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ORIGINAL ARTICLE

Adhesion of Different Brands of Glass Ionomer Cements to a Ceramometal Alloy

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Aims: *The aim of the study was to assess, compare and evaluate the adhesive strength and compressive strength of different brands of glass ionomer cements to a ceramometal alloy.* ***Materials:*** *(A) Glass ionomer cements: GC Fuji II – GC Corporation, Tokyo; Chem Flex – Dentsply DeTrey, Germany; Glass ionomer FX – Shofu-11, Japan; MR dental – MR Dental Suppliers Pvt. Ltd., England; (B) ceramometal alloy – Ugirex III; (C) cold cure acrylic resin; (E) temperature cum humidity control chamber; and (F) Instron universal testing machine.* ***Methods:*** *Four different types of glass ionomer cements were used in the study. From each type of the glass ionomer cements, 15 specimens were made to evaluate the compressive strength and adhesive strength, respectively. Fifteen specimens were further divided into 3 subgroups each having 5 specimens. For compressive strength, specimens were tested at 2, 4 and 12 hours by using Instron universal testing machine. To evaluate the adhesive strength, specimens were surface treated with diamond bur, silicone carbide bur and sandblasting, and tested under Instron universal testing machine.* ***Results and conclusions:*** *It was concluded from the study that the compressive strength as well as the adhesive bond strength of MR dental glass ionomer cement with a ceramometal alloy was found to be maximum compare to other glass ionomer cements. Sandblasting surface treatment of ceramometal alloy was found to be comparatively more effective for adhesive bond strength between alloy and glass ionomer cement.*

Keywords: Glass ionomer cement, Ceramometal alloy, Compressive strength, Adhesive strength

Introduction

Dental luting cements form the link between a fixed restoration and the supportive tooth structure. Recently, glass ionomer cement has made a significant impact on restorative dentistry, as they bond chemically to the tooth tissue and release fluoride, which prevents the secondary caries. Apart from being for small restorations, glass ionomer cement can be used for repair of defective composite resin restoration, ceramometal alloy restoration margins and for luting of crown and bridge prosthesis.

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There are several reports on adhesion between glass ionomer and composite resin, but little information is available on adhesive properties between ceramometal alloy and glass ionomer cement.

Therefore, this comparative study has been undertaken to evaluate the adhesion of different brands of glass ionomer cement to a ceramometal alloy.

Materials and Methods

Fabrication of Specimens

Two different types of specimens were made for obtaining compressive strength and adhesive strength, which were divided into division A specimens and division B specimens, respectively as follows:

Division A Specimens

These specimens were used to assess the compressive strength of different brands (denoted as groups in the study) of glass ionomer cements. Specimens were made by mixing recommended powder - liquid ratio of different glass ionomer cements, mechanically spatulated for 20–30 seconds. Each specimen was made in the dimension of 2 mm thick and 5 mm in width and length as shown in Figure 1. The prepared and set specimens were stored in temperature cum humidity control chamber [1] at the temperature of 37°C–40°C, until they were tested.

For each brand of the cement 15 specimens were made, which were further divided into 3 subgroups having 5 specimens each, as shown in Table 1.

Subgroup a – Specimen tested at 2 hours.

Subgroup b – Specimen tested at 4 hours.

Subgroup c – Specimen tested at 12 hours.

Division B Specimens

The specimen of ceramometal alloy (Ugerix - III) was made in the form of an alloy ingot, having dimension of 2 mm thick and 5 mm in diameter. These specimens were fixed to the chemically cured polymethyl methacrylate resin bars.

Conventional glass ionomer cements (Fuji II - group I) were mixed according to the manufacturer recommendations. The mixed cement was injected into a syringe tube (cross-sectional diameter 5 mm, that was partly filled with chemically cured polymethyl methacrylate (PMMA) [2]. The syringe tube was placed in contact with the surface of treated ceramometal alloy specimens as shown in Figure 2, and cement was allowed to set for 4 minutes. The specimen assembly was stored in temperature cum humidity control chamber until they were tested.

For each type of cements (denoted as group), 5 specimens assembles were made which were further divided into 3 subgroups, having 5 specimens each as shown in Table 1.

Subgroup a – Ceramometal alloy surface treated by diamond bur.

Subgroup b – Ceramometal alloy surface treated by silicone carbide bur.

Subgroup c – Ceramometal alloy surface treated by sand blasting.

