Article **ECORFAN Journal-Bolivia**
December 2022, Vol.9 No.17 29-34

In vitro study of the film thickness of six resin cements

Estudio *In vitro* del espesor de película de seis cementos resinosos

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DOI: 10.35429/EJB.2022.17.9.29.34 Received: July 10, 2022; Accepted: December 30, 2022

Abstract

Objectives. Study the differences of the film thickness of six cements to determine that they comply with the standards.

Methodology. Experimental, cross-sectional, *in vitro* study. Film thickness test of resinous cements using the standards of ISO 9917-1.

30 samples were made dividing them into 6 groups of 5 samples each. Group 1: Prime Dent, Group 2, iCem, Group 3: Relyx Ultimate, Group 4: MaxCem, Group 5: TheraCem, Group 6: BisCem. The thickness of two glass slab placed one on top of the other was measured, the resin cement was prepared by placing it (0.05 ± 0.005 ml) at the center of the glass slab with a 3 ml syringe, it was measured again. The weight was removed after 10 minutes, the thickness of both glass slad was measured. Film thickness was calculated by taking the difference between the thickness of the glass slab with and without the sample between them.

Results: An ANOVA test was performed to obtain the statistical value; it was obtained that p=0.000, therefore there are statistically significant differences between the cements. Contribution. The application of dental cements for indirect restorations is used daily, so knowing the film thickness provides security when choosing the ideal material.

Thickness, Cement, Resin

Resumen

Objetivos. Estudiar las diferencias de espesor de película de seis cementos para determinar que cumplan con la norma.

Metodología. Estudio experimental, transversal, *in vitro*. Prueba de espesor de película de cementos resinosos mediante los estándares de la Norma ISO 9917-1.

Se realizaron 30 muestras dividiendolas en 6 grupos de 5 muestras cada uno. Grupo 1: Prime Dent, Grupo 2: iCem, Grupo 3: Relyx Ultimate, Grupo 4: MaxCem, Grupo 5:TheraCem, Grupo 6: BisCem. Se midió el grosor de dos losetas colocadas una sobre otra., se preparó el cemento resinoso colocándolo (0.05 ± 0.005 ml) al centro de la loseta con una jeringa de 3ml, se volvió a medir. Se retiró el peso a los 10 minutos, se midió el grosor de ambas losetas. Se calculó el espesor de película tomando la diferencia entre el grosor de las losetas con y sin la muestra entre ellas.

Resultdos: Se realizó una prueba de ANOVA para obtener el valor estadístico; se obtuvo que p=0.000 por lo tanto existen diferencias estadisticamente significativas entre los cementos.

Contribución. La aplicación de cementos dentales para restauraciones indirectas se usa en el día a día, por lo que el conocer el espesor de película, proporciona seguridad al elegir el material idóneo.

Espesor, Cemento, Resinoso

Citation: ROESCH-RAMOS, Laura, MORA-SÁNCHEZ, Aura Leonora, MORENO-MARÍN, Flora and MANTILLA-RUIZ, Manuel. *In vitro* study of the film thickness of six resin cements. ECORFAN-Bolivia Journal. 2022. 9-17:29-34.

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Introduction

The evolution of restorative dentistry has brought with it the modification of materials and cementation techniques that seek to improve the working time and duration of the materials in the mouth.

The introduction of new materials has made it possible to reduce working times with the benefit that their properties are not impaired. The new luting materials are created with the aim of achieving a material that has the best characteristics of the natural tooth, that is why we must know the characteristics, limitations and advantages that each one offers us to be able to select the ideal material. Added to that, the process the bonding process is currently widely used helping the cementation of a restoration (Ocejo, 2018).

The properties of resin cements are influenced by the nature of the matrix, type of filler, volume of filler and matrix, filler loading and the polymerization mode that allows the conversion of monomers and that meet the minimum thickness according to ISO 9917-1 (ISO9917-1, 2007).

