SCANNING ELECTRON MICROSCOPE STUDY OF HUMAN ENAMEL SURFACES TREATED WITH TOPICAL FLUORIDE AGENTS

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SUMMARY : The effect of a neutral sodium fluoride (NaF) gel and an acidulated phosphate fluoride (AFP) gel on surface morphology of twenty enamel specimens were obtained from human enamel were studied. Two groups of ten teeth were treated with one of the topical fluoride agents. Spherical globular agglomerates that are thought to be CaF_2 particles, were observed when specimens were examined by scanning electron microscope on enamel surfaces. Then five specimens randomly chosen of each group were immersed in 1 mol/L KOH for 16 hours. As a result of etching properties of APF, prism etched pits were filled with small CaF_2 particles. These results indicate that the CaF_2 particles. These results indicate that the CaF_2 particles formed in etched pits of the enamel do not dissolve in 1 mol/L KOH in in-vitro conditions which suggest that the same particles most likely are not cleared away by the saliva in the mouth under normal circumstances.

Key Words : Calcium fluoride, enamel surface morphology, topical fluorides.

INTRODUCTION

Topical fluorides are widely used in pediatric dentistry as caries preventive agents (2, 6-8,12,17, 21). It has been shown that topical application of fluoride on enamel promotes deposition of a reaction product coating composed of CaF_2 or a mixture of CaF_2 and fluorapatite (9, 5).

The general view in the past has been that the formation of CaF_2 is undesirable because it is thought to dissolve during the first 24 hr. after its formation (11,14). However more recent trials have shown that phosphate ions (HPO_4^{-2}) when present in an aqueous phase together with CaF_2 crystals adsorb to the surface of CaF_2 layer and reduce their dissolution rate (18).

The deposited CaF_2 later will have an antimicrobial effect due to large amounts of fluoride released during dissolution (9,11). In spite of this, fluoride loss will occur to a lesser extent in craks and cervices of teeth and in the aproximal areas and demineralization will be avoided in these areas (15).

The crystallographic structure of surface coatings produced by application of topical fluoride should be well detected in order to understand anti-cariogenic mechanisms of these agents (4, 5,14).

While x-ray differ action studies suggest that CaF_2 is a component of the layer deposited on enamel after topical fluoride applications (1), previous electron microscope observations showed that the reaction product particles

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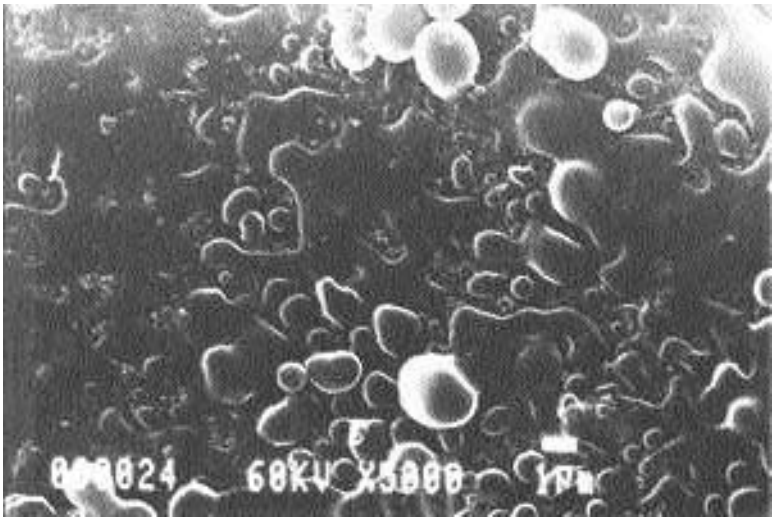
Figure 1: SEM image of coating deposited on intact human enamel surfaces by a neutral NaF application.



being amorphous or having an extremely small crystallite size (9).

In this study the surface layer morphologies of enamel treated with an NaF or APF gel were investigated using scanning electron microscopy (SEM). The agglomeration characteristics of each surface layer and etching patterns of these topical fluoride agents were assessed.

MATERIALS AND METHODS

Freshly extracted 20 sound human third molars were collected and stored in deionized water (containing thymol) at 4°C until they were used.

Before application of the fluoride agents the crowns were cleaned with pumice and water. Enamel blocks of 3x2 mm^2 were sectioned from the labial surfaces of the teeth and examined with the naked eye in order to eliminate the defective ones such as hypoplasia or cracks.

