Effectiveness of Commonly Available Surface Protecting Agents in Maintaining Microhardness of Two Cements

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ABSTRACT

Objective: To estimate the microhardness of glass ionomer cement (vitrofil) and resin modified glass ionomer cement (vitremere) in the presence and absence of different surface protections.

Study Design: An *in-vitro* experimental study.

Place and Duration of Study: The Department of Operative Dentistry, Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences and the Department of Material Sciences, NED University, Karachi, from August 2011 to January 2012.

Methodology: Seventy-two discs of each material were made in polytetrafluoroethylene mold which was 10 mm in diameter and 2 mm in thickness. Four groups were made for each material containing 18 discs; G1/G5 (control group), G2/G6 (solid petroleum jelly), G3/G7 vernal (resin varnish), G4/G8 (nail varnish). After initial setting reaction surface protection was applied to discs. Once the surface protection was dried, discs were stored in deionized water at 37°C for 24 hours. After 24 hours, the discs were polished. Microhardness test were performed in digital microhardness tester. The results were statistically analyzed with the help of two-way ANOVA.

Results: For glass ionomer cement the only G4 (nail varnish) differed from the G1 (control group) [$p < 0.05$], No significant difference was seen with other surface protection agents. For resin modified glass ionomer cement, the G7 (resin varnish) and G8 (nail varnish) gave better result from the G5 (control group).

Conclusion: Nail varnish and resin varnish showed better surface protection for GIC and RMGIC. The presence of toluene in nail varnish have harmful effects so should not be preferred if resin varnish is available.

Key words: *Conventional glass ionomer cement. Resin modified glass ionomer cement. Microhardness. Surface protection.*

INTRODUCTION

Conventional glass ionomer cement (GIC) is a popular restorative material commonly used to fill small defects and erosive lesions of vital teeth.[1] Its liquid component is aqueous solution of poly acrylic acid, stabilized with 5% tartaric acid. The powder component is usually a fluoroaluminosilicate glass. When powder and liquid are mixed, it results in acid-base reaction.[2]

Glass ionomer cement is esthetically and clinically more attractive than other metallic restorative materials.[3] Dentist leans towards them because of their many advantages.[4] They make chemical bond to tooth structure which helps in protecting the pulp, sealing the cavity, reducing secondary caries as addition of fluoride enhances their anticariogenic properties.[5] Moreover they seem to be less toxic and biocompatible.[4] Although in addition to their advantages, GIC exhibit some limitations which are poor mechanical strength, low abrasion, wear resistance and loss of microhardness and luminousness due to moisture contamination before setting and desiccation in dry conditions.[6,7]

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Initial setting reaction takes only few minutes but gelation and hydration occurs in 24 hours. During this time cements are tremendously susceptible to hydration and dehydration.[8] Hence, if loss of water occurs during setting reaction, it leads to dimensional alteration, microcracks in restoration and lack of adhesion. If restoration comes in premature contact with moisture it will result in surface erosion, loss of calcium and aluminum ions and lack of the translucency.[9]

In early 1990s, a resin monomer named 2-hydroxyethyl methacrylate (HEMA) was added to GIC to formulate resin modified glass ionomer cement (RMGIC).[5] This modification reduced the harms of moisture sensitivity related with conventional glass ionomer cements to some extent. Presence of resin polymerization in the modified materials improved its low initial mechanical strength, while keeping their advantages undisturbed such as fluoride release and self-adhesive nature.[10]

Resin-modified glass ionomer cements is set by two processes: primary and prominent setting by acid-base reaction and secondary auxiliary setting by photo polymerization reaction.[11] With respect to their conventional counterpart, RMGIC have longer working time, quick setting time, superior esthetic appearance and superior initial strength.[12] They can be finished and polished on the same visit.[13] However, RMGIC keeps some properties of glass ionomer cements. Resin monomer and photo polymerization have not considerably reduced the susceptibility of RMGIC to dehydration problems.[9] Only a few studies have addressed the importance of surface protection for RMGIC. On the contrary, RMGIC can be used with or without surface protection.[14]

To decrease the vulnerability of conventional glass ionomer cement and its hybrid version to moisture, surface protectors are recommended.[15] Today several commercial products are available such as varnishes, petroleum jelly (solid, liquid) and nail varnishes.