In the use of dental cements, working with large thicknesses will result in low wear resistance, increased erosion of the luting film exposed to the oral environment, low mechanical strength and low marginal sealing, as well as inadequate seating of the restoration to the tooth surface.

It is important for the operator to know that the film thickness should have a minimum cement thickness that will allow the restoration to support the functional loads of mastication and have an adequate mechanical behavior (Diez, 2022).

When homogeneous cementation films are not handled or there are bubbles, erosions or regions without cementing material, it is easier for microleakage, stress accumulation in uncemented areas or secondary caries to occur, leading to the failure of the restoration.

The present study was carried out to evaluate the film thickness of six self-adhesive resin cements, thus allowing the selection of a luting material that complies with the characteristic of minimum thickness for the correct oral rehabilitation and thus achieve long-term success in the restoration.

The great variety of cements in the market makes it difficult to choose the ideal one, so six of the most used cements in the market are studied to verify that they comply with the qualities they offer.

Over time, new materials have been developed, such as self-adhesive cements, which have been widely accepted due to the reduction of working time.

Currently there are several adhesive cements which ensure optimum adhesion and have better characteristics than those of previous generations, among the factors that are closely related is the film thickness that when handled incorrectly can generate deficiencies in the treatment.

Cementation is determined by the existing space between the restoration and the tooth surface and by the intrinsic capacity of a cementitious material that will occupy that space (bustillos, 2019).

The more complex a preparation is, the greater the possibility of the existence of cement accumulation spaces or air bubble formation, which will affect the fit and the ability to resist mechanical loads (Usechi, 2019).

Currently, resin cements have a fluidity that allows obtaining a sufficiently thin film capable of providing an ideal adaptation of the restoration to the tooth surface, the thickness and homogeneity of the luting layer are related to the mechanical behavior of the cement, directly influencing the durability of the restoration in the mouth (Acosta, 2020 and Manriquez, 2018).

The film thickness in luting materials should not exceed 25 μm above any value stipulated by the manufacturer and the standard (ISO9917-1, 2007).

ISSN-On line: 2410-4191

For this reason, the need arose to conduct a study on these cementitious materials to determine whether they meet the quality standards set forth in ISO 9917-1 and to compare six resinous cements:

Prime Dent, iCem, Relyx Ultimate, MaxCem, TheraCem, BisCem.

Each of the cements in this research has the ability to adhere to multiple substrates, has a high resistance, insolubility in oral medium, apart from its potential to mimic colors (Camacho, 2020).

The objective is to determine the differences in film thickness of the six cements to determine that they meet the standard and contribute to the ideal choice for each clinical case.

The application of dental cements for indirect restorations is a day-to-day treatment in dental practice (Bustillos, 2019).

In physical properties, it is also advisable to evaluate the cements in addition to film thickness, fluidity, sorption and solubility in order to have a more complete study of all the physical properties of self-adhesive resin cements (Severino, 2022).

Therefore, knowing more precisely one of the most important characteristics, such as film thickness, provides the clinician with certainty when choosing the ideal material.

Methodology

An experimental, cross-sectional, in vitro study was carried out to test the film thickness of self-adhesive resinous cements according to the standards established in ISO 9917-1.

Thirty samples were taken and the study was divided into six groups of five samples each.

- Group 1: Prime Dent

- Group 2: iCem

- Group 3: Relyx Ultimate

- Group 4: MaxCem

- Group 5: TheraCem

- Group 6: BisCem

The present study was carried out in the facilities of the Laboratory of the Faculty of Dentistry of the Universidad Veracruzana, Veracruz Region, during the period August 2020 - August 2022.

As required by the ISO 9917-1 standard, the environmental conditions were standardized, with a temperature of 25° and humidity of 50%.

The procedure was carried out as follows:

The thickness of two tiles placed one on top of the other was measured and the value recorded, then the self-adhesive resinous cement was prepared and (0.05 ± 0.005) ml of the material was placed in the center of the tile with the help of a 3 ml syringe.

