

Comparative evaluation and effect of organic and inorganic fluoride dentifrices on enamel microhardness: An *in vitro* study

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Abstract

Aim: To compare and evaluate the microhardness of enamel surface after the application of organic fluoride and inorganic fluoride dentifrices. **Materials and Methods:** Twenty freshly extracted premolars were collected and decoronation of all the teeth was done at cemento-enamel junction. The crowns were sectioned mesiodistally into two halves with the help of diamond disc, and then the subsequent forty samples kept in 1% citric acid for the demineralization and divided into two groups by simple randomization, that is, Group A (inorganic sodium fluoride dentifrice) and Group B (organic amine fluoride dentifrice). They were treated using same protocol for 3 min, daily twice for 7 days. Those samples preserved in artificial saliva in between treatment. The enamel surface microhardness evaluated using Vickers hardness test at base level, after demineralization, as well as after remineralization. Statistical analysis of surface microhardness obtained at different stages done by Student's *t*-test and $P < 0.05$ was considered statistically significant. **Results:** The samples which were treated with sodium fluoride (Group A) could not restore the mean microhardness after treatment to that of preoperative level whereas amine fluoride (Group B) treated samples showed a statistically significant increase in mean surface microhardness from baseline. **Conclusion:** Organic fluoride (amine fluoride) remineralization was more effective in restoring enamel microhardness than inorganic fluoride (sodium fluoride) remineralization.

Key words: Amine fluoride, demineralization, dentifrices, microhardness, remineralization, sodium fluoride

INTRODUCTION

Dental caries is an infectious disease affecting human population. It cannot be treated using restorative method alone. Since it is not accessible to all of the population due to lack of many factors, recent researches in the field of dentistry have helped to understand caries process and its treatment. The discovery of preventive agents such as fluorides is a boon for the field of dentistry. Fluoride

is a remineralizing agent which improves the process of remineralization by forming fluorhydroxyapatite crystals. Regular use of fluoride, present in the mouthwashes and toothpastes, is the most effective method for the remineralization process.^[1,2]

The significant role played by dentifrices is to provide fluoride content to the enamel during tooth brushing

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as well as to prevent caries and remineralize the teeth. There are various types of inorganic fluoride containing dentifrices and mouthwashes commercially available such as stannous fluoride, acidulated phosphate fluoride, sodium mono-fluorophosphate, and sodium fluoride.^[1]

Muhlemann in his study concluded that organic fluorides such as amino fluoride have shown significant superior results than that of inorganic fluorides in decreasing the solubility of enamel.^[3] This amino fluoride has an added antiplaque effect. Galuscan *et al.* and Busscher *et al.* have also observed that amino fluorides are powerful agents for the remineralization process of enamel.^[4,5]

Since fluorides have an effective remineralization property and it also strengthens the surface enamel, the objective of this study was to evaluate and compare microhardness of the enamel after the treatment with organic (amine fluoride) and inorganic (sodium fluoride) fluoride dentifrices.

MATERIALS AND METHODS

For this prospective study, 20 caries free, freshly extracted premolars were collected. Carious teeth were excluded from samples. The sample size was selected according to systematic random sampling method and ISO 24153:2009 standards.^[6] Decoronation of all the teeth was done at cemento-enamel junction, and the crowns were sectioned mesiodistally into two halves with the help of diamond disc. Then, the subsequent forty samples distributed in two groups by simple randomization, that is, Group A and Group B with 20 samples each.

The samples placed in acrylic resin filled molds. A Vickers microhardness indenter (UHL VMHT, Germany) used to check the baseline microhardness under the load of 100 g, which was applied for 15 s at three different positions, each was 1 mm apart, and the mean was calculated.

Samples were immersed in 1% citric acid (20 ml demineralizing solution) and stored in an incubator at 35°C temperature for 72 h for demineralization. After demineralization, once again, surface microhardness was calculated using the Vickers hardness indenter.

The samples of Group A and Group B treated with prepared dentifrices slurries, i.e., Group A with sodium fluoride dentifrice slurry (Clinpro™ tooth creme, 3M)

and Group B with amine fluoride dentifrice slurry (Amflor™ toothpaste, Group pharmaceuticals) using same protocol, that is, 3 min, daily twice for 7 days. The samples were kept in artificial saliva (ICPA, Mumbai, Maharashtra, India) in between treatment.

After the treatment, the enamel surface microhardness in both the groups evaluated with the help of Vickers hardness indenter and a comparative analysis done. Statistical analysis of surface microhardness obtained at different stages done by Student's *t*-test and $P < 0.05$ was considered statistically significant.