The function of these products seems to maintain the "water balance" in the restoration.[16] Moreover, additional benefit of using these protective agents is to preserve color stability of restoration by filling small surface voids and defects and to decrease the uptake of stains.[17]

The hypothesis of the present study was that there was statistically significant difference between the micro-hardness value of protected and unprotected samples.

The purpose of this study was to assess the change in microhardness of a conventional glass ionomer and a resin modified glass ionomer after application of various types of surface protection agents.

METHODOLOGY

This experimental study was conducted at Department of Operative Dentistry, Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, Karachi. Microhardness evaluation was carried out at the Department of Material Sciences, NED University, Karachi, from August 2011 to January 2012.

Materials used in the study included conventional glass ionomer cement and resin modified glass ionomer cement. Details of materials are shown in Table I.

Seventy two specimens of each restorative material were made using polytetrafluoroethylene mold (10 mm diameter 2 mm of thickness). vitremer and vitrofil were mixed manually according to manufacturer's instructions. After mixing, molds were overfilled, to avoid air bubbles and inclusions molds were covered with Mylar strip and compressed with glass slides from the upper and lower surfaces. Vitremer were light cured at the distance of 1 mm for 40 seconds on each side with LED curing lamp Mectron (intensity 1.000 mw/cm^2 starlight pro-led curing lamp, Italy). Vitrofil specimens were left for 5 minutes for setting. After setting, glass slides and mylar strips were removed. Discs with voids, bubbles and uneven rough surface texture were excluded from the study. Each material was divided in four groups, each group contained 18 specimens including Group-1: control group, Group-2: Solid petroleum jelly, Group-3: resin varnish (varnal) and Group-4: Nail varnish. Details of protecting agents are shown in Table II.

Table I: Material used in the present study.

Vitrofil	FAS: aluminium fluorosilicate glass, PPA: polyacrilic acid, water	DFL dental product, Brazil.	10081066
Vitremer	FAS: aluminium fluorosilicate glass, PMAA: polymethacrylic acid, HEMA: hydroxyethylmethacrylate	3M Dental Products, St. Paul, MN, USA.	20090302

Table II: Details of protecting agent.

Protecting agent	Composition
Petroleum jelly	Mineral oils, paraffin and microcrystalline waxes.
Varnish (varnal)	Resin staybilite, dimetylcetone.
Nail varnish	Camphor, nitrocellulose, sulfonamide, toluene.

All samples were stored for 24 hours in deionized water. After 24 hours, the samples discs were polished with fine and ultra fine aluminum oxide abrasive disks (Sof-Lex Pop-on, 3M Dental products, Saint Paul, MN, USA) in the presence of water to obtain a flat polished surface.

The Vicker's microhardness measurements were done after 24 hours in digital microhardness tester (Micro-vicker's hardness tester, Wolpert group, China) with 50 g of load and 30 second well time. In each specimen three measurements were accomplished, and the mean was used for subsequent statistical analysis.

Data was entered in Statistical Package for Social Sciences (SPSS) version 16. Descriptive analysis was executed in the form of mean ± standard deviation for surface microhardness. The level of significance (P) was calculated with the help of repeated measure ANOVA. For multiple comparisons, Tukey's Honestly Significant Difference (HSD) was used. The significance level was considered as $p < 0.05$.

RESULTS

The mean microhardness value for vitremer was highest in comparison to vitrofil. According to surface protective agents applied on vitrofil the microhardness values from highest to lowest were found as follow: group-4 (nail varnish) showed highest microhardness values followed by group-3 (resin varnish vernal), group-2 (solid petroleum jelly) and group-1 (control group) showed least values for microhardness and there was slight difference between them.

A significant difference was seen between group-1 (control group) with group-3 (resin varnish) and group-4 (nail varnish). There were no statistical significant difference ($p = 0.795$) seen between group-1 (control group) and group-2 (petroleum jelly) as shown in Table III.

According to surface protective agents applied on vitremer the microhardness values from highest to lowest were found as follow: group-8 (nail varnish) and group-7 (resin varnish vernal) showed highest microhardness values followed by group-6 (solid petroleum jelly) and group-7 (control group) showed

Table III: Means (± standard deviation) (Vickers) of the microhardness values obtained for glass ionomer cement (vitrofil) and resin modified glass ionomer cement (vitremere).

