EFFECT OF HYDROXYAPATITE TOOTHPASTE ON REMINERALIZATION OF PRIMARY TEETH VERSUS FLUORIDE TOOTHPASTE

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Marwa Gamal Nazief

*Dedication *

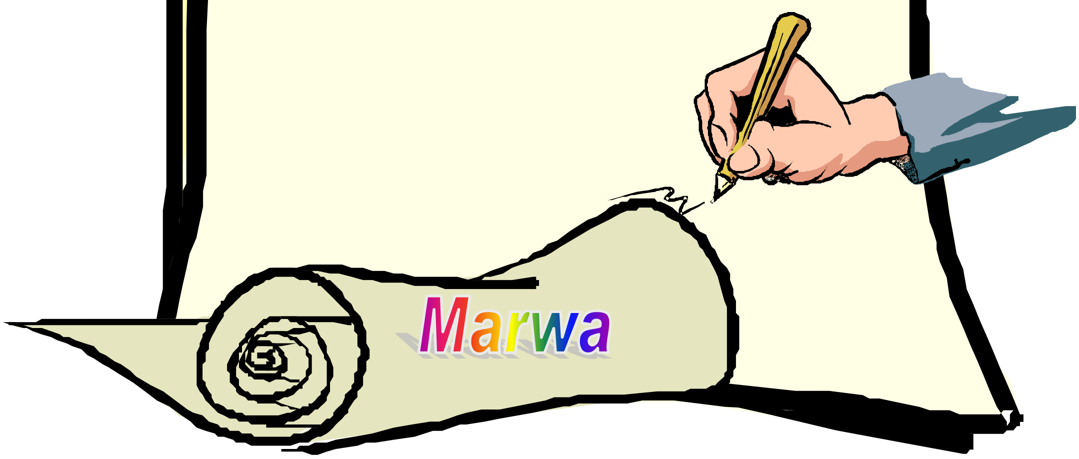
My Mother & My Father

sole who always support me

My dear Husband

Who have always been there

for me when I needed them



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List of Abbreviations

HAP........................ Hydroxyapatite

FAP......................... Fluorohydroxyapatite

F .... Fluoride

RDAS..................... Recommended daily allowances

n-HAP.................... Nano Hydroxyapatite

SMH .... Surface microhardness

SEM …………… Scanning electron microscopy

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INTRODUCTION

Hydroxyapatite is the main component of enamel that gives the tooth a bright white appearance and eliminates the diffused reflection of light by filling up the fine pores of the tooth surface. Accordingly, remineralization of the teeth can be expected to some extent if hydroxyapatite is used to treat an incipient caries lesion (early white spot lesions). [(1)]

Hydroxyapatite has been widely used as a bone filler and prosthetic coating due to its biocompatibility and osteoconductivity; also it is used as a product in toothpastes. [(2)]

Hydroxyapatite, as well as in bone, is responsible for the mechanical behavior of the dental tissues. Unlike bone, in enamel and dentin, when hydroxyapatite is dissolved or abraded, it cannot spontaneously remineralize because enamel contains no cells and dentin apposition occurs only towards the pulp tissues. Therefore, both enamel and dentin can be reconstructed only by the application of alloplastic materials providing a sort of prosthetic restoration. [(3)]

Fluoride ions generate a surface modification of natural enamel apatite crystals increasing their crystallinity degree and relative mechanical and acid resistance. On the other hand, the remineralization produced by hydroxyapatite consists in deposition of a new apatitic mineral into the enamel surface scratches. [(4)]

Frequent application of a high concentration of topical fluoride may be of some benefit in preventing further demineralization and increasing the abrasion resistance of erosion lesions. (5)

One of the methods for altering enamel surface remineralization is using hydroxyapatite crystals which mimic the composition, structure, nanodimensions and morphology of tooth apatite crystals and resemble closely natural apatite's chemical and physical properties.(4)