RESULTS

Vickers hardness values of the samples obtained at the baseline were in the range of 357.23–358.41 VHN. After remineralization, mean microhardness in Group A increased to 348.58 VHN and Group B increased to 362.73 VHN. Table 1 shows comparison of microhardness within each group while Figure 1 shows comparative microhardness in Groups A and B at baseline, after demineralization as well as remineralization processes. Samples which were treated with sodium fluoride (Group A) could not restore the mean microhardness after treatment to that of preoperative level whereas amine fluoride (Group B) treated samples showed a statistically significant increase in mean microhardness from baseline (degree of freedom = 38).

DISCUSSION

It is observed that the balance between demineralization and remineralization influences dental caries initiation and reversal. This balance is dependent on factors such as presence of calcium, phosphate, and fluoride in saliva, as well as pH of saliva.^[7]

Ten Cate in their study observed that enamel demineralization results in the loss of hydroxyapatite crystals, calcium, and phosphate ions from the enamel while enamel remineralization starts when the alkaline pH increases and salivary calcium, phosphate, and fluoride form new hydroxyapatite crystals.^[8]

In case of demineralization and remineralization, the critical pH ranges from 4.3 to 5.0. Remineralization of enamel occurs when the alkaline pH increases.^[9]

Different fluoride combinations may show different results in prevention of caries. Dentifrices and mouthwashes are very popular in the world. The use

Table 1: Comparison of microhardness within each group

	Group	N	Mean	SD	t	P	Inference
Baseline	A	20	358.41	35.30	-0.138	0.891 (>0.05)	Not significant
	B	20	357.23	14.77			
After demineralization	A	20	332.37	35.39	-0.087	0.931 (>0.05)	Not significant
	B	20	333.11	14.70			
After treatment	A	20	348.58	34.96	-1.653	0.045 (<0.05)	Significant
	B	20	362.73	15.57			

SD=Standard deviation

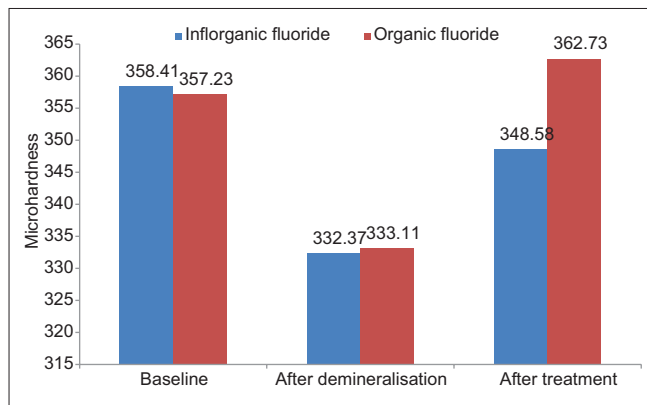


Figure 1: Graph representing microhardness within each group

of dentifrices as therapeutic agents is well accepted in dentistry.^[10]

White *et al.* in their study evaluated different methods for enamel demineralization and remineralization such as direct methods and indirect methods. Direct methods include transverse microradiography, wavelength-independent X-ray microradiography, and longitudinal microradiography while indirect methods include microhardness measurement methods, polarized light optical microscopy, and energy dispersive X-ray analysis. In the present study, indirect method, i.e., microhardness measurement method is used because it can measure changes in the physical parameters such as surface structural strength, and also it is simple, fast and least destructive method to determine demineralization and remineralization.^[11,12]

There are different types of microhardness tests which include Knoop, Vickers, and Brinell. Darshan and Shashikiran in their study observed that even small changes can be detected easily, by the square shape indent obtained after Vickers hardness test.^[13] Hence, in the current study, Vickers hardness test selected for investigation over Knoop and Brinell test.

Chaudhary *et al.* in their study observed that dentifrices can help enamel against erosion and caries by increasing the enamel microhardness with remineralizing effect.^[1]

Sh *et al.* in their study evaluated effect of amine fluoride and sodium fluoride mouthwashes on enamel microhardness, and they concluded that amine fluoride increased enamel microhardness more than sodium fluoride.^[2]

Galuscan *et al.* in their study observed that amine fluoride helps to promote the remineralization of initial lesions by releasing high quantities of fluoride molecules during the acid attack.^[4]

In this present study, the Vickers hardness values obtained at the baseline were in the range of 357.23–358.41 VHN. After demineralization, the mean microhardness values of the samples decreased to 332.37–333.11 VHN. After remineralization process, the mean microhardness value of Group A was 348.58 VHN and in Group B, it increased to 362.73 VHN. The results of the current study showed significant increase in mean microhardness after amino fluoride remineralization than sodium fluoride remineralization and it was statistically significant.

However, the present *in vitro* study may appear quite different in clinical situation. Therefore, further clinical study may be necessary to validate the findings from the present study.

CONCLUSION

Organic fluoride (amine fluoride) remineralization was more effective in restoring enamel microhardness than inorganic fluoride (sodium fluoride) remineralization.

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Conflicts of interest

There are no conflicts of interest.

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