Does Addition of Propolis to Glass Ionomer Cement Alter its Physicomechanical Properties? An *in Vitro* Study

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Propolis is a natural resinous substance produced by honey bees. The antimicrobial effects of glass ionomer cement have been shown to improve with the addition of propolis; however its effect on the physicomechanical properties of the cement is not known. ***Aim****: The purpose of this study was to evaluate the compressive strength and solubility of conventional restorative glass ionomer cement following the addition of propolis.* ***Study design****: Twenty half cylindrical samples were prepared with conventional restorative glass ionomer cement formed the control group. Another twenty samples were prepared with propolis added to conventional restorative glass ionomer cement formed the experimental group. The compressive strength was assessed using universal testing machine. To assess solubility, the samples were immersed in deionised water at room temperature, for 7 days. The solubility was measured as a difference in the weight of the sample; prior to immersion and following immersion at the end of each day. Results: The control group had a significantly higher mean compressive strength of 146.26 Mpa as compared to the experimental group (135.06 Mpa). The solubility between the groups was significant.* ***Conclusion****: In comparison to the control group, incorporation of propolis to conventional restorative glass ionomer cement decreased the compressive strength significantly. The solubility of the cement in the experimental group increased significantly over 7day period as compared to the control group.*

Key words*: glass ionomer cement, propolis, compressive strength, solubility*

INTRODUCTION

Glass ionomer cement was introduced to the dental profession in 1971 by Wilson and Kent as a material consisting of an ion leachable, calcium aluminium fluorosilicate glass powder that is usually combined with polyacrylic acid or its copolymers.[1] Glass ionomers are popular for their superior properties like adhesion to tooth surface, biocompatibility, thermal compatibility with tooth enamel and release of fluoride. However its limitations include low compressive strength and increased solubility. Many modifications of the original cement have been done using several additives like metals, resins, chlorhexidine, antibiotics and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) with the purpose of enhancing its mechanical properties and expanding its clinical applications.[2-6]

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Over the last few decades, a worldwide increase has been observed in the use of natural products for pharmacological purposes. Propolis is a natural resinous substance produced by honey bees. Bees extract it from plant and process it by using an enzyme found in their salivary glandules. The defense of plants against microorganisms explains the antimicrobial effect of propolis.[7] Propolis has been dispensed in various forms such as powder, water and alcohol based solutions, jelly, lozenges and drops. It is incorporated in tooth pastes (Dentavit, Colgate Propolis), mouth wash (Beevital), soaps and cosmetics.

In an *in vitro* study, the antimicrobial effect of glass ionomer cement has shown to improve with the addition of propolis. [8] However its effect on the physicomechanical properties of the cement is not known. Hence the purpose of this study was to evaluate the compressive strength and solubility of conventional restorative glass ionomer cement following the addition of propolis.

MATERIALS AND METHOD

The conventional restorative glass ionomer cement (GC FUJI TYPE II, GC Corporation, Tokyo, Japan) and propolis (Propolis Platinum by K link Health products) were commercially obtained for the study. Custom made half cylindrical moulds with a diameter of 4mm and height of 8mm were used for the preparation of the samples. Twenty samples formed the control group (conventional restorative glass ionomer cement). Glass ionomer cement was mixed according to the manufacturer's instructions using a plastic spatula on an impermeable paper. The quantity of cement required

for each sample was two scoops of powder and four drops of liquid (5.4/2ml). After mixing, the cement was loaded into half cylindrical moulds which were previously coated with a thin layer of petroleum jelly; loading was done slowly to avoid air bubble formation. The moulds were slightly overfilled to the brim and flattened out using a cellophane sheet to obtain a smooth surface. After setting, they were removed from the moulds and the excess cement was trimmed using a Bard Parker blade.

A total of twenty samples formed the experimental group (propolis added to conventional restorative glass ionomer cement). The cement was mixed in a similar manner but for the addition of 1% w/v of propolis. Propolis was measured using a pipette and 2 drops (1% w/v) was added to the conventional glass ionomer cement during manipulation. The samples were then prepared in a similar manner to that of the control group.

The compressive strength test was done according to ISO standardization[9]. Ten samples each, from both groups was immersed in deionised water and stored at room temperature for 24 hours. They were then subjected to a universal testing machine at a crosshead speed of 1.0mm/min (3M ESPE); till the sample fractured. The compressive strength for the samples was calculated using the equation $P/\pi r^2$. Where: P= load at fracture, r = the radius of sample cylinder, and $\pi\pi$(constant) = 3.14; the values obtained were expressed in Mpa.