Two groups of ten teeth were treated with one of the following topical fluoride agents; on APF gel that contains 2% NaF and PH : 5.4. Neutral fluoride gel containing 5% NaF, APF gel and NaF gel were applied to the enamel surfaces for 8 minutes. The specimens were then washed with distilled water for 30 seconds and allowed to warm to room temperature. Two samples of each group were fractured for cross-section SEM study.

KOH extraction

After removing the gel 5 specimens of each groups were placed in 50 ml of 1 mol/L KOH and agitated for 16 hours at room temperature and then washed in distilled water.

SEM examination

Samples were fixed and dehydrated in increasing concentrations of acetone. All specimens were attached to aluminum stubs and then sputtered with a 200 °A thick layer gold for examination under the SEM (Jeol-ASIDIO) operated at 40, 50, 60, KV.

RESULTS

The appearance of enamel surfaces exposed to NaF and APF gels are shown in Figures 1 and 2 respectively. District surface coating surface morphologies deposited by the two topical fluoride agents, however were different from each other under SEM investigation.

Both NaF and APF gel produced surface reaction products that were deposited in clumps or mounds. At higher magnification spherical globular agglomerates were observed in the surface layer of enamel produced by neutral NaF gel (Figure 3). The spherical globules varied in size from place to place.

The APF gel produced a surface coating where no large spherical globules were observed. The globules were placed separately and there was no tendency to form agglomerates as produced by neutral NaF gel.

In Fractured cross section specimens the surface coating produced on enamel surfaces are more distinct

Figure 2: SEM image of coating deposited on intact human enamel surfaces by an APF application.

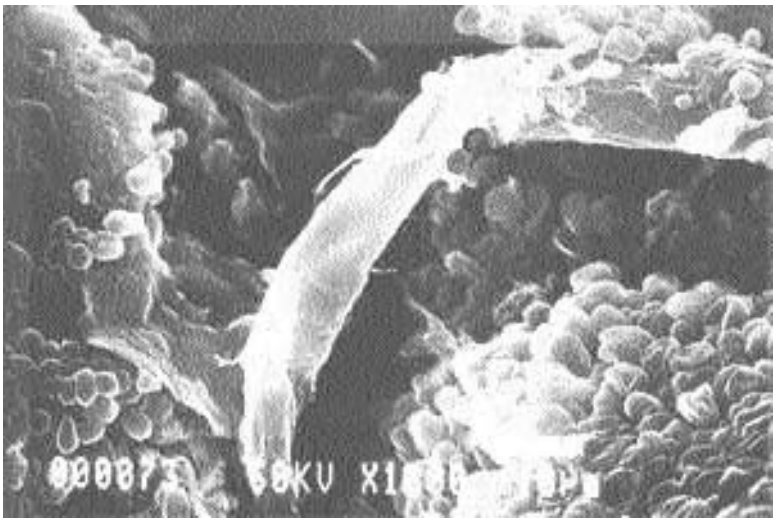
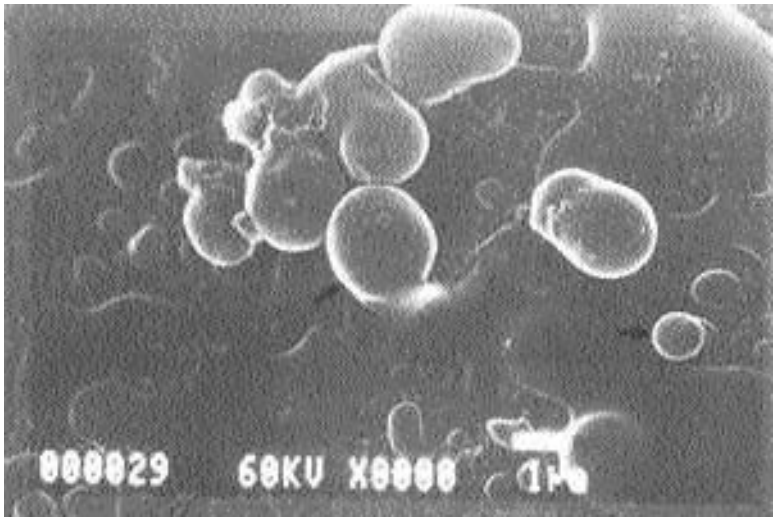


Figure 3: High magnification of spherical globular agglomerates by application of a neutral NaF application.



(Figures 4 and 5). None of the topical fluoride agents produced a surface coating that had crystallographic morphology.

The specimens immersed in KOH for 16 hours had different surface enamel morphologies. The APF gel produced large shallow surface etch pits on enamel surface (Figure 6). The deep prism etch pits were filled with globules at high magnification (Figure 7).

