

Comparative Evaluation of Film Thickness and Temperature of Different Luting Cements: An *In Vitro* Study

Raneem S Alofi

ABSTRACT

Aim: The aim of the present study was to compare and assess film thickness and temperature of different luting cements.

Materials and methods: A total of 45 samples (15 glass slabs with respective cements in each group) were prepared. Group I: zinc phosphate, group II: resin-modified glass-ionomer cement (RMGIC), group III: glass ionomer cement type I. This study was conducted as per the American Dental Association (ADA) specification no. 8 guidelines. Two glass slabs of 2 cm width and 5 cm length were used. The complete assembly of glass slabs was placed in a water bath at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ temperature. One glass slab was placed on top of the other glass slab and a metallurgical microscope with a magnification of $10\times$ was used to measure the space between the two glass slabs.

Results: The lowest film thickness (22.180 ± 0.68) was reported for RMGIC, followed by the glass ionomer cement type I group (26.844 ± 0.24) and then the zinc phosphate group (27.650 ± 0.32). ANOVA analysis indicated statistically significant intergroup differences between different luting cements' film thickness at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ temperature. At $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ temperature, the lowest film thickness (26.262 ± 0.16) was reported for RMGIC, immediately followed by the glass ionomer cement type I group (27.713 ± 0.01) and then the zinc phosphate group (28.103 ± 0.10). However, the film thicknesses of different luting cements at $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ temperature were not found to be statistically significant.

Conclusion: After considering the limitations of this study, it can be concluded that the resin-modified glass ionomer cement demonstrates the lowest film thickness when compared to the glass ionomer cement and zinc phosphate. This suggests that a temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ is preferred for mixing the cement when it has to be used for the luting purpose.

Clinical significance: The selection of the luting cement is a critical part in restorative dentistry. This study evaluated the effect of temperature on film thicknesses of different luting cements, which helps in the clinical selection of dental cements.

Keywords: Dental cements, Film thickness, Luting, Temperature.

World Journal of Dentistry (2019); 10.5005/jp-journals-10015-1672

INTRODUCTION

An ideal restorative material is one that offers excellent seal along the margins between the tooth surface and restoration, which is critical in reducing microleakage. Several unfavorable clinical conditions emerge as a result of poor adaptation such as marginal staining, bacterial infiltration, secondary caries, postoperative sensitivity, failure of restoration, and pulpitis. Modern technology and advanced equipment attempt to improve the restorative material to provide expectable treatment life.¹

There are various intraoral uses of the dental cement. The most apparent use is to retain metallic and nonmetallic indirect restorations to the tooth. When dental cements are used for this purpose, they are called luting agents, as they adhere or lute the surfaces one to the other. Further, dental cements are used as bonding agents for orthodontic applications, as restorative materials, and as cementing agents for pins and posts that retain large restorations.²

Due to their reduced strength when compared to amalgam and resin-based composites, the restorative cements have been limited for use in low-stress bearing areas only. The dental cements also protect the dental pulp against thermal and chemical insults when used as a protecting agent under metallic and composite restorations, a pulp-capping agent, and cavity liners.³

In dentistry, cements can be used as luting agents, bases, and restorations. The luting agents commonly used in dentistry are zinc phosphate, glass ionomer, polycarboxylate, resin-modified glass ionomer, compomer, and adhesive resin cements. As per ADA specification no. 8, dental cements when used for luting indirect

Department of Restorative Dental Sciences, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia

Corresponding Author: Raneem S Alofi, Department of Restorative Dental Sciences, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia, Phone: +966 118058206, e-mail: draneem@gmail.com

How to cite this article: Alofi RS. Comparative Evaluation of Film Thickness and Temperature of Different Luting Cements: An *In Vitro* Study. *World J Dent* 2019;10(6):428–431.

