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Effect of chlorhexidine gel on the hardness of glass ionomer

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Abstract:

Aim: the objective of this study is to discover the effect of chlorhexidine gel on hardness of glass ionomer filling material

Method: A total of sixty samples were divided into two main groups based on mixing Glass Ionomer with Chlorhexidine. Each group was further divided into three subgroups according to storage time: twenty-four hours, one week and one month.

Results: there were no significant dwasrences between the hardness of Chlorhexidine-glass Ionomer and Glass Ionomer at all periods of examination extended to one month, and the hardness value of both glass Ionomer and chlorhexidine-glass Ionomer mixture were enhanced over time.

Conclusion: Chlorhexidine-Glass Ionomer mixture has the same hardness as Glass Ionomer.

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Introduction

Wilson and Kent (1970) were trying to overcome shortcomings of silicate cements and to retain or improve their advantages when they developed Glass Ionomer Cement. Glass Ionomer Cement material was developed by combining strength, rigidity, and fluoride release properties of a silicate glass powder with the biocompatibility and adhesive characteristics of a polyacrylic acid liquid. This turned out to be a hybrid cement of silicate-polycarboxylate consisting of calcium fluoroaluminosilicate glass powder and polyacrylic and itaconic acid liquid. These glasses were of the same generic type as had been used in the former dental Silicate Cement but modified to be of greater basicity to compensate for the reduced acid strength of the polymer compared with the phosphoric acid used in the dental Silicates. When first developed, the Glass Ionomer Cement was labeled ASPA for its basic ingredients: “A”lumino, “S”ilicate powder and “P”olyacrylic-“A”cid liquid [1-3].

The setting of conventional Glass Ionomer Cements is carried out by an acid–base reaction between a degradable alumino-silicate glass and an aqueous solution of polyalkenoic acid. The acid attacks and degrades the alumino-silicate glass structure, releasing calcium and aluminum cations. These cations are then chelated by the carboxylate groups and cross-link the polyalkenoic acid chains. This cross-linking reaction is a continuous process evident by the increase in mechanical properties of the cement with time. The acid–base reaction was almost complete within one day [4].

The surface hardness of Glass Ionomer cements when stored in a humid atmosphere generally increases with time. However, subtle but distinct time-dependent differences in Knoop hardness, which can be attributed to differences in chemical and physical formulation, are observed. When Glass Ionomer cements are stored in water after an initial setting of 15 min. a surface softening occurs independent of the formulation. The changes in surface hardness with time suggest that this softening most probably is caused by an inhibition of the secondary setting reaction in a superficial layer of the cement and not by erosion [5-8].

Material and Methods

Preparation of Glass Ionomer samples

All samples were prepared by adding three measures of Glass Ionomer powder on

clean sterilized glass slab and three drops of Glass Ionomer liquid were dispensed beside and mixed with solid plastic spatula.

For cement materials the mixing time, working time and setting time were (30-40 sec, 2-3 min. and 5-7min.) respectively. While for filling materials, the mixing time, working time and setting time were (50 sec, 2-3 min. 2-5 min.) respectively.

Glass Ionomer materials were packed with plastic spatula inside split dissembled Brass molds with internal diameter 6 mm and 2 mm height which were placed on celluloid strips.

Another celluloid strip was placed on top of split Brass mold containing packed materials.

Another glass slap was placed on the top of colloid strip for 10 min to insure complete setting of the material.

A constant load (250 mg) was placed on top of the second glass plate for the whole period of setting of the material.

Specimens were stored in incubator at 37°C and 100% relative humidity till the end of storage times.

Preparation of Glass Ionomer-Chlorhexidine mixture samples

A total of 0.5 ml of Chlorhexidine gluconate slurry 2.0% was added by graduated syringe, to the same amount of glass Ionomer materials.

The mixture of Chlorhexidine to glass Ionomer materials was done by plastic spatula on clean glass slab for 55 sec.

Glass Ionomer- Chlorhexidine mixtures were packed in the split Brass mold as discussed before.

However, working and setting times were prolonged to 4min and 8min respectively.

Specimens were stored in incubator at 37°C and 100% relative humidity till the end of storage times (twenty hours, one week and one month).

