Al-Rafidain Dental Journal, Vol. 23, Issue No.1, 2023 (76-84)

Al-Rafidain Dental Journal

rden.mosuljournals.com

The Effect of Different Surface Treatments on The Shear Bond Strength Between Flowable Composite and Glass Ionomer Cement

* **Manaf B. Ahmed**

Department of Conservative Dentistry, College of Dentistry, University of Mosul

Article information

Received: Juley 22, 2022
Accepted: November 9, 2022
Available online: March 10, 2023

Keywords
Surface roughness
Shear bond strength
Glass ionomer cement
Flowable composite

***Correspondence:**
E-mail:
Manaf.basil86@uomosul.edu.iq

Abstract

Aims: The study aims to evaluate the effect of different surface treatments on the shear bond strength between flowable composite and glass ionomer cement. **Materials and Methods**: 40 samples of glass ionomer cement were prepared by mixing the GIC under manufacturer instructions and applied inside a transparent ring measured 3mm in diameter and 2 mm in height. Then the samples were segmented into 4 groups, Group (1) as a control negative group without surface treatment, Group (2) with surface treated by 37% phosphoric acid, Group (3) surface treated by air abrasion with aluminum oxide particles, and Group (4) surface treated by polishing discs. Then Adper single bond 2 was placed over samples of groups (2,3,4) and light cured, then another transparent ring measured 3 mm in diameter and 6 mm in height was applied over each GIC disc, and flow the flowable composite incrementally into two layers, each layer as 3mm and cured by light cure. Then remove the transparent rings to obtain the two bonded materials, GIC, and flowable composite as one sample, then measure the bond strength between the two materials for all groups by using the universal testing machine. Data were analyzed by using One-Way Analysis of Variance and Tukey's test. **Results**: A significant difference is observed in shear bond strength (SBS) of the groups (P<0.05). Group (3) showed the high SBS and Group (1) showed the lowest SBS and there is a significant difference between all the groups in relation to SBS. The high difference between Gp(3) and Gps(1,4) whereas the lowest difference is between Gp(2) and Gp(4). **Conclusions**: Within the limitation of this study, the treatments of surface increase the shear bond strength between GIC and flowable composite, and high bond strength is obtained by air abrasion technique then followed by acid etching and polishing disc respectively.

الخلاصة

الاهداف: تهدف الدراســة الى تقييم تأثير المعالجات السـطحية المختلفة على قوة رابطة القص بين الأســمنت المركب القابل للتدفق والأسـمنت الشـاردي الزجاجي. **المواد وطرائق العمل:** تم تحضـير 40 عينة من الأسـمنت الشـاردي الزجاجي بخلط GIC بموجب تعليمات التصـنيع وتطبيقها داخل حلقات شـفافة بقطر 3 مم وارتفاع 2 مم. ثم تم تقسـيم العينات إلى 4 مجموعات ، المجموعة (1) كمجموعة تحكم سلبية بدون معالجة سطحية ، المجموعة (2) سطح معالج بنسـبة 37٪ لحمض الفوسـفوريك ، المجموعة (3) سـطح معالج بواسـطة كشـط الهواء بجزيئات أوكسـيد الألومنيوم والمجموعة (4) سـطح معالج بأقراص التلميع. ثم تم وضـع مادة اللصـق Adper المفردة 2 فوق عينات المجموعات (2،3،4) وتم تصـليبها بالضـوء ، ثم تم تطبيق حلقات شـفافة أخرى بقطر 3 مم وارتفاع 6 مم فوق كل قرص من أقراص GIC وتدفق المركب القابل للتدفق تدريجياً إلى طبقتين ، كل طبقة بسـمك 3 مم وعلاجها بالضـوء. ثم قمنا بإزالة الحلقات الشفافة للحصول على المادتين المترابطتين ، GIC والمركب القابل للتدفق كعينة واحدة ، ثم قمنا بقياس قوة الرابطة بين مادتين لجميع المجموعات باستخدام آلة اختبار عالمية. تم تحليل البيانات باستخدام اختبار ANOVA أحادي الاتجاه واختبار Tukey. **النتائج**: لوحظ وجود فرق كبير في SBS للمجموعات (P <0.05). تظهر المجموعة (3) ارتفاع SBS والمجموعة (1) تظهر أدنى SBS وهناك فرق كبير بين جميع المجموعات فيما يتعلق بـــ SBS. الفرق الكبير بين (Gp3 (و (1،4) Gps بينما أقل فرق بين (2) Gp و 4) Gp). **الاسـتنتاجات**: ضـمن حدود هذه الدراسـة ، تزيد معاملات السـطح من قوة رابطة القص بين GIC والمركب القابل للتدفق ويتم الحصـول على قوة الرابطة العالية بتقنية كشط الهواء ثم يتبعها النقش الحمضي وقرص التلميع على التوالي.

