The Influence of Hydrogen Peroxyde Treatment on the Bond Strength of Orthodontic Brackets on Human Enamel

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Enamel treatment with hydrogen peroxyde or carbamide peroxyde is a dental cosmetic procedure also known as tooth bleaching. This method has gained more and more popularity in the past decade due to the rapid effects and to the low cost compared to aesthetic restorations. Even so, tooth bleaching is controversial because some studies state that it impaires on the bond strength of resins to enamel due to remaining oxygen on the enamel surface. The aim of our study was to test the action of an antioxidant in order to evaluate to what extent it improves bond strength. 20 human permanent teeth were collected, professionally cleaned and divided into two groups: group 1 served as control and in group 2 the teeth were bleached using a professional in-office bleaching system (Pola Office +, SDI) along with a curing light for effect enhancement (SmartLite, Dentsply DeTrey). After bleaching the teeth from group 2 were immersed in a 10% sodium ascorbate solution for 10 min and then they were kept in saline solution for a week. Prior to sample fabrication, teeth from group 2 were again treated with sodium ascorbate for 10 min. Then the teeth from both groups were bonded with orthodontic brackets using a no-mix self-curing adhesive (Ortho-Loc, DentsplyGAC). After the bonding procedure, the teeth were kept for 24 h at 37°C and then they were included in acrylic resin blocks so that the buccal surface would be parallel to the acrylic base. Shear bond strength testing was performed on both groups using a universal testing machine (Multitest 5i). The values were converted from N to MPa and statistically analysed. No statistically significant differences were noted between the two groups, both groups showing clinically acceptable bond strengths. Thus, we can draw the conclusion that antioxidant treatment of dental enamel after bleaching with hydrogen peroxyde is very helpful in obtaining clinically acceptable bond strengths, rendering values close to those obtained for untreated enamel.

Tooth whitening or bleaching is a very popular procedure among patients due to its good outcome and due to the great amount of publicity that it receives. The method itself is controversial and long term effects on human enamel are not yet known. Although virtually any tooth can be whitened, the genuine medical indication refers to tetracycline discoloration and to non-vital teeth.

In-office whitening systems are usually bi-or tri-component consisting in a powder, a liquid and optionally an activator. Any system must also contain a gingival mask (guard) designed to be applied onto the gingiva and then cured having the role to protect it from potential burns. By mixing the powder and the liquid a hydrogen peroxyde or carbamide peroxyde gel is obtained. This gel can be applied on the tooth surface to act by itself or its action can be enhanced by using a light-curing lamp working at a wavelength of 470-490 nm, which corresponds to blue light on the visible spectrum. Respecting the manufacturer’s instructions and regular fluoridation after whitening are crucial in order to avoid/minimize post-operative sensitivity which is the best-known side effect of bleaching in patients over 30 years of age.

Data from literature is controversial in what bonding is concerned. Many authors state that bonding procedures after tooth bleaching should be postponed for two weeks after the procedure since bonded brackets, composite restorations have a larger tendency to fail. Also, in cases where tooth bleaching is performed at home using over the counter bleaching kits, there is no control on the frequency, on the outcome or on the long term effects. In this case patients can come in for an orthodontic/dental appointment, avoid to inform their doctor about having done a whitening procedure at home with a negative impact on potential composite restoration/bonded orthodontic brackets. The mechanism that is thought to be the culprit in lower bond strengths on bleached teeth is the persistence of active oxygen on the enamel surface which is known to have a negative effect on the polymerization process of resins.

The aim of the study was to investigate to what extent the treatment of bleached enamel with an antioxidant (sodium ascorbate) would minimize a negative outcome in what bonding is concerned.

