

MICROHARDNESS OF TEETH ENAMEL ON WHITENING COMBINED WITH REMINERALIZATION TREATMENT

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ABSTRACT

The aim of this study was to evaluate the effect of different bleaching agents used for teeth whitening on the microhardness of the enamel. 35% HP and 17% CP were applied on several samples of human incisors. Different treatment strategies were followed and the results show that all of bleaching agents caused a reduction in Vickers microhardness of specimens. Remineralization treatment was applied on samples, after this process the microhardness of the teeth being restored close to initial values measured prior to whitening.

Keywords: microhardness, teeth enamel, whitening, bleaching agents, remineralization

1. Introduction

Dental enamel is a crystalline latticework composed of various minerals, the principal component of which is a complex calcium phosphate mineral called hydroxyapatite. A substantial number of mineral ions can be removed from hydroxyapatite latticework without destroying its structural integrity; however, such demineralized enamel transmits hot, cold, pressure and pain much more readily than normal enamel. Many users of whitening products experience temporary tooth and gum pain, which in some cases can be severe. The most common side effects are mild or moderate tooth sensitivity and gum irritation. Tooth sensitivity corresponds to the concentration of bleaching agent; higher percentages of peroxide are apt to cause more irritation.

Since its introduction by Haywood and Heymann, teeth bleaching have been suggested as an efficient and simple procedure for removing intrinsic and extrinsic stains from teeth. Many products and systems have appeared on the market for in-office use, such as 35 percent hydrogen peroxide, as well as for over-the-counter use. However, a 10 percent carbamide peroxide bleaching agent is the most commonly used at-home bleaching product, owing to its safety and effectiveness. Variations of this technique have been introduced, including the use of higher concentrations of carbamide peroxide agents (from 10 to 22 percent), with carboxy polymethylene polymer used as a thickening agent to improve tissue adherence and to result in a timed or sustained release of the whitening agent. Many studies [1-7] revealed that different concentrations of bleaching agents result in decreases in enamel microhardness from baseline values.

Remineralization of teeth is a process in which minerals are returned to the molecular structure of the tooth itself. Our bodies utilize carbon dioxide from our breath and water from our saliva to create a mild, unstable acid, carbonic acid. Carbonic acid is the heart of the natural remineralization process. Like all acids, carbonic acids can dissolve minerals in our saliva (present from our food); however, unlike strong stable acids, carbonic acid quickly and easily converts to carbon dioxide and water. When this happens, the mineral ions that are dissolved in it precipitate out as solid mineral ions again - but not necessarily as the original mineral molecules. If a particular mineral ion is near a demineralized portion of the hydroxyapatite crystal that requires that ion, the ion is incorporated into the dental enamel. Though natural remineralization is always taking place, the level of activity varies according to conditions in the mouth.

Fluoride therapy is often used to promote artificial remineralization. This produces the stronger and more acid-resistant fluorapatite, rather than the natural hydroxylapatite. Both are made of calcium. The fluoride takes the place of a hydroxide. Fluoride exerts its major effect by creating low levels of fluoride ions in saliva and plaque fluid, thus exerting a topical or surface effect. When fluoride ions are present in plaque fluid along with dissolved hydroxyapatite, and the pH is higher than 4.5, a fluorapatite-like remineralized veneer is formed over the remaining surface of the enamel; this veneer is much more acid-resistant than the original hydroxyapatite, and is formed more quickly than ordinary remineralized enamel would be.

Studies showed that the detrimental effect of bleaching treatment can be eliminated by using a well conducted remineralization treatment [8].

The mechanical behavior of dental enamel has been the subject of many investigations. Initial studies assumed that it was a more or less homogeneous material with uniform mechanical properties. Now it is generally recognized that the mechanical response of enamel depends upon location, chemical composition, and prism orientation.

Microhardness tests are commonly used to study the physical properties of materials, and they are widely used to measure the hardness of teeth. This method is easy, quick, and requires only a tiny area of specimen surface for testing.