Source of support: Nil

Conflict of interest: None

restorations such as inlays, onlays, crowns, and bridges to the tooth structure, they should have 0.25 mm film thickness.⁴

An effective luting agent should meet biological, mechanical, and handling requirements. It should be harmonious with the tooth and tissue, provide adequate working time, flow acceptably, associated with negligible microleakage, have sufficient compressive strength, possess good adhesiveness and esthetics, barely soluble in oral fluids, cost-effective, and ease of removal of excess material.⁵ A comprehensive literature review indicates that at this time there are no available luting agents that fulfill all these ideal requirements and selection of an appropriate luting agent depends on the proficiency of the clinician and requirements of the patient and particular clinical circumstances. The operating clinician should possess an in-depth knowledge of all available

Table 1: Materials used in the study

Groups	Number of samples	Commercial brand	Manufacturer
Group I	15	Zinc F	PrevestDenpro Limited, Digiana, Jammu
Group II	15	GC Fuji Plus	GC Corporation, Tokyo, Japan
Group III	15	GC luting and lining cement	GC Corporation, Tokyo, Japan

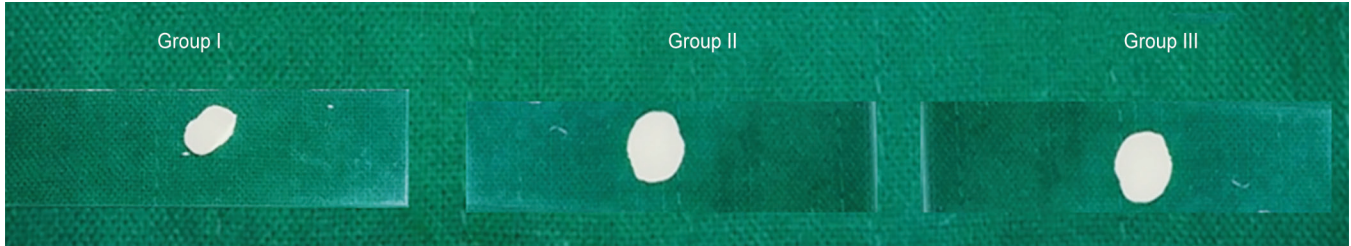


Fig. 1: Glass slab with three different luting cements (group I: zinc phosphate, group II: resin-modified glass-ionomer cement, group III: glass ionomer cement type I)

luting agents.⁶ Therefore, the current study aimed to estimate film thickness and the temperature effect on different luting cements.

MATERIALS AND METHODS

The present study was conducted in College of Dentistry, King Saud University, Riyadh, Saudi Arabia. A total of 45 samples (15 glass slabs with respective cements in each group) were prepared (Table 1). Samples of all the three groups' cements were assessed at 25°C ± 2°C and 35°C ± 2°C temperature.

Group I: Zinc Phosphate

A stainless steel spatula was used in a circular fashion following an incremental method to mix 1 g of powder and 0.5 mL of liquid into a homogeneous mix of luting consistency and was placed on a glass slab. Soon after that, another glass slab was placed over this glass slab.

Group II: Resin-modified Glass-ionomer Cement (RMGIC)

An agate spatula was used to mix 1 scoop of the RMGIC powder and 2 liquid drops for 45 seconds to get a homogeneously stable luting consistency cement and was placed on a glass slab.

Group III: Glass Ionomer Cement Type I

An agate spatula was used to mix 1 scoop of the glass ionomer powder and 2 drops of liquid for 45 seconds to get a homogeneously stable luting consistency cement and was placed on a glass slab.

This study was strictly conducted as per ADA specification no. 8 guidelines (Fig. 1). Two glass slabs of 2 cm in width and 5 cm in length were used. The complete glass slab assembly was placed in a single water bath (Fig. 2) that was maintained at 25°C ± 2°C and 35°C ± 2°C temperature, respectively. One glass slab was placed on top of the other glass slab and a metallurgical microscope with a magnification of 10× was used to measure the space between the two glass slabs.

RESULTS

A SPSS Version 17.0 software and analysis of variance (ANOVA) were used to statistically analyze the collected data. A probability value of less than 0.05 was considered statistically significant for luting cements in the comparative analysis.



Fig. 2: Water bath used in the study to regulate temperature

The values for film thickness are shown in Table 2 for all the three groups at temperature 25°C ± 2°C. The lowest film thickness (22.180 ± 0.68) was recorded for RMGIC, followed by the glass ionomer cement type I group (26.844 ± 0.24) and then the zinc phosphate group (27.650 ± 0.32). A statistically significant intergroup difference among the film thicknesses of different luting cements at 25°C ± 2°C temperature was shown by ANOVA.

