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ORIGINAL RESEARCH

Comparison of Film Thickness of Two Commercial Brands of Glass Ionomer Cement and One Dual-cured Composite: An *in vitro* Study

[1]Rajat R Khajuria, [2]Rishav Singh, [3]Pranamee Barua, [4]Nausheen Hajira, [5]Naveen Gupta, [6]Rohit R Thakkar

ABSTRACT

Aim: The present study is undertaken to examine the film thickness of three most commonly used luting cements and to determine their usage as a luting agent.

Materials and methods: This study was carried out strictly according to the guidelines of American Dental Association (ADS) specification no. 8. Two glass slabs of 5 cm in length and 2 cm in width were used. One glass slab was kept over the other glass slab and the space between the two glass slabs was measured using metallurgical microscope at the power of 10×. Two brands of glass ionomer cement (GIC) and one dual-cured resin cement were used in this study. The test cement is sandwiched between two glass slabs. A static load of 15 kg was applied using universal testing machine on the glass slabs for 1 hour and the space present between the two glass slabs was measured using metallurgical microscope at the power of 10×.

Results: Greatest film thickness was found in group III (Paracore) followed by group II (micron) and lowest in group I (GC luting and lining cement). All the tested samples can be used for luting purposes.

Conclusion: Greatest film thickness was observed in Paracore followed by micron and lowest in GC luting and lining cement. This suggests that the 25 to 27°C is ideal for mixing of the cement when used for luting consistency. The cement with film thickness more than 30 μm should never be used for luting purposes.

Clinical significance: The dentist should choose the luting cement with utmost care noting the film thickness and bond strength of the cement. The cement with low exothermic heat production and good bond strength should be encouraged.

Keywords: Cement, Film, Metallurgical, Static.

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[1]Department of Prosthodontics and Dental Materials, Indira Gandhi Govt. Dental College & Hospital, Jammu, Jammu and Kashmir, India

[2]Department of Pedodontics and Preventive Dentistry, Hazaribag College of Dental Sciences & Hospital, Hazaribagh, Jharkhand India

[3]Department of Pedodontics, Regional Dental College, Guwahati Assam, India

[4]Department of Prosthodontics including Crown and Bridge Alnarjis Alwardi Clinic, Najran, Kingdom of Saudi Arabia

[5]Department of Prosthodontics, R.R. Dental College and Hospital, Umarda, Udaipur, Rajasthan, India

[6]Department of Periodontics, Siddhpur Dental College & Hospital, Sidhpur, Gujarat, India

Corresponding Author: Rajat R Khajuria, Department of Prosthodontics and Dental Materials, Indira Gandhi Govt. Dental College & Hospital, Jammu, Jammu and Kashmir, India, e-mail: drrajatkhajuria@yahoo.com

INTRODUCTION

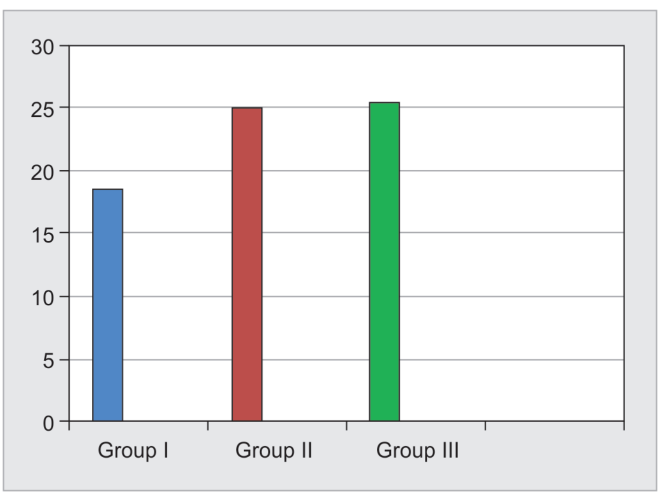
Various cements are used in dentistry according to their uses, such as dental cement for luting, bases, and restorations. According to the ADA no. 8, dental cement should have a film thickness of 0.25 mm.[1] They serve the purpose of luting indirect restorations, such as crowns, inlays, onlays, and chips to the tooth structure.

