

Surface Microhardness Changes and Enamel Fluoride Uptake in a 20 Day In Vitro Caries Cycling Model

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Overview

This study involved the use of an *in vitro* caries cycling model to evaluate sodium fluoride (NaF) and sodium monofluorophosphate (MFP) dentifrices.

Introduction

The purpose of this study was to determine the efficacy of fluoride dentifrices to, 1) promote enamel fluoride uptake; 2) promote lesion remineralization; and, 3) diminish subsequent demineralization under dynamic conditions simulating *in vivo* caries formation.

Methods

Artificial lesions were formed in the human enamel specimens (N = 18 per test group) by 72-96-hour immersion in 0.1 M lactic acid pH 5.0 containing 0.2%w/v Carbopol C-907, 50% saturated with hydroxyapatite. The lesion surface microhardness (SMH) range was 25-45 Vickers hardness numbers (VHN). The average lesion depth was approximately 70µm.

Test Products:

Experimental NaF/silica A, Experimental NaF/silica B, MFP Calcium carbonate, MFP dicalcium phosphate and Fluoride free placebo. All the fluoride containing product contained a nominal 1100ppm F⁻.

The daily cycling regimen comprised: 4 x 1 min treatments with 1 part dentifrice slurried with 2 parts pooled human saliva; 1 x 4 hour challenge using the lesion forming solution; remineralization in pooled human saliva. The treatment schedule is summarised:

- | | |
|----------------|-------------------------|
| a. 8:00-8:01 | Dentifrice treatment 1* |
| b. 8:01-9:00 | Saliva |
| c. 9:00-9:01 | Dentifrice treatment 2 |
| d. 09:01-10:00 | Saliva |
| e. 10:00-14:00 | Acid buffer challenge |
| f. 14:00-15:00 | Saliva |
| g. 15:00-15:01 | Dentifrice treatment 3 |
| h. 15:01-16:00 | Saliva |
| i. 16:00-16:01 | Dentifrice treatment 4 |
| j. 16:02- 8:00 | Saliva treatment |
| k. Back to (a) | |

* On the first day, this treatment was not given; the test began with one hour in saliva to permit pellicle development prior to any treatments..

SMH was measured at baseline, 10 and 20 days. Fluoride content of biopsied specimens was determined at 20 days using the microdrill technique to a depth of 100µm. Fluoride data were calculated as µg F/cm³: (µg F x dilution factor – volume of drilling).

The resistance of the treated enamel to a subsequent acid challenge was determined by placing the treated specimens into the lesion formation solution (with no remineralization phase) for one 2-hour and one 16-hour period of simulated plaque acid challenge (SPAC). Following each acid challenge, the surface hardness of the specimens was measured.

Available fluoride was determined using ion chromatography from slurry supernatant slurries of 1 part dentifrice plus 3 parts waters.

Table 1 SMH, SPAC and Statistics for the Groups

	Baseline		10 Days		20 Days		2hrs SPAC Mean
	Mean	SEM	Mean	SEM	Mean	SEM	
Fluoride free placebo	38.3	1.3	37.7	1.9	30.7	1.7	31.1
MFP dicalcium phosphate	38.1	1.4	46.0	2.2	47.9	2.3	45.7
MFP Calcium carbonate	38.1	1.4	46.2	1.8	47.9	1.7	44.8
Experimental NaF/silica B	38.2	1.3	52.2	2.1	56.7	2.6	55.6
Experimental NaF/silica A	38.1	1.4	64.4	2.4	68.1	3.5	67.1