The values for film thickness are shown in Table 3 for all the three groups at temperature 35°C ± 2°C. The lowest film thickness (26.262 ± 0.16) was recorded by RMGIC, followed by the glass ionomer cement type I group (27.713 ± 0.01) and then the zinc phosphate group (28.103 ± 0.10). However, the difference between the film thicknesses of different luting cements at temperature of 35°C ± 2°C was not statistically significant.

DISCUSSION

Dental luting agents provide a link between the prepared tooth structure and restoration, linking them by chemical, mechanical, and/or micro-mechanical type of surface attachment. The clinical success of cast restorations and fixed prosthodontics depends on numerous factors like design of the preparation, oral microflora, oral hygiene, mechanical forces, and suitable restorative materials. In addition, an important success factor is

Table 2: Film thickness values recorded of all the three groups at temperature 25°C ± 2°C

Groups	Mean ± SD	F value	p value	Significance
Group I: zinc phosphate	27.650 ± 0.32	48.102	0.001	HS
Group II: RMGIC	22.180 ± 0.68			
Group III: glass ionomer cement type I	26.844 ± 0.24			

p < 0.05; HS, highly significant

Table 3: Film thickness values recorded of all the three groups at temperature 35°C ± 2°C

Groups	Mean ± SD	F value	p value	Significance
Group I: zinc phosphate	28.103 ± 0.10	44.110	0.08	NS
Group II: RMGIC	26.262 ± 0.16			
Group III: glass ionomer cement type I	27.713 ± 0.01			

p < 0.05; NS, not significant

the selection of an appropriate luting agent and the cementation technique.²

Attar et al.⁷ enlist biologic, physical, and handling properties of the material combined with particular clinical situations as factors that decide the choice of the appropriate dental luting cement. In addition, another important factor of a luting agent that has to be considered is the radio-opacity of the dental luting cements that aids in the diagnosis of secondary caries and recognition of open gingival margins and residual material. Furthermore, if the radio-opacity of a luting agent is less than that of the dentin, it is not easy to spot a cement liner of post or restorative crowns radiographically.

As per Cem et al.,⁸ long-term clinical success of the luting procedure depends on the film thickness of luting agents. The significant factors that determine the film thickness of luting cement are the dentist's knowledge about the material as well as the mixing technique, temperature, and ratio of the cement's powder and liquid. However, the chief deciding factor is the cement's viscosity. Thus, in factual clinical situations, actual cement thickness differs based on the experience of the dentist and the restorative material used.

In this study, the lowest film thickness was obtained at different temperatures by RMGIC, followed by the glass ionomer cement type I group and the zinc phosphate group. According to ADA specification no. 8, the standard test for zinc phosphate cement film thickness involves filling the cement between two glass discs. The final film thickness was then estimated by deducting the original thickness of both the glass discs before and after filling the cement using a micrometer. In the present study, two glass plates with a surface area of 2 cm² were used and the cement was filled in between them to measure the film thickness. A similar procedure was followed by White and Yu⁹ to measure the thickness of the film of the cements tried. With a minor change in the ADA technique and replacement of glass discs with plastic, Sadig and Qudami¹⁰ led a comparable trial to study the film thickness. A significant reduction in film thickness was demonstrated by Jorgensen and Petersen¹¹ after substituting the ADA specification no. 8 technique

with a tapered-pin system. They reported that the tapered-pin technique measured the powder grain size and denoted the least film thickness, whereas the ADA technique measured the viscosity. A similar kind of study was conducted by Hembree Jr et al.¹² on resins and presented that ethylene, Durelon, butyl methacrylate and glycidal methacrylate, epoxylic glycidal butyl acrylate, Fynal, and zinc phosphate have film thicknesses that are thinner than the film thickness of fluoro-thin and ethylene butyl acrylate.

In the initial times of resin-based cements, a study by Van Meerbeek et al.¹³ demonstrated a higher film thickness for resin cements compared to zinc phosphate cements. It was found by White and Yu⁹ that few resin-based cements did not fulfill the specifications by ADA for a 25 µm maximum film thickness whereas these cements exceeded beyond 40 µm. The authors concluded that high viscosity could have influenced the film thickness. Even before flowing sufficiently to attain their minimum film thickness, highly viscous resin-based materials set quickly.