To assess solubility, ten samples from each group were weighed using an electronic balance analyzer (METTLER A J150, Switzerland) and their weights recorded as baseline data. The samples were immersed in deionised water at room temperature, for 7 days. However at the end of each day (24 hours), the samples were removed, blot dried, weighed and then reimmersed. This was repeated over the 7 day study period. The solubility was measured as a difference in the weight of the sample; prior to immersion and following immersion at the end of each day.

Data was subjected to statistical analysis using Mann Whitney U test.

RESULTS

The control group had a mean compressive strength of 146.06 Mpa as compared to the experimental group that had only 135.26 Mpa and this difference was statistically significant. ($p \leq 0.05$ (Graph I)

The results for the solubility showed that the difference in mean weight between the two cements was not significant at baseline, and also during the initial 3 days. However, a significant difference existed between the two groups on the 4th day ($p<0.05$). From the 5th to 7th day, a significantly higher mean weight of 0.80g was recorded in the experimental group as compared to the control group (0.78g) ($p<0.001$) (Graph II)

DISCUSSION

Propolis is a natural product widely consumed in folk medicine and has been added to various formulations due to its antimicrobial and antioxidant properties.[7] The chemical composition of this natural substance is complex. More than 300 components have been found in propolis, mainly composed of phenolic compounds (flavanoids, aromatic compounds), terpens and essential oils. Flavanoids and cinnamic acid derivatives have been considered as the main primary biologically active components. Flavanoids, also collectively known as vitamin P and citrin, are a class of plant secondary metabolites. They are all ketone containing compounds, and are the most important plant pigments. They aid in the immune system of human beings by reducing inflammatory reactions by blocking the lipooxygenase pathway. It stimulates various phagocytic activities, improves cell immunity and also acts as a very good microbial agent by breaking down the bacterial cell membrane thus preventing their multiplication.[10,11] Although the antibacterial and antifungal properties of propolis have been extensively investigated, its effect on the various properties of dental cements is not yet known.

The resistance to fracture within a restorative material is specified by a fracture stress, which is often referred to strength of the material.[12] The compressive strength is an important property in restorative materials, particularly in the process of mastication. Glass ionomers are brittle materials and assessment of compressive strength is most commonly employed method to evaluate the strength of these materials.

The addition of increasing concentrations of antibiotics was shown to have increasingly adverse effects on the physical properties of glass ionomer cement.[5] This was also observed in our study wherein the incorporation of propolis decreased the compressive strength of glass ionomer cement. This might be attributed to the interference of propolis with the reaction of glass particles and polyacrylic acid, thereby increasing the number of unreacted particles in the structure. Also propolis could have delayed the setting time by interfering with the setting reaction of the cement.[15] A study showed that addition of propolis to the liquid of glass ionomer cement makes the liquid less viscous due to an increase in the ratio of liquid to powder. The working time was prolonged and there was a decrease in tensile strength. [14]

Similarly a study was conducted to investigate the optimal concentration of chlorhexidine to be added to glass ionomer cement to provide an appropriate balance between antibacterial and physical properties the cement. The incorporation of chlorhexidine decreased the compressive strength by interfering with the reaction of the glass ionomer cement. This resulted in an increased number of unreacted particles in the structure which in turn decreased the strength.[4]