DOI: 10.33899/rdenj.2023.178382,

INTRODUCTION

The traditional flowable composites and resin-modified glass ionomer cement (RMGICs) have different approaches to bonding to the dental substrate and are considered one of the most used tooth esthetic restorative materials. [(1)]

Glass Ionomer Cements (GICs) were invented by Kent and Wilson in 1970. [(2)] It has been a wide range for using in the dental field because it has many favorable properties like chemical adhesion to the surface of the tooth, releasing fluoride, the coefficient of thermal expansion same as to the tooth, without needing to dry field, low contraction in volume and good stability of color. [(3)]

The sandwich filling was considered one of the techniques used in a restoration like dental composites, in which composite resin and glass ionomer are applied together. In this method, the dentin gingival margin was elevated by glass-ionomer cement and occlusal composite restoration was placed over GIC. [(4)]

The perfect adhesion between glass ionomer cement and composite resin is important for a good filling. That technique is mostly used and gains both the aesthetic properties and physical characteristics of these materials. Glass ionomer has two good properties in fillings by self-adhere to the dentin and release of fluoride. [(5)]

Etching the glass ionomer cement is efficient to get the perfect bond to composite. [(6)] Using phosphoric acid in 35% as a treatment surface of glass ionomer cement enhances the SBS between cement and composite. [(7)]

The adhesion force between the traditional glass ionomer cement and resin composite is a result of the gaps in the etched surface of glass ionomer cement. [(8)] It was observed that in the etching method, a thickness within 0.5mm of glass ionomer cement and twenty seconds of etching is important to obtain proper surface bonding. [(9)]

The observation of differences between the hardness of the matrix and inorganic fillers of glass ionomer cement, also the heterogeneity of glass ionomer composition that is lead to trouble in the finished and polished glass ionomer cement surface end with irregular abrasion. Was remains indistinct that either the use of 1-step, 2-step, or 3-step polishing methods affects the surface character of glass ionomer materials. [(10)]

Seemingly, the SBS between glass ionomer cement and flowable composite extremely affects the clinical prognosis of cosmetic fillings. So my study was designed to assess the SBS of flowable resin composite adhered to traditional glass ionomer cement after different surface treatments of GIC using a bonding agent.

MATERIALS AND METHODS

A total of 40 specimens of glass ionomer cement (GC Fuji I, GC Co; Japan) were prepared under the manufacturer's instructions, mixing should be inserted into transparent plastic circles customized by using a syringe for insulin injection (Shri Sai Pharma Co; India) that is sectioned by diamond disk (Falcon, Sigma Abrasives Co; China) into many circles with these dimensions (3mm of diameter and 2mm of height) and then left the glass ionomer cement to chemically cure.

The surface of glass ionomer luting cement samples was flattened by applied celluloid strips over samples and pressed by a glass slap under pressure (240Pa) for 10 minutes to out the excess material from the rings, after removed the glass ionomer from the circles, the samples were segmented into four groups (10 samples for each group) as shown in table (1). Group (1) as a negative control left without any surface treatment. Group (2) rough the surface with 37% phosphoric acid (Super etch, SDI co; Ireland) for 15 seconds then wash and dry the samples for 10 seconds. Group (3) rough the surface by air abrasion (Dengnuo, DNdent Co; China) with fifteen-micron aluminum oxide particles for 5 seconds and the device away for 1cm and 90 degree above samples then wash and dry the surface for 10 seconds. Group (4) rough the surface by polishing disc-type coarse grit (Super-snap, Shofu Co; Japan) for 5 seconds then wash and dry for 10 seconds, the samples were polished according to the instructions of manufacture with fixation of the rotational speed of the slow speed handpiece (Being Foshan Co; China), the polishing technique was completed equally from left to right direction, all samples were done by the same person to avoid individual personal differences with equal pressure on the glass ionomer samples.

