

Int Poster J Dent Oral Med 2011, Vol 13 No 4, Poster 555

## A New Dental Material for Remineralisation of Caries Lesion Used as a Root Canal Sealer

**Language:** English

### Authors:

Assist. Prof. Dr. Ammar A. Mustafa,  
Kulliyyah (Faculty) of Dentistry, International Islamic University Malaysia, Pahang, Malaysia  
Prof. Dr. Khalid A. S. Al-Khateeb, Prof. Dr. Ahmad Faris Ismail,  
Kulliyyah (Faculty) of Engineering, International Islamic University Malaysia, Pahang, Malaysia

### Date/Event/Venue:

17-19 February 2011  
Malaysian Technology Expo MTE 2011, an International Expo on Technology, Invention & Innovation  
Kuala Lumpur, Malaysia

Poster Award  
Silver Medal

### Introduction

The aim of this study was to evaluate the remineralization effect of a new formula of GIC-based root canal sealer on the dematerialized internal surfaces of root canal and consequently on the existence of accessory canals. Dental cements are of few materials in dentistry that are used frequently. There is no one universally accepted cement that fulfills all applications; there are a variety of cements whose properties and manipulation lead them to be an appropriate choice for a given application. (Hatrack et al 2003)

According to Anusavice (2004), Cements are generally hard, brittle materials formed when a powdered oxide or a glass is mixed with a liquid. When mixed to a cementing consistency, dental cements are used to retain ceramic crowns and esthetic inlays, onlays, and veneers. When mixed to a thicker consistency, some cement types are used as temporary filling materials or to provide thermal insulation and mechanical support to teeth restored with other materials, such as amalgam, composites, or gold. Cements classified as low-strength bases or liners provide protection to the pulp from irritants or serve therapeutically as pulp-capping agents.

Cements must exhibit a sufficiently low viscosity to flow along the interfaces between hard tissue and a fixed prosthesis, and they must be capable of wetting both surfaces to hold the prosthesis in place. This type of material is called a luting agent. Before placement of a restoration or seating of prosthesis, the pulp may have been irritated or damaged from a variety of sources, such as the caries process or cavity preparation. As a means of protecting the pulp against further thermal and chemical trauma, some types of dental cement can be used to prepare bases that are placed under restorations and as pulp capping agents and cavity liners that are placed on prepared tooth surfaces areas close to the pulp chamber. O'Brien (2002)

The glass ionomer cement was formulated first by bringing together the silicate and poly-acrylate systems. The use of an acid-reactive glass powder together with poly-acrylic acid solution leads to a translucent, stronger cement that can be used for luting and restorative materials. Glass-ionomer cements are used for the cementation of cast-alloy and porcelain restorations and orthodontic bands, as cavity liners or base materials, and as restorative materials, especially for erosion lesions. They are being replaced by hybrid ionomer cements, which allow better handling. (Carter 1996; Vorhies et al., 1999)

### Objectives

After performing a clinically successful root canal therapy, recurrent caries lesions may relapse because of secondary root canals.

### Material and Methods

Two experimental GIC-based root canal sealers were prepared for the purpose of the study with a main formula of boro-tri-fluoro-alumino-silicate (BTFAS) for test-1 and strontium fluoride SrF<sub>2</sub> (99% BDH, Malaysia) for test-2. The study materials consisted of 90 samples of human sound teeth extracted for orthodontic reasons. The teeth were embedded into an acrylic mould 4x4 cm. A conventional root canal therapy was performed (but with no root canal filling) on these teeth. Then all the samples were sectioned longitudinally and the surfaces of the tooth structure rather than the canal were painted with a nail polish. The internal side of the canal was subjected to a demineralizing solution with basic active ingredient consisted of 0.1 M lactic acid and 6 wt% carboxymethyl-cellulose at a pH 5.0, 37°C for 14 days to produce a caries-like lesion. After the end of the demineralizing period, the specimens were rinsed thoroughly with distilled water for 10 minutes and the nail polish was removed by the use of commercial acetone solution. The specimens were examined under transversal micro-radiography to have the (control radiographs). Then a film layer of the experimental sealer test-1 was applied to half of the specimens (n=45) and another film of experimental sealer test-2 was applied to the rest of the specimens (n=45). The specimens were divided into three time groups (n=15 for each test time) to be re-evaluated by transversal micro-radiography (test-radiographs) after 14 days, 28 days, and two months. The demineralized-then-remineralised areas for all specimens were measured by means of a precision micrometer (Microcator C.E. Johansson/Eskilstuna, Stockholm, Sweden) with reading ability down to a value of 0.5 µm. The tested areas of test and control specimens were chosen from the same area of the tooth. The specimens were further sectioned and examined under SEM to support the findings of transversal radio-micrograph. Two-way ANOVA test was used for research statistical analysis among all groups. Two-sided paired t-test and a test based on average means were used for statistical analysis to determine significances between test-radiographs and control-radiographs in the same group ( $\alpha = 0.05$ ).