Table 1 Distribution of specimens made up of different brands of glass ionomer cements

Groups	Division A specimens			Division B specimens		
	Subgroup a	Subgroup b	Subgroup c	Subgroup a	Subgroup b	Subgroup c
Group I	5	5	5	5	5	5
Group II	5	5	5	5	5	5
Group III	5	5	5	5	5	5
Group IV	5	5	5	5	5	5
Total	20	20	20	20	20	20

Group I = GC Fuji II; Group II = Chem Flex; Group III = Glass ionomer FX; Group IV = MR dental

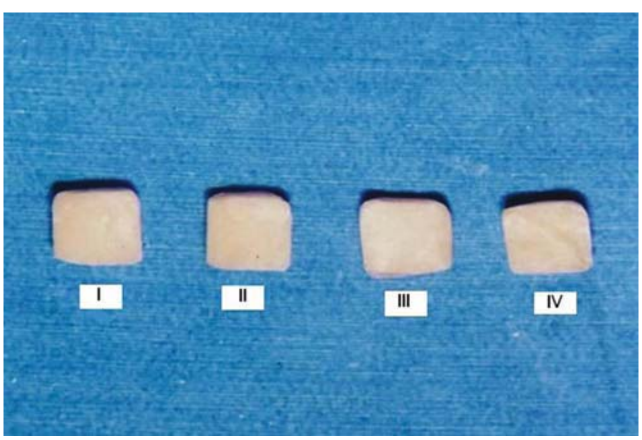

Fig. 1 Specimens before compressive strength testing

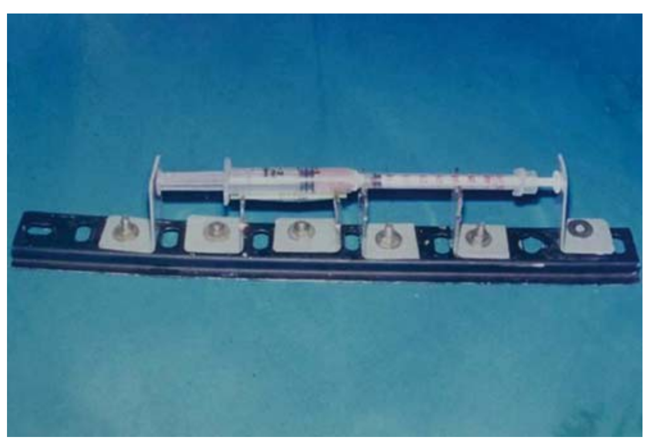

Fig. 2 Master assembly with specimen before adhesive strength testing

Master Assembly

This assembly was 11 inch long, flat rod attached with 6 metal plates, 3 cm vertical and 2.5 cm horizontally placed and joined with nuts and bolts. These metal plates hold the syringe as shown in Figure 2. Four metal plates were round. Notches were placed in the vertical sections of 4 metal plates to aid in placement of two syringes as shown in Figure 2. One end vertical section of the plate on each side acts as stops to prevent displacement of the syringes [3].

Testing of Compressive Strength

The specimens were mounted vertically one after the other between two platens of the jig attach to the Instron universal testing machine. Now the Instron machine was set in the following manner:

- Cross heads speed of 0.5 mm/min
- Immediate return after fracture
- A 5,000 kg load was applied.

The maximum load at which the specimen fractured as shown in Figure 3, was recorded. The following formula was used to calculate the compressive strength of the specimens,

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Area}} \qquad \text{Or}$$

$$\text{Compressive strength (MPa)} = P \times 9.804 / \pi r^2$$

where “P” is a compressive fracture load (in kg) and “r” is radius of the specimen (1 mm).

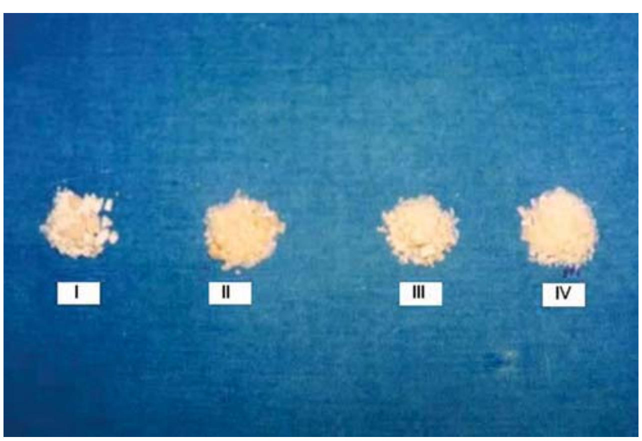

Fig. 3 Fractured specimens after compressive strength testing

Testing of Adhesive Strength

The specimen was tested with the help of Instron universal testing machine. The specimens were mounted horizontally on the Instron universal testing machine and the load was applied vertically at a crosshead test speed of 20 mm/min. The peak load at which bonded specimen assembly separated as shown in Figure 4, was recorded and adhesive bond strength was calculated accordingly.

