Effect of Hard, Soft Laser and Fluoride Varnish on Enamel Demineralization and Remineralization

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DEDICATION

This thesis is lovely dedicated to the one, Allah has covered him with prestige and dignity, I carry his name proudly, his words are stiff shining such as stars to guide me today, tomorrow, and in the future, my beloved ***father.***

The meaning of love and tenderness, the smile of life, the secret behind my success, the most beloved among off all loves my beloved ***mother.***

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List of Abbreviation

Abbreviation	Term
(Er, Cr: YSGG)	The erbium, chromium: yttrium–scandium–gallium–garnet.
Ca10(PO4)6(OH)2	Hydroxyapatite crystals.
Ca	Calcium.
P	Phosphate.
CaF2	Calcium fluoride.
(OH)	Hydroxyl ions.
(Ca10(PO4)6F2)	Fluorapatite.
HF	Hydrogen fluoride.
H-	Hydrogen ions.
F-	Fluoride ions.
(APF)	Acidulated phosphate fluoride.
(Nd:YAG)	Neodymium- Doped Yttrium Aluminium Garnet.
(Er:YAG)	Erbium-Doped Yttrium Aluminum Garnet.
(CO2)	Carbon dioxide.

W	Watt.
J	Joules.
Hz	Hertz.
S	Second.
hr	Hour

INTRODUCTION

Dental caries is a major oral health problem in most industrialized countries, and it is affecting more than two-thirds of school children and the vast majority of adults [(1)]. Significantly, it is a dynamic bacterial disease process caused by that acids come from bacterial metabolism diffusing into enamel and dentine and dissolving their mineral content. The bacteria are responsible for producing organic acids as a by-product of their metabolism of fermentable carbohydrates. Thus, the caries process is a continuum resulting from many cycles of demineralization and remineralization [(2)].

Demineralization begins at the atomic level at the crystal surface inside the enamel or dentine and can continue unless halted with the end-point being cavitation. There are many possibilities to intervene in this continuing process to arrest or reverse the progress of the lesion [(1)].

Remineralization is the natural repair process for non-cavitated lesions and relies on calcium and phosphate ions assisted by fluoride to rebuild a new surface on existing crystal remnants in subsurface lesions remaining after demineralization. These remineralized crystals are acid resistant, being much less soluble than the original mineral [(2)].

The first sign of dental caries in the enamel is the white spot lesion, which could be observed clinically as a small area of sub-surface enamel porosity from demineralization placed under the dental plaque. It appears as a milky white opacity on smooth surfaces, due to changes in a light scattering of the decalcified area of enamel [(3–6)].

The development of dental caries starts occurring continually from the first molecular changes in the apatite crystals of the enamel till becomes a visible white spot lesion that continues to expand through the dentin

formation of a cavitated lesion if the demineralization is not arrested or reversed [7,8].

Untreated dental caries causes the progressive destruction of teeth that might be accompanied by a severe pain and discomfort in children. Restoring decayed teeth is extremely costly in terms of time and money and could be a major drain on the resources of health care systems. Therefore, the prevention of caries in children and adolescents is considered as a priority and more cost-effective than its treatment in dental services [9].

Effective efforts to prevent caries and development of the non-invasive treatment of initial carious lesions in young children are required. Therefore fluoride is widely used and accepted because it is the most effective used tool for the prevention of dental caries [10].

It has been confirmed by many studies that fluoride is an effective treatment for the prevention of dental caries as it enhances remineralization and inhibiting demineralization [11]. Other studies also indicate that fluoride varnish can reverse or arrest white spot lesion. In addition fluoride can prevent the demineralization process of white spot lesion when used with other preventive measures such as diet control and dental biofilm control[12,13].

One of the recently introduced methods of prevention which has been also claimed to be effective in interfering with the demineralization process is the use of lasers, which first was suggested by ***Stern and Sognnaes*** [14].

Over the past thirty years, many studies have indicated that lasers such as the carbon dioxide (CO2), argon, Nd:YAG, and Er,Cr:YSGG can be employed to thermally modify the chemical composition of dental enamel to

render it more resistant to acid dissolution and more resistant to dental caries[15–17].

It has been proposed by many researchers that laser treatment is potentially effective in increasing the enamel resistance to cariogenic challenge by changing the surface structure and physical properties, including melting and recrystallization of the enamel hydroxyapatite crystals[18]. Also other researchers have been reported the impact of the laser on enamel, either alone or together with fluoride [19–21].

Er, Cr: YSGG laser is a relatively new device. It has been used to ablate dental hard tissues especially enamel, with minimum injury to the pulp and surrounding tissues due to its high absorption in water, and the hydroxyl radicals present in the hydroxyapatite crystals. In contrast, the laser cannot be applied to ablate enamel surface when used for prevention of caries. It can be applied to change the chemical composition or morphology of enamel [22-24].

Another type of laser that was employed in several studies studying it is effect on the enamel was diode lasers. Diode lasers have numerous applications in dentistry, including a wide range of soft tissue surgical procedures [25,26]. It also has a number of unique characteristics such as its low cost compared to other lasers, its smaller size and ease of application intraorally because of the optic fibers [27–29].

REVIEW OF LITERATURE

The acids from bacterial metabolism presented in the dental plaque lead to the formation of dental caries [30]. This is a multifactorial disease resulting from an imbalance in pathological processes and preventive factors[31]. During the early stages, the disease might be reversed by removing plaque biofilm, improving the diet and increasing the protective factors such as salivary flow and fluoride exposure [32].

The formation of the dental caries is a consequence of an interaction over time between three principal factors which are the micro flora (plaque), the substrate (diet) and the host (saliva and teeth) [33]. Also, an imbalance in the physiological equilibrium between teeth minerals and oral microbial biofilms is a contributing factor [34,35].

The micro flora dental plaque is an undesirable dynamic biofilm. However, the presence of a healthy biofilm acts as a fluoride reservoir from sources outside the oral cavity, allowing the remineralization of the enamel and its protection from erosion [30].

Indeed, the dental plaque harbors masses of aciduric and acidogenic bacteria that grows on the surface of the teeth. The Streptococcus mutant in combination with lactobacilli initiates and progresses the biofilm formation. Then, the dental caries process begins when the pH of the plaque drops below the critical level of approximately 5.5 leading to a net mineral loss. This desaturation will last for 20 min or longer depending on outside sources of bioavailable calcium, phosphate, and fluoride. It also depends on the effect of the saliva and the availability of fermentable substrate [30].

Diet plays an important role in the caries development. The most important dietary factors that cause dental caries are sugars. Nowadays, with