The Effect of Casein Phosphopeptide-
Amorphous Calcium Phosphate versus Fluoride Gel on Microhardness and Surface Roughness of Partially Demineralized Enamel:
An *In-Vitro* Study

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قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا

عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

صدق الله العظيم

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To my mother; a great source of motivation.

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LIST OF ABBREVIATIONS

µ	:	Microns
ANOVA	:	Analysis of variance
APF	:	Acidulated Phosphate Fluoride
Ca	:	Calcium
CPP	:	Casein Phosphopeptide
CPP-ACFP	:	Casein Phosphopeptide- Amorphous Calcium Fluoride Phosphate
CPP-ACP	:	Casein Phosphopeptide- Amorphous Calcium Phosphate
F	:	Fluoride
FA	:	Fluorapatite
HA	:	Hydroxyapatite
M	:	Moles
M I	:	Minimum Intervention Dentistry
mg	:	Milligrams
mg/L	:	Milligram per liter
ml	:	Milliliter
mM	:	Mili moles
mm	:	Millimeter
NaF	:	Sodium fluoride
P	:	Probability value
PO_4	:	Phosphate
ppm	:	Parts per million
S Ra	:	Surface Roughness
SD	:	Standard deviation
SMH	:	Surface Microhardness
VHN	:	Vickers Microhardness number
W/W	:	Weight /weight

INTRODUCTION

"An ounce of prevention is worth a pound of cure" says an old proverb. It is reasonable to prevent a disease from both the ethical point of view as well as its cost effectiveness. Prevention of dental caries and minimal intervention dentistry play a vital role in dental practice. Minimum intervention dentistry (M I) can be defined as a philosophy of professional care concerned with the earliest detection, and earliest possible cure of disease on micro (molecular) levels, followed by minimally – invasive and patient friendly treatment to repair irreversible damage caused by such disease.[1]

Remineralization is the natural repair process for caries lesions. In recent decades the therapeutic importance of remineralization has been generally accepted. [2]

Fluoride is the most commonly used remineralizing agent, but high fluoride strategy cannot be followed in most instances to avoid potential for adverse effects due to over exposure to fluoride. [3]

Nowadays, the gel form of acidulated phosphate fluoride (1.23% APF) is the most commonly used fluoride product in dental practice. However the high reactivity of fluoride agents used in topical applications is a source of concern regarding the adverse effects on restorative materials. Thus, there is a need for agents, which may be used with fluoride to enhance anti-caries activity. [4]

This need has redirected dental research to develop novel preventive agents that can act as an adjunct to fluoride or independent of it. Casein Phosphopeptide (CPP) is one such agent that has been proposed to have anti-cariogenic properties. Casein phosphopeptides- amorphous calcium phosphate (CPP-ACP) and recently a new material Casein phosphopeptides- amorphous calcium fluoride phosphate (CPP-ACFP) that combines both CPP-ACP and fluoride-were introduced to the market. [2]

It is important for the dentist to be able to choose the formula and concentration of the topical remineralizing agent which is effective in managing dental caries for each patient. So it is necessary to be aware of the properties of the selected agent; these include reactivity of the remineralizing agent with the tooth structure.

Thus, the purpose of the present study was to use an *in vitro* pH cycling model to compare the effects of those newer materials with the more commonly used acidulated phosphate fluoride.

REVIEW OF LITERATURE

Historically, dentistry has been focused on treating dental disease through the excision of diseased tissue and restoration of the defect. The minimal intervention dentistry (M I) involves prevention and the preservation of tooth structure. These require a risk assessment for individual patients and the tailoring of care based on the level of risk, which requires an understanding of the caries process and its influencers. [1]

Optimally, diseases should be prevented and if present treated at an early stage to minimize their impact and severity in the least invasive and most effective way. Any "curative" treatment provided should be minimally invasive, preferably completely non surgical and conserve tooth structure as much as possible. [1]

A cavity, however, is only the terminal stage of a progressive mineral loss provoked in enamel by caries as a silent disease. [5]

The disease progresses silently until white spot lesions (areas of demineralization) are clinically visible. If the disease is not controlled, dental destruction will not be prevented. [6]

Clinical discussion on strategies to repair the changes in enamel through a non- invasive treatment started in dentistry. However, if the disease signs are the only factors taken into consideration, the strategies used to treat patients with white spot lesions may repeat the same mistakes made in the past when filling was considered as the only solution for caries. [7]

The consequence of disease control would be seen clinically by a change in the appearance of white spots, from chalky and rough (active) to bright and smooth (inactive). Eventually, the white spot could even disappear. [8]

Enamel Minerals

The mineral in enamel and dentine is not pure hydroxyapatite (HA), but rather a mixture of compounds including a number of carbonated apatites, with greater diversity of composition in dentine than in enamel. Fluorapatite is less acid soluble than HA which in turn is less soluble than carbonated apatites. Because of this chemical in-homogeneity of enamel, the process of enamel remineralization is rather complex. [9]

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 appears suitable, there is evidence which supports other ratios for 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. [10]

Enamel Remineralization

Remineralization is the natural repair process for non-cavitated lesions, and relies on Ca and PO_4 ions assisted by F to rebuild a new surface on existing crystal remnants in subsurface lesions remaining after demineralization. These remineralized crystals are less acid soluble than the original mineral [11].The composition and the concentration of inorganic ions in saliva and in dental plaque