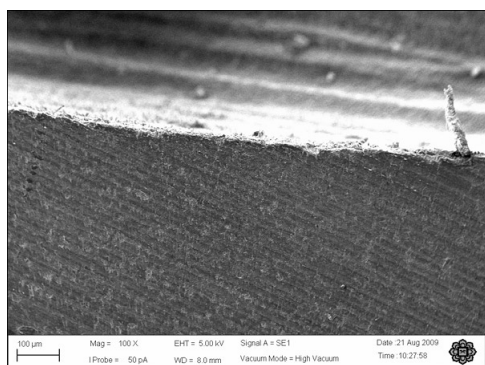


Fig. 1: SEM 1

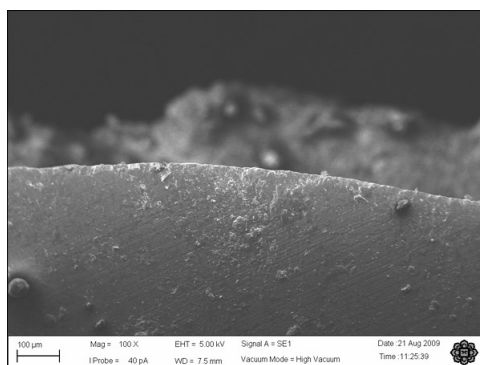


Fig. 2: SEM 2

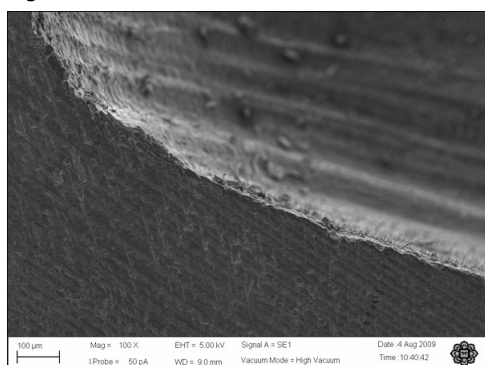


Fig. 3: SEM 3

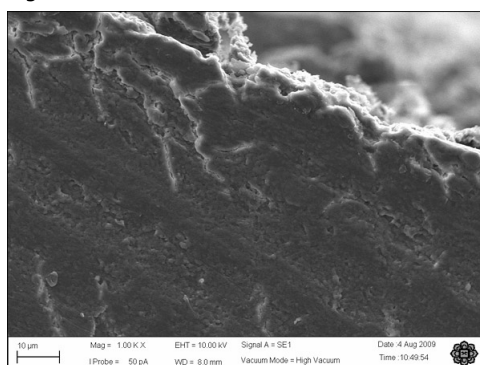


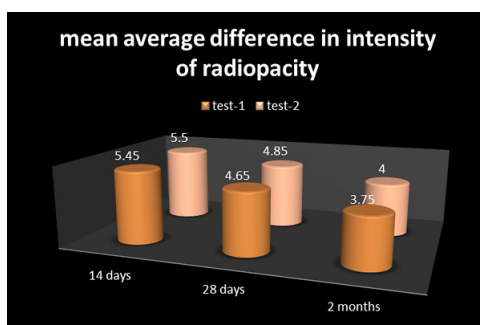
Fig. 4: SEM 4

## Results

There was no significant difference between the experimental sealer test-1 and experimental sealer test-2 in spite of higher numerical values of remineralization with sealer test-1 group. Average means of difference in the intensity of radiopacity showed higher values for test-radiographs at the demineralised-then-remineralised area.

There was an obvious decrease in the depth of the lesion between the control-radiograph and the two months test-radiograph for both test groups. There was no significant difference between 14 days and 28 days and between them and the control-radiograph.

The comparison results of transverse micro-radiography for the two test groups have shown significant differences at time groups of 28 days and two months but no significant difference with the 14 days group. There was an obvious change in the form and texture of the accessory canals at the end of the study but there was no change in quantity of these canals.



## Conclusions

Remineralization is one aspect of the general process of dental caries. However, it is principally studied in shallow lesions. This study was targeting to explore whether carious lesions in enamel and dentin can be remineralized.

