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Review Article

Effect of 8.25% Sodium Hypochlorite on Shear Bond Strength and the Ability of Ascorbic Acid to Reverse it

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Abstract

Aim: The purpose of this experiment was to evaluate the immediate shear bond strength on dentin surfaces exposed to 8.25% NaOCl for a clinically significant amount of time and to see if subsequent treatment of the dentin with 10% ascorbic acid can reverse any effect.

Methods: 100 samples were divided into 5 experimental groups. Group 1 was the only negative control. Control group 2 was exposed to NaOCl, group 3 was exposed to 10% ascorbic acid solution after exposure to NaOCl. Groups 1, 2 and 3 were restored with Clearfil SE bond 2 and Clearfil DC Core Plus (Kuraray, Tokyo, Japan). Groups 4 and 5 were restored with Fuji 2 LC and Fuji 9 (GC America, IL) respectively. The specimens were then subjected to shear bond strength testing and analyzed using Kruskal-Wallace and Mann-Whiteney U

Results: The mean sheer bond strength (MPa) results and standard deviations were as follows: Control, 24.54 +/- 4.31, NaOCl, 13.2 +/- 5.89, 1 min ascorbic acid, 24.25 +/-4.93, Fuji 9, 2.6 +/-1.18. Fuji 2, failed without yielding any data. There was no difference in sheer bond strength between the control group and the samples that were exposed to sodium hypochlorite for 1 hour and subsequently exposed to ascorbic acid 10% for 1 min (P=. 4364)

Conclusion: While sheer bond strength values are reduced for Clearfil SE Bond 2 when used on dentin that has been exposed to 8.25% NaOCl for 1h, this effect can be completely reversed by a 1 minute application of a 10% ascorbic acid solution.

Keywords: Sheer bond strength; Ascorbic acid

Introduction

Background: Bleaching agents have evolved in improving the appearance of discolored teeth. These agents can be hydrogen peroxide, carbamide peroxide or other proprietary material that breaks down into water and oxygen. The dissociated products penetrate through pores of enamel and dentine changing the value of the tooth. Some of the materials used in endodontics as an irrigant have mechanism of action similar to tooth whitening effects. Studies have previously shown that exposure of dentin during endodontic treatment to Sodium Hypochlorite (NaOCl) can lead to decreased bond strengths due to increased oxygenation [1-4].

With the rising popularity of quartz glass fiber posts for restoring endodontic treated teeth, providing suitable bonding substrate as all manufacturers recommend the use of dental bonding to insure optimal results. These restorations rely on dentin bonding to provide not only strength to the restoration and remaining tooth structure, but to also provide a coronal seal against microleakeage and recontamination of the canal system [5].

The wait period for bonding a bleached tooth with composite varies from one to 4 weeks. The reported shrinkage of composite restorative resins has been reported to be between 2% and 6% with variations in the amount of filler being the reason for this variation [5]. Due to this polymerization shrinkage the initial bond strength of the dentin bonding agent must be high enough to resist the contracture strain otherwise gap formation occurs which can reduce the longevity of the tooth [6]. Previous studies have shown that bleaching effect may be reversed by application of 10% ascorbic acid [7-13] and that the mode of failure is an adhesive failure; a failure of the dentin-bonding agent to adhere to the tooth structure [8]. Unfortunately most of these studies have involved NaOCl application times that are not reflective of typical clinical treatment times and none have tested an 8.25% concentration of NaOCl, which has recently become available.

Therefore the aim of the study was to evaluate the immediate shear bond strength on dentin surfaces exposed to 8.25% NaOCl for a clinically significant amount of time and to see if subsequent treatment of the dentin with 10% ascorbic acid can reverse any effect.

Hypothesis: The null hypothesis is that there is no difference in shear bond strength of resins applied with a dentin-bonding agent to surfaces exposed to NaOCl

Materials and Methods

100 polished dentin discs (Ultradent Products Inc, South Jordan, UT)-which consisted of non-carious extracted human molars embedded in acrylic blocks were sandblasted with 50 micron aluminum oxide at 50PSI for 5 seconds at 1cm away in order to simulate a clinical surface prepared with a diamond bur while maintaining a flat surface. 80 of these samples were treated for 1 hour in 8.25% sodium hypochlorite (Chlorox Corp, Oakland, CA) in order to simulate the exposure time during molar endodontics, rinsed, dried, and divided into experimental groups of 20. The last 20 served as negative controls. The disks were then stored in room temperature iso-tonic water while not in use to prevent desiccation.

