SCIENTIFIC REPORT

Bifluorid 12 – Remineralisation

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Bifluorid 12 from VOCO is a fluoridation varnish which has been established on the market for many years now. In Germany, Bifluorid 12 has been approved as a pharmaceutical for caries prophylaxis.* The varnish's unique effect is based on the combination of the salts sodium fluoride and calcium fluoride, which act in different ways on and in the tooth hard substance. The impact of carbonated mineral water and soft drinks on the effectiveness of fluoridation products in terms of the de- and remineralisation of human enamel was the subject of a study conducted at the University of Shanghai.[1]

The question as to the degree to which fluoridation products can influence treatment success depends, on the one hand, on the composition of the respective product and, on the other hand, on the patient's conduct and behaviour. In this study, two special aspects were considered: The influence of various fluoride products on a) the acid resistance of the enamel upon consumption of acidic drinks and b) the degree of remineralisation of tooth hard substance which has been damaged by acid. Previous studies serve to confirm that the consumption of carbonated drinks causes etching of the tooth enamel and, with this, a reduction in enamel hardness. In this study, the degree of remineralisation was determined indirectly on the basis of enamel hardness.

Examination of the quality of polymerisation

At the University of Shanghai, Fengmei et al. initially studied the change in mineralisation following administration of fluoride products and the subsequent influence of acidic drinks on the previously treated teeth.[1] In this *in vitro* study, freshly extracted deciduous teeth without caries or pre-carious lesions were collected over a two week period and prepared for subsequent tests. The degree of enamel mineralisation is linked directly with hardness and, as such, the influence of the various fluoride products was determined by measuring microhardness according to Vickers [MHV].
The deciduous teeth in control group A were treated with artificial saliva, in group B freshly produced 0.1 % sodium fluoride solution was used, in group C Fluor Protector (0.1% fluorides from a special fluorsilane, Ivoclar Vivadent) and, finally, in group D, Bifluorid 12 (6 % NaF, 6 % CaF_2). Carbonated mineral water and orange soda were used as the drinks. At the start of the experiment, the hardness of the dental hard tissue was measured in each case, the test teeth were then treated with the relevant product as per the manufacturer's instructions and subsequently stored in artificial saliva for a period of seven days at 37 °C.
Graphic 1, which displays the surface hardness before and after fluoridation, shows that the enamel hardness of the control group without fluoridation fell significantly, whereby the hardness of the enamel in the groups with fluoridation rose slightly. This effect is to be expected, since both fluoride ions are stored in the hydroxyapatite lattice and fluoride depots are formed on the tooth hard substance as a result of the fluoride products administered.

