simulate the clinical situation.

Group A (Total-etch bonding agent) (AdperSinglebond 2 Total Etch Bonding Agent, 3M ESPE Inc, St Paul, MN, USA)

An initial set of glass ionomers was confirmed with a sharp explorer after waiting seven minutes. The surface was treated with 37% phosphoric acid for 15 sec and then rinsed. The bonding agent was applied and light cured. The composite material was then added in increments to a height of 2 mm and each increment was light cured (QHL 75, Dentsply, Caulk, USA) for 40 sec.

Group B (Self-etch primer before initial set of GIC) (Adper™ Easy One, 3M ESPE Inc, St Paul, MN, USA)

Self-etch adhesive was applied before the initial set of GIC. Air drying was done after 20 sec; self-etch bonding agent applied and light cured. Composite material was then added in increments to a height of 2 mm and light cured for 40 sec.

Group C (Self-etch primer after initial set of GIC) (Adper™ Easy One, 3M ESPE Inc, St Paul, MN, USA).

Self-etch adhesive was applied, after the initial set of GIC was confirmed with a sharp explorer after seven minutes. Air-drying was done after 20 sec; self-etch bonding agent was applied and light cured. Composite material was then added in increments to a height of 2 mm and each increment was light-cured for 40 sec (QHL 75, Dentsply, Caulk, USA). The samples were then placed in 100% humidity at room temperature for 48 h. The shear bond strength was determined using the Universal Testing Machine (Instron model 4302, Germany) at a crosshead speed of 1 mm/min and directing the shearing force on the glass-ionomer composite interface [Table/Fig-1]. The specimens were examined to determine the nature of fracture.

RESULTS

The mean shear bond strength and standard deviation are shown in [Table/Fig-2]. The data was computed and analysed by ANOVA (one-way analysis of variance). The Analysis was carried out with SPSS software version 13. One-way analysis with ANOVA revealed significant differences in bond strength values among the different groups ($p<0.01$). Group B (self-etch primer was applied before the initial set of GIC) showed higher bond strength than Group A& Group C ($p<0.01$). Group C (self-etch primer applied after the initial set of GIC) showed the least bond strength values.The maximum number of cohesive failure was seen in Group B and minimum number in Group C. The maximum number of adhesive failure was seen in Group C and minimum number in Group B. These results shows that higher the bond strength, more the number of cohesive failure and lesser the number of adhesive failure.

DISCUSSION

A strong bond between GIC and composite is an important factor for the quality of bilayered or sandwitch restorations and it has been previously shown that GIC and composite resin can adhere effectively to each other [8,14]. The bond strength between these materials is influenced by four factors: 1) the tensile strength of GIC, which is mostly dependent on the powder/liquid ratio; 2) the viscosity of the bonding agent and its ability to wet the GIC's surface; 3) the volumetric change in the composite resin during polymerization and; 4) the difficulties in packing and adaptation of the composite resin to the GIC without incorporation of voids [15]. The bonding agent and resin composite may be co-cured to GIC either before or after the initial set has occurred. Knight and others proposed that sequential layering of glass ionomer cement, resin modified glass ionomer cement and resin composite prior to photo-polymerization and before the initial set of GIC produces a significantly strong chemical bond between the GIC and resin composite compared to the etch and rinse technique. It eliminates several placement steps also [16].

Two types of glass-ionomer cements, i.e., conventional or resin-modified, can be used which have differences in the adhesion mechanism, setting reaction, and sensitivity to the moisture of the materials. Arora and others used resin modified GIC which has demonstrated a better bonding to composite resin than the conventional GIC, but exhibits a command set when activated by light [17,18]. Navimipour and others observed that surface treatment with phosphoric acid or Er,Cr:YSGG laser increased the shear bond strength of conventional GIC to composite resin; however, in RMGIC only laser etching resulted in significantly higher bond strength [19]. Zhang and others observed that total-etch adhesive has a lower bond strength than the self-etch adhesives when bonded to conventional GIC [20]. Gopikrishna and others showed that the bond strength of composite to GIC was significantly higher for the self-etch primer group employed on unset GIC [13]. But they observed superior performance of GIC based adhesive over set GIC which could be attributed to chemical bonding between the composites and resin modified glass-ionomers, which has been proven by previous reports [21]. Kandaswami and others concludes that the use of mild self-etching bonding agent over unset GIC has improved bond strength compared to the use of strong and intermediate self-etching bonding agent [22]. However, no study till date has evaluated bonding between the conventional GIC and composite using recently available self-etch adhesive - Adper easy one, total etch adhesive - Adper ™ Singlebond 2 and composite resin - Filtek™ Z350 XT.

In the present study these new materials were used to evaluate the bonding between GIC and composite. The self etch samples were observed at two time intervals i.e. immediately and 7 min after placing glass ionomer cement. The total etch samples were not observed immediately after placing GIC because it will create weak mechanical bond and lead to deleterious effect on the material. The glass-ionomer surfaces were left uninstrumented in all the groups and not finished to a glass-smooth surface to simulate the clinical condition. The initial set of glass ionomer cement was verified with a sharp explorer in accordance with the previous study by Magnum

and others [4]. In the etch and rinse group, the samples exhibited bond strength values that were comparable to values in previous studies [4,16]. However, in the self-etch primer groups, the samples wherein the self-etch primer was applied over the unset GIC (Group B) performed statistically better than the samples wherein the self-etch primer was applied after initial setting of the GIC (Group C). This group B was statistically superior to the total-etch group (Group A) also. This can be explained as the carboxylic monomers in self etch primers could have chemically bonded to calcium in unset GIC leading to higher bond strength. This could be the reason for the higher number of cohesive failures in group B. Yoshida and others have also proven that carboxylic acid monomers present in self-etch primers have a chemical bonding potential to calcium of residual hydroxyapatite of dentin [23]. Hence, it can be said that carboxylic monomers in self etch primers could have chemically bonded to calcium in unset GIC and, hence, a chemical union could be one possible reason for the higher bond strength using these new materials also.

