

Scanning Electron Microscopic Study of Shear Bond Strength with Acidulated Phosphate Fluoride Applied before Acid Etching

G Viswanathan MDS

Assistant Professor, Dental Department, Government Sivaganga Medical College, Sivaganga, Tamilnadu, India
Email- gviswanathan1990[at]gmail

Abstract: Introduction: The topical fluoride is effective in increasing resistance to dental caries or enamel decalcification. Acidulated phosphate fluoride increased the uptake of fluoride by the enamel at rates higher than either stannous fluoride or neutral sodium fluoride. The fluoride deposits in hydroxyapatite to form fluorapatite. However the fluorapatite may affect the bond strength or debonded interface this study is to evaluate the shear bond strength with acidulated phosphate fluoride before acid etching and detect the changes on the enamel surface after debonding with the fluoride application before acid etching with scanning electron microscope. Materials and Methods: Forty human premolar teeth were extracted from teenagers (9 to 16 years of age). The teeth were randomly divided into two groups of 20 teeth each for evaluating shear strength. The specimens of Group 1 (Control Group) the etchant solution was applied on the buccal surface of each crown for 15 seconds then rinsed with an abundant spray of water for 10 seconds and dried with an air spray. In the group 2 the teeth were immersed in APF gel (Vishal Pharma Ahmedabad) for 4 minutes. The treated teeth were removed from the APF gel and left untouched for 30 minutes. Subsequently the gel was washed off with a 1 minute water spray. The enamel of each tooth was etched for 15 seconds with acid solution for bonding. The buccal surfaces of the teeth were abundantly washed with a water spray for 10 seconds then dried again etched enamel and bracket base were coated with a sealant and the composite resins (3M Unitek Co, USA) immediately applied to the bracket base. Results: The Mean shear strength of control group (Group I) 10.76 MPa Group II (APF application before acid etching) 10.55 MPa. In the SEM study APF gel produced surface coating appeared to consist of a uniformly thick layer of densely packed small globular particles present before acid etching. Conclusion: There is no statistically significant difference in bond strength with the APF application before acid etching compared to the control group.

Keywords: Acidulated phosphate fluoride, orthodontic brackets, shear bond strength, Scanning electron microscope

1. Introduction

The most significant development in the field of orthodontics for more than 60 years is the acid etch technique introduced by Buonocore in 1955 (19) that has been used in the direct bonding of orthodontic brackets. However in patients with poor oral hygiene decalcification and decay have been observed around the bonded brackets. Many studies have proven that topical fluoride is effective in increasing resistance to dental caries or enamel decalcification. These include pretreatment with topical fluoride before etching, incorporation of fluoride in the etching solution, and topical application of fluoride in the etched surface before bonding. Acidulated phosphate fluoride increased the uptake of fluoride by the enamel at rates higher than either stannous fluoride or neutral sodium fluoride. The mechanism by which fluoride reduces decalcification and caries has also been shown to increase the resistance of enamel to acids, increase the maturation rate of enamel and interfere with the metabolism of microorganisms. The fluoride deposits in hydroxyapatite to form fluorapatite. However the fluorapatite may affect the bond strength

The aim of the study is to evaluate the shear bond strength with acidulated phosphate fluoride before acid etching and detect the changes on the enamel surface after debonding with the fluoride application before acid etching with scanning electron microscope

2. Materials and Methods

Teeth

Forty human premolar teeth were extracted from teenagers (9 to 16 years of age). After extraction the teeth were washed and immersed in a closed plastic box with physiologic saline solution to keep them free from fungal and bacterial contamination for period of 3 months.

Brackets

Stainless steel mini-mesh curved Beggs bracket with the bracket base measurement of 3mm X 3mm (256 – 650C) manufactured by TP orthodontic Inc (USA) were used in this study.

Method

The teeth were randomly divided into two groups of 20 teeth each for evaluating shear strength.

Mounting of specimens

The specimens were mounted on an acrylic block of dimension (4x2x1cm) to make it compatible to the jigs of the Hounsfield universal testing machine.

Bonding Procedure

The buccal surfaces of the crown were cleaned with pumice using polishing brush for 10 seconds then washed with water and dried with an air spray.

The specimens of Group 1 (Control Group) the etchant solution was applied on the buccal surface of each crown for 15 seconds then rinsed with an abundant spray of water for

10 seconds