After that bonding agent was used (per single bond 2, 3M ESPE Co; USA), by using a dental brush to apply the bond in scraping motion for 10s over each sample of Gp (2), Gp (3), and Gp (4), then light-cured by using light cure (woodpecker B-cure, Woodpecker Co; China) with intensity about 1200 mW/cm^2 for 20s above the samples at 0.5cm in distance. The radiometer is used to measure the intensity of irradiation. After that apply new transparent plastic circles over the glass ionomer samples, these plastic circles with measurement (3mm in diameter and 6mm in height). Then begin to inject the flowable composite (B and E flow, South Korea) inside these circles as two layers, 3mm for each layer over the glass ionomer samples, and light cured the composite by using woodpecker light cure with an intensity of 1200 mW/cm^2 for 20 seconds for each layer.

After removing the glass ionomer with a flowable composite from the circles as one sample as shown in figure (1), then stored at room temperature (33C^o) inside sealed box for 24 hours. All procedures were completed by a single person. Then the SBS was measured by using a universal testing machine (GT-Ko3B, Gester international company, China) at a crosshead speed of one mm per minute as shown in figures (2) and (3). The samples were tested for shear bond strength and applied this equation: Stress (MPa) = Failure load (newton)/ surface area (mm^2) was used to obtain the shear bond strength values for each sample. [11] The mean shear bond strength was obtained for each group.

The data were collected in SPSS version 25 software. Analyzing of data was done by One-Way Aalyasis of Variance and Tukey's HSD post-hoc test among the means of groups with a significance level of ≤ 0.05.

Figure (1). Glass ionomer with flowable composite as one sample and the adjacent rings that are used for preparing samples.

Figure (2). Universal testing machine.

Figure (3). Measuring of Shear bond strength by universal testing machine.

Table (1): Groups of samples

Groups	**Type of surface treatment**	**Using of bonding agent or not**
Group 1	Without surface treatment	Without using bonding
Group 2	37% phosphoric acid etching	Use bonding
Group 3	Air abrasion with aluminum oxide particles	Use bonding
Group 4	Polishing disc	Use bonding

RESULTS

After analysis of data for this study by the One-way Analysis of Varience test and Tukey's HSD post-hoc test, the descriptive analysis of groups showed the highest mean value of SBS in the group (3) then followed by groups (2,4) respectively, and the lowest mean value of shear bond strength in the group (1), mean values and standard deviations as shown in table (2). ANOVA test showed statistically there is a significant difference between groups as demonstrated in the table (3).

Tukey's HSD post-hoc test demonstrates a significant difference is appeared between all the groups, as gp (3) is highly significant than gps (1,4,2) respectively and the lowest significant one is shown between gp (2) and gp (4) as shown in table (4).

Table (2): Descriptive analysis of the means values and standard deviations for the shear bond strength of groups.

Groups	N	Mean	SD
Group (1)	10	0.06550	0.010690
Group (2)	10	0.15090	0.026117
Group (3)	10	0.19030	0.038753
Group (4)	10	0.11510	0.027469
Total	40	0.13045	0.053593

SD: Standard Deviation , N: number of samples.

Table (3): One-Way ANOVA analysis among the means values for the shear bond strength of groups.

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between groups	0.085	3	0.028	36.926	0.000*
Within groups	0.027	36	0.001		
Total	0.112	39			

df: degree of difference, F: F value at P≤ 0.05 , Sig: significantly

*: Significantly different.

Table (4): The comparison among groups by Tukey's HSD post-hoc test according to shear bond strength.

(1) Groups	(J) groups	Mean Difference (I-J)	Significance
Group (3)	Group (1)	0.124800	0.000*
Group (3)	Group (2)	0.039400	0.015*
Group (3)	Group (4)	0.075200	0.000*
Group (2)	Group (1)	0.085400	0.000*
Group (2)	Group (4)	0.035800	0.031*
Group (4)	Group (1)	0.049600	0.002*

*:Significant difference.

DISCUSSION

Despite the good physical properties of glass ionomer cement and its esthetic advantage but remain a limitation in dental use because need sensitive technique and short longevity.(12) So the sandwich technique was used by dentists to benefit from releasing fluoride and the chemical adhesion to tooth surface provided by the glass ionomer cement and to progress the mechanical and esthetic properties using composite resin over GIC.

