






Remineralization agents used in dental fillings

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Keywords

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Abstract

Tooth decay is an infectious microbiological disease that causes damage and loss of dental hard tissues. Rotten is a dynamic process that occurs when demineralization becomes dominant among the demineralization-remineralization reactions that occur as a result of ion exchange between dental hard tissues and saliva in the mouth. Prevention of tooth decays is based on shifting the demineralization-remineralization balance towards the remineralization direction. The most effective remineralizing agent proven by many studies is fluoride. Although fluorine is the gold standard in remineralization, new remineralization agents and methods have been sought that can increase the efficiency of fluoride or be an alternative to fluoride in order to reduce fluoride concentrations due to its possible side effects. With the developing dental technologies, new materials and methods are being discovered that increase remineralization and prevent demineralization. In the study, remineralization agents used as alternatives to fluoride, applications for remineralization and remineralization characterization methods were investigated and presented.

Introduction

In restorative dental treatment, biocompatible dental filling materials lead to modern biomaterials research as they replace biological tissue both in appearance and function. Polymer matrix composites have continued to be developed for about 60 years in restoring the loss or malformations of tooth enamel or dentin tissue as a result of caries, trauma or congenital anomalies and providing the aesthetic appearance of anterior teeth [1].

Tooth decay is explained by the process of demineralization. The demineralization process is explained by the transition of H⁺ ions from the plaque structure to the tooth surface and the diffusion of dissolved mineral ions (Ca²⁺, (PO₄)⁻³) from the tooth surface to the outer surface. This reaction takes place due to increasing H⁺ ion concentration. The rapid increase in the concentration of H⁺ ions in the environment (100-1000 times) causes the rapid push and diffusion of H⁺ ions towards the liquid in the pores surrounding the hydroxyapatite crystals in the surface and sub-surface regions of the enamel. As a result of this reaction, Ca²⁺ and (PO₄)⁻³ ions present in the superficial enamel also move into the mouth. This event is expressed as the beginning of the demineralization process on the enamel surface [2].

The most important preventive application in the prevention of dental caries, which is seen at a very high rate in the society, is remineralization treatments. Reversing the decay process and stopping the decay by placing tooth minerals on demineralized (rotten) lesions is called remineralization. Diffusion of CaHPO₄ and associated calcium and phosphate ions through demineralized enamel pores filled with protein and water occurs during mineralization (Figure 1) [3,4].

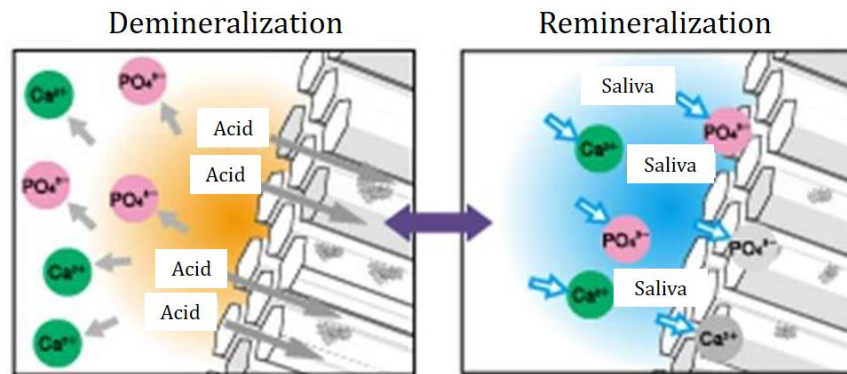


Fig. 1. Demineralization and Remineralization diagram [4]

Thanks to the numerous researches on the tooth remineralization process, technologies or new agents that can promote remineralization and/or reduce demineralization have been started to be used. Although fluoride is frequently used in tooth remineralization, fluoride and similar current remineralization agents do not have the potential to support the formation of hydroxyapatite crystals. For this reason, with the effect of developments in tissue engineering, biomimetic methods that can provide enamel regeneration with bio mineralization have begun to be investigated [3-8].

Materials used in studies on the remineralization of demineralized dentin include nano Hydroxyapatite (nHAP), Calcium Phosphate, Calcium Silicate, Bioactive Glass and Functional Biomimetic Analogs. Hydroxyapatite is a synthetic biomaterial that is similar to the structure of tooth enamel in terms of morphology, structure and crystallinity, and it has been proven to have remineralization efficiency in restorative dentistry. It has been reported that nanoparticles with increased efficiency are deposited on demineralized enamel, thanks to nano hydroxyapatite crystals, the mechanism of which is still unknown. β -Tricalcium phosphate (β -TCP) is an important calcium-phosphate system and is a bioactive component with its mineralizing components. Bio glasses are another remineralizing agent, they influence cell signals to initiate tissue regeneration and restructuring of functions, and act as a biomimetic mineralizing agent that mimics natural mineralization mechanisms that occur in vivo [3-8].

In addition to agents, laser and ozone applications, which are alternative methods, are also used as auxiliary methods in the prevention of dental caries. It has been reported that the use of laser accelerates mineralization and can also control hydroxyapatite crystal growth [9-11]. It has been reported that ozone gas can support the remineralization cycle without removing the tissue affected by the caries lesion, thanks to its strong antibacterial properties as well as its strong oxidizing properties [3, 12-14].

The addition of a new agents to the remineralization products developed to be used in the non-invasive treatment of initial caries lesions by remineralization has brought along studies comparing the efficacy of these products. In such studies, iodine permeability test, micro hardness test, especially transversal microradiography and polarized light microscopy, are used in the measurement of mineral changes due to de-/re mineralization in initial caries lesions. Laser fluorescence, confocal laser scanning microscopy and computerized micro tomography are also used for determining remineralization efficacy [15,16].

Conclusion

In the study, remineralization agents used as alternatives to fluoride, applications for remineralization and remineralization characterization methods were investigated and presented. The most important preventive application in the prevention of dental caries is remineralization treatments. As a result of scientific researches made in recent years, many promising new materials have been developed as an alternative to fluoride, which is a good remineralization agent, and although it has been proven that these agents have remineralization potential, studies on this subject are still ongoing.

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