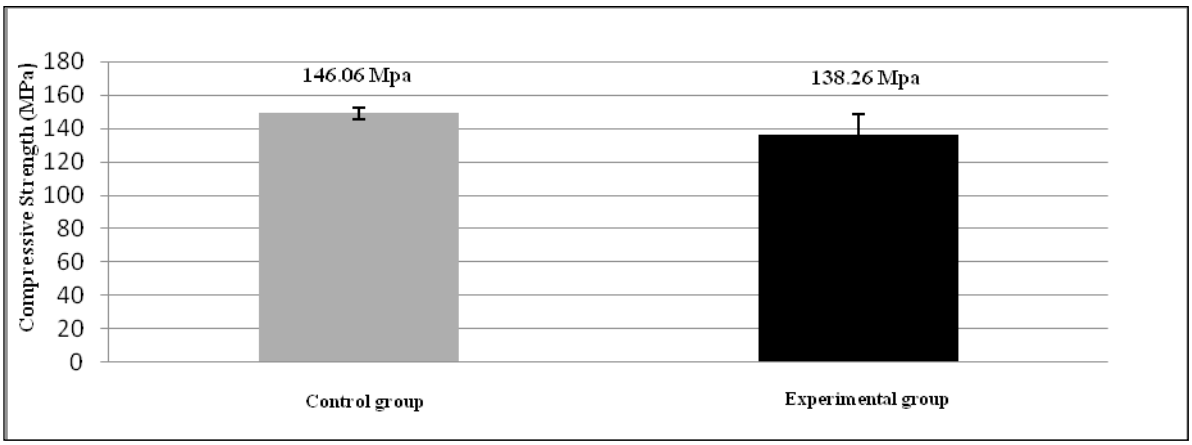
Solubility is an important property while assessing the clinical durability of dental cements as it influences both the rate of degradation and their biocompatibility. Apart from having decreased compressive strength glass ionomers are sensitive to water erosion. This is mainly because of the hydrolysis of the cement components.[13]

Glass ionomer cement usually sets by an acid base mechanism; in the initial phase the glass ionomer cement absorbs water and disintegration of the surface layer takes place. Although continued setting reaction usually decreases the solubility, continued exposure and constant interaction with water further deteriorates the gel matrix and leads to leaching of the ions.[1]

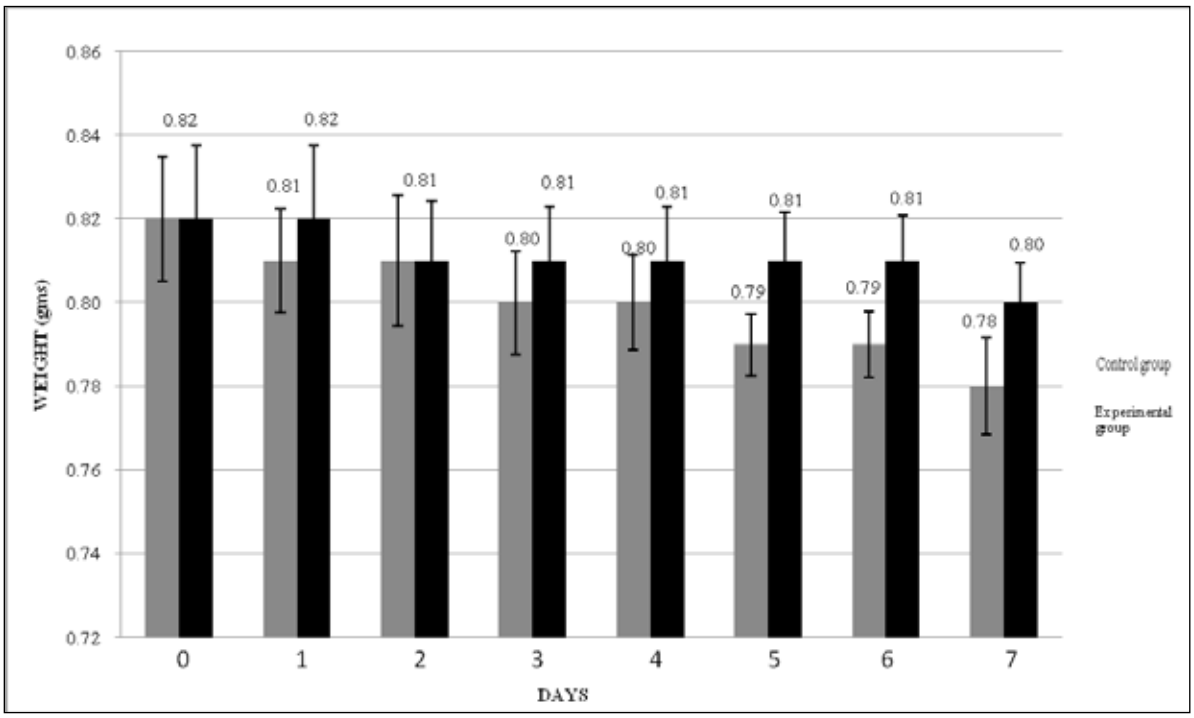
In resin-modified glass ionomer cement, the setting reaction is said to be of a dual mechanism. The usual glass ionomer acid-base reaction begins on mixing the material, followed by a free radical polymerization reaction which may be generated by either photoinitiators or by chemical initiators or both. If chemical initiators are included, then the polymerization reaction will begin on mixing as well.[3]