Group 1 (n=20) was assigned as the negative control. The discs were air dried and Clearfil SE bond 2 (Kuraray, Tokyo, Japan) applied, air thinned until surface ripples were no longer seen, mounted in Ultradent Jigs (Ultradent Products Inc, South Jordan, UT), cured for 20 seconds with a Blue Phase G2 curing light (Ivoclar Vivadent) and were restored with Clearfil DC Core Plus as per Manufacturers Instructions (MI) (Kuraray, Tokyo, Japan) simulating clinical protocols.

Group 2 (n=20) consisted of no treatment after exposure to NaOCl The discs were air dried and Clearfil SE bond 2 (Kuraray, Tokyo, Japan) applied, air thinned until surface ripples were no longer seen, mounted

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in Ultradent Jigs (Ultradent Products Inc, South Jordan, UT), cured for 20 seconds with a Blue Phase G2 curing light (Ivoclar Vivadent) and were restored with Clearfil DC Core Plus as per Manufacturers instructions (MI) (Kuraray, Tokyo, Japan) simulating clinical protocols.

Group 3 (n=20) were treated with 10% ascorbic acid for 1 min after 1 hour of exposure to NaOCl. The discs were air dried and Clearfil SE bond 2 (Kuraray, Tokyo, Japan) applied, air thinned until surface ripples were no longer seen, mounted in Ultradent Jigs (Ultradent Products Inc, South Jordan, UT), cured for 20 seconds with a Blue Phase G2 curing light (Ivoclar Vivadent) and were restored with Clearfil DC Core Plus as per Manufacturers Instructions (MI) (Kuraray, Tokyo, Japan) simulating clinical protocols.

Group 4 (n=20) were treated with polyacryclic acid (GC America, IL) for 10 seconds, rinsed, blotted dry while leaving the dentin moist, mounted in the Ultradent jig and restored with Fuji 2 LC.

Group 5 (n=20) were treated with polyacryclic acid (GC America, IL) for 10 seconds, rinsed, blotted dry while leaving the dentin moist, mounted in the Ultradent jig and restored with Fuji 9.

The specimens were then subjected for shear bond testing (Shear bond tester Machine; Ultradent Products, South Jordan, UT,). Testing was performed at a crosshead speed of 1 mm/min. All specimens were subjected to shear bond testing the same day of completion of the bonding procedures. The bond strength readings were then recorded as shown in Table 1.

Results

All of the samples in the Fuji 2 LC group failed upon jig removal and were unable to be tested. Kruskal-Wallis test revealed a significant difference between the remaining groups (H=60.71, df=3 P<0.0001). A Mann-Whitney analysis was performed for all groups against the control group to analyze the difference. Analysis shows that between the control group and the 1 hour of exposure to sodium hypochlorite there was a significant decrease in bond strength (P<.0001) as shown in Table 2. Additionally, there was a significant difference in sheer bond strength between the control group and the Fuji 9 group (P<.0001) as shown in Figure 1. However, there was no difference in sheer bond strength between the control group and the samples that were exposed to sodium hypochlorite for 1 hour and subsequently exposed to ascorbic acid 10% for 1 min (P=.4364)

Discussion

While there have been many previous reports on the effect of NaOCl exposure on subsequent bond strengths, most failed to reflect actual clinical conditions [5-10]. Even when there was agreement on the reduction of bond strength, there was disagreement as to whether the reduction in bond strength was due to oxidation of the dentin surface or if it was due to the removal of the organic component of the dentin by NaOCl [13]. The sheer bond strength values obtained for the Fuji 9 group when compared with values obtained in previous studies indicate that dentin exposed to NaOCl does significantly affect the sheer bond strength of Fuji 9 although the values are so low for this group that a much larger sample size would be needed to confirm this finding [14-16].