Groups	Surface protection	n	Mean + SD	p-value
Group-1	Without any surface protection	18	19.050 ± 87515	0.232
Group-2	With petroleum jelly with varnish	18	21.822 ± 4.536722	0.232
Group-3	With nail varnish	18	25.0556 ± 3.54122	0.001
Group-4	Without any surface protection	18	30.7556 ± 3.54122	0.001
Group-5	Without any surface protection	18	26.2667 ± 4.14473	0.005
Group-6	With petroleum jelly	18	24.5833 ± 50980	0.005
Group-7	With resin varnish	18	35.7556 ± 4.72232	0.001
Group-8	With nail varnish	18	36.1822 ± 65111	0.001

The level of significance (p) was calculated with the help of two way ANOVA for multiple comparison Tukey's honestly significat difference (HSD) was used. The significance level was considered as p < 0.05.

least values for microhardness and there was slight difference between them.

Statistical difference (p < 0.001) was seen among the group-5 (control group) with group-7 (resin varnish) and group-8 (nail varnish). There was no statistical significant difference (p = 0.983) seen between group-5 (control group) and group-6 (petroleum jelly) as well as between group-7 (resin varnish) and group-8 (nail varnish) shown in Table III.

DISCUSSION

Water plays a key role for the maturation of GIC; water dehydration and contamination during the initial setting stages can compromise the physical properties of the restoration.[18]

According to the results of the present study, micro-hardness of the GIC group protected with petroleum jelly did not significantly differ from the control group. The reason is, it easily washed away while setting reaction was continued, but in case of RMGIC, microhardness of samples protected with petroleum jelly is significantly different from control group because setting reaction is quite fast in it.

Results of the present study are in accordance with the study done by Cecilia *et al.*, which proved that microhardness of unprotected samples of GIC was reduced significantly than protected samples.[19] Serra *et al*. concluded that all surface protecting agents including nail varnish, shofu varnish, copalite varnish and vaseline were effective in protecting setting reaction of GIC. But nail varnish provides the best result. Similar to the findings of Serra *et al*., this present study revealed that copal and nail varnish are quite effective in maintaining microhardness of GIC cement.[20] Moreover, Luciana *et al*. concluded that no significant difference was observed among the types of protections used on GIC at 24 hours of storage. The results of Luciana is contrary from the present study because of small sample size (n = 36) and different media used for storage of samples (distilled water).[21] The present study had a larger sample size (n = 72) as well as deionized water is used to store control samples. Microhardness and strength of metal-reinforced GIC was significantly increased with surface protecting agents.[22]

Riberio *et al*. suggested that there were no difference in dye uptake among the RMGIC of three different manufacturers, all of them required surface protection to maintain water balance and mechanical properties of material.[23] Thus, it has been proved that additional resin monomer and supplementary photo polymerization have not considerably reduced the vulnerability of RMGIC to dehydration problems.[9]

Results of present study are corroborating with the results obtained by Serpil *et al.*, which concluded that there were no statistically significant differences among copal and nail varnishes for GIC and RMGIC.[24] Furthermore, Cerqueira *et al*. reported that nail varnish and copal varnish both are best surface protectors in retaining the hardness of GIC and RMGIC.[25]

Thus, it has been justified from the results of present study that nail varnish is the best agent for surface protection as well as maintaining microhardness because of the fact that nail varnish forms a film that quickly sticks to the surface.

In addition to its qualities; presence of toluene in nail varnish makes it harmful for health as it can affect the nervous system. But positively surface protecting agents are used in very minute amount that could not cause any health problems.[19]

This present study has some limitations as it could not completely replicate the complex oral environment. The role of artificial saliva, thermocycler and all versions of material was not taken into consideration.

So, it is suggested that in future clinical studies are also necessary to compare the advantages of different protective agents over conventional GIC and its hybrid combinations.

CONCLUSION

Resin modified glass ionomer cement (vitremere) present higher mean surface microhardness value than the conventional glass ionomer cement (vitrofil). Microhardness value of controlled sample decreased considerably in deionized water than the protected samples. Among protecting agents, nail varnish and resin varnish showed better surface protection for the GIC and RMGIC. The presence of toluene in nail varnish have harmful effects so should not be preferred if resin varnish is available.

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