The KOH extracted enamel surfaces of neutral NaF gel had untreated enamel appearance. Inter-crystallite

Figure 4: SEM image of cross-sections of enamel treated with a neutral NaF gel.

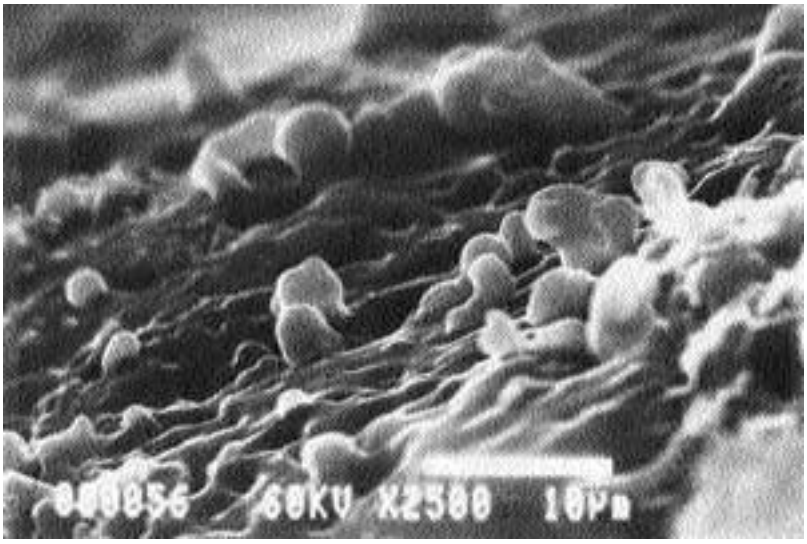
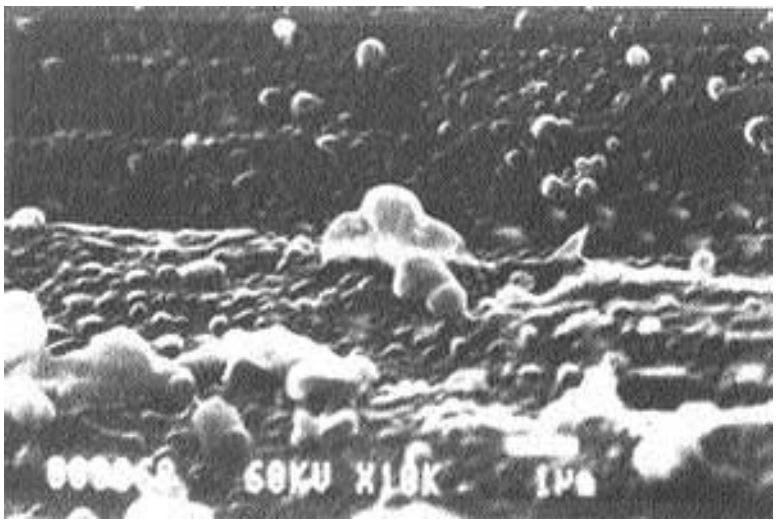


Figure 5: SEM image of cross-sections of enamel treated with an APF gel.



etching produced a rough surface, while pores like those produced by the APF gel were not observed (Figure 8).

DISCUSSION

Application of topical APF and NaF gels deposit a reaction product layer composed of amorphous globular agglomerates identified as being of CaF_2 layer (9,14,15,19).

In our study, the APF gel produced a surface coating where no large spherical globules were observed. However NaF gel produced a uniform surface with some large spherical globules. Nelson (15) suggested that the particle

Figure 6: SEM image of the KOH-extracted enamel surfaces with an APF gel. (Large and small etch pits on enamel surface)