CONCLUSION

In conclusion, an alternative technique for the laminate restorations i.e. self-etch primer over unset glass ionomer cement may be used instead of the traditional total-etch system. This technique saves the time, as there is no need for etching and rinsing in this technique. Further in vivo studies are required to determine the bonding between the glass ionomer cement and the composite resin bonded with different adhesive systems used.

REFERENCES

[1] Mandava D, Ajitha P, Lakshmi-Narayanan L. Comparative evaluation of tensile bond strengths of total-etch adhesives and self-etch adhesives with single and multiple consecutive applications: An in vitro study. *J Cons Dent.* 2009;12(2):55–59.

[2] Xie D, Brantley WA, Culbertson BM, Wang G. Mechanical properties and microstructures of glass-ionomer cements. *Dent Mater.* 2000;16:129-38.

[3] Dellabona A, Pinzetta C, Rosa V. Effect of acid etching of glass ionomer cement surface on the microleakage of sandwich restorations. *J Appl Oral Sci.* 2007;15(3): 230-34.

[4] Mangum FI, Berry EA 3rd, Parikh UK, Ladd D. Optimal etching time of glass ionomer cement for maximum bond of composite resin. *J Am Dent Assoc.* 1990;120(5):535-38.

[5] Sensi LG, Lopes GC, Monteiro S, JR, Baratieri LN, Vieira LC. Dentin bond strength of self etching primers/adhesives. *Oper Dent*. 2005;30:63–68.

[6] De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M. A critical review of the durability of adhesion to tooth tissue: methods and results. *J Dent Res.* 2005;84:118-32.

[7] Lührs AK, Guhr S, Schilke R, Borchers L, Geurtsen W, Günay H. Shear Bond Strength of Self-etch Adhesives to Enamel with Additional Phosphoric Acid Etching. *Oper Dent.* 2008;33(2):155-62.

[8] McLean JW, Powis DR, Prosser HJ. The use of glass ionomer cements in bonding composite resin to dentine. *Brit Dent J.* 1985;158:410-14.

[9] Zanat RL, Navarro FL, Ishikiriama A, Junior MHSS, Delazari RCMF. Bond Strength Between Resin Composite and Etched and Non-etched Glass Ionomer. *Braz Dent J*. 1997;8(2):73-78.

[10] García-Godoy F, Draheim RN, Titus HW. Shear bond strength of a posterior composite resin to glass ionomer bases. *Quint Int.* 1988;19(5):357-59.

[11] Naughton WT, Latta MA. Bond strength of composite to dentin using self-etching adhesive systems. *Quint Int.* 2005;36(4):259-62.

[12] Lopes GC, Marson FC, Vieira LC, de Caldeira AM, Baratieri LN. Composite bond strength to enamel with self-etching primers. *Oper Dent*. 2004;29(4):424-29.

[13] Gopikrishna V, Abarajithan M, Krithikadatta J, Kandaswamy D. Shear Bond Strength Evaluation of Resin Composite Bonded to GIC Using Three Different Adhesives. *Oper Dent*. 2009;34(4)46:9-73.

[14] Mount GJ. Clinical requirements for a successful 'sandwich' - dentine to glass ionomer cement to composite resin. *Aust Dent J.* 1989;34:259-65.

[15] Mount GJ. The tensile strength of the union between various glass ionomer cements and various composite resins. *Aust Dent J*. 1989;34:136-46.

[16] Knight GM, McIntyre JM, Mulyani. Bond strengths between composite resin and auto cure glass ionomer cement using the co-cure technique. *Aust Dent J.* 2006;51(2):175-79.

[17] Arora V, Kundabala M, Parolia A, Thomas MS, Pai V. Comparison of the shear bond strength of RMGIC to a resin composite using different adhesive systems: An in vitro study. *J Conserv Dent*. 2010;13:80–83.

[18] Pamir T, Sen BH, Evcin O. Effects of etching and adhesive applications on the bond strength between composite resin and glass-ionomer cements. *J Appl Oral Sci.* 2012;20(6):636-42.

[19] Navimipour EJ, Oskoee SS, Oskoee PA, Bahari M, Rikhtegaran S, Ghojazadeh M. Effect of acid and laser etching on shear bond strength of conventional and resin-modified glass-ionomer cements to composite resin. *Lasers Med Sci.* 2012;27(2):305-11.

[20] Zhang Y, Burrow MF, Palamara JEA, Thomas CDL. Bonding to Glass Ionomer Cements Using Resin-based Adhesives. *Oper Dent.* 2011;36(6):618-25.

[21] Tyas MJ, Burrow MF. Clinical evaluation of a resin modified glass ionomer adhesive system: Results at five years. *Oper Dent*. 2002;27(5):438-41.

[22] Kandaswamy D, Rajan KJ, Venkateshbabu N, Porkodi I. Shear bond strength evaluation of resin composite bonded to glass-ionomer cement using self-etching bonding agents with different pH: In vitro study. *J Conserv Dent.* 2012;15(1):27-31.

[23] Yoshida Y, Nagakane K, Fukuda R, Nakayama Y, Okazaki M, Shintani H, et al. Comparative study on adhesive performance of functional monomers. *J Dent Res.* 2004;83(6):454-58.

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