Hardness Test

Surface Micro-hardness of the specimens was determined using Digital Display Vickers Micro-hardness Tester (Model HVS-50, Laizhou Huayin Testing Instrument Co., Ltd. China) with a Vickers diamond indenter and a 20X objective lens.

A load of 100 g was applied to the surface of the specimens for 10 seconds. Three indentations, which were equally placed over a 1 mm diameter circle and not closer than 300 µm to the adjacent indentations, were made on the surface of each specimen. The diagonals length of the indentations was measured by built in scaled

microscope and Vickers values were converted into micro-hardness values.

Results

Hardness of GI with and without CHX at different storage times (one day, one week and one month):

After one day, the mean value of hardness of GI (41.7) was higher than the hardness of GI- CHX mixture (41.2) and this difference was statistically insignificant.

After 1 week, the mean value of hardness of GI (42.2) was higher than the hardness of GI- CHX mixture (41.8) and this difference was statistically insignificant *(P ≤ 0.05)*.

After 1 month, the mean value of hardness of GI (42.8) was higher than the hardness of GI- CHX mixture (42.4) and this difference was statistically insignificant *(P ≤ 0.05)*.

Side / Period	Control		CHX		*P*-value
	Mean	SD	Mean	SD	
One day	41.7	0.9	41.2	1.2	0.088
1 week	42.2	1.1	41.8	1.5	0.296
1 month	42.8	1.1	42.4	1.3	0.056

Table 1: The mean, standard deviation (SD) values and results of paired t-test for comparison between hardness of GI filling with and without CHX in Group A

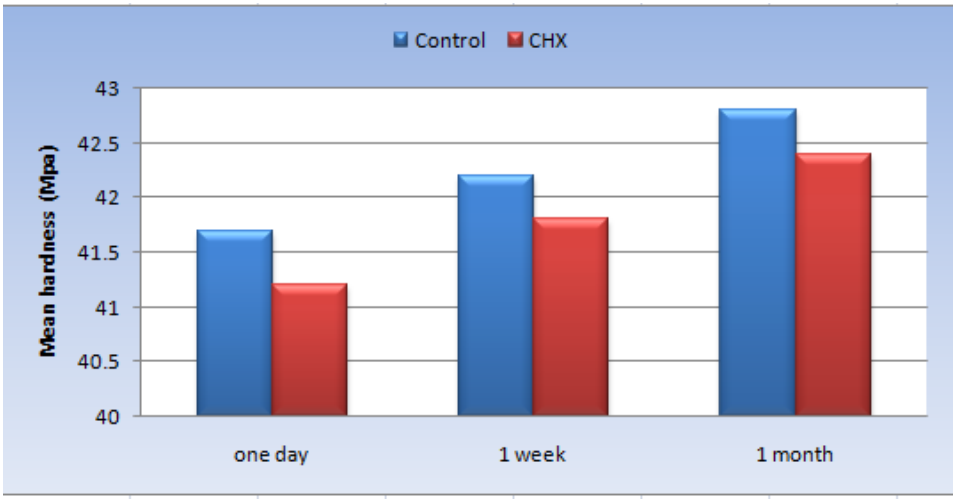

Figure 1: Bar chart representing mean hardness of GI filling with and without CHX in Group A

Comparison between different time periods

Effect of storage times (one day, one week and one month) on Mean hardness values (VHS) of GI with and without CHX shown in tables (1,2) and illustrated in figures (16,17)

After one day, the mean value of hardness of GI cement (41.2) showed increase in mean hardness value after one weak (41.8) and one month (42.4), but this increase was non-statistically significant *(P ≤ 0.05)*.

After one day, the mean value of hardness of GI cement (31.1) showed increase in mean hardness value after one week (31.4) and one month (32.2), but this increase was non-statistically significant *(P ≤ 0.05)*.

Group / Period	Group A		Group B	
	Mean	SD	Mean	SD
One day	41.7	0.9	31.1	1
1 week	42.2	1.1	31.4	1
1 month	42.8	1.1	32.2	1
P-value	0.069		0.059	

**: Significant at P ≤ 0.05*

Table 2: The mean, standard deviation (SD) values and results of one-way ANOVA test for comparison between hardness of GI cement and filling without CHX at different time periods.