One of the reasons for the success of the sandwich technique between GIC and flowable resin composite is the good adhesion between them, and the use of bonding agents that enhance and increase the bonding strength between two materials. (12)

The treatment surface of GIC before the application of resin composite is remain debatable. Although etching by the acid of the surface of glass ionomer cement enhances the tensile bond strength to composite resin. (13)

The roughness of the surface of glass ionomer cement by acid etching with cleaned mildly leads to high surface energy. So this procedure would fulfill the requirements of intimate touch and a much interface interlocked between glass ionomer cement and a resin composite. [14]

Past research, does not show improvement in the adhesion among GIC and resin composite after acid etching surface of GIC.[13],[15],[16]

From the past to the present, a large improvement in the restorative materials, adhesion systems, and techniques of application, therefore the different methods of treatment surface of GIC remain very important.

Sheth et al suggested that etching by the acid of the GIC can lead to undermining the surface of the cement. [17] Some researchers have restricted the time of etching to 15 seconds because the impairment of the surface of cement occurs over a long period. [18]

The present study agrees with **Tijen et al** that the present etching method improved the bond between glass ionomer cement and resin composite. Yet, after the etch and rinse technique was used. [19]

Phosphoric acid should be dissolved in the matrix of the conventional glass ionomer cement that leads to a rough with voids within the surface which is a retentive factor to enhance the bonding to composite resin.[20]

Eiichiro et al study showed the adhesion strength between conventional glass ionomer cement and composite resin was higher for the phosphoric acid etching group and air abrasion group in regarding to the control group, and there are no significant differences among these two groups. [21]

Los and Barkmeier (1994) show that airborne-particle abrasion may result in type of smear layer that plays a role in the improved bond strength.[22]

Schneider et al and Manhart et al observed that the increase in the surface area as a result of airborne particle roughening may lead to improvements in the bond strength with this system. [23],[24]

In the present study, the results agree with **Arzu and Osman's study (2004)** that observed the airborne-particle abrasion significantly enhanced the SBS of filling materials (a compomer, a resin composite, a resin-modified glass ionomer cement, and a traditional glass ionomer cement) to enamel and dentin. [25]

After polishing tooth-colored restorative materials with different methods, the roughness of the surface may be contributed to the size of particles and their designs inside the matrix resin. For the finishing technique to be efficient, the cutter particles should be stronger than the filler particles; else, the abrasive medium may cut the softer matrix only and leave the fillers, so higher surface roughness may result, So the bonding strength was increased. [26]

Erdemir et al (2012) were found that the surface of materials polished with Sof-Lex and PoGo polishing systems attributed to higher surface roughness than those polished with Mylar strips. [27]

CONCLUSION

Within the limitation of this study, it can be concluded the roughness of GICs by different techniques is enough to increase the shear bond strength with a flowable composite. Results showed the most effective technique that increases SBS is air abrasion with aluminum oxide then followed by the phosphoric acid etching technique and the less effective one by polishing disc, which results obtained by using a bonding agent in combination with those surface treatments.

