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RESEARCH ARTICLE

REMINERALIZATION OF TEETH.....DENTISTRY IS A STEP AHEAD NOW

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ABSTRACT

Dental caries is an infectious microbiologic disease that results in destruction of calcified tissues. The routine drill and fill technique eliminates bacteria only at the site of restoration and recolonization can occur in remaining part of oral cavity. Present day treatment aims on conservation of tooth structure by identifying decalcification in earlier stages followed by treatment with remineralization. This paper discusses on various remineralization treatment options available and their mode of action.

Key Words: Casein Phosphopeptide-amorphous calcium phosphate, Dental Caries, Fluorides, Remineralization, Ozone

INTRODUCTION

The oral cavity is a battlefield of activities of both remineralization and demineralization. The ratio between demineralization and remineralization determines the hardness and strength of the tooth structure. Remineralization is the natural repair process of restoring minerals again in the form of mineral ions to the hydroxyapatite's latticework structure. The incidence of decalcification has been reported between 2- 96 per cent. Decalcified lesions are unaesthetic and additionally, they may become irreversible and result in cavities. White spot lesions are hence of great concern to orthodontists and developments in orthodontic adhesive materials could potentially reduce or prevent their incidence. It would be ideal to have materials available that obviate patient compliance and recent improvements of bonding materials focus on their caries-protective features (Melgerg *et al*., 1967; Hatibovic and Kofman, 1991 and Wesenberg, 1980). It has been generally accepted that the combined application of a fluoride regimen, oral hygiene instructions, and dietary control can contribute greatly to the inhibition of demineralization. Since the 1990s, people have been interested in the anticaries effect of milk in which casein phosphopeptide amorphous calcium phosphate (CPP-ACP) plays a main role by suppressing demineralization and enhancing remineralization. CPP-ACP has been shown to slow the progression of caries significantly and to promote the regression of early lesions in randomized, controlled clinical trials.

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Systematic review with meta-analysis studies also indicate that CPP-ACP has a short-term remineralization effect. However, the clinical benefits of CPP-ACP in paste form with or without fluoride have not yet been substantiated with credible scientific evidence (Benelli *et al*., 1993). Early diagnosis of incipient lesions can lead to new era in the form of remineralization. The best mode for caries management is use of remineralizing products. Presently fluoride, calcium phosphate-based systems, ozone and calcium sodium phosphosilicate, etc., that help in remineralization are available commercially.

Requirements of an ideal remineralization material

- Diffuses into the subsurface, or delivers calcium and phosphate into the subsurface
- Does not deliver an excess of calcium
- Does not favour calculus formation
- Works at an acidic pH
- Works in xerostomic patients
- Boosts the remineralizing properties of saliva
- For novel materials, shows a benefit over fluoride

Mineral or ionic technologies: Fluoride

Fluoride works primarily via topical mechanisms which include

- Inhibition of demineralization at the crystal surfaces inside the tooth
- Enhancement of remineralization at the crystal surfaces (giving an acid resistant surface to the reformed crystals), and, at high concentrations

- Inhibition of bacterial enzymes. Low levels of fluoride in saliva and plaque help prevent and reverse caries by inhibiting demineralization and enhancing remineralization. On the other hand, high levels of surface fluoride can increase resistance to carious lesion formation and to dental erosion.

Numerous laboratory studies have shown that low levels of fluoride, typical of those found after many hours in resting plaque and saliva, and resulting from the regular use of fluoride dentifrices, can have a profound effect on enamel demineralization and remineralization (Seppa *et al*., 1995; Featherstone, 1999). Fluoride present in the oral fluids alters the continuously occurring dissolution and reprecipitation processes at the tooth-oral fluid interface. Remineralization of incipient caries lesions is accelerated by trace amounts of fluoride. High concentration fluoride therapies lead to deposition of aggregates of calcium fluoride on the surface, which then acts as a reservoir of fluoride.

The rate of fluoride release is enhanced at lower pH levels. A pH less than 5 causes loss of adsorbed phosphate, and triggers a slow dissolution of the calcium fluoride. To increase its surface area, nano-sized particles of calcium fluoride have been prepared, with a diameter of some 41nm. Such particles are many times larger than those in Recaldent™ (CPP-ACP or CPP-ACFP), where the nanoclusters are only 2 nm in diameter. In laboratory studies where there is no saliva or plaque present and prolonged contact with remineralizing agents is assured, artificial solutions containing calcium and phosphate, and fluoride (at levels of 1 ppm) can result in mineral gain in natural and laboratory-created white spot carious lesions over a 4 week period. This, however, is not a realistic manner in which to test for the true remineralizing capabilities of a particular agent or formulation (Melgerg *et al*., 1967; Wesenberg and Hals, 1980; Ten Cate and Featherstone, 1991 and Ogaard *et al*., 1990). Fluoride is also used in the form of dentrifices and professionally applied fluoride solutions very commonly that helps in prevention of dental caries.

Remineralization allows the subsequent loss of calcium, phosphate, and fluoride ions to be replaced by fluorapatite crystals. These crystals are more resistant to acid dissolution and are substantially larger than the original crystals, thereby providing a more favourable surface to volume ratio. Thus, larger apatite crystals in remineralized enamel are more resistant to enamel breakdown by the resident organic acids. This dissolution continues until the pH returns to the normal level. Conversely, when the pH level rises the minerals, calcium, phosphate and fluoride ions in the form fluorapatite gets deposited back to the tooth structure resulting in newly formed crystals, these crystals fuse with each other to form large hexagonal crystals. The best strategy for caries management is to recover the plaque pH level higher than the critical pH with the aid of remineralization agents (Featherstone, 1999; Ten Cate and Featherstone, 1991; Arends and Christoffersen, 1990).