2. Experimental

For our experiments 3 integer human incisor were prepared. Each of incisors were treated in different way, being the subject of bleaching with different chemical agents. After the whitening, the teeth undergo a remineralization treatment with a fluoride based product (Ultraez). Between different stages of the treatment the teeth were preserved in artificial saliva. Incisor 1 was bleached during 4 series of treatment with 35% hydrogen peroxide (35% HP). After that, 19 series of remineralization occur. Incisor 2 was bleached during 2 series of treatment with 35% hydrogen peroxide (35% HP), followed by 8 series of remineralization. Incisor 3 was the subject of 14 series of bleaching with 17% carbamide peroxide (17% CP) followed by 5 series of remineralization.

Determination of microhardness of as treated teeth was made using a CV-AAT 400 Vickers microhardness tester. Enamel and dentin have specific microstructures; thus their hardness may depend upon indentation loads or times. In the case of Vickers microhardness test applied on human teeth, studies revealed that loading time has no significant

influence on test results [9]. Thus, in our experiments a loading time of 20 s was chose. The loading force was set in the domain of micro loads (25 gf) having in mind that the depth of indentation has to be less than 10% of enamel thickness.

3. Results and discussion

On each sample, after each phase of treatment, there were made 10 determination of Vickers microhardness, on different location of each tooth. The following tables and figures present the average values of these measurements.

Table 1 presents the strategy of whitening followed by remineralization treatment for incisor 1. Figure 1 shows the evolution of Vickers microhardness during this treatment. Examining the results some conclusions can be formulated. It is to observe that, after each series of 2 whitening treatment, there is a great drop in Vickers microhardness of teeth enamel. The average decreasing percent for microhardness is 40% for each bleaching treatment. In the case of sample 1, after 2x2 series of whitening treatment the original natural microhardness of sample (406 HV) dropped with 64%, being only 148 HV at the finish of the treatment.

Table 1. Vickers microhardness during the treatment of sample 1

Sample Incisor 1	
Treatment strategy	Hardness HV [kgf/mm ²]
Before whitening	406
After 2 x whitening with 35% HP	240
After 4 x whitening with 35% HP	148
After 4 x remineralization	164
After 8 x remineralization	247
After 14 x remineralization	314
After 19 x remineralization	326

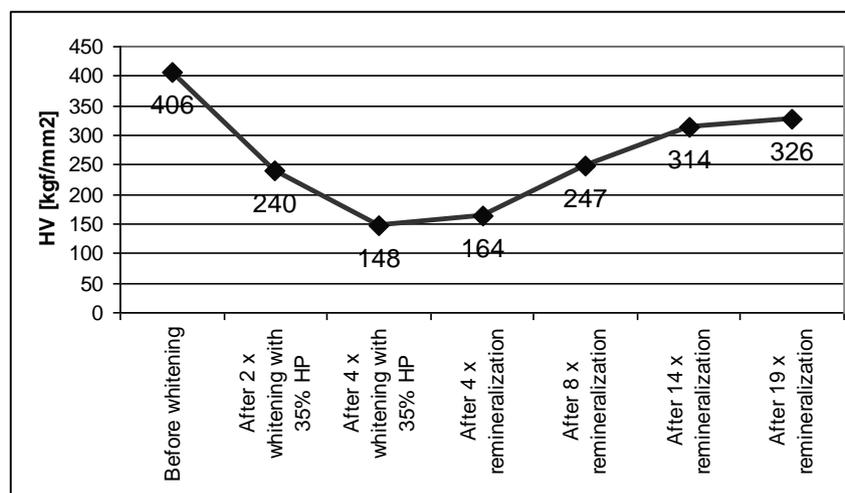


Fig. 1 – The evolution of Vickers microhardness during the treatment of incisor 1

These results, even if they seem dramatically, are concordant with the data presented in a meeting of Materials Research Society, data which showed that the diminishing of teeth microhardness during whitening treatments with concentrated bleaching agents (such is 35% HP) is up to 82% [10].

In order to restore the initial teeth condition, related with their hardness, a remineralization treatment was planned and conducted in the manner that is presented in Table 1. It consists in 19 several stages, after 4, 8, 14 and 19 stages Vickers microhardness determination were made. As the Figure 1 shows, there is a clear process of hardness restoration, the process started slowly in the first stages, being accelerated in the following ones. After 14 stages of remineralization the tooth hardness is 77% of initial one. The next stages bring only a small improvement in microhardness, at the finish of the treatment its value being 326 HV. This is 82% from initial microhardness value of 406 HV, presented by

the tooth before the whitening treatment to begin. This can be considered a good result, proving the value of remineralization treatment from the point of view of teeth microhardness restoration.