REFERENCES

1. Bücher K, Metz I, Pitchika V, Hickel R, Kühnisch J. Survival characteristics of composite restorations in primary teeth. *Clin Oral Investig*. 2015 Sep;19(7):1653-62.
2. Wilson AD, Kent BE. A new translucent cement for dentistry. The glass ionomer cement. *Br Dent J*. 1972 Feb 15;132(4):133-5.
3. Van Duinen R, Shahid S, Hill R, Glavina D. In-vitro study on temperature changes in the pulp chamber due to thermo-curing of glass ionomer cements. *Acta Stomatol Croat*. 2016 Dec;50(4):287-291.
4. Koubi S, Raskin A, Dejou J, About I, Tassery H, Camps J, Proust JP. Effect of dual cure composite as dentin substitute on the marginal integrity of Class II open-sandwich restorations. *Oper Dent*. 2010; 35: 165-171.
5. Alavi AA, Sharafeddin F, Tondari A. The Effect of Adding Glass and Polyethylene Fibres on Flexural Strength of Three Types of Glass-Ionomer Cements. *Res J Biologic Scien*. 2013; 8: 66-70.
6. Farah CS, Orton VG, Collard SM. Shear bond strength of chemical and light-cured glass ionomer cements bonded to resin composites. *Aust Dent J*. 1998;43:81-86.
7. 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: 305-311.
8. Li J, Liu Y, Liu Y, Söremark R, Sundström F. Flexure strength of resin-modified glass ionomer cements and their bond strength to dental composites. *Acta Odontol Scand*. 1996; 54: 55-58.
9. Smith ED, Martin FE. Acid etching of a glass ionomer cement base: SEM study. *Aust Dent J*. 1990; 35: 236-240.
10. Madhyastha PS, Hegde S, Srikant N, Kotian R, Iyer SS. Effect of finishing/polishing techniques and time on surface roughness of esthetic restorative materials. *Dent Res J*. 2017;14:326-330.
11. Komal Nanavati; Farhin Katge, Vamsi Krishna Chimata, Debapriya Pradhan, Aishwarya Kamble, Devendra Patil. Comparative Evaluation of Shear Bond Strength of Bioactive Restorative Material, Zirconia Reinforced Glass Ionomer Cement and Conventional Glass Ionomer Cement to the Dentinal Surface of Primary Molars: an in vitro Study. *J Dent Shiraz Univ Med Sci*. December 2021; 22(4): 260-266.
12. Farahnaz Sharafeddin, Mohammad Mehdi Choobineh. Assessment of the Shear Bond Strength between Nanofilled Composite Bonded to Glass-ionomer Cement Using Self-etch Adhesive with Different PHs and Total-Etch Adhesive. *J Dent Shiraz UnivMed Sci*., 2016 March; 17(1): 1-6.
13. Hinoura K, Moore BK, Phillips RW. Tensile bond strength between glass ionomer

cement and composite resin. *J Am Dent Assoc.* 1987;114:167-72.

14. Álvaro Della Bona, Caroline Pinzetta, Vinícius Rosa. Effect of acid etching of glass ionomer cement surface on the microleakage of sandwich restorations. *J Appl Oral Sci.* 2007;15(3):230-4.
15. Sneed WD, Looper SW. Shear strength of a composite resin to an etched glass ionomer. *Dent Mater*. 1985;1:127-8.
16. Taggart SE, Pearson GJ. The effect of etching on glass polyalkenoate cement. *J Oral Rehabil*. 1991;18:31-42.
17. Sheth JJ, Jensen ME, Sheth PJ, Versteeg J. Effect of etching glass-ionomer cements on bond strength to composite resin. *J Dent Res.* 1989;68:1082-7.
18. Farah CS, Orton VG, Collard SM. Shear bond strength of chemical and light-cured glass ionomer cements bonded to composite resins. *Aust Dent J.* 1998;43:81-6.
19. Tijen Pamir, Bilge Hakan Şen, Özgür Evcin. 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.
20. Subrata G, Davidson CL. The effect of various surface treatments on the shear strength between composite resin and glass-ionomer cement. *J Dent* 1989; 17: 28-32.
21. Eiichiro Otsuka, Akimasa Tsujimoto, Toshiki Takamizawa, Tetsuya Furuichi, Miho Yokokawa, Keishi Tsubota, Masashi Miyazaki. Influence of surface treatment of glass-ionomers on surface free energy and bond strength of resin composite. *Dent Mat J* 2013; 32(5): 702–708.
22. Los SA, Barkmeier WW. Effects of dentin air abrasion with aluminum oxide and hydroxyapatite on adhesive bond strength. *Oper Dent* 1994;19:169-75.
23. Schneider BT, Baumann MA, Watanabe LG, Marshall GW Jr. Dentin shear bond strength of compomers and composites. *Dent Mater* 2000;16:15-9.
24. Manhart J, Mehl A, Schroeter R, Obster B, Hickel R. Bond strength of composite to dentin treated by air abrasion. *Oper Dent* 1999;24:223-32.
25. Arzu Mujdeci, Osman Gokay. The effect of airborne particle abrasion on the shear bond strength of four restorative materials to enamel and dentin. *The Journal Of Prosthetic Dentistry* 2004;92;no.3;245-249.
26. Prashanthi Sampath Madhyastha, Shreya Hegde, N. Srikant, Ravindra Kotian, Srividhya Sriraman Iyer. Effect of finishing/polishing techniques and time on surface roughness of esthetic restorative materials. *Dent Res J* 2017; Vol.14; Issue 5;326-330.
27. Erdemir U, Sancakli HS, Yildiz E. The effect of one-step and multistep polishing systems on the surface roughness and microhardness of novel resin composites. *Eur J Dent*. 2012;6:198–205.