Casein Phospho Peptide - Amorphous Calcium Phosphate (CPP-ACP)

Recaldent, with the technical name casein phosphopeptide – amorphous calcium phosphate or CPP-ACP, is a milk-derived product that strengthens and remineralizes teeth and helps prevent dental caries. ACP technology was developed by Dr. Ming S. Tung. It was first incorporated into a consumer toothpaste product called Enamelon in 1999. The technology was reintroduced in the Enamel Care Toothpaste brand in mid 2004. A dual compartment tube has also been suggested to be sources of calcium and phosphate ions in the form of calcium sulfate and dipotassium phosphate. CPP-ACP system is essentially a two phase system which when mixed together reacts to form ACP material that precipitates on to the tooth structure. It is available in solutions, gums, lozenges and creams. Reynolds *et al*. suggested that CPP binds to the plaque, soft tissue and dentin. The reservoir of calcium and phosphate gets accumulated on the saliva and enamel and changes the pH to acidic, thus enabling the remineralizing action.

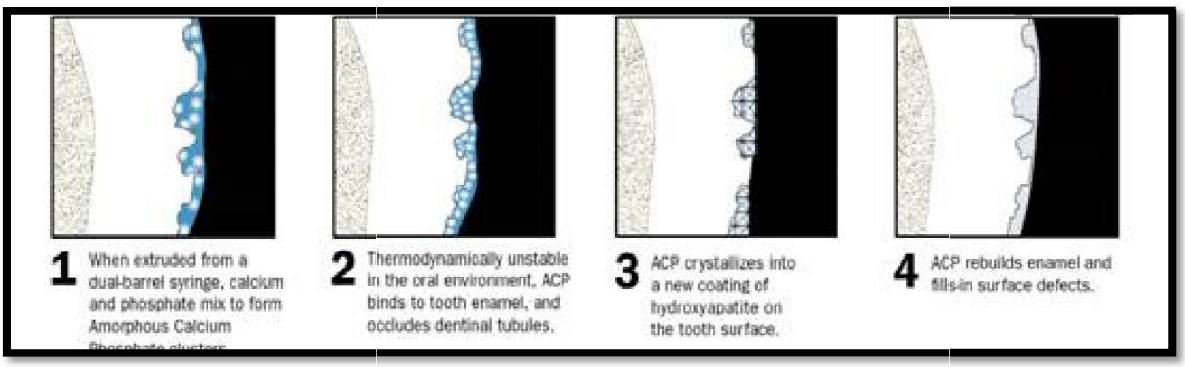

Figure 1. Mechanism of action of CPP-ACP (Courtesy: http://www.discusdental.com/images/ACP)

Calcium Phosphate Based Remineralization

Demineralization occurs at a low pH when the oral environment is under saturated with mineral ions, relative to a tooth's mineral content. The enamel crystal, which consists of carbonated apatite, is dissolved by organic acids (lactic and acetic) that are produced by the cellular action of plaque bacteria in the presence of dietary carbohydrates.

The CPP in milk stabilizes the calcium and phosphate ions through the formation of complexes which are more readily absorbed by the intestine (Seppa *et al*., 1995; Ogaard *et al*., 1990; Llena *et al*., 2009 and Neuhaus and Lussi, 2009). The same concept has been applied to Recaldent (see Fig. 1.). The bioavailable complexes of calcium and phosphate are created in the appropriate form for optimal remineralization of subsurface lesions in enamel, not just on the enamel surface.

CPP also localizes the ACP in the dental plaque biofilm. This initiates remineralization in the enamel and thus reduces the caries incidence. This paste has been claimed to fight demineralization while improving saliva flow, boosting fluoride uptake and soothing sensitive surfaces. It restores minerals that strengthen tooth enamel, reduces sensitivity from post-whitening procedures, reduces high oral acid levels from excessive soft drinks, relieves dry mouth caused by certain medications and buffers plaque and bacteria acid. The latest product available commercially is the GC Tooth Mousse (Llena *et al*., 2009; Neuhaus and Lussi, 2009; Ten Cate and Duijsters, 1982). It is a water based, sugar free crème containing Recaldent® CPP-ACP. It helps to neutralize an acidic oral environment.

Sugar Substitute

Xylitol is a naturally occurring pentilol which is a sugar substitute incorporated in chewing gums. Manton *et al*. showed that remineralization can occur with the use of sugar-free gum containing xylitol.

Xylitol acts by:

- Reducing plaque formation
- Making plaque less adhesive
- Neutralize plaque acids by decreasing the production of lactic acid
- Reducing the levels of cariogenic bacteria such as streptococcus mutans & Helicobector pylori
- Increasing the salivary flow
- Limits pathogenic bacteria levels transmitted from parents/ caregivers to children

Ozone

Ozone is a chemical compound which is a powerful oxidizing agent. Ozone acts by attacking thiol groups of cysteine amino acid and destroys the cellular membrane of carious bacteria. Ozone can shift microbial flora from acidogenic and aciduric micro-organisms to normal commensals allowing remineralization to occur. Presently HealOzone (KaVo GmbH, Germany) remineralizing solution consisting of xylitol, fluoride, calcium, phosphate and zinc is approved for treatment of caries. It can be used as 2100 ppm of ozone ± 5% at a flow rate of 615cc/min for 40 seconds (Baysan and Beighton, 2007 and Baysan and Lynch, 2005).

Conclusion

The recent approach in caries management is the noninvasive method.11 Non-cavitated and cavitated lesions extending up to dentinoenamel junction can be arrested if the cariogenic challenges of certain microenvironment are sufficiently controlled and if therapeutic agents are applied for tissue healing.

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