RESEARCH PAPER

Effect of Ambient Temperature on the Film Thickness of Glass Ionomer Luting Agent: An In-Vitro Study

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ABSTRACT

Background: Ambient temperature is one of the important factors affecting the setting of GICs when used as a luting agent for cementation. This *in vitro* study was planned to evaluate the effect of ambient room temperature on film thickness of GI luting agent. **Materials and Methods**:According to ADA specification no. 8 for the film thickness, the glass ionomer cement was mixed and placed between the two glass plates of 2cm^{2}surface area and a load of 15kg was applied for 10 minutes. The space between the two glass plates was measured with the magnifying lens of mettalurgical microscope with an accuracy of 10x. Each test was performed for 10 times at each temperature. The difference between the space of the glass plates with or without cement was considered as film thickness.Each test was performed for 10 times under three ambient temperatures conditions, *viz.* 16°±2°C (Group I), 24°±2°C (Group II) and 34°±2°C (Group III).Data was analyzed using SPSS 20.0 software. Kruskal-Wallis test followed by Mann-Whitney U test was used to analyze the data. **Result**:Meanfilm thickness of Groups I, II and III was16.92±0.75 µm,24.52±0.71 µm and 26.78±0.46 µm respectively. Inter and between group differences were significant statistically ($p<0.05$).**Conclusion**: With increasing ambient temperature, film thickness of GI luting agent showed a significant increase. Further studies to recognize optimal temperature conditions are recommended.

Key words: Glass ionomer luting agent,Film Thickness, Ambient temperature, Setting

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INTRODUCTION

Dental cements are widely used in dentistry with different clinical uses in dentistry like liners and base materials to protect the pulp from thermal, electrical and chemical effects, as root canal sealing agents, orthodontic bracket adhesives, pit and fissure sealants, core build up, temporary filling material to covers the cavity hermetically and protect the tooth from external effects, restorative materials and luting materials in adapting tooth to indirect restorations prepared out of mouth. The luting agents may be permanent or temporary depending on their physical properties and the planned longevity of the restoration[1].

Glass Ionomer cement was developedby Wilson and Kent and their coworkers in 1972.It derived from aqueous polyalkenoic acid such as polyacrylic acid and a glass component that is usually a fluoroaluminosilicate.The maximum allowable film thickness for Type 1 Glass Ionomer cements is 25µm.[2] Minimal film thickness will lead to improved casting retention and maintenance of established occlusal relationship.[3]Reduced cement film thickness can also decreased the marginal discrepancies, which in turn reduce the plaque accumulation, periodontal disease and cement dissolution.[4] An increased film thickness may cause incomplete seating of casting.The setting reaction of GIC is an acid-base reaction between polyacid liquid and glass[5].The setting of the GICs can also be influenced by external factors like temperature, humidity,pressure, and mixing time[6-9].This eventually has an impact on the physical properties such asfilm thickness.

Hence, the present study was planned to evaluate the effect of ambient temperature on the film thickness of glass ionomer luting agents.

MATERIAL AND METHOD

The film thickness measurement was done according to ADA specification no.8. Two glass plates of uniform thickness having a surface area of 2cm^2 were used (Fig.1). First the space between two glass plates was measure when they are placed atop one another without cement in between.

One scoop of powder and two drops of liquid of HY- Bond glass ionomer CX cement was dispensed on oil impregnated mixing pad (Fig.2). The powder was divided into two equal increments. The powder was incorporated into liquid to obtain a homogenous consistency. The mixing was performed for 30seconds (Fig.3). Immediately after mixing, the cement was placed between a pair of glass slab of uniform thickness (Fig.4). Three minutes after mixing, a static load of 15 kg was applied on the top of glass plates (Fig.5). After 10 minutes of the mixing, the space between the two glass plates when placed atop one another with the set cement was measured with magnifying lens of mettalurgical microscope with an accuracy of 10x (Fig.6). The difference between the space of two glass plates with and without the cement was considered as the film thickness. This test was performed for 10 times in each temperature (16°±2°C (Group I), 24°±2°C (Group II) and 34°±2°C (Group III).