Results

The results were analyzed statistically by using Students ‘t’ test.

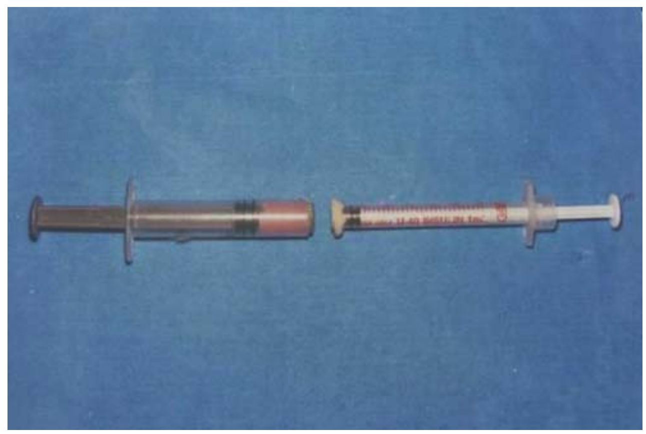

Fig. 4 Separated specimen after adhesive strength testing

As shown in the Table 2 and Figure 5 the compressive strength was maximum for group IV and minimum for group III. These observations delineate that mean compressive strength increased with time in each group of the cement.

As shown in the Table 3 and Figure 6, the result shows the increasing order of mean adhesive strength, that is maximum with the ceramometal alloy surface treated by sandblasting (subgroup c), than in ceramometal alloy surface treated by silicone carbide stone (subgroup b), and minimum with ceramometal alloy treated by diamond bur (subgroup a). Whereas the adhesive strength was found maximum in group IV, followed by group II, then in group I and minimum in group III cements irrespective of each subgroup.

Discussion

The present *in vitro* study was conducted to asses, compare and evaluate the compressive strength and adhesive bond

Table 2 Analysis of compressive strength in different groups at different time intervals

Groups	2 hours mean ± SD n = 5	4 hours mean ± SD n = 5	12 hours mean ± SD n = 5
I	250.30 ± 0.251	254.85 ± 3.72	259.14 ± 2.47
II	334.04 ± 2.79	338.84 ± 2.19	349.97 ± 19.38
III	182.50 ± 2.51	215.08 ± 10.61	244.65 ± 4.56
IV	391.40 ± 2.19	403.98 ± 11.90	417.51 ± 20.38

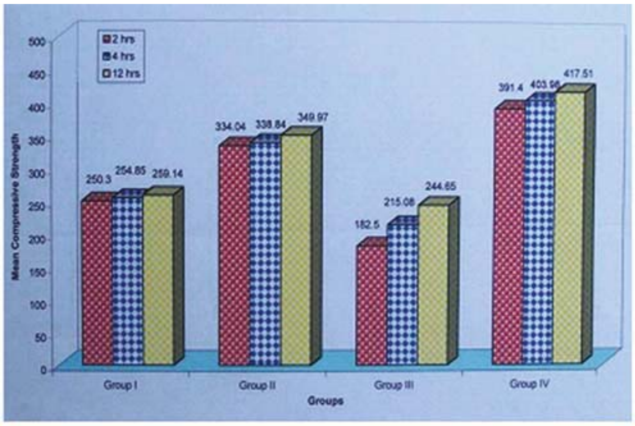

Fig. 5 Compressive strength in different groups at different time intervals

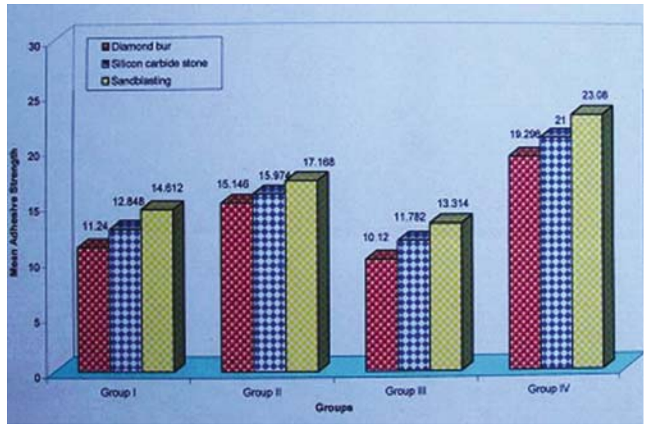

Fig. 6 Adhesive strength in different groups with different surface treatments

Table 3 Analysis of adhesive strength in different groups after different types of surface treatments

