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CHEMICAL REACTIONS OF FLUORIDE WITH SUPERFICIAL DENTAL ENAMEL AND ITS CARIES INHIBITORY EFFECT

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Though the cariostatic effect of topical tooth fluoridation has been demonstrated by numerous clinical investigations, the mechanisms of fluoride incorporation into surface enamel are still a matter of controversy. Because fluoride interactions with dental apatite are restricted mainly to a surface layer as thin as about 1 µm, this is partly due to lacking analytical information. Recently, in this laboratory, ESCA combined with Ar-Ion-Etching was introduced to the problem. In repeated cycles of etching and measurement depth profiles of the distribution of reaction products could be obtained in steps of about 20 nm. The hyperfine depth resolutions provided additional information for better understanding the fluoride surface reactions.

Presently in vitro experiments of touching bovine incisors with sodium fluoride and an organic amine hydrofluoride are presented. After treatment with both agents depth profiles of high but exponentially decreasing fluoride accumulation were observed. Accumulation factors decreased from 700 at the topmost surface to about 20 even 3 um below the surface (natural value: 500 ppm). Fluoride incorporation went along with phosphate depletion, whereas calcium fractions nearly remained unchanged. This is evidence for severe surface degradation of dental apatite. In topmost enamel the stoichiometry of calciumfluoride nearly is approached. Deeper layers obviously are mixed of calciumfluoride, calciumphosphates and dental apatite.

First evidence for the cariostatic effect of fluoride incorporation were etching experiments with perchloric acid. The depths of etching were determined by interference microscopy. Under otherwise identical conditions fluoridated teeth were more acid resistant than untreated control samples. The markedly reduced acid solubility is restricted to surface layers of about 0.5 to 1 um. Obviously acid resistance is correlated with the superficial formation of calciumfluoride and calciumphosphates. Thus the extreme depth resolution of the present technique can contribute to better understanding the reaction mechanisms of fluoride in dental enamel.