Statistical Analysis: The data so collected was subjected to analysis using Statistical Package for Social Sciences (SPSS) version 20.0. On normality assessment, asymmetry was found, hence a non-parametric evaluation plan was adopted. Data was analyzed using Kruskal-Wallis test followed by Mann-Whitney U test. 'p' value less than 0.05 was considered to be indicative of statistically significant difference.

RESULTS

Film thickness ranged from 14μm to 28μmin different groups. In Group I (16±2ºC), mean film thickness was minimum (16.92±0.75 μm, Median 16.81 μm)followed by Group II (24±2ºC) (Mean 24.52±0.71 μm, Median 24.30 μm) and maximum in Group III (34±2ºC) (Mean 26.78±0.46,Median26.75 μm). Statistically, intergroup differences were significant (H=25.806; p<0.001).On evaluating the between group differences too, all the between group differences were significant (Table 1; Fig. 7). On the basis of these observations, the order offilm thickness in different groups was as follows:

Group I <Group II<Group III.

Table 1: Intergroup Comparison of Film Thickness (μm)

SN	Group	n	Mean	SD	Min	Max	Median
1.	I	10	16.92	0.75	16.12	18.27	16.81
2.	II	10	24.52	0.71	23.44	25.76	24.30
3.	III	10	26.78	0.46	26.00	27.67	26.75

H=25.806 (df=2); p<0.001(Kruskall Wallis test)
z=3.780; p<0.001 (I vs II), z=3.7803; p<0.001 (I vs III), z=3.7802; p<0.001 (II vs III) (Mann Whitney U test)

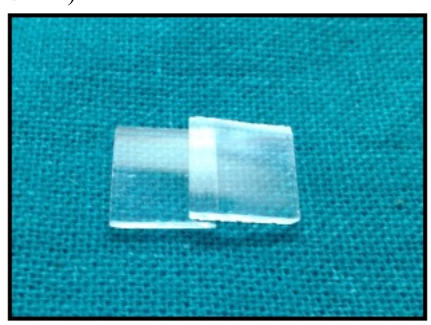

Fig1: Two glass slab of uniform Fig2: HY- Bond glass ionomer CX cement
thickness having a surface area of 2cm^{2}was dispensed on oil impregnated mixing pad

Fig 3: Mixing of glass ionomer powder
Fig 4: The cement was placed between a pair of glass slab of uniform thickness

Fig 5: A static load of 15 kg was applied on the top of glass plates

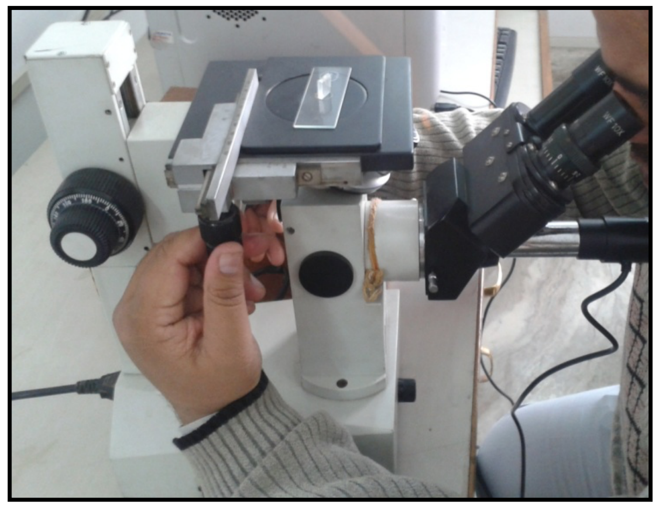

Fig 6: The space between the two glass plates with the set cement was
measured with mettalurgical microscope.