Groups	Diamond bur mean ± SD	Silicon carbide stone mean ± SD	Sandblasting mean ± SD
I (n = 5)	11.24 ± 0.1693	12.848 ± 0.778	14.612 ± 0.2941
II (n = 5)	15.146 ± 0.1064	15.974 ± 0.1725	17.168 ± 0.5998
III (n = 5)	10.12 ± 0.1255	11.782 ± 0.3839	13.314 ± 0.2982
IV (n = 5)	12.296 ± 0.4059	21.00 ± 0.33538	23.08 ± 0.2550

strength of different four brands of glass ionomer cements with a ceramometal alloy.

Glass ionomer cements are being used for restoration of minor secondary carious lesion, sealing of endodontic access and in repairing of defective margins such as amalgam restoration, composite and ceramometal alloy restorations and building of fractured crown margins [4]. Little information is available on the bonding between various types of glass ionomer cements to ceramometal and metal alloys.

The good bonding between the two different materials (the ceramometal and glass ionomer cement) helps in keeping the restorations in place. It also prevents microleakage, which might promotes the development of secondary carious below the restorations [1, 5]. The strength of the luting agent is also important as it prevent the fracture of the material under various functional stresses.

In the present study, the evaluation was done for adhesive strength and compressive strength of different brands of commercially and locally available glass ionomer restorative cements, which can also be used for marginal defect corrections.

The result of the present study delineates that the compressive strength of each group of the glass ionomer increased as the time elapsed, as shown in Table 2 and Figure 5. The results were in accordance with previous studies [5, 6]. It can be explained on the basis of the mechanism of setting of the glass ionomer cements, that the formation of calcium polysalts is responsible for the initial set strength. Later on, the aluminum polysalts form over the next several hours, which improve the physical properties like compressive strength of set material [4, 6].

When defects adjacent to the existing ceramometal restorations are repaired, adhesion between ceramometal alloy and restorative material is important to prevent microleakage. Several investigators studied the relationship of microleakage to the type of cements used and found that the use of glass ionomer cements in crown cementation did not predispose microleakage [7]. Hence, the different groups of commercially available glass ionomer cements were used to evaluate the adhesive bond strength in the present study, and it was found that adhesive bond strength of meadway and riverside (MR) dental (group IV) glass ionomer cement was maximum, followed by GC Fuzi (group I), then Chem Flex (group II) and was minimum with GI FX (group III) cement at a definite time interval and the similar environment condition as shown in Table 3 and Figure 6.

The present study also revealed that the comparative compressive strength of MR dental glass ionomer cement was maximum, followed by Chem Flex then GC Fuji and minimum with GI FX as shown in Table 2 and Figure 5.

In this study, the means of improving the bond strength of the ionomer cement to the surface of ceramometal alloys were evaluated because the previous studies have shown that the good retention of glass ionomer cement results in less microleakage. It was found that adhesive strength of all group of cements with ceramometal alloy treated by sandblasting, were higher than with ceramometal alloy treated either by grinding with diamond bur or by silicone carbide stone, as shown in Figure 6 The previous studies done by Vallittu and Forss also support such findings [1]. Several other studies also revealed that sandblasted ceramometal alloy offer good micromechanical retention to dental material. The improved adhesive strength with sandblasted ceramometal alloy can be explained on the basis of micromechanical retention. The previous studies through scanning electron microscopy had explored that alloy surface ground with diamond bur or silicone carbide stone had less microirregularities, than the alloy surface which had been sandblasted.

Therefore, ceramometal alloy surface ground with diamond bur or with silicone carbide stone resulted much coarse and less microirregularities surface topography, hence it did not offer good retention.

Conclusion

Within the limitations of this *in vitro* study, the following conclusions were drawn:

- The adhesive bond strength between ceramometal alloy specimens and glass ionomer cements of different groups was found to be statistically significant, being maximum in group IV, followed by group II and group I and minimum being with group III cements.
- The adhesive bond strength of ceramometal alloy specimens treated with sandblasting was found to be maximum, followed by silicone carbide and diamond bur. All the groups of glass ionomer cements remained statistically significant.
- The compressive strength of group IV glass ionomer cement was found to be maximum, followed by group II and group I, while minimum in group III being statistically significant within all the groups.
- The compressive strength of different groups of glass ionomer cements was maximum after 12 hours, followed by at 4 hours and minimum at 2 hours which was statistically significant.

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