More research is needed to test the effect of various exposure times of a 10% ascorbic acid solution to dentin surfaces that have been exposed to NaOCl for clinically significant amounts of time. While many studies have previously shown that a 10% ascorbic acid solution is able the reverse the bond strength reduction found in dentin treated with NaOCl, Prasansuttiporn et al. found that even with a 30 second exposure to NaOCl, both 5 seconds and 10 seconds of exposure to 10% ascorbic acid was not enough to restore bond strength [10].

Given that the reduction of sheer bond strength due to exposure of dentin to 8.25% NaOCl for one hour was is in agreement with previous studies where much shorter exposure times for NaOCl were utilized, more research must be performed to determine if the reversal effect of ascorbic acid is instantaneous irrespective of the concentration or duration of exposure of NaOCl. Another question to be explored in future studies is if the effect observed translates across all of the different types of dentin bonding agents such as total etch, single bottle self etch, and self etching cements. Furthermore, it is recommended that one have to quantitatively evaluate the surface analyzing the effects of resin tags on bleached surface to better understand the process.

S. No	Control Mean +/- S.D MPA	NaOCl 1h Mean +/- S.D MPA	1 m ascorbic Mean +/- S.DMPA	Fuji 9 Mean +/- S.DMPA
	24.54 +/- 4.31	**13.2 +/-5.89**	**24.25 +/-4.93**	**2.6 +/-1.18**
1	16.5	10.8	16	2.6
2	28	12.4	28.2	2.6
3	20.1	13.5	27.5	3.9
4	28.6	21.5	27.7	2.5
5	19.8	7.2	31.6	1
6	31.1	4.5	20.6	3
7	23.2	17.3	23	2.4
8	23.5	19.2	18.9	2.5
9	17.9	7.2	25.4	2.7
10	26.7	4.1	32.9	2.5
11	25.6	21.6	23.8	6.1
12	29.1	11.9	21.1	3.4
13	23.9	8.3	16	1.6
14	25.6	15	26.6	1.6
15	23.7	17.5	21.2	2.1
16	24.2	18.4	27.9	3.7
17	22.1	21.2	18.4	2.2
18	26.9	11.6	21.5	1.7
19	33.2	4.3	28.7	0.6
20	21	16.4	28	3.3

Table 1: Data depicting the bond strengths of various test groups (MPa).

	Sheer Bond Strength (MPa) Mean +/- S.D
Control	24.54 +/- 4.31
NaOCl	13.2 +/-5.89
Ascorbic Acid	24.25 +/-4.93
Fuji 9	2.6 +/-1.18

Table 2: Shear bond strength values among different treatment groups.

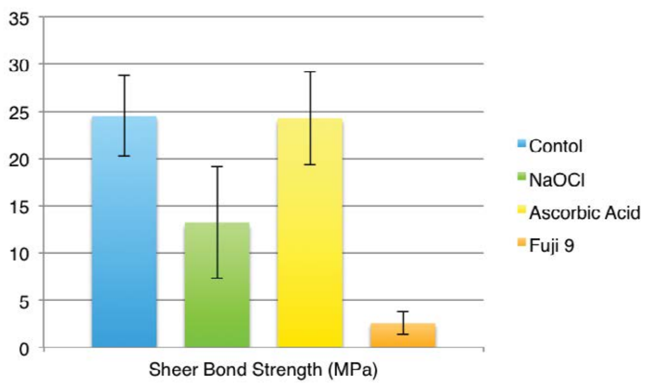

Figure 1: No difference in shear bond strength between the control gropu and the group exposed to NaOCl and treated with 10% ascorbic acid for 1 minute.

Conclusion

This study is in agreement that when a tooth is exposed to a bleaching agent the adhesion of composite resin is compromised, and should be delayed for at least a week as cited in the literature. Endodontists use bleaching agents like sodium hypochlorite and RC prep both as an irrigant and as a lubricant while preparing the canal. The materials undergo complete oxidation reaction releasing oxygen free radicals that chemically break down organic molecules within enamel and dentin releasing nascent oxygen. These free oxygen radicals will interfere with the bonding of composite materials due to the oxygen rich surface later. In view of the results noted in our study clinicians should surface treat the exposed tooth structure by a minute application of 10% ascorbic acid. While shear bond strength values are reduced for Clearfil SE Bond 2 when used on dentin that has been exposed to 8.25% NaOCl for 1h, this effect can be completely reversed by a 1 minute application of a 10% ascorbic acid solution.

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