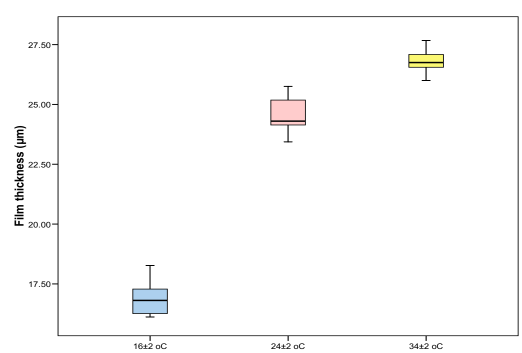

Fig 7:Box Plot showing dispersion of film thickness values at different

temperature conditions

DISCUSSION

A number of studies evaluating the physical properties of luting agents have been conducted under room temperature[7-9], however, recent evidence has indicated an effect of variable temperatures[4]. Encouraged by this, the present study was carried out to evaluate the effect of variable temperature on the film thicknessof glass ionomer luting agents. In present study, the selection of temperatures was done in consonance with the seasonal variation in temperature, specifically, in tropical countries. In India, during summer the average temperature is 34°±2°C whereas in winters it reaches to 16°±2°C whereas in spring it remains at 24°±2°C. Considering the Indian climatic conditions, three different ambient temperatures i.e 34°±2°C, 24°±2°C and 16°±2°C were selected for this study as these represent extreme temperature variations in India.

The inter group comparison in present study revealed a direct relationship between increasing ambient temperature and film thickness.In the previous studies, many authors evaluated film thicknesswithdifferent methods using glass plates, plastic plates and tapered dies at room temperature i.e 23°±2°C. Similar to results of present study,Bagheri[4]has shown that setting of glass ionomer luting agents under variable temperature conditions results in difference in film thickness with film thickness showing a direct relationship with increasing temperature. It has been shown in a separate study that increasing film thickness of dental cement results in incomplete seating of the crowns which could lead to increased marginal discrepancies thusincreasing the probability of secondary caries.

Sharma et al. (2024) evaluated the influence of ambient temperature on the film thickness and flow characteristics of glass ionomer luting cements. Their results demonstrated a statistically significant increase in mean film thickness with rising temperature. At 15–18 °C, the mean film thickness remained within ADA limits, whereas temperatures above 30 °C resulted in film thickness values exceeding recommended standards. The authors reported reduced flowability and accelerated setting at higher temperatures, leading to compromised seating potential of indirect restorations [10]. **Kim et al. (2024)** analyzed the effect of environmental temperature variations on the setting kinetics and marginal adaptation of glass ionomer luting agents. The results revealed that specimens manipulated at higher temperatures (32–35 °C) exhibited faster initial setting times and significantly increased film thickness compared to those handled at controlled room temperature (23 ± 2 °C). Marginal gap measurements showed a positive correlation with increased film thickness, indicating poorer marginal adaptation at elevated temperatures [11].

A study by Alqahtani et al. (2025) conducted a comparative evaluation of conventional and resin-modified glass ionomer cements under different temperature conditions. Their findings showed that both cement types exhibited increased film thickness with rising temperature; however, conventional glass ionomer cements demonstrated a significantly greater increase compared to resin-modified variants. At temperatures above 30 °C, conventional GICs frequently exceeded the maximum allowable film thickness, while resin-modified GICs maintained relatively stable values due to improved flow properties [12]. **Patel et al. (2025)** investigated the role of climatic temperature variations on the physical properties of dental luting cements used in fixed prosthodontics. The results indicated a significant deterioration in film thickness control when cementation was performed under high ambient temperatures typical of tropical climates. The study reported increased viscosity and reduced working time at elevated temperatures, resulting in higher film thickness values and incomplete seating of prosthetic restorations [13].

A study by Wang et al. (2024) assessed temperature-dependent changes in viscosity, film thickness, and seating accuracy of glass ionomer luting cements. Their results demonstrated that increased ambient temperature led to a proportional increase in cement viscosity and film thickness, accompanied by a measurable reduction in seating accuracy of cast restorations. Statistical analysis confirmed a strong positive correlation between temperature elevation and film thickness, reinforcing the importance of temperature regulation during cement manipulation [14].

