Combined Enamel and Dentin Effects in a pH Cycling Model

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ABSTRACT

Well-controlled *in vitro* studies that determine the ability of dentifrices to promote remineralization and/or inhibit demineralization are routinely used in the anticaries assessment of fluoride-containing formulations. **Objective:** To use a pH cycling model (Featherstone, et al., 1990) to determine the effect of sodium fluoride (NaF) dentifrice products on demineralization and remineralization of enamel and dentin simultaneously. **Methods:** The dose response to fluoride using NaF/silica based formulations (from 0-1100ppm F) was determined using a cross-sectional microhardness technique (ΔZ: Featherstone, et al, 1988, 1989, 1992). Each test cell consisted of ten human tooth crowns with one exposed window each and twenty human tooth roots. Each group of specimens was subjected to 14 days of alternating demin and remin with 2x daily dentifrice treatments. Dentifrices compared were: a) 1100 ppm F (NaF)/silica b) 550ppm F (NaF)/silica; c) 250ppm F (NaF)/silica; and d) placebo (<1ppm F). Upon completion of treatments, all specimens were assessed by cross-sectional microhardness, and mineral loss calculated (ΔZ, vol. % min x μm). **Results:** Mean (SD) ΔZ values for enamel specimens were: a) 789 (535); b) 729 (860); c) 778 (516); and d) 1307 (606) with b=c=a<d (p<0.05). Mean (SD) ΔZ results for dentin specimens were: a) 985 (434); b) 1265 (510); c) 1582 (615); and d) 2303 (655) with a<b<c<d (p<0.05). **Conclusion: Under conditions of limited volume, root mineral dissolves preferentially to enamel mineral, providing enough mineral saturation to remineralize enamel lesions, while allowing the roots to continue to demineralize. These results suggest this model may be applicable for assessing performance of products targeted toward the treatment of the condition known as "hidden caries" where root caries is seen to increase (in the absence of an increase in coronal caries) in individuals with compromised salivary flow.**

INTRODUCTION

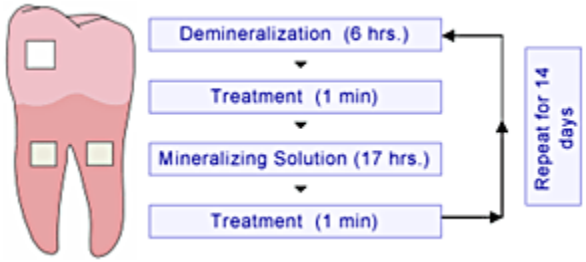
In vitro pH cycling models are routinely used to demonstrate the relative ability of fluoride containing dentifrices to fluoridate, remineralize or inhibit the demineralization of enamel or root specimens.

While *in situ* models have demonstrated the ability to simultaneously assess the impact of various formulations on enamel and root caries lesions, there is little information available with respect to the ability of any of the currently used *in vitro* models to provide a similar type of simultaneous assessment.

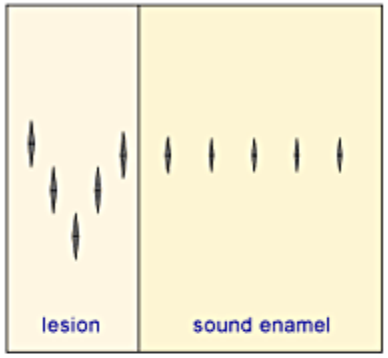
PURPOSE

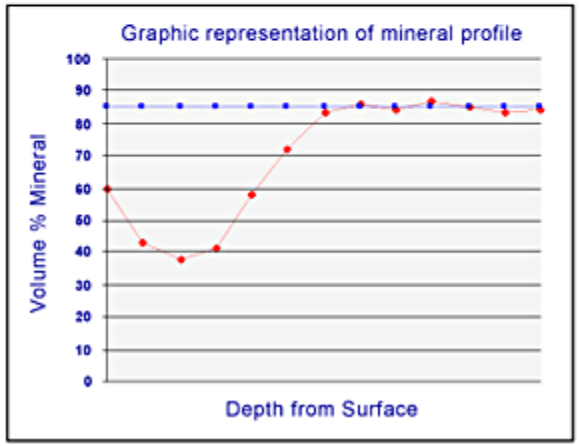
The purpose of this study was to simultaneously determine the relative impact of sodium fluoride dentifrices on artificially induced enamel and root caries lesions using an *in vitro* pH cycling model.