The acid-base reaction in this modified cement system is known to slow down as some of the water has been replaced by

Graph I –Comparison of Compressive Strength Between the Groups



Graph II- Comparison of Solubility Between the Groups



hydroxyethyl methacrylate (HEMA). Finally, two matrices are formed: a metal polyacrylate salt hydrogel and a polymer. The initial set of the resin-modified glass ionomer cement is the result of the formation of polymer matrix and the acid-base reaction serves to harden and strengthen the formed matrix.[3]

In the current study, the addition of propolis increased the solubility of glass ionomer cement by incorporating a resinous network which reduces the diffusion of water into the cement. Water is important for the setting reaction of glass ionomer in the initial phase; disintegration of the surface layer is also a problem as it leads to leaching of ions and glass particles.[2] The addition of resins reduces the diffusion of water into the structure of the cement preventing the maturation of the cement and hence increases the solubility.[2,13]

An important observation in our study was that propolis discolored the cement and decreased its compressive strength. Hence further research is required using various concentrations of propolis to obtain an optimum concentration to improve the physico-mechanical properties of glass ionomer cement without altering its aesthetics.

CONCLUSION

In comparison to the control group, incorporation of propolis to conventional restorative glass ionomer cement decreased the compressive strength significantly.

The solubility of the cement in the experimental group increased significantly over 7day period as compared to the control group.

REFERENCES

1. Wilson AD, McLean JW. Glass ionomer cement. Chicago: Quintessence Publ Co,:1- 4. 1988.
2. Yap AUJ, Cheang PH, Chay PL. Mechanical properties of two restorative reinforced glass-ionomer cements. J Oral Rehabil.; 29(7):682-8. 2002.
3. Hse KM, Leung SK, Wei SH. Resin-ionomer restorative materials for children: a review. Aust Dent J.; 44(1):1-11. 1999.
4. Takahashi Y, Imazato S, Kaneshiro AV, Ebisu S, Frecken JE, Tay FR. Antibacterial effects and physical properties of glass ionomer cement containing chlorhexidine for the ART approach. Dent Mater.; 22:647-52.2006.
5. Yesilyurt C, Er K, Tasdemir T, Buruk K, Celik D. Antibacterial activity and physical properties of glass-ionomer cements containing antibiotics. Oper Dent.; 34(1):18-23.2009.
6. Al Zraikat H, Palamara JE, Messer HH, Burrow MF, Reynolds EC. The incorporation of casein phosphopeptide-amorphous calcium phosphate into glass ionomer cement. Dent mater.; 27(3):235-43.2011.
7. Kumazawa S, Hamasaka T, Nakayama T. Antioxidant activity of propolis of various geographic origins. Food Chem. ; 84:329–339. 2004.
8. Topcuoglu N, Ozan F, Ozyurt M, Kulekci G. In vitro antibacterial effects of glass-ionomer cement containing ethanolic extract of propolis on Streptococcus mutans. Eur J Dent.; 6(4):428-33.2012.
9. International Organization for standardization. ISO9917. Dental glass polyalkenoate cements. Geneva; ISO 9917-2:2010
10. Vassya Bankova. Recent trends and important developments in propolis research. eCAM.; 2(1) 29-32.2005.
11. Da Silva FB, De Almeida JM, De Sousa SMG. Natural medicaments in endodontics-a comparative study of the anti inflammatory action. Braz Oral Res.; 18(2):174-9.2004.
12. Yap AUJ, Pek YS, Cheang P. Physicomechanical properties of a fast set highly viscous GIC restorative cement. J Oral Rehabil.; 30:1-8.2003.
13. Toledano M, Osorio R, Osorio E, Fuentes V, Prati C, Garcia-Godoy F. Sorption and solubility of resin-based restorative dental materials, J Dent.; 31(1):43-50. 2003.
14. Hatunoglua E, Ozturkb F, Bilenlerc T, Aksakallıd S, Simseke N. Antibacterial and mechanical properties of propolis added to glass ionomer cement. Angle Orthod.;84:368–373. 2014.
15. Troca VBPB, Fernandes KBP, Terrile AE, Marcucci MC, de Andrade FB, Wang LD. Effect of green propolis addition to physical-mechanical properties of glass ionomer cements. J Appl Oral Sci.;19:100–105. 2011.