Silicates were the earliest cements used and were esthetically acceptable, but high solubility led us to think of other alternatives. The GIC was developed by Wilson et al in 1972.[2] They are supplied as powder and liquid. Powder comprises glass particles along with fluorine and silica, which formulate fluoroaluminosilicate. Liquid component has polyacrylic acid along with itaconic acid, maleic acid, and tartaric acid. The GIC is also referred to as aluminosilicate polyacrylic acid or polyalkenoate cement. They provide the properties of translucency and esthetics similar to silicates and property of chemical bonding similar to that of polycarboxylate.[2] According to ADA no. 66, GIC has setting time of 4 to 5 minutes for Type I and 6 to 7 minutes for Type II.[1]

The setting mechanism is basically a chelation reaction that involves chelation of carboxyl groups of the polyacids with the calcium in the apatite of the enamel and dentin.[2] The bond strength to enamel is always higher than that to dentin because of the greater inorganic content of enamel. The final structure comprises core of unreacted powder surrounded by gel sheath of set particles.[2]

Fuji[3] classified GICs based on their uses: Type I for luting, Type II for restorative, Type III for liners and bases, Type IV for metal-modified glass ionomer, Type V for light cured, Type VI for pit and fissure sealant, Type VII for core buildup, Type VIII for orthodontic, and Type IX for atraumatic. Film thickness of luting agents is a significant property and is an important aspect of restorative dentistry. Minimal film thickness will lead to improved casting retention and maintenance of established occlusal relationship.[4] Reduced cement film thickness can also decrease the marginal discrepancies, which in turn reduce the plaque accumulation, periodontal disease, and cement dissolution.[5] The maximum allowable film thickness for zinc phosphate cement is 25 μm and the same is required for Type I GICs.[6] The GICs have the advantage of being adhesive to both enamel and dentin, which would help to retain the casting for a longer period.[7]

Dual-cured resins are popularly used as luting agents because of their better adhesive potential and less marginal gap than GIC. They have the properties of both chemical and light curing.[8] The light curing cures the resin from the outer walls and the resin which is not cured by the light is cured slowly by chemical reactions.[9]



Graph 1: Mean values of film thickness in micro-meters

The physical properties of dental cement are an important aspect that determines the usage of the cement. Setting of the GICs can also be influenced by external factors, such as temperature, pressure, humidity, and mixing time.[3-5,10,11] The GIC basically undergoes an acid–base reaction compromising initial strength. The setting reaction is a continuous process with increase in mechanical properties of the cement with time.[4] Water plays a key role in setting of GIC. The premature exposure to water leads to leaching of ions, swelling, and weakening, whereas loss of water leads to shrinkage and cracking.[3] Null hypothesis states no difference in different brands of GIC and dual-cured resin cement in terms of film thickness. Various studies[3-5,8-11] have evaluated the film thickness of zinc phosphate and GICs, but to the best of our knowledge, no study has evaluated the film thickness of different commercial brands of GICs and dual-cured resin cement. The aim of this study is to measure the film thickness of different commercial brands of GICs and resin cement.

MATERIALS AND METHODS

This study was conducted with the aim to evaluate film thickness of different commercial brands of GICs and one dual-cured resin cement (Graph 1). Thirty samples were fabricated, with 10 in each group used for this study (Table 1). Group I was GC luting and lining cement, group II was micron, and group III was Paracore dual-cure resin cement. This study was carried out strictly according to the guidelines of ADA specification no. 8. Two glass slabs of 5 cm in length and 2 cm in width were used. The room temperature was maintained at 27°C. One glass slab was kept over the other glass slab and the space between the two glass slabs was measured using metallurgical microscope at the power of 10×.

One scoop of particular commercial brand of powder and two drops of liquid were mixed to a homogeneous consistency using a plastic spatula in luting consistency for 45 seconds and was kept on one glass slab (Fig. 1).