REVIEW OF LITERATURE

Enamel is the hardest and most mineralized tissue of human body. It is structured in order to resist the mechanical injuries, abrasion, and chemical attack. Differently from all the other mineralized tissues, it lacks proteins even if they are essential to its formation. Actually, matrix proteins are cleaved by proteinases secreted by the ameloblasts during tooth formation; hence, the matrix proteins of enamel are not incorporated into enamel prisms. (6)

Almost immediately after the tooth erupts into the oral cavity, the exposed tooth surface is covered by an acquired enamel pellicle. (7)

Degradation and resumption of enamel matrix proteins is the reason of why enamel prisms, once formed, cannot be remodeled. After enamel prism formation, only the amount of hydroxyapatite within the prisms may decrease in consequence of chemical changes into the oral environment.(8)

Enamel is the hardest tissue in the body. It is a highly mineralized tissue composed mainly of calcium phosphate (hydroxyapatite) and a little proportion of calcium carbonate. Other elements are present in trace amounts. (9)

Although macroscopically dental enamel may seem very solid, at high magnification it is relatively porous. The mineral phase is about 96% of the total weight, 85% by volume; the remaining 15% by volume consists of 11% water and 4% protein and lipid (fatty material) present in approximately equal amounts. These constitute the diffusion channels between crystals and prisms allowing acid, minerals, and fluoride to pass in or out of the enamel during demineralization or remineralization. [10]

The surface enamel has received particular attention, because of its significant resistance to the initiation of dental caries, and for adhesion of polymeric restorative materials. [11]

The physicochemical integrity of dental enamel in the oral environment is entirely dependent on the composition and chemical behavior of the surrounding fluids as saliva and plaque fluids. The main factors governing the stability of enamel apatite are pH and the free active concentrations of calcium, phosphate and fluoride in solution. [10]

Studies with radioactive isotopes confirm the belief that little replacement of enamel is accomplished via normal metabolic pathways, progressively through pulp and dentin. The same techniques reveal that the mineral components of the enamel surface are being constantly replaced or added by salivary ions. [11]

These replacements and / or additions to the surface enamel can come from three major sources, the normal oral environment including saliva, materials that are introduced into the mouth ordinarily in eating and drinking and materials that are introduced for therapeutic purposes as for example, dental restorations and soluble therapeutic agents. [11]

The mineral content of enamel and dentin is not pure hydroxyapatite (HAP), but rather a mixture of compounds including a number of carbonated apatites, with greater diversity of composition in dentin than in enamel. Fluorapatite is less acid soluble than HAP which in turn is less soluble than carbonated apatites. Because of this chemical in-homogenecity of enamel, the process of enamel remineralization is rather complex. [12]

While the formula $[Ca_{10}(PO_4)_6(OH)_2]$ with a ratio of 10 calcium ions to 6 phosphate ions to 2 fluoride or hydroxyl ions is well known, there is evidence which supports other ratios of Ca to other components. Nevertheless, Ca availability remains the singular limiting factor in enamel remineralization. One of the most important properties of $Ca_3 (PO4)_2$ /$Ca F_2$ materials is their solubility behavior, bearing in mind that the majority of Ca compounds are very insoluble. [13]

Dental Caries:

There are four main factors required for caries formation: a tooth surface (enamel or dentin), cariogenic bacteria, fermentable carbohydrates (such as sucrose), and time.[14]

However, it is also known that these four factors are not always enough to cause the disease and a sheltered environment promoting development of a cariogenic biofilm is required. The caries process does not have an inevitable outcome, and different individuals will be susceptible to different degrees depending on the shape of their teeth, oral hygiene habits, and the buffering capacity of their saliva.[15]

Caries is caused by specific types of bacteria that produce acid in the presence of fermentable carbohydrates such as sucrose, fructose, and glucose. The frequency of exposure to cariogenic (acidic) environments affects the likelihood of caries development.[16]