Remineralization Potential of Amorphous Calcium Phosphate With And Without Fluoride In Artificial Enamel Lesions

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By

Sara Mohamed Yahia Najuib

B.D.S 2009

Faculty of Dentistry, Ain Shams University

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Supervisors

Dr. Hanan Abdel Aziz Niazi

Professor of Operative Dentistry,

Faculty of Dentistry, Ain Shams University

Dr. Ahmed Ahmed Laithy

Lecturer of Operative Dentistry,

Faculty of Dentistry, Ain Shams University

بسم الله الرحمن الرحيم

(قالو سبحانك ربنا لا علم لنا الا ماعلمتنا انك انت العليم الحكيم)

صدق الله العظيم

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Dedication

To my Family,

for their endless love and support

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White-spot lesions are the first clinical sign of tooth caries and can be considered as the initial stage of enamel demineralization[(1)]. Dental caries is initiated by acid-producing bacteria which cause carious lesions in the presence of fermentable carbohydrates. The process involves a series of demineralization and remineralization events in enamel and dentin. If the demineralization process predominates, the initial caries lesion progresses into cavity formation. Thus, enhancing remineralization of early carious lesions may be an effective noninvasive treatment of the disease [(2)].

The presence of fluoride either from dentifrices usage or released from dental materials may significantly interfere with the progression of caries lesions. The amorphous calcium phosphate complexes are anticariogenic and capable of remineralizing the early stages of enamel lesions in situ and in vivo. The application of ACP (amorphous calcium phosphate) to sound enamel surfaces helps in inhibition of enamel demineralization. The beneficial effect obtained with ACP is associated with the ability to localize calcium and phosphate in dental plaque in the proximity of the tooth, thus making it available when needed. In the presence of an acidic environment, such as after eating, when the pH of the

mouth decreases, the phosphopeptide proteins release amorphous calcium and phosphate, creating a supersaturated state of calcium and phosphate around the tooth [(2)].

Peric et al, 2015 [(3)] showed that pastes containing CPP-ACP/CPP-ACFP enhance remineralization potential compared with NaF mouth rinse. While **(Chokshi et al, 2016)** [(4)] concluded that Fluoride varnish has the greatest remineralization potential for artificial carious lesions followed by CPP- ACP Paste and fTCP (functionalized Tricalcium Phosphate Paste) respectively, they recommended using CPP – ACP as an effective adjunct to fluoride therapy but not as an alternative to fluoride.

However, similar studies **(Vyavhare et al, 2015**[(5)] and **Oliveira et al,2016**[(2)]**)** showed that MI paste plus demonstrated a greater protective effect against demineralization than MI paste and showed smoother surfaces. However, both studies didn't show the same remineralization behavior of CPP-ACP without Fluoride.

Wide range of conflicts between both in vitro **(Al-Mullahi and Toumba, 2010; Hamba et al, 2011; Elkassas and Arafa, 2014; Memarpour et al, 2015** and **Heravi et al, 2018**[(6–10)]**)** and in vivo **(Bröchner and Christensen, 2011; Shen et al, 2011** and **Sitthisettapong**

et al, 2015[11–13]**)** studies about the effect of ACP when used in addition to fluoride in remineralization of early enamel lesions. Therefore, it was thought it would be beneficial to study the effect of ACP and fluoride separately or combined in remineralization potential.

I-Enamel Lesions:

Dental lesions are the result of tooth structure demineralization done by acids that are produced through bacterial metabolism of carbohydrates leading to cavity formation[14] .Caries is still one of the most prevalent diseases affecting humans, the prevention of dental caries and the remineralization of enamel subsurface lesions before restorative intervention is a major challenge and goal of modern dentistry[12].Early enamel lesions can remineralize naturally, very slowly by the calcium and phosphate ions in saliva if no further sugar challenge occurs, however if left unrepaired the caries process can lead to pulpitis and tooth loss[15].

Dental lesions are classified according to the depth appeared in the radiograph to: E1: less than half way through proximal enamel, E2: more than half way through proximal enamel, not penetrating DEJ, D1: slightly past DEJ, D2: less than half way through dentin and D3: half or more through dentin. E1 and E2 has no radiographic evidence and more likely to remineralization than D1, while D2 and D3 need restorative treatment [16].

ICDAS* Caries Classification: (Jeffery,2015)[17]

ICDAS code	Description
0	Sound tooth surface.
1	First visual change in enamel.
2	Distinct visual change in enamel.
3	Localized enamel breakdown due to caries with no visible dentin.
4	Underlying dark shadow from dentin (with or without enamel breakdown).
5	Distinct cavity with visible dentin.
6	Extensive distinct cavity with visible dentin.

White spots are the first sign of dental decay it could be noticed in enamel as opaque white areas, caused by minerals loss below the superficial enamel layer. If WSLs were neglected or even undiagnosed, more invasion could be done to treat that advanced condition [1].Half of the white spot lesions in young individuals remineralized due to the electrically charged hydration layer present around the enamel crystals [18].

*ICDAS: International Caries Detection and Assessment System.

II-Diagnosis of dental lesions :

With the purpose of improving the quality of dental caries diagnosis, the association of adjunct diagnostic methods with the conventional visual examination has been proposed [(19)].New methods for early caries diagnosis have been developed to detect lesions in the early stages before cavitation is produced and a restoration is needed [(20)].As early detection of enamel lesions could allow reversing the demineralization process with minimal intervention methods by the biological approach which is the basic principle of remineralization, that could be done by using remineralizing agents [(21)].

Recent diagnostic aids:

- Visible Light - Enhanced Visual Techniques.

Enhanced visual techniques are based upon the phenomenon of light scattering , these are three techniques: Fiber Optic Transillumination (**FOTI)**, Quantitative Light Induced Fluorescence (**QLF**) and Digital Image Fiber Optic Transillumination (**DIFOTI**).The differential transmission of light through healthy tooth structure as compared to carious tooth structure can be detected when using fiber optic light [(22)] .

The difference between FOTI and DIFOTI is that the DIFOTI system has a built-in CCD camera to allow for image capture of the tooth for documentation purposes, while QLF depends on the natural fluorescence of enamel by using a CCD-based intraoral camera with specially developed software for image capture and storage. Quantitative light-induced fluorescence (QLF) technology measures the refractive differences between healthy enamel and demineralized porous enamel. Caries and demineralization show less fluorescence [(17)], enamel lesions progress deeper , more scattered light and there is less fluorescence from dentin present, the image of demineralization is seen as a dark area against a green background[(22)].

-Electronic conductance measurements:

The basic concept behind electrical conductance technology is that there is a differential conductivity between sound versus demineralized tooth enamel due to changes in porosity. Saliva soaks into the pores of the demineralized enamel and increases the electrical conductivity of the tooth [(23)] .