Table 2 presents the strategy of whitening followed by remineralization treatment for incisor 2. Figure 2 shows the evolution of Vickers microhardness during this treatment.

Table 2. Vickers microhardness during the treatment of sample 2

Sample Incisor 2	
Treatment strategy	Hardness HV [kgf/mm ²]
Before whitening	423
After 2 x whitening with 35% HP	252
After 4 x remineralization	259
After 8 x remineralization	367

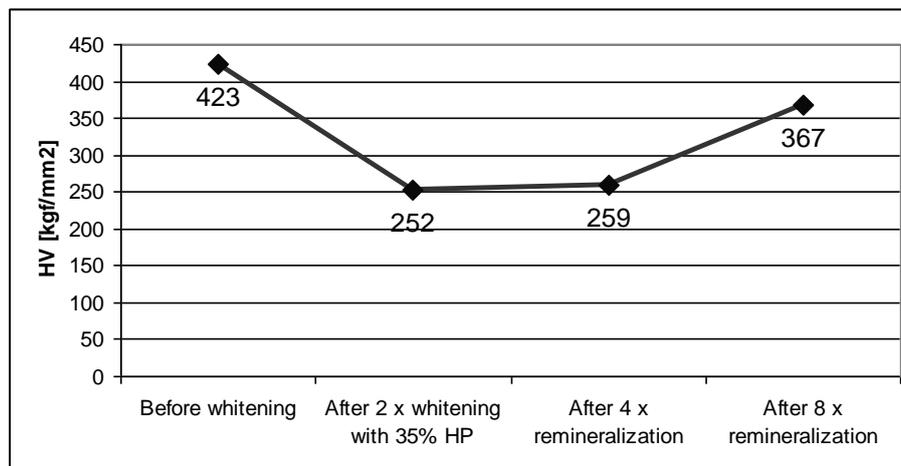


Fig. 2 – The evolution of Vickers microhardness during the treatment of incisor 2

After whitening treatment there is a great drop in Vickers microhardness of teeth enamel with a percentage of 40%. This result is concordant with the results obtained in the case of incisor 1. We can conclude that after each 2 subsequent bleaching processes the microhardness decrease has an average value of 40% from previous one. A process of hardness restoration occurs also on incisor 2 by the means of remineralization treatment. After 8 stages of remineralization the tooth hardness is 87% of initial one.

For sample 3, a much milder bleaching agent was chose. This is 17% carbamide peroxide, a whitening solution that can be use in at home treatments. Incisor 3 was the subject of 14 successive whitening stages, followed by 5 remineralization stages. Table 3 presents the strategy of whitening followed by remineralization treatment for incisor 3. Figure 3 shows the evolution of Vickers microhardness during this treatment.

After whitening treatment there is only a mild drop in Vickers microhardness of teeth enamel. If the

initial value was 421 HV, the final one is 373 HV, with a total drop percentage of 12%. We can conclude that after each 7 subsequent bleaching processes (this means a week of home treatment) the microhardness decrease has an average value of 6% from previous one. Even the diminishing of hardness is low in the particular case of 17% CP, remineralization treatment can be applied, restoring the initial microhardness close to the value before the whitening treatment. After 5 stages of remineralization the tooth hardness is 94% of initial one.

Table 3. Vickers microhardness during the treatment of sample 3

Sample Incisor 3	
Treatment strategy	Hardness HV [kgf/mm ²]
Before whitening	421
After 6 x whitening with 17% CP	396
After 14 x whitening with 17% CP	373
After 5 x remineralization	394

