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Comparative evaluation of different home-use remineralizing agents on microhardness of Glass Ionomer Restoration: An in vitro study

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Abstract

Objective: Although various properties of tooth-coloured materials have been described, little data have been published on the effect of home-use topically applied remineralizing agents on the hardness of Glass Ionomer Cement (GIC). So, the present study was conducted to compare effects of Casein Phosphopeptide- Amorphous Calcium Phosphate (CPP-ACP), Bioactive glass (BAG) and Calcium Sucrose Phosphate (CaSP) on microhardness of GIC Restoration.

Study design: 45 extracted permanent posterior teeth were collected and class I cavity was prepared on them. Specimens were kept in tap water to prevent from dehydration. Cavities were restored with GIC and baseline Vickers microhardness was measured. Teeth were randomly divided into 3 groups and treated everyday with CPP-ACP (GC Tooth Mousse), BAG (Sensodyne toothpaste) and CaSP (Toothmin toothcream). After 3 months, microhardness of GIC was measured again.

Results: Microhardness decreased in all 3 groups but numerically less in Sensodyne group. However, difference was statistically non-significant. ($p>0.05$)

Conclusion: Surface microhardness of GIC was decreased after topical application of all tested remineralizing agents.

Keywords: Remineralizing agents, Glass ionomer cement, Microhardness, Casein Phosphopeptide-Amorphous Calcium Phosphate, Bioactive glass, Calcium Sucrose Phosphate

Introduction

Dental caries is known to occur when the equilibrium between demineralization and remineralization at the tooth surface is shifted in favour of demineralization. Prevention of initiation and interruption in progression of early lesions are the desirable modes of caries management [1]. Technology containing Casein Phosphopeptide - Amorphous Calcium Phosphate (CPP-ACP), Bioactive glass (BAG), Nano- hydroxyapatite, Calcium Silicate, Calcium Sucrose Phosphate (CaSP) is compared for the enamel remineralization ability with fluoride which is long known to be effective method of remineralization [2]. At present replacement of the lost enamel structure is done by various man-made restorative materials. However, these materials have an inherent drawback. They are not the same structure as that of the sound tooth [3]. GIC which is used most commonly for deciduous teeth releases fluoride, but the ion release is slow. They are also capable of acquiring further fluoride ions (rechargeability) following exposure to fluoridated products. But, commonly used topical fluoride may affect the clinical durability of the restoration [4].

The aim of this study is to evaluate and compare in vitro surface microhardness of GIC after topical application of home-use remineralizing agents i.e. CPP-ACP, Bioactive glass and Calcium Sucrose Phosphate in an attempt to enhance the remineralizing capacity of GIC.

Materials and Methods

A total of 45 extracted human permanent molars/premolars were selected. All soft tissue and debris was removed using ultrasonic scaling instrument and cleaned with water spray. Teeth were impregnated in the cold- cure acrylic resin. These teeth were stored in distilled water till the commencement of the study.

Class I cavity was prepared on the occlusal surface of all the teeth in a high speed airotor hand piece with water cooling. The width of cavity was about one-fourth of intercuspal distance and a depth of 0.5-1 mm below the dentino-enamel junction (DEJ) calibrated by measuring with a periodontal probe [5]. All the teeth were restored with GIC (Fuji IX).

Baseline microhardness of GIC was tested using Vickers microhardness tester. The tests were carried out according to the manufacturer's instructions. The test specimens were placed on the stage of the tester and stabilized. Then area to indent was selected by focusing with 10× objective lens. After this, the test was carried out where the indentations were made with a rate of 300 gram (g) load for 15 seconds. The indentation formed was viewed and measured on the display monitor. The average microhardness of the specimen was determined from two indentations to avoid any discrepancy. The procedure was repeated for all the 45 specimens.

Teeth were randomly divided into 3 groups:

Group 1: CPP-ACP group (GC Tooth Mousse)

Group 2: Bioactive glass group (Sensodyne Repair & Protect toothpaste)

Group 3: Calcium Sucrose Phosphate group (Toothmin toothcream)

The restored teeth were surface treated with the agents in the respective group once a day for 3 months and stored in distilled water. At the end of 3 months, the samples were washed and blotted dry. After that Vickers microhardness of GIC was measured again as above. Results were obtained and analyzed. One way ANOVA and Post Hoc tests were used for statistical analysis.

Results

Mean microhardness of all samples at baseline was recorded as 103.38 (±10.89). Microhardness decreased in all the 3 groups after 3 months. However, it was not significant (Table 1).