Deminerlization was induced by the researchers in dentin so as to study the depth of GIC intrusion into these tooth substrates. Remineralisation was observed in both of enamel and dentin, demonstrating that, the effect of the experimental material can go deep into dentin, that is to say the pores become supersaturated to apatite formation. This may be explained by a relatively fast diffusion of mineral ions, with precipitation being rate-limiting. The results proposed that deep remineralization can be achieved and could possibly be used in clinical treatment strategies.

The change in the texture of secondary canals in the current study may be attributed to the precipitation of mineral ions into these canals indicating that GIC is highly recommended to be used as a root canal sealer.

Basically, Glass-ionomer root canal sealers are commonly used because of their chemical bonding and favorable physical and mechanical characteristics when bonding to dentin.

The experimental GIC based root canal sealer preparation was based on the technologies and the chemistry from silicate and zinc polycarboxylate materials in order to incorporate the desirable characteristics of both. The glass ionomer powder is an acid-soluble boro-trifluoro-alumino-silicate (BTFAS) glass. The raw materials were fused to a uniform glass by heating them to a temperature of 1100°C to 1500°C. The glass was ground into a powder having particles in the range of 15µm to 50µm. Fluoride can promote calcium uptake by dematerialized tissue during remineralization process while Strontium form calcium-strontium apatite complex at the apatite crystal surface which retards the acid dissolution of hydroxyapatite. There are not enough studies on the use of boron oxides salts in dentistry and its relation to remineralization of dental hard tissues.

In addition of being a glass former, the incorporation of boron oxides salts into the formula of experimental sealer has shown an obvious remineralisation effect on the demineralised hard tissues of the teeth and consequently, it can minimise the size of the secondary canals by precipitating leachable mineral ions into these canals.

## Literature

- R.W. Billington, J.A. Williams, G.J. Pearson. Ion processes in glass ionomer cements. *Journal of dentistry* 34 (2006) 544-555
- Manshui Zhoua, James L. Drummond, Luke Hanley. Barium and strontium leaching from aged glass particle/resin matrix dental composites. *Dental Materials* (2005) 21, 145-155
- Beata Czarnecka, John W. Nicholson. Ion release by resin-modified glass-ionomer cements into water and lactic acid solutions. *Journal of dentistry* 34 (2006) 539-543.
- Hien C. Ngo, Graham Mount, John Mc Intyre, J. Tuisuva, R.J. Von Doussa. Chemical exchange between glass-ionomer restorations and residual carious dentine in permanent molars: An in vivo study. *Journal of dentistry* 34 (2006) 608-613
- H. Yamazaki and H.C. Margolis. Enhanced Enamel Remineralization under Acidic Conditions in vitro. *J DENT RES* 2008 87:569
- Sui Mai, Young Kyung Kim, Jongryul Kim, Cynthia K.Y. Yiu, Junqi Ling, David H. Pashley, and Franklin R. Tay. In vitro remineralization of severely compromised bonded dentin. *J Dent Res*. 2010 April; 89(4): 405-410.
- Stephen H.Y. Wei, Jean C. Kaqueler and Maury Massler. Remineralization of Carious Dentin. *J DENT RES* 1968 47: 381
- Anusavice J. Kenneth. *Philips' Science of Dental Materials*. 11th ed. 2004. Elsevier.
- Hatrick CD, Eakle SW, Bird WF. *Dental Materials: clinical applications for dental assistants and dental hygienists*. 1st ed. 2003. Saunders.
- O'Brien WJ. *Dental Materials and Their Selection*. 3rd ed. Kimberly: Quintessence Publishing. 2002: 132-55.
- Carter RN. Glass Ionomer Orthodontic Splints. *Journal of Clinical Ortho* 1996; 30(2):106-9.(Abstract)
- Vorhies AB, Donly KJ, Staley RN, Wefel JS. Demineralization adjacent to orthodontic brackets bonded with hybrid glass ionomer cements; an in vitro study. *Am. J Ortho Dentofac Orthoped* 1999; 114:668-74.(abstract)
- Lammers PC, Borggreven JM, Driessens FC. Influence of fluoride on in vitro remineralization of artificial subsurface lesions determined with a sandwich technique. *Caries Res* 1990;24:81-5.
- Featherstone JDB, O'reilly MM, Shariati M, Brugler S. Enhancement of remineralisation in vitro and in vivo. In: Leach SA, editor. *Factors relating to demineralization and remineralisation of teeth*. Oxford: IRL Press; 1986. p. 23-34.
- Dedhiya MG, Young F, Higuchi WI. Mechanism for the retardation of the acid dissolution rate of hydroxyapatite by strontium. *J Dent Res* 1973;52:1097-109.
- Gibbs CD, Atherton SE, Huntington E, Lynch RJM, Duckworth RM. Effect of low levels of fluoride on calcium uptake by demineralized human enamel. *Arch Oral Biol* 1995;40:879-81.