Table 1: Materials used in the study

Groups	*Number of Samples*	*Commercial Brand*	*Manufacturer*
I	10	GC Luting and Lining cement	GC corporation, 76-1 Hasunuma-CHO, Itabashi, Tokyo, Japan
II	10	Micron	Pervest Denpro Limited, Unit 1, Digiana, Jammu, India
III	10	Para core	ColteneWhaledent AG, 9450, Altstatten, Switzerland

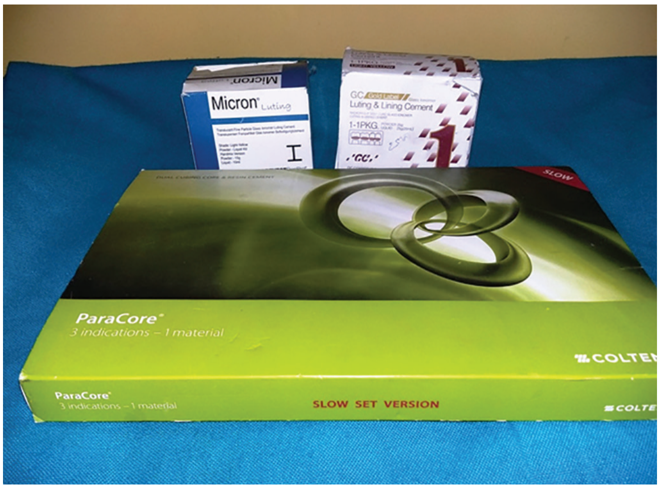


Fig. 1: Materials used in the study

Fig. 2: Testing of film thickness with a layer of cement in between two glass slabs

Immediately after, another glass slab was kept over the glass slab. Thus, the GIC is sandwiched between two glass slabs. A static load of 15 kg was applied using universal testing machine on the glass slabs for 1 hour and the space present between the two glass slabs was measured using metallurgical microscope at the power of 10×.[1]

For dual-cured resin cement, the cement was dispensed directly through the cartridge on the glass slab and the entire procedure was repeated for testing. Entire procedure was repeated 10 times for each group and the data collected were recorded and statistically analyzed using Statistical Package for the Social Sciences software.

RESULTS

The film thickness of all the samples was recorded and their mean values were calculated (Table 2 and Fig. 3). Median for group III was found to be 25.492 µm followed by group II (24.876 µm) and lowest in group I (18.353 µm). Highest film thickness was found in group III (25.528 ± 1.84 µm) followed by group II (25.122 ± 1.46 µm) and lowest in group I (18.470 ± 1.19 µm). The confidence level was kept at 68.3% for uniform distribution. The differences were found to be statistically significant ($p < 0.01$) (Tables 3 and 4).

Table 2: Film thickness values recorded of all the three groups

Group I(µm)	*Group II(µm)*	*Group III(µm)*
18.124	23.213	27.532
17.139	26.135	24.449
19.990	24.198	22.578
19.548	22.996	25.043
20.135	24.750	27.778
17.653	26.454	24.635
19.196	27.322	26.113
17.450	24.503	23.349
16.889	25.002	25.942
18.582	26.545	27.868
18.470	25.122	25.528

DISCUSSION

After the introduction of GIC in 1972,[2] the usage of the cement is expanding. The most popular use is as luting cement due to the chemical bond with the tooth structure and high biocompatibility with living tissues. The film thickness has an important role in determining the seating capability of the final restoration. Many times, occlusally correct crowns with no high points develop high points after cementation.[5] Here, the role of film thickness comes to play. The thickness of the film formed between the tooth structure and inner walls of crowns determines the final positioning of crowns. More the film thickness, more will be the high points in the restoration and more occlusal corrections have to be carried out. This study was carried out with the aim of evaluating two brands of GIC and one dual-cured resin cement based on film thickness. The room temperature was maintained at 25°C