Experimental part

Materials and method

Twenty sound permanent teeth with an intact buccal surface were collected. These were carefully cleaned of any debris and kept in a 0.1% thymol solution at 4°C until the samples were processed. The teeth were also professionally cleaned with rotary brushes and fluoride-free paste and then randomly divided into two groups:

- Group 1 – unbleached teeth (control)
- Group 2 – bleached teeth with H2O2 treatment

Testing was performed on both groups using a universal testing machine (Multitest 5i). The values were converted from N to MPa and statistically analysed. No statistically significant differences were noted between the two groups, both groups showing clinically acceptable bond strengths. Thus, we can draw the conclusion that antioxidant treatment of dental enamel after bleaching with hydrogen peroxyde is very helpful in obtaining clinically acceptable bond strengths, rendering values close to those obtained for untreated enamel.
In group 2, a professional whitening system was used (Pola Office +, SDI). The manufacturer’s instructions were strictly followed and in order to gain maximum effect the gel covered dental surfaces were irradiated with blue light from a curing lamp (Smartlite, Dentsply DeTrey). After bleaching, the teeth from group 2 were thoroughly rinsed and immersed in a 10% sodium ascorbate solution for an hour and then kept in saline solution for another week. Before bonding, teeth were again treated with sodium ascorbate for 10 min [1].

All teeth were bonded with metal orthodontic brackets with a mean surface of 9.79 mm². The bonding procedure used a self-curing no-mix orthodontic adhesive (Ortho-Loc, DentsplyGAC) and was performed identically for both groups as follows:

- 30 s acid etching of the buccal surface with 37% orthophosphoric acid;
- rinsing and drying;
- application of the bonding agent on the tooth followed by gentle air drying;
- application of the orthodontic resin on the bracket base followed by pressing it firmly onto the tooth surface in the desired position. The excess composite was removed with a scale before curing.

After bonding the teeth were kept in distilled water at 37°C for 24 h. Then, they were horizontally included in self-curing acrylic resin (Duracryl, Spofa) with the buccal surface left free and placed parallel to the resin block.

Shear bond strength testing was performed on all samples using a universal testing device (Mecmesin Multitest 5i) operating at a speed of 1 mm/min. We recorded to shear bond strengths in N and then converted the data into MPa. All data were statistically analyzed.

**Results and discussions**

The shear bond strength are presented in tables 1 and 2. For the statistical analysis of the results we applied the One-Way ANOVA test (table 3) and to further compare the two groups we employed the t-unpaired test. We obtained statistically insignificant differences between the two groups (p= 0.719, α = 0.05). The graphic representation of the distribution of shear bond strength of the samples of the two groups is found in figure 1.

A series of studies report low bond strengths of brackets bonded to bleached enamel [1,2]. The lowest values are found in studies where bonding was performed immediately after bleaching to the remaining active oxygen that is known to have an inhibiting effect on the polymerization, determining an inhomogenous enamel-adhesive interface with gaseous inclusions within the adhesive resulting from chemical interaction between the resin and the remaining peroxide [3,4]. This decrease in bond strength is at least partially reversible by postponing the bonding session for up to one month [5]. Data from literature suggest that at least a week would be necessary between the bleaching and bonding session [2,6,7].

In order to counteract the effects of active oxygen on adhesion a series of methods were imagined that include storing in distilled water, saline solution or artificial saliva and treating with antioxidants. The action of the later was extensively discussed in medical literature [8,9] and their effect on free radicals is also universally accepted.

In order to observe to what extent sodium ascorbate would positively influence the adhesion to whitened teeth...
we treated the enamel after a personal protocol obtaining encouraging results. All results that were obtained are within the range of clinical acceptability (6-8 MPa) [10] for both groups, with slightly higher values for samples from group I (unbleached enamel). Even though the values from group I were higher, there were no statistically significant differences between the values obtained for the two groups.

Conclusions

Dental bleaching generates changes in the enamel surface and surface chemistry with a negative influence on the adhesion.

By postponing the bonding procedure by one week minimum higher bond strengths are obtained.

Combining immersion in saline solution or artificial saliva with sodium ascorbate treatment rebalances the surface composition of enamel thus generating better adhesion.

Neutralizing the residual active oxygen after bleaching is the key in obtaining higher bonds strengths.

References


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