## Abbreviations

GIC = glass ionomer cement

*This Poster was submitted by Assist. Prof. Dr. Ammar A. Mustafa.*

## Correspondence address:

Assist. Prof. Dr. Ammar A. Mustafa  
Kulliyah of Dentistry, International Islamic University Malaysia  
Kuantan campus, Bandar Indera Mahkota  
25200 Kuantan  
Pahang, Malaysia

# A New Dental Material for Remineralisation of Caries Lesion Used as a Root Canal Sealer (Certified Patent)



Ammar A. Mustafa<sup>1</sup>, Khalid A. S. Al-Khabeet<sup>2</sup>, and Ahmad Faris Ismail

<sup>1</sup>Kulliyah of Dentistry and <sup>2</sup>Kulliyah of Engineering International Islamic University Malaysia  
Phone: 0199202975, E-mail: drammar71@gmail.com

## Materials and Methods:

Two experimental GIC-based root canal sealers were prepared for the purpose of the study with a main formula of boro-tro-fluoro-alumino-silicate for test-1 and strontium fluoride (99% BDH, Malaysia) for test-2. Ninety specimens of human teeth were embedded into an acrylic mould 4x4 cm. A conventional root canal preparation without root canal filling was performed. After sectioning the teeth longitudinally, the internal side of the canal has been subjected to a demineralising solution to produce a caries-like lesion. The specimens were examined under transversal microradiography to have the (control radiographs). Then a film layer of the experimental sealer test-1 was applied to half of the specimens (n=45). Another film of experimental sealer test-2 was applied to the rest of the specimens (n=45). The test specimens were divided into three time groups to be reevaluated by transversal microradiography (test radiographs) after 14 days, 28 days and two months. The specimens were further sectioned and examined under SEM to support the findings of transversal microradiography.

Two-way ANOVA test was used for research statistical analysis among all groups. Two-sided paired t-test was used for statistical analysis to determine significance between test radiographs and control-radiographs in the same group.

## Results, Discussion & Conclusion

### RESULTS:

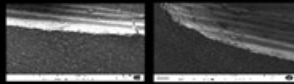
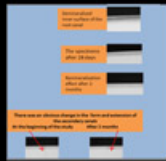
There was no significant difference between the experimental sealers test-1 and test-2 in spite of higher numerical values of remineralisation with test-1 group. Average means of difference in the intensity of radiopacity showed higher value for test-1 radiographs at the demineralised-then-remineralised area. There was an obvious decrease in the depth of the lesion between the control-radiographs and the two months test-radiographs for both test groups. In test-1 group, the form and texture of the secondary canals exhibited noticeable changes at the end of the study but there was no change in the quantity of these canals.

### Discussion:

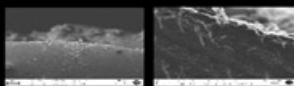
Demineralisation was induced in dentin so as to study the depth of GIC intrusion into this substrate. Remineralisation was observed in dentin demonstrating that the effect of the experimental materials can go deep into the dentin tubules. The pores become supersaturated to apatite formation. This can be explained by a relatively fast diffusion of minerals into these tubules indicating that GIC is highly recommended to use as a root canal sealer.

### Conclusion:

In addition of being a glass former, the incorporation of boron oxides salts into the formula of experimental sealer has shown an obvious remineralisation effect on the demineralised hard tissues of the teeth and consequently, it can minimize the size of the secondary canals by precipitating leachable mineral ions into these canals.

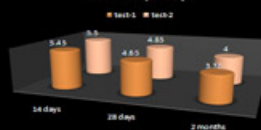


Demineralised dentinal tissue



Remineralised dentinal tissue after 2 months

mean average difference in intensity of radiopacity



## Novelty

1. The remineralization effect of BTFA is achieved for the first time
2. The invention is applicable not only to the dental tissues but to other bones in the body, hence, it is an upgrading invention to include orthopedic and maxilla-facial replacement of bones.
3. The current invention can solve a wide broad problem in endodontics as it remineralizes the secondary canals on which is considered one of the main causative features in root canal failures.
4. Marketability is highly predictable.
5. A patent has been registered by Research Management Center IIUM for this study.