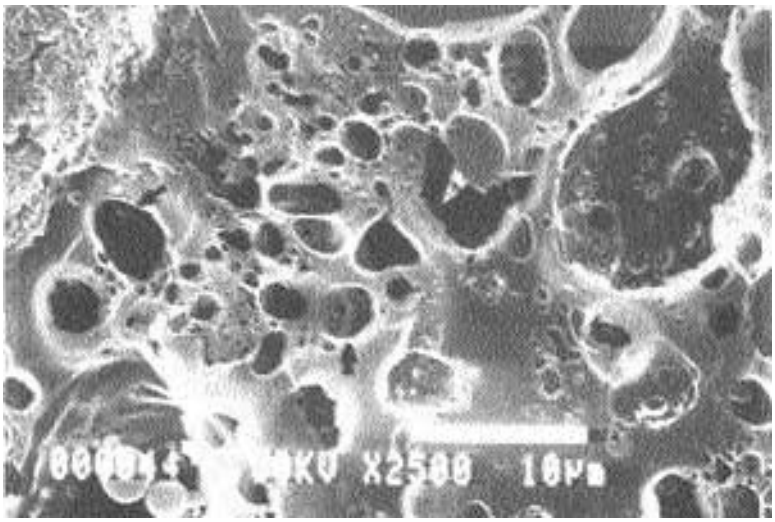
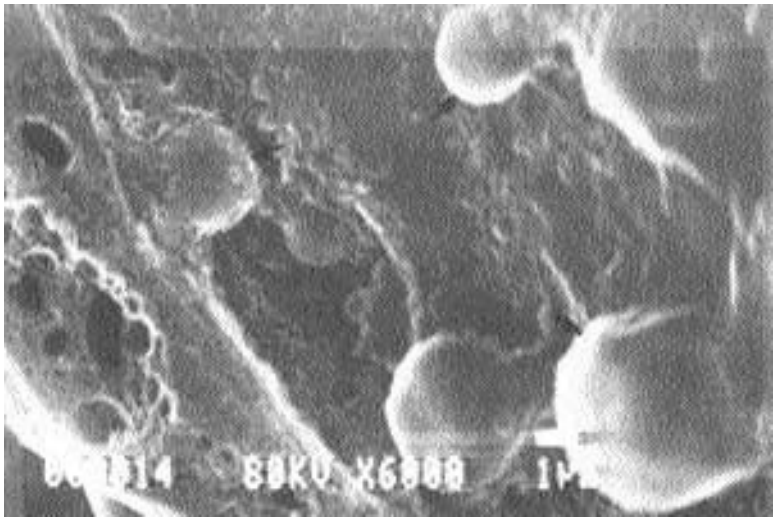


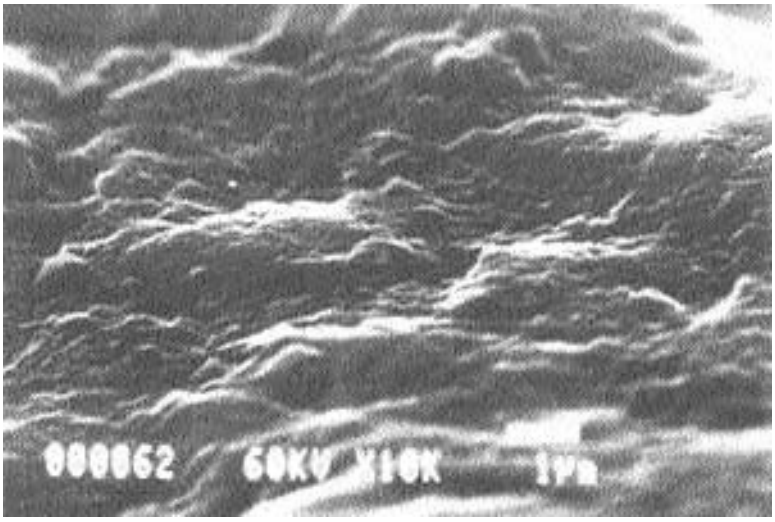
Figure 7: High magnification of prism etch pits filled with extremely small CaF_2 particles after application of an APF gel.



size of CaF_2 deposits in the surface coating produced by topical fluoride agent may be an important factor in determining the effectiveness of a topical fluoride agents. As the solubility of crystals decrease with their increasing sizes, CaF_2 particles occurring as a result of APF application will dissolve slower than those of NaF application.

Another important factor is the etching properties of topical agents. According to Cruz (5) low pH increases the amount of CaF_2 deposited on enamel during topical F application. Also the small CaF_2 particles formed at low pH have a lower solubility then CaF_2 particles formed at high pH (18). Although none of the crystals that were observed as a result of both topical fluoride agents were permanently bound, prism etch pits were filled with small CaF_2 particles as a result of etching properties of APF application.

Figure 8: SEM image of the KOH extracted enamel surfaces treated with a neutral NAF gel.



Cavlaska (13) has shown that the loosely bound Fluoride ions will dissolve in 1 M KOH solution. As NaF gel had little etching property the CaF_2 crystals dissolved from the smooth enamel surface. According to etching properties of APF gel CaF_2 filled the deep prism etch pits that could not be washed away by KOH application. Thus it can be concluded that topical fluoride agents with etching properties have more anti cariogenic effect.

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