Table 3: Mean comparison of 3 groups

	Group I	*Group II*	*Group III*	*Total*
N	10	10	10	30
$\sum X$	184.706	251.118	255.287	691.111
Mean	18.470	25.122	25.528	29.037
$\sum X^2$	3424.513	6325.243	6547.860	16297.617
SD	1.1964	1.4613	1.8474	3.603

SD: Standard deviation

Table 4: Comparison between the groups

Source	*SS*	*Df*	*MS*	
Between treatments	313.6537	2	156.826	
Within treatments	62.8164	27	2.3265	F=67.4079
Total	376.4701	29		

SS: Sum of squares; p-value is <0.00001; The result is significant at $p<0.01$; DF: Degree of freedom; MS: Mean of squares keeping in view that most of the dental operatories are air-conditioned and have an average temperature of 25°C. Various studies[3,6-10] have been conducted to study the film thickness variations by fluctuating temperatures. Gavelis et al[5] determined the film thickness and flow rate of the resin cement, self-adhesive resins, and resin-modified glass ionomer luting cements at different temperature.

Difference in the temperature altered the film thickness and flow properties of all materials to varying degrees. Three types of cements commonly used for the purpose of luting were used in the study to depict the clinical implications of this study. In both commercial brands of GIC, one scoop of powder and two drops of liquid were dispensed each time the cement had to be applied during testing. This was kept in consideration so as to omit any chances of error due to change in powder/liquid ratio. For film thickness, difference between two glass plates with and without cement is measured with the help of metallurgical microscope and recorded. This testing was carried out taking into consideration the guidelines recommended by the ADA.[1]

A total of 10 specimens were prepared of each group and were distributed in groups I to III respectively. Since the sample size was small, all the samples were tested for the normality and one-way analysis of variance was carried out. In intergroup comparison between three groups, it is found that group III was having highest mean film thickness followed by group II and lowest in group I. This can be explained as group III is a dual-cured composite resin which may have larger particle size. A similar study conducted by Mansur et al[11] on film thickness of four different resins found mean value more than 25 μm. White and Yu[12] conducted an *in vitro* study to determine and compare the film thickness of different classes of adhesive luting agents by the method in compliance with ADA specification no. 8. They concluded that four out of the five glass ionomer luting agents tested conformed to ADA specification for Type I cement.

Hembree et al[13] also conducted a similar study on resins and showed that Durelon, ethylene, butyl methacrlate and glycidal methacrylate, zinc phosphate, Epoxylite Glycidal Butyl Acrylate, and Fynal had thinner film thicknesses than Ethylene Butyl Acrylate and Fluoro-Thin. In addition, venting of a crown resulted in lower film thicknesses with all cement except Fynal.[5] Levine[14] conducted a similar study and found that resin luting agents have films thin enough to allow successful placement of etched cast-metal retainers. He also warned not to use restorative resins since their greater film thickness leads to unsatisfactory use as luting agents.

We, in this study, have tried to create a homogeneous environment to evaluate the film thickness of three commonly used materials. Since this is an *in vitro* study, other influencing factors, such as intrapulpal temperature,[15] humidity, water/powder ratio, and type of preparation[16] are not taken into consideration, which depicts limitations of the present study. Jorgensen and Petersen[17] reported significant reductions in film thickness when a tapered pin system was substituted for the method described in the ADA specification no. 8. They concluded that the ADA method was a measure of viscosity, whereas their tapered pin method was a measure of the grain size of the powder and represented a minimal film thickness. Further, long-term studies are directed toward *in vivo* application of the present study and testing of adhesive resins for the same parameters.

CONCLUSION

Within the limitations of the present study, following conclusions can be drawn:

- Greatest film thickness was observed in Paracore followed by micron and lowest in GC luting and lining cement.
- All the cements tested in this study can be used for the purpose of cementing extracoronal restorations.
- This suggests that the 25 to 27°C is ideal for mixing of the cement when used for luting consistency.
- The cement with film thickness more than 30 μm should never be used.

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