After the application of the sample, a second tile was placed and a constant load of 150 N, equivalent to 15.295 kg force x mm^2, was applied for 150 seconds.

The weight was removed after 10 minutes and the thickness of both tiles was measured with the aid of a micrometer (mitituyo) and the film thickness was calculated by taking the difference between the thickness of the tiles with and without the cement sample between them and the data was recorded.

This procedure was performed in the same way and with a calibrated operator performing the same steps for the five samples of the six groups of the study.

Results

The results were as follows:

Group 1: Minimum value of 0.014, maximum value of 0.023 with a mean of 0.0178, variance 0.000022 and standard deviation of 0.00476. See graphic 1.

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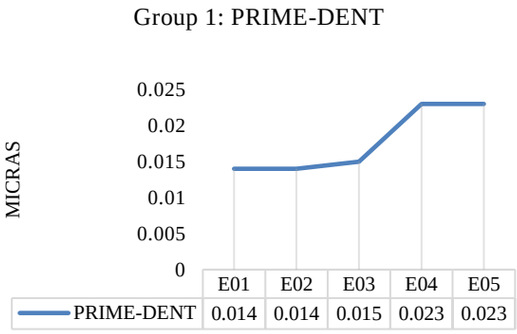
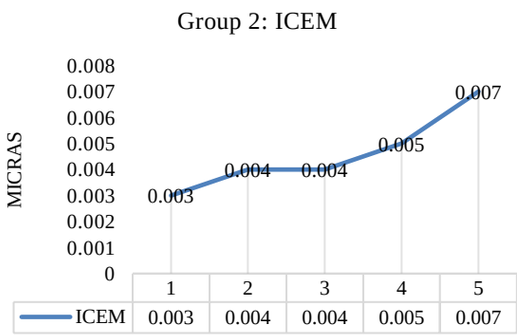


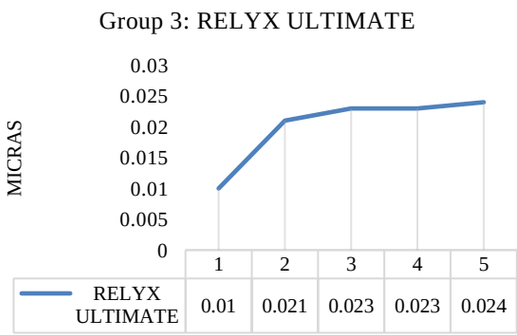
Graphic 1 Results and behavior of Prime Dent Cement

Group 2: Minimum value of 0.003, maximum value of 0.007 with a mean of 0.0046, variance 0.0000023 and standard deviation of 0.001516. See graphic 2.



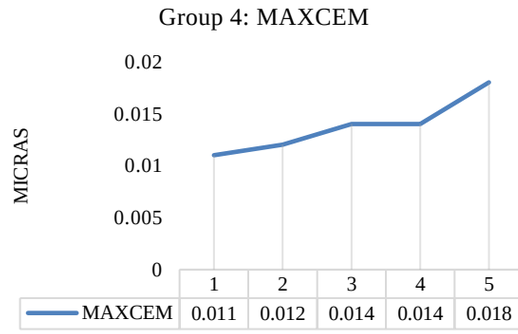
Graphic 2 Results and performance of ICem Cement.

Group 3: Minimum value of 0.01, maximum value of 0.024 with a mean of 0.0202, variance 0.0000337 and standard deviation of 0.005805. See graphic 3.



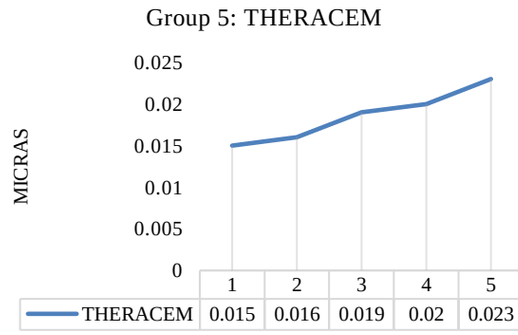
Graphic 3 Results and performance of RelyX Ultimate Cement

Group 4: Minimum value of 0.011, maximum value of 0.018 with a mean of 0.0138, variance 0.0000072 and standard deviation of 0.002683. See graphic 4.