*Due to legal restrictions Bifluorid 12 is not available in every country

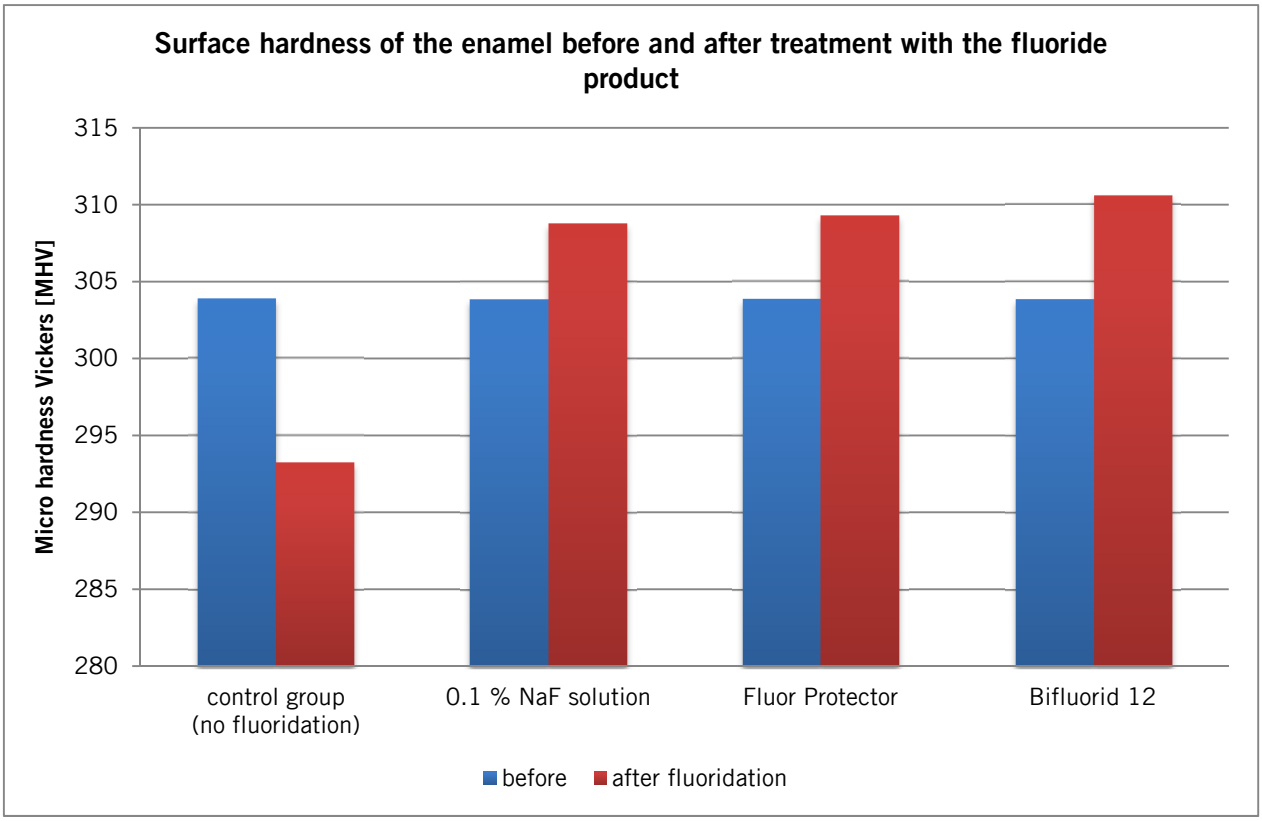

Figure 1: Surface hardness of the enamel before and after administration of the fluoride products

Following this, the fluoridated test teeth were exposed to carbonated drinks. The procedure was such that the teeth were immersed in the drink for 1 minute with a subsequent break of 30 seconds for a total of 15 minutes (ten cycles in all). These ten cycles were repeated five times a day for seven days. This results in a contact time of the fluoridated test teeth with the drink of 350 minutes over the space of a week. Fig. 2 shows the results.