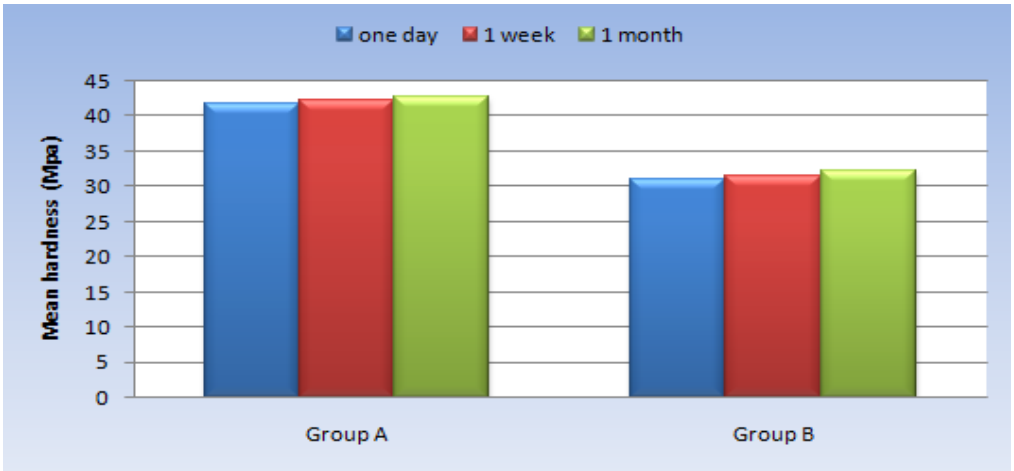

Figure 2: Bar chart representing mean hardness of GI cement and filling without CHX at different time periods.

Table 2: The mean, standard deviation (SD) values and results of one-way ANOVA test for comparison between hardness of GI cement and filling with CHX at different time periods.

Group / Period	Group A		Group B	
	Mean	SD	Mean	SD
One day	41.7	0.9	31.1	1
1 week	42.2	1.1	31.4	1
1 month	42.8	1.1	32.2	1
P-value	0.069		0.059	

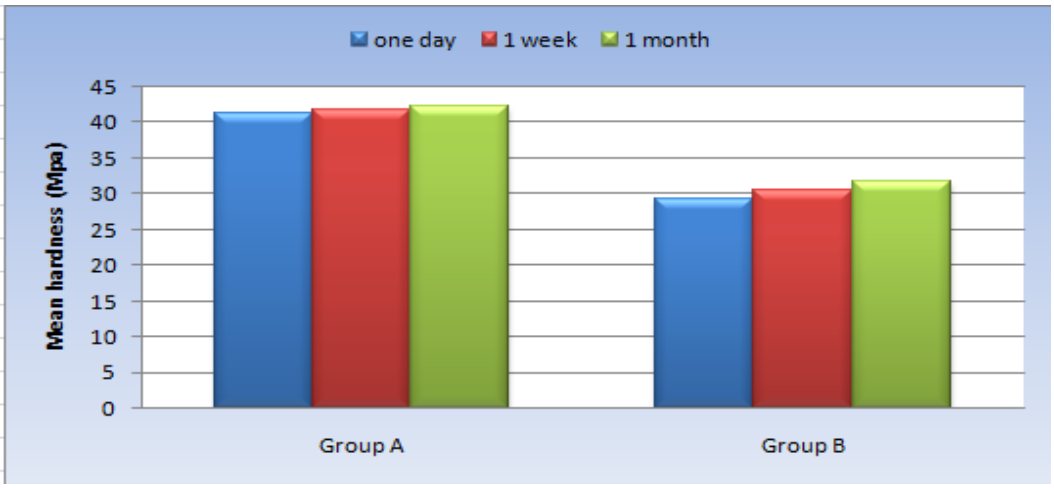

Figure 3: Bar chart representing mean hardness of GI cement and filling with CHX at different time periods.

Discussion

In this study Chlorhexidine gel -with silica content- was used to provide strong and slow release of the active ingredients.