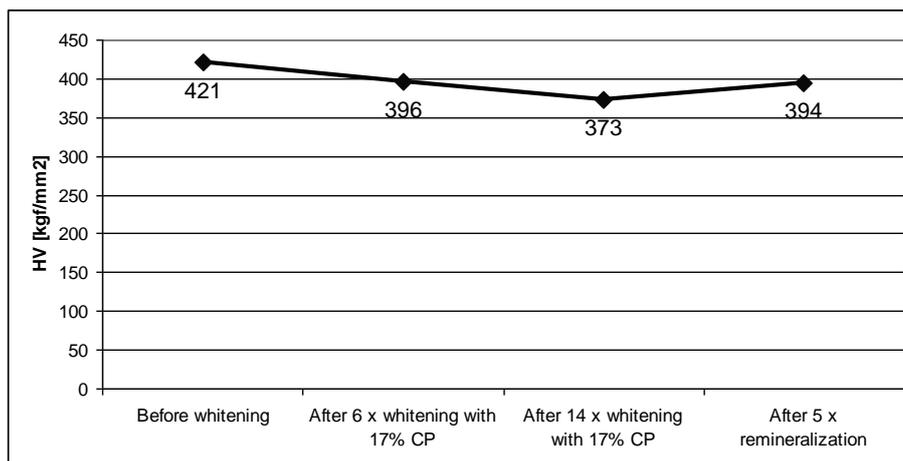


Fig. 3 – The evolution of Vickers microhardness during the treatment of incisor 3

4. Conclusions

Figure 4 presents the comparative results of whitening combined with remineralization treatments that were applied on this work.

The results of the present experimental study show that there is a significant reduction in microhardness of teeth that undergoes a whitening treatment when concentrated bleaching agents (such 35% hydrogen peroxide) are used. This treatment is generally applied by the dentist in the medical unit. It can be done in 2, or 4 separate stages. The reduction in terms of teeth hardness is dramatic, being of 40% from previous one, at each pair of subsequent whitening treatments. The patient can find himself in the situation in which, the original hardness of teeth is reduced even with 80% percent. It is clear that there is a need of hardness restoration and this can be done

by using remineralization treatments. After several stages of remineralization with dedicated products, the hardness of teeth can be recuperated. The restored value can be up to 80...90% from original value of teeth hardness before whitening treatment.

In the case of whitening with mild agents, such as 17% carbamide peroxide, generally the treatment is performed at home, by applying the bleaching agent for a limited period of time of several hours, each day, during one or two weeks. Our study shows that in this case the drop in terms of teeth hardness is only minor (approx. 10% from initial value) and is very easy to recuperate by using remineralization treatments which restore the final value of microhardness very close to initial value. The restored value can be up to 95% from original value of teeth hardness before whitening treatment.

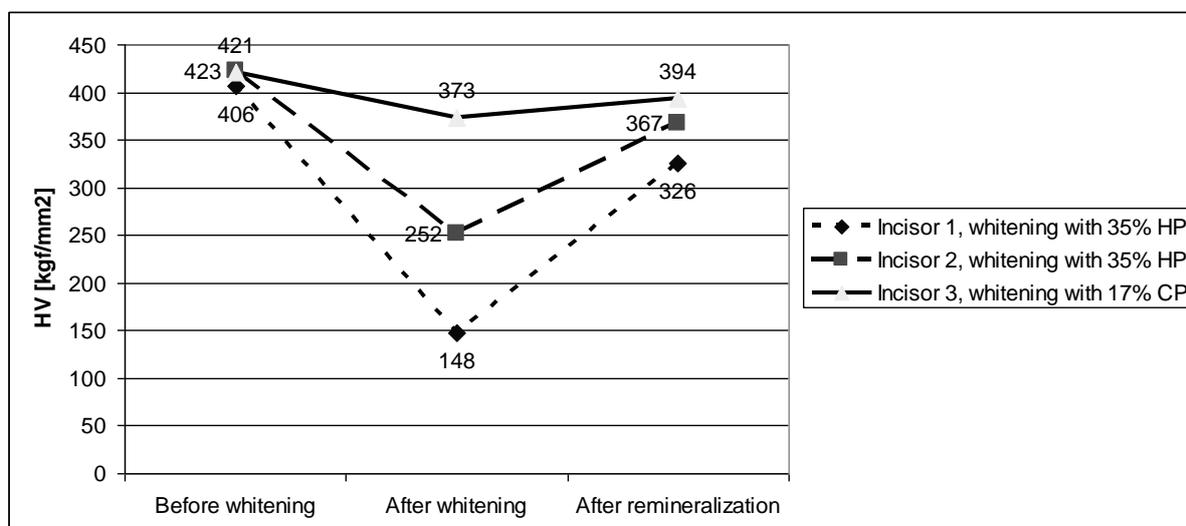


Fig. 4 – The evolution of Vickers microhardness during different whitening followed by remineralization treatments

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