Table 1: Microhardness Values At Baseline And After 3 Months

Groups	N	Mean	Std. Deviation	Std. Error	*p* value*
Baseline	45	103.38	10.89	1.623	0.621 (NS)
After 3 months					

Group 1 (CPP-ACP)	15	101.27	11.16	2.881	
Group 2 (BAG)	15	103.13	11.23	2.900	
Group 3 (CSP)	15	99.53	6.58	1.698	
*p value<0.05 = Significant			NS = Non Significant		

Group 1 showed mean difference of 2.11 with baseline microhardness. Group 2 showed least mean difference of 0.24 with baseline microhardness. Group 3 showed highest mean difference of 3.84 with baseline microhardness. There was no significant difference between any of the groups (Table 2).

Table 2: Mean Difference Between Microhardness Of All Groups With Baseline Values

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	*p* value*
Baseline	Group 1	2.11	3.105	0.904 (NS)
Baseline	Group 2	0.24	3.105	1.000 (NS)
Baseline	Group 3	3.84	3.105	0.605 (NS)
*p value<0.05 = Significant		NS = Non Significant		

Discussion

Glass ionomer cements are clinically accepted preventive restorative materials because of their fluoride releasing property besides their esthetics, biocompatibility and chemical adhesion to enamel and dentin. Since they release fluoride ions, they can reduce enamel solubility and plaque formation by bacteria that initiate dental caries, thereby preventing enamel demineralization along with preventing secondary caries and caries on adjacent teeth. The evolution of high strength, high viscosity conventional GICs with improved physical properties has led to increasing clinical acceptance of these materials. The setting reaction of these materials is rapid, with the early moisture sensitivity considerably reduced and solubility in oral fluids becoming very low [4].

Restorative filling materials used in dentistry are required to have long term durability in the oral cavity. One of the most important physical properties of restorative filling material is surface hardness and the concept is linked to the resistance of a material to indentation/penetration [6]. Surface hardness tests may be applied to evaluate the degradation and durability of dental materials, to observe the effect of storage mediums on the surface, as indicative of resistance to wear and durability, and also to monitor the hardening process of cements [7]. Moreover hardness has been used to predict the ability to abrade or being abraded by opposing dental structures and materials.

When the storage media is either water or saliva, the surface hardness is not affected or is slightly decreased after initial setting. However, when the materials are contaminated with saliva before set, it may result in significant alteration of microhardness [8]. The hardness loss of a restorative material may contribute to the deterioration of the material in a clinical environment leading to increased surface roughness, increased plaque retention, loss of anatomical form, and discoloration. This may significantly shorten the lifespan of the restorations [4].

Vicker's microhardness test was used in this study as this test is suitable for determining the hardness of brittle materials [9]. Microhardness of glass ionomer cement was evaluated after application of 3 different home-use remineralizing agents; CPP-ACP, Bioactive glass and Calcium Sucrose Phosphate.

Test agents which were used are already proven remineralizing agents on enamel surface. CPP-ACP has been proven to promote remineralization in dental erosion and increase microhardness of bleached enamel [10,11]. Bioactive glass has been proven to resist & prevent demineralization of enamel and for the treatment of white spot lesion [12,13]. Anticay has been proven to reduce the depth of enamel lesion and has remineralizing effect over teeth affected by acid challenge [14,15]. All these agents are meant to be used on tooth surface. Till date little literature has been reported regarding effects of these agents on hardness of already existing restorations.

In the present study, decrease in microhardness was observed in all 3 groups after 3 months. This could be attributed to the type of storage media used. Exposure to any liquid storage medium has a softening effect on the GIC surface & shows significant decrease in microhardness [16,17]. For group 1, presence of phosphoric acid in the composition of the test material (GC Tooth Mousse) might be the reason of decreased microhardness of GIC. Phosphoric acid is capable of forming stable complexes with metal ions in the GIC and causing dissolution of the matrix [18]. Group 2 has shown least changes among the three groups which can be attributed to the presence of fluoride. When bioactive glass is added to fluoride dentifrices it significantly enhanced fluoride uptake into artificial carious lesions in enamel surfaces and provides a synergistic action [19]. Also, bioactive glass-containing toothpaste has shown significant reduction in dentin permeability and excellent resistance to acid challenge [13]. Group 3 showed highest changes in microhardness. The results being unclear, more clinical studies are required to determine the exact possible cause of this decrease.

Conclusion

Within the limitations of the present study it can be concluded that all experimental groups i.e CPP-ACP, Bioactive glass & Calcium Sucrose Phosphate decreases the microhardness of Glass Ionomer Cement surface ($p>0.05$).

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