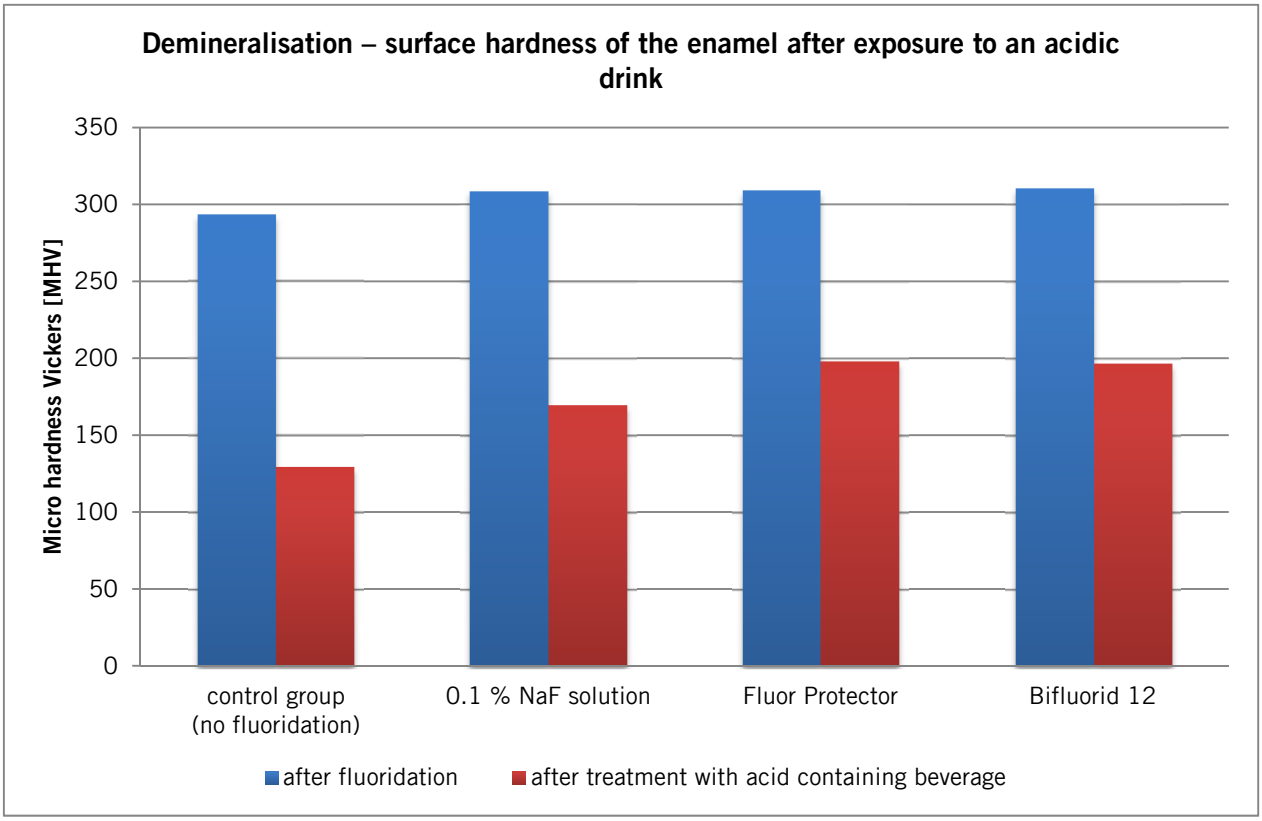

Figure 2: The surface hardness of the enamel before and after treatment in an acidic drink for 350 minutes

On the basis of graphic 2, it can be concluded that the hardness of the enamel was significantly reduced due to the attacks from the acids in the drink. This means that the drinks have caused demineralisation or enamel degradation. As was to be expected, the non-fluoridated control group was most badly affected, with enamel hardness here reduced by around 56 % by the acid. In the sodium fluoride group, the drop in hardness was around 45 %. The best results were achieved with Fluor Protector and Bifluorid 12. In these two groups, enamel hardness only fell by around 36 %. The indirectly calculated degrees of demineralisation would appear to be alarmingly high at first glance however it should be noted that a precise correlation between surface hardness and degree of demineralisation cannot be established due to the various sizes and nature of the teeth. In addition, 350 minutes of exposure to carbonated drinks within a week is an extreme case which does not correspond to everyday human drinking habits.

Finally Fengmei et al. studied the degree of enamel remineralisation. To this end, three sub-groups were created from the control group. The aim of the study here was the remineralisation of the enamel which was attacked by the acid as described above via the administration of fluoride products. The fluoride products used were also 0.1 % sodium fluoride solution, Fluor Protector and Bifluorid 12. For this experiment, the test teeth which were not fluoridated beforehand were immersed in carbonated drinks for 350 minutes over a seven day period as per the procedure described above in order to create a state of demineralisation. The fluoride products were then applied as per the manufacturers' instructions and the microhardness as per Vickers was determined. Figure 3 shows the results.