MATERIALS AND METHODS



Human molars with caries-free crown and roots were prepared using standard procedures (Featherstone et al., 1983). Each tooth specimen (10/group) was coated with acid resistant nail varnish, leaving one exposed window on the crown and one exposed window on each separate side of the root. These teeth were suspended during the 14 day procedure so only the windows were exposed to the treatment and cycling solutions following the methods of Featherstone et al.,(1986).





Following the 14 day cycling period, the methods of Featherstone et al., (1983) and ten Cate et al., (1985) were used to analyze the specimens. The teeth were rinsed with deionized water, sectioned longitudinally through the lesion and embedded in epoxy resin. Specimens were serially polished and the lesions were assessed by microhardness examination at 25μm intervals to a depth of 300μm. Relative mineral loss, ΔZ (vol. % mineral x μm), was calculated for each test group.

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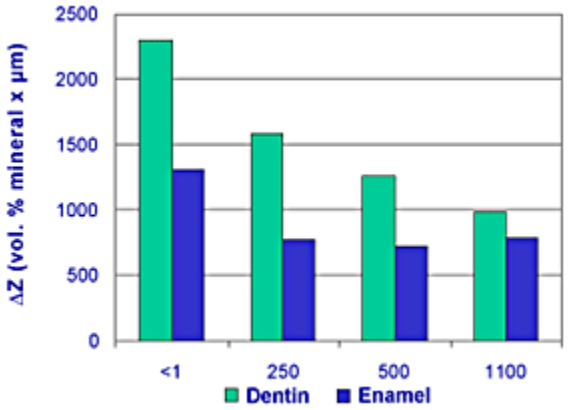
DATA



RESULTS AND DISCUSSION

The use of a controlled volume pH cycling model has produced results in which a clear dose response is demonstrated in dentin lesions, but no dose response effects noted among the fluoride containing products with respect to coronal lesions. In this controlled volume system, it is likely the demineralization of root lesions occurs preferentially to enamel lesions, resulting in a dose response progression of lesions in dentin. As mineral is depleted from the dentin, the concentration of minerals in the buffered acid increases to a point that effectively reduces the amount of demineralization occurring on the more resistant coronal surfaces.

In a similar manner, anecdotal reports from dentists indicate a growing number of patients who appear to be free of active coronal caries, but upon further examination are found to have significant and active root caries lesions. This phenomenon, referred to as "hidden caries", appears to be on the rise. Although the reason for the increase in this condition is speculative, one belief is that the condition may be a result of a significant increase in the use of saliva altering medications, such as anti-depressants. A potential side-effect of these, and many other medications, is reduced salivary flow. Reduced salivary flow would be expected to negatively impact caries activity.

These results suggest root caries will proceed preferentially to coronal caries under conditions of restricted salivary volume. Similar effects in *in situ* models designed to simultaneously monitor coronal and root lesions in otherwise healthy patients (i.e. normal saliva flow) have not been noted.

CONCLUSION

The results of this study suggest that under conditions of reduced salivary flow (as represented by the controlled volumes of solution used in the *in vitro* study), one might expect dentin lesions to progress in the absence of coronal decay. Indeed, as mineral is depleted preferentially from dentin, enhanced levels of mineral in saliva may provide a sufficient level of protection to significantly reduce the incidence of coronal decay. As the progression of root caries occurs at a rate that exceeds that of coronal decay, the clinical importance of this finding is potentially significant. Under conditions of reduced salivary flow, special attention should be focused on the root caries needs of patients at risk.

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