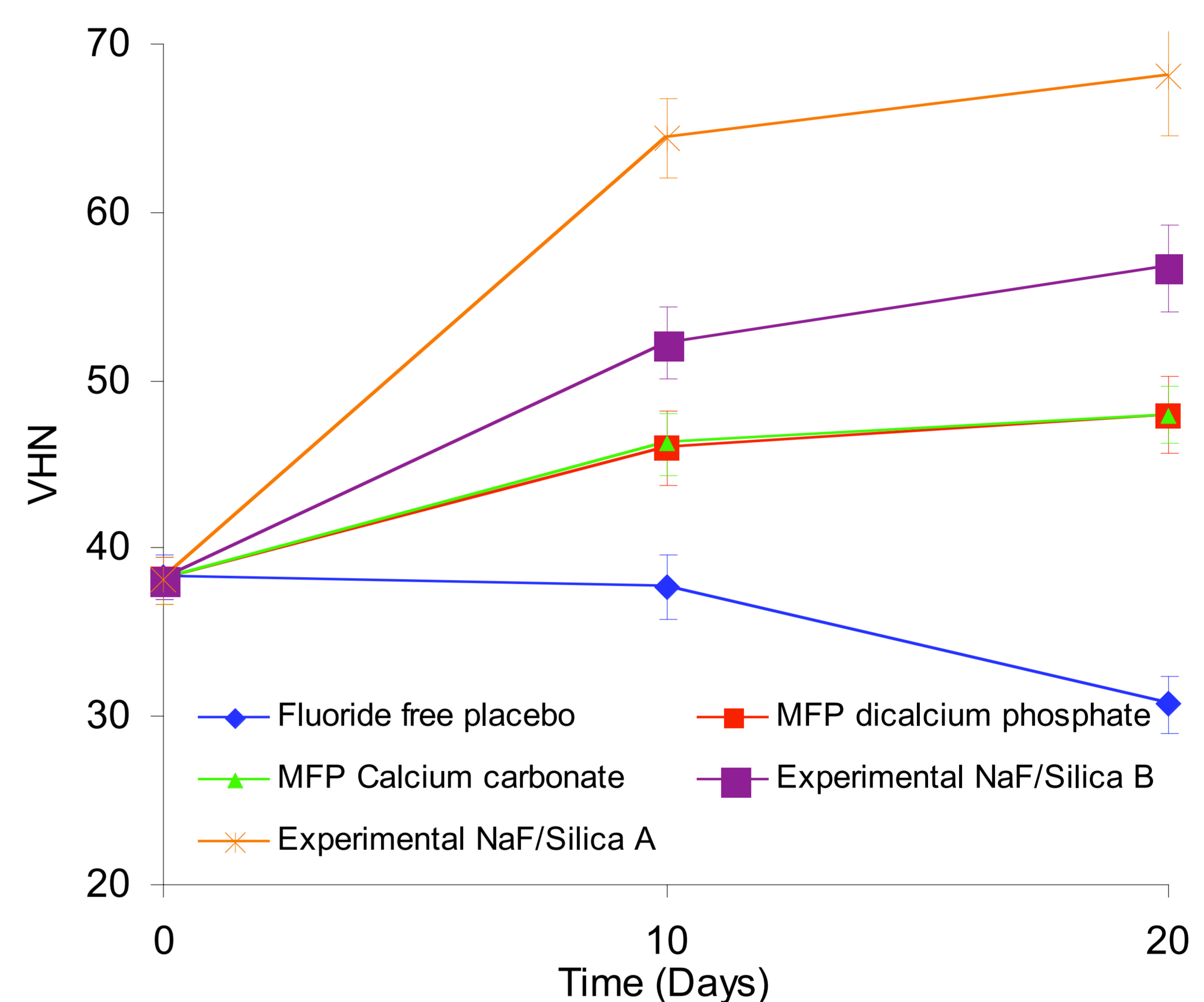
* Mean ± SEM (N=18)

** Values within brackets do not differ significantly (p>0.05) as determined by SNK analysis
SPAC - Simulated plaque acid challenge (post cycling, no remineralisation)

Results

Differences in SMH analysis were observed between the fluoride dentifrices at 10 days and 20 days. Enamel fluoride content exhibited the same order and statistical differences as the SMH analysis. Available fluoride was similar for all test products (900 to 1160ppm).

Figure 1 Surface Microhardness of Enamel Specimens



N = 18, ± s.e.m.

Table 2 Enamel Fluoride Uptake after 20days In Vitro Cycling

Dentifrice	Fluoride Uptake (µgF/cm ³)
Fluoride free placebo	387 ± 77*
MFP dicalcium phosphate	1054 ± 54 **
MFP Calcium carbonate	1419 ± 85
Experimental NaF/silica B	4083 ± 261
Experimental NaF/silica A	5029 ± 246

* Mean ± SEM (N=18)

** Values within brackets do not differ significantly (p>0.05) as determined by SNK analysis

Discussion

Significant differences between the MFP and NaF dentifrices were expected and observed. Significant differences between NaF/silica paste A and B were also observed with paste A being superior with respect to promoting remineralization, prevention of demineralisation and enamel fluoride uptake.

The order differential between the NaF dentifrices and the MFP/dicalcium phosphate dentifrice *in vitro* were similar to several literature publications¹⁻³.

Conclusions

- Differences in microhardness correlated with fluoride uptake.
- Significant differences in promotion of demineralization, prevention of demineralisation and enamel fluoride uptake between 2 NaF formulations with similar available fluoride were observed.

References

1. Volpe AR, Petrone ME, Davies RM: A critical review of the 10 pivotal caries clinical studies used in a recent meta-analysis comparing the anti-caries efficacy of sodium fluoride and sodium monofluorophosphate dentifrices. Am J Dent 6:S13-S42, 1993.
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