Letter to Editor

Remineralization of Dentine using Nanoparticles: A New Era of Dentistry

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Dear Sir,

Remineralization is a process of restoring dissolved minerals that have been previously lost by the action of acids to tooth structure. It is a repair process for non-cavitated lesions and relies on calcium and phosphate ions supported by fluoride to reconstruct new surfaces on existing crystal remnants remaining after demineralization.

Aiming at strengthening and re-establish the function of the affected tissues and preventing a future loss of tooth structure. Compared with enamel, remineralization of dentine is more difficult due to less amount of residual mineral crystals and the rich presence of organic matrix, that consists of type I collagen fibrils, and non-collagenous extracellular proteins. Remineralization of the carious lesions could be possible and suggested by previous works based on the fact that cariogenic bacteria produce organic acids during the metabolism of fermentable carbohydrates such as lactic, acetic, formic and propionic, which dissolve the inorganic structure of dentine, leaving the collagen matrix unaffected. The unaffected collagen would serve as a scaffold for the deposition of minerals and would provide nucleation sites for remineralization that reinforce the matrix, and therefore allow the re-mineralization of the dentine. That way, more of natural tooth tissues would be retained since less dentine is removed during cavity preparation. Consequently, the structural integrity of the tooth and the pulp vitality are preserved. A part from the previous mentioned acids, there are other sources of acids that have great potential to cause demineralization such as gastric acid juice, which contains hydrochloric acid, and fruit juices and soft drinks. Different approaches using various materials have been used to enhance remineralization of dentine such as; fluoride-releasing restorative materials, artificial saliva solutions, calcium hydroxide, bioactive glass S53P4, resin infiltration technology, portland cement as a source of slow releasing calcium ions, sodium trimetaphosphate and saturated $Ca(OH)_2$, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) complexes.

Recently, the use of nanotechnology to promote the precipitation of nanoparticles within the dentine collagen matrix is becoming the focus of research in the field. Nanoparticles are functional materials or structures at the nanometer scale of approximately 0.1-100.0 nm, have spherical, cubic and needle-like surface characteristics. The nanoparticles provide superior antimicrobial activity with great physical properties that can be used to deliver antibiotics and bioactive components and hence can control the formation of cariogenic oral biofilms. The action of the nanoparticles is mainly attributed to their small size and high surface area enabling a greater presence of atoms on their surfaces, which provides maximum contact with the environment and releases high levels of ions. In addition, the surface charge, degree of hydrophobicity, and the ability of the nanoparticles to adsorb or be collected on the surface are desired properties for these particles. Nano-sized carbonated apatite (n-CAP), nano-hydroxyapatite (n-HAp) and zinc-carbonate/nanohydroxyapatite ($ZnCO_3$/n-HAp), calcium fluoride nanoparticles (CaF_2), calcium phosphate ($CaPO_4$) nanoparticles, carbonated-hydroxyapatite nano-crystals (CHA) and bioactive glass nanoparticles seem to be capable to increase the mineral content of enamel and dentine and demonstrate promising results. A significant challenge with the use of these nano-materials is to achieve an effective and deep infiltration of the demineralized dentine collagen with nanoparticles without precipitation on the surface. Nowadays, there is growing research interest in using nanoparticles in the field of restorative dentistry as a filler component in restorative materials and showed promising results such as bioactive glass and silica nanoparticles. It has been demonstrated that silica nanoparticles have the ability to infiltrate and remain embedded in the dentine collagen matrix, and hence considered as one of the materials that have the potential to enhance dentine remineralization, as well as block the dentinal tubules for treating the dentine hypersensitivity.

Best regards,
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