Bioactive glass as a tooth remineralisation agent

Aran Batth, Julian Zeolla, Hannah Gorgui-Naguib and **Ian Thompson** investigate the role of Sylc in remineralising tooth structure

As teeth are exposed to biofilm-related organic acid production, the rate of demineralisation of carbonated hydroxyapatite exceeds that of remineralisation by ions contained within the saliva (Featherstone, 2008; Banerjee et al, 2010). This imbalance results in exposed dentinal tubules, leading to hypersensitivity.

Hypersensitivity is prevalent within the UK, having been reported to affect 4% of the population.

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CPD

Education aims and objectives

This article aims to explain how bioactive glass can help remineralise teeth and reduce hypersensitivity.

Expected outcomes

Correctly answering the questions on page 50, worth one hour of verifiable CPD, will demonstrate that the reader understands the mechanisms involved in the remineralisation of tooth structure by bioactive glasses.

Various remineralising vehicles – including topical fluoridation, casein phosphopeptide-amorphous calcium phosphate formation and bioactive glasses –have been employed to address this clinical issue (Pizzo et al, 2007; Wang et al, 2011).

An introduction to bioactive glass

Bioactive glass acts to supply biologic material with the source of calcium and phosphates contained within its silicate frame (Hench and Wilson 1993), in the same proportion to hydroxyapatite.

In an aqueous environment the glass reacts in dissolution of the phosphates and calcium to form hydroxycarbonate apatite, resultant in adhesion of cells to the glass. The safety of bioactive glass has been assayed and shown to be adequate in vivo making it suitable for clinical application

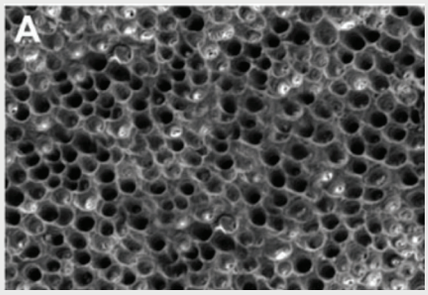

Figure1a: 1000x SEM micrograph – exposed dentinal tubules after H3PO4 application

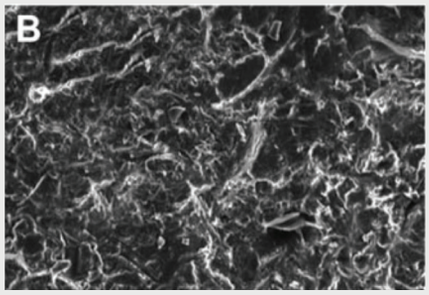

Figure1b: 1000x SEM micrograph – Sylc bioactive glass powder applicational effects, result in smeared layers on surface occluding dentinal tubules. (Sauro, 2011)

(Hench and Wilson 1993).

Sylc bioactive glass can be employed for use in combatting dental hypersensitivity or remineralising the resin-dentine interface prior to air-cutting procedures – giving great clinical scope for the Sylc products (Suaro et al, 2011).

Sylc as a remineralisation agent

Bioactive glass leads to increased of tubular occlusion in vitro. It is a biomaterial extensively used in tissue engineering, bone regeneration and dentine remineralisation due to its process of hydroxycarbonate apatite formation (Litkowski et al, 1997).

Tubular occlusion by use of Sylc results in island formation of calcium phosphate and smearing across the dentine border (Figure 1) (Suaro et al, 2011).

Reacting with a salivary environment, the active ingredient of Sylc – Novamin – releases calcium and phosphate ions (Burwell et al, 2009). The ions integrate into the dentine structure to reintroduce a remineralised framework to the tooth interface.

This is achieved by precipitation of a phosphate-based analogue to hydroxyapatite, which is functional as a protective barrier to oral acidity (Earl et al, 2011; Mehta et al, 2014).

Data

When compared to other test materials (Prophy Powder and EMS Perio), Sylc bioactive glass is shown by Raman Spectroscopy to produce peaks that indicate hydroxycarbonate apatite formation and thus remineralisation (Sauro et al, 2011).

An interaction between dentine and bioactive glass results in leaching of materials through salivary submergence, shown in vitro by (Efflandt et al, 2002; Paolinelis et al, 2007). Through an active process of mineral release from the glass complexes; recovery from a demineralised state has been shown through X-ray diffraction studies in the form of apatite growth and mineral elements observed (Wang et al, 2011).

Summary

The Sylc range of products offers a diversity of use, predominately downstream of the particulate's ability to remineralise dentine. After treatment with bioactive glass (Sylc), tooth dentine surface is protected by a smear of crystallised hydroxyapatite-like material. Such remineralisation can restore a mineral balance to the tooth structure, reduce hypersensitivity and offers caries protection.

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References

Banerjee A, Hajatdoost-Sani M, Farrel S, Thompson I (2010). A clinical evaluation and comparison of bioactive glass and sodium bicarbonate air-polishing powders. Journal of Dentistry 38: 475-479

Burwell A, Litkowski L, Greenspan D (2009). Calcium Sodium Phosphosilicate (NovaMin): Remineralization Potential. Advances in Dental Research 21: 35-39

Earl J, Leary R, Muller K, Langford R, Greenspan D (2011). Physical and chemical characterization of dentin surface following treatment with NovaMin technology. Journal of Clinical Dentistry 2(3): 62-7

Efflandt S, Magne P, Douglas W, Francis L (2002). Interaction between bioactive glasses and human dentin. Journal of Material Science 13: 557-565

Featherstone J (2008). Dental caries: A dynamic disease process. Australian Dental Journal 53(3): 286-291

Hench L, Wilson J, eds (1993). An introduction to bioceramics. World Scientific Publishing, Singapore

Litkowski L, Hack G, Sheaffer H, Greenspan D (1997). Occlusion of Dentine Tubules by 45S5. Bioceramics 10

Mehta A, Kuman V, Jose R, Izadikhah V (2014). Remineralization potential of bioactive glass and casein phosphopeptide-amorphous calcium phosphate on initial carious lesion: An in-vivo pH-cycling study. Journal of Conserv Dent, 17(1), pp. 3-7.

Paolinelis G, Banerjee A, Watson T (2007). An in vitro investigation of the effect and retention of bioactive glass air-abrasive on sound and carious dentine. Journal of Dentistry 36: 214-218

Pizzo P, Piscopo M, Pizzo I, Giuliana G (2007). Community water fluoridation and caries prevention: a critical review. Clinical Oral Investigations 11(3): 189-193

Sauro S, Thompson I, Watson T (2011). Effects of Common Dental Materials used in Preventative or Operative Dentistry on Dentin Permeability and Remineralisation. Operative Dentistry 36(2): 222-230

Wang Z, Jiang T, Sauro S, Pashley D, Toledano M, Osorio R, Liang S, Xing W, Sa Y, Wang Y (2011). The dentine remineralization activity of a desensitizing bioactive glass-containing toothpaste: an in vitro study. Australian Dental Journal 56: 372-381

Wang Z, Jiang T, Sauro S, Wang Y, Thompson I, Watson T, Sa Y, Xing W, Shen Y, Haapasalo M (2011). Dentine Remineralisation induced by two bioactive glasses developed for the air abrasion purposes. Journal of Dentistry