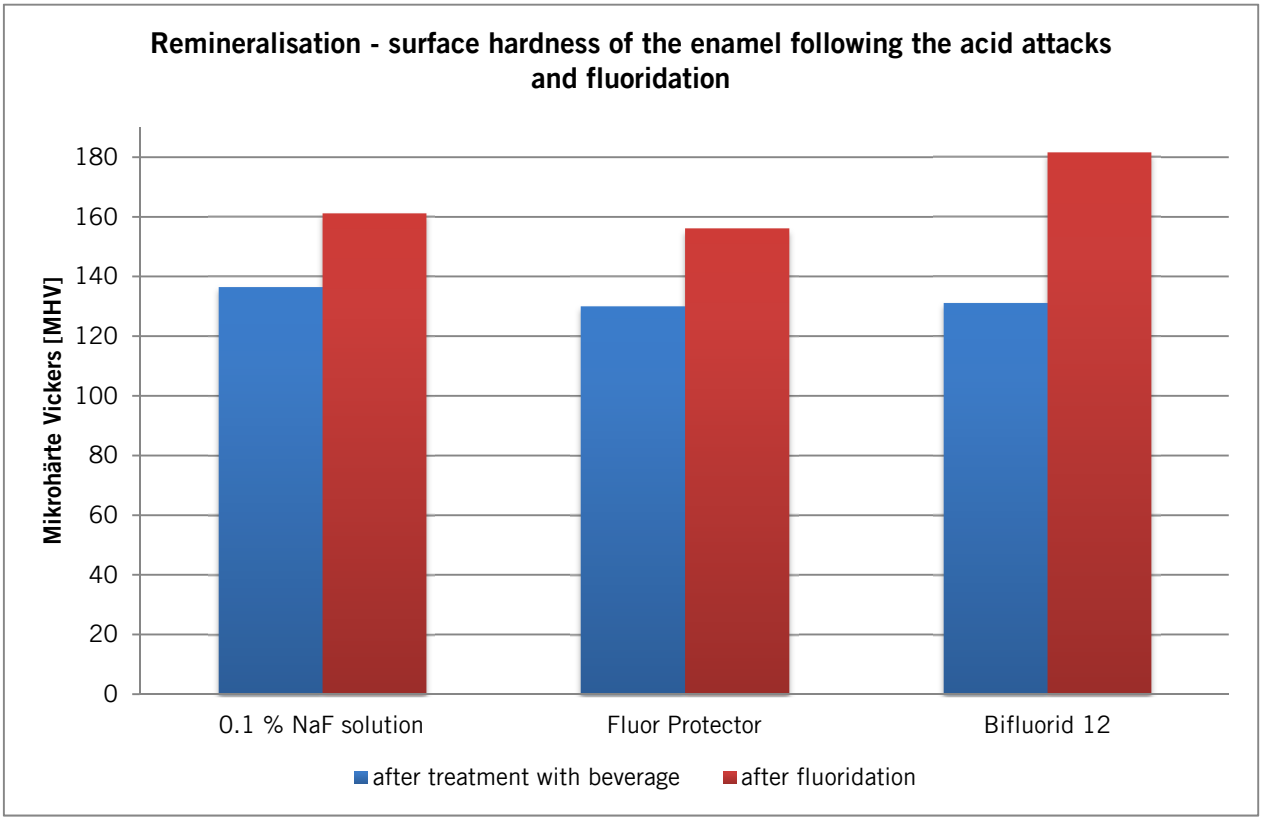

Figure 3: Surface hardness of the enamel following the acid attacks and subsequent fluoridation

After exposure to the carbonated drink, a hardness of around 130 MHV was measured for all the groups. Subsequent fluoridation with 0.1 % sodium fluoride solution increases enamel hardness by around 25 MHV, which is the equivalent of a remineralisation degree of around 18 %. Sodium fluoride is a readily soluble salt which cannot form fluoride depots on the tooth hard substance. The process of fluoridation with this salt is such that the fluoride ions are only incorporated in the demineralised apatite lattice of the tooth, which means that the effectiveness of sodium fluoride together with the mode of operation is limited by the concentration of the salt. The use of Fluor Protector increases the surface hardness of the demineralised enamel by around 26 MHV which is the equivalent of a remineralisation degree of around 20 %. Fluor Protector from Ivoclar Vivadent is based on a complex flurosilane*, a total of 0.1 % fluoride ions are contained.

*exact designation: Bis{4-[2-difluorohydroxysilyl)ethyl]-2-methoxycyclohexyl} [N,N-(trimethylhexane-1.6-diyl)dicarbamate]

On the basis of these results, it can also be assumed that this fluorsilane is easily soluble and thus not capable of forming fluoride depots. The low level of remineralisation of 20 % was also only achieved through the incorporation of fluoride ions into the apatite lattice of the dental hard tissue.

The application of Bifluorid 12 onto the demineralised test teeth serves to increase the hardness of the enamel by 55 MHV. This is the equivalent of a remineralisation degree of around 40 %. In addition to readily soluble sodium fluoride, Bifluorid 12 also contains calcium fluoride of low solubility. Whilst the sodium fluoride ensures the direct structural incorporation of fluoride ions into the apatite lattice of the tooth, thanks to the not readily soluble calcium fluoride, fluoride depots are formed on the tooth hard substance which result in the significant strengthening of the surface. The value of these fluoride depots is even more evident in the long term: The enriched calcium fluoride on the tooth hard substance acts as a reservoir over a period of up to several months, enabling fluoride ions to be incorporated into the apatite lattice little by little and thus ensuring steady remineralisation of the tooth hard substance.

Conclusion: Bifluorid 12, a simple sodium fluoride solution and Fluor Protector improve the mineralisation of healthy, non-damaged tooth hard substance. However significant differences are evident between the products in terms of the remineralisation process of damaged, demineralised tooth hard substance. Whilst sodium fluoride and Fluor Protector only enable the incorporation of fluoride ions into the apatite lattice of the tooth, thanks to the combination of sodium fluoride and calcium fluoride, Bifluorid 12 also allows fluoride depots to be generated which act as a fluoride reservoir for the remineralisation of tooth hard substance, even over a period of several weeks. For the dentist, Bifluorid 12 ensures that patients' tooth hard substance always has a high degree of mineralisation and, as such, is protected against acid and bacteria attacks.

[1] P. Fengmei, W. Xiaoli, W. Guoxiang, *Shanghai Journal of Stomatology,* Vol. 11, No. 4, 346, 2002.