The film thickness of the material is affected by temperature.¹⁴ This study reported a reduced film thickness at a temperature of 25°C ± 2°C. Schwartz¹⁵ used cold glass slabs and reported a decrease in the film thickness.

Several trials can be conducted based on other influencing factors like the water/powder ratio, type of preparation, humidity, and appropriate device in the future. It can be highlighted that the results obtained in this study are valid for the existing circumstances of the laboratory. Although laboratory data may provide an understanding of the clinical performance, a direct link between the laboratory and clinical performance cannot always be presumed.

CONCLUSION

After considering the limitation of this study, it can be concluded that the resin-modified glass-ionomer cement demonstrates the lowest film thickness when compared to the glass ionomer cement and zinc phosphate. This suggests that a temperature of 25°C ± 2°C is perfect for mixing the cement when it has to be used for the luting purpose.

REFERENCES

- Milsom KM, Tickle M, Blinkhorn A. The prescription and relative outcomes of different materials used in general dental practice in the northwest region of England to restore the primary dentition. *J Dent* 2002;30(2-3):77-82. DOI: 10.1016/S0300-5712(01)00061-6.
- Ladha K, Verma M. Conventional and contemporary luting cements: an overview. *J Indian Prosthodont Soc* 2010;10(2):79-88. DOI: 10.1007/s13191-010-0022-0.
- Kim TH, Jivraj SA, Donovan TE. Selection of luting agents: part 2. *J Calif Dent Assoc* 2006;34(2):161-166.
- Paffenberger G, Beall J. American dental association specification no. 8 for dental zinc phosphate cement. *J Am Dent Assoc* 1937;24(12):2019-2023. DOI: 10.14219/jada.archive.1937.0388.
- Hill EE. Dental cements for definitive luting: a review and practical clinical considerations. *Dent Clin North Am* 2007;51(3):643-658. DOI: 10.1016/j.cden.2007.04.002.
- De la Macorra JC, Pradies G. Conventional and adhesive luting cements. *Clin Oral Investig* 2002;6(4):198-204. DOI: 10.1007/s00784-002-0184-1.
- Attar N, Tam LE, McComb D. Mechanical and physical properties of contemporary dental luting agents. *J Prosthet Dent* 2003;89(2):127-134. DOI: 10.1067/mpr.2003.20.
- Cem KU, Hakan UY, Amirullah MA. Influence of layer thickness on stress distribution in ceramic-cement-dentin multilayer systems. *Dent Mater J* 2008;27(4):626-632. DOI: 10.4012/dmj.27.626.



9. White SN, Yu Z. Film thickness of new adhesive luting agents. *J Prosthet Dent* 1992;67(6):782–785. DOI: 10.1016/0022-3913(92)90582-U.
10. Sadig W, Qudami E. Evaluation of film thickness of new adhesive luting resins. *Saudi Dent J* 1995;5:157–162.
11. Jorgensen KD, Petersen GF. The grain size of zinc phosphate cements. *Acta Odontol Scand* 1963;21:255–270. DOI: 10.3109/00016356308993960.
12. Hembree Jr JH, George TA, Hembree ME. Film thickness of cements beneath complete crowns. *J Prosthet Dent* 1978;39(5):533–535. DOI: 10.1016/S0022-3913(78)80188-7.
13. Van Meerbeek B, Inokoshi S, Davidson CL, et al. Dual cure luting composites--part II: clinically related properties. *J Oral Rehabil* 1994;21(1):57–66. DOI: 10.1111/j.1365-2842.1994.tb01124.x.
14. Kumar MP, Priyadarshini R, Kumar YM, et al. Effect of temperature on film thickness of two types of commonly used luting cements. *J Contemp Dent Pract* 2017;18(12):1159–1163. DOI: 10.5005/jp-journals-10024-2192.
15. Schwartz IS. A review of methods and techniques to improve the fit of cast restorations. *J Prosthet Dent* 1986;56(3):279–283. DOI: 10.1016/0022-3913(86)90003-X.