Verraedt(2010) [9] reported that silica materials are an important class of controlled release matrices. An important advantage of silica materials is their excellent biocompatibility around controlled release.

In this study the surface hardness of Glass Ionomer – Chlorhexidine mixture was checked to predict its clinical behavior. This principal is in agreeing with **Wasson (1993)** [10] who stated that; the surface hardness is an important factor that correlates well with wear, abrasion resistance, and compressive strength; so, it can be used as an indication of likely long-term durability of materials. Also, **Peutzfeldt (1997)** [11] reported that; the decreases in micro-hardness of restorative material may cause the abrasion of the material resulting in lower resistance to the occlusal forces. Furthermore, **Silva (2007)** [12] proved that; micro-hardness testing has been suggested to be a valuable method to detect the surface alterations of Glass Ionomer, as it provides more accurate data to assess the setting reaction characteristics of Glass Ionomer having influence on their optimal long-term clinical performance.

On the other hand **Mair (1996)**[13] and **Okada(2001)** [14] stated that; superficial micro-hardness measurements cannot reliably detect the setting reaction occurring in the bulk of the material and cannot always explain the real clinical longevity of Glass Ionomer because of certain factors such as saliva, pH changes, food, liquids, and masticatory functions in the oral environment.

In this study micro-hardness testing of Glass Ionomer and Glass Ionomer – Chlorhexidine mixture was performed at different storage time (one day, one week and one month), these methods were cheeked by **Ellakuria (2003)** [15] he found that for accurate and reliable results it is better to perform hardness testing of Glass Ionomer at different storage time. Also, **Zainuddin (2009)** [16] concluded that the reconstruction of the silicate network contributed to the increase in hardness with time during the period after the gelation by cross-linking was completed.

According to results of this study the hardness of Glass Ionomer was higher than Glass Ionomer - Chlorhexidine during all periods of examination which extended to one month. However, this deference was statistically insignificant, indicating that

addition of Chlorhexidine did not seriously decrease the hardness of the mixture.

The neglected difference in hardness between Glass Ionomer and Glass Ionomer – Chlorhexidine mixture may be explained by that the silica content of Chlorhexidine gel (**Consepsis Scrub)** [17] is well compatible with that of Glass Ionomer silica powder and it is known that there is a significant correlation between increase of silica content of Glass Ionomer and increase rate of the surface hardness[18] ,thus the silica content of Chlorhexidine gel may compensate any decrease in hardness of Glass Ionomer produces by incorporation with Chlorhexidine

Our results in agree with **Sanders (2002)** [19] he found that the Glass Ionomer Chlorhexidine combinations exhibited less micro-hardness compared to the control (additive-free) group, but no significant differences were indicated after 6 weeks from the initial setting reaction of Glass Ionomer-Chlorhexidine mixture. On the other hand, our results in disagreement with **Türkün (2008)** [20] who showed that there was significant decreased in hardness values of Glass Ionomer-Chlorhexidine than Glass Ionomer additives free. This contradiction may be attributed to the difference in concentration of Chlorhexidine used in our study (2%) and their study (2.5%) also, it may be attributed to the physical form of Chlorhexidine used, while Chlorhexidine gel was used in our study. Chlorhexidine liquid was used in their study.

The results of this study indicated that the hardness of Glass Ionomer and Glass Ionomer – Chlorhexidine mixture increased with time. However, this increase was not statistically significant.

Our results agree with **De Moor et a**l **(1998)** [21] they reported that; In a humid atmosphere the surface hardness generally increases rapidly initially, followed after 1 day by a more gradual increase.

According to the result of this study the hardness of Glass Ionomer filling (medifill) was significantly higher than Glass Ionomer cement (medicem) this may attributed to the hardness values is affected significantly with the microstructure of Glass Ionomer, the very dense surface texture of Glass Ionomer filling (Medifill) with tightly packed, smaller size glass particles in the matrix, resulted in a higher hardness value than Glass Ionmer Cement (Medicem).

Our results agree with **Xie (2000)** [22] who reported that; smaller glass particle sizes and lower micro structural porosity were correlated with higher hardness values.

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