This study demonstrated a significant influence of ambient temperature on the film thickness of glass ionomer luting cement. The results showed that as the temperature increased, the cement exhibited a noticeable increase in film thickness, which can affect the seating accuracy of indirect restorations and marginal adaptation. These findings are consistent with recent studies (Sharma et al., 2024; Kim et al., 2024; Alqahtani et al., 2025) that highlight the impact of temperature variations on the physical properties of dental cements.

An increase in film thickness beyond optimal levels can potentially compromise the clinical success of restorations, leading to issues such as marginal gaps, plaque retention, and secondary caries. Therefore, it is crucial for clinicians to be aware of environmental factors, such as ambient temperature, when using glass ionomer cements, especially in regions with fluctuating temperatures.

Given the implications of this study, future research should explore the effect of other environmental variables, such as humidity and pressure, on the physical properties of dental cements. Further clinical studies are also needed to validate these laboratory findings in real-world settings. Optimizing the handling and cementation protocols based on environmental conditions will help enhance the clinical performance of glass ionomer luting cements and contribute to the longevity of indirect restorations.

CONCLUSION

In a controlled environment, change in ambient temperature showed a significant relationship with film thickness of Glass ionomer luting agents.

Declarations:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: We have consent to participate.

Consent for publication: We have consent for the publication of this paper.

Authors' contributions: All the authors equally contributed the work.

REFERENCES

1. Sumer E, Deger Y. Contemporay permanent luting agents used in dentistry: A literature review. Int Dent Res 2011; 1:26-31.
2. Dental cements. In Craig RG, Powers JM. Restorative Dental Materials. 11th ed. Missouri Mosby 2001, 594-634.
3. Eames WB et al. Techniques to improve the seating of castings. J Am Dent Assoc 1978;96:432-437.
4. Bagheri R. Film thickness and flow properties of resin-based cements at different temperatures. J Dent Shiraz Univ Med Scien 2013; 14(2):57-63.
5. Pameijer CH. A Review of Luting Agents. Int J Dent 2012;2012:1-7.
6. Judith M. Strutz JM, White SH, Yu Z, Kane CL. Luting cement-metal surface physicochemical interactions on film thickness. J Prosthet Dent 1994;72:128-32.
7. Nazirkar G, Singh S, Badgujar M, Gaikwad B, Bhanushali S, Nalawade S. Effect of Marginal Sealant on Shear Bond Strength of Glass Ionomer Cement: Used as A Luting Agent. Journal of International Oral Health : JIOH. 2014;6(3):65-69.
8. Patil SG, Sajjan MS, Patil R. The Effect of Temperature on Compressive and Tensile Strengths of Commonly Used Luting Cements: An In Vitro Study. Journal of International Oral Health : JIOH. 2015;7(2):13-19.
9. Lad PP, Kamath M, Tarale K, Kusugal PB. Practical clinical considerations of luting cements: A review. Journal of International Oral Health : JIOH. 2014;6(1):116-120.
10. Sharma A, Gupta R, Verma P. Influence of ambient temperature on film thickness and flow characteristics of glass ionomer luting cements: An in vitro study. *J Prosthet Dent*. **2024**;131(2):245–251.
11. Kim JH, Park SH, Lee YK. Effect of environmental temperature variations on setting kinetics and marginal adaptation of

glass ionomer luting agents. *Dent Mater J*. **2024**;43(4):612–619.

12. Alqahtani NM, Alzahrani FM, Alhassan RS**.** Comparative evaluation of film thickness of conventional and resin-modified glass ionomer cements under different temperature conditions. *Saudi Dent J*. **2025**;37(1):45–52.
13. Patel K, Mehta S, Desai R. Role of climatic temperature variations on physical properties of dental luting cements used for fixed prosthodontics. *J Indian Prosthodont Soc*. **2025**;25(2):168–175.
14. Wang Y, Chen L, Zhou X. **Temperature**-dependent changes in viscosity, film thickness, and seating accuracy of glass ionomer luting cements. *Int J Prosthodont*. **2024**;37(6):489–496.