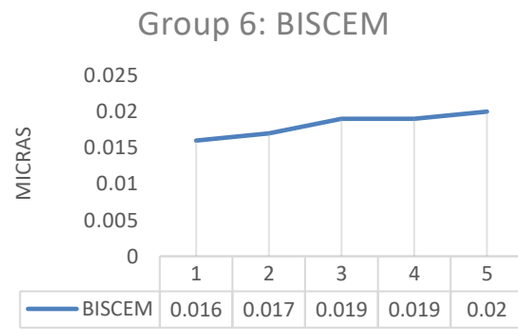
Graphic 4 Results and performance of MaxCemt Cement

Group 5: Minimum value of 0.015, maximum value of 0.023 with a mean of 0.0186, variance 0.0000103 and standard deviation of 0.003209. See graphic 5.



Graphic 5 Results and performance of TheraCemt cement

Group 6: Minimum value of 0.016, maximum value of 0.020 with a mean of 0.0182, variance 0.0000027 and standard deviation of 0.001643. See graphic 6.



Graphic 6 Results and performance of BisCemt cement

All the values obtained by the six groups of cements are detailed in Table 1.

	Prime Dent Group 1	iCem Group 2	Relyx Ultimate Group 3	MaxCem Group 4	TheraCem Group 5	BisCem Group_6
E01	0.014	0.003	0.021	0.011	0.023	0.02
E02	0.023	0.004	0.024	0.014	0.015	0.019
E03	0.014	0.007	0.023	0.018	0.016	0.019
E04	0.023	0.004	0.023	0.012	0.019	0.017
E05	0.015	0.005	0.01	0.014	0.02	0.016

Table 1 Results of the 30 samples that made up the study presenting the values in microns

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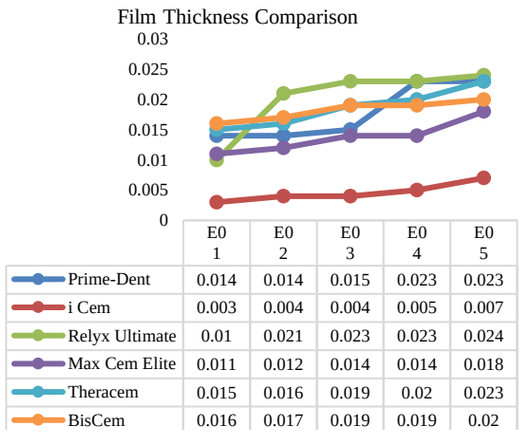
A comparative graph is also made to evaluate the overall performance of the six self-adhesive resinous cements. See graphic 7.



	E01	E02	E03	E04	E05
Prime-Dent	0.014	0.014	0.015	0.023	0.023
i Cem	0.003	0.004	0.004	0.005	0.007
Relyx Ultimate	0.01	0.021	0.023	0.023	0.024
Max Cem Elite	0.011	0.012	0.014	0.014	0.018
Theracem	0.015	0.016	0.019	0.02	0.023
BisCem	0.016	0.017	0.019	0.019	0.02

Graphic 7 Comparative graph of the values of the 30 samples

An ANOVA test was performed to obtain the statistical value and it was obtained that p=0.000, therefore there are statistically significant differences between the cements.

Once the results were analyzed, it was determined that all the cements comply with the standards, but there is a significant difference between them.

Conclusions

It is important to comment that in spite of the fact that all the cements comply with the norm of having a thickness of .25 microns in the graphs we can see that the most stable cements and with a better clinical behavior are: BisCem in the first place, MaxCem in the second place, MaxCem in the third place and MaxCem in the third place: BisCem in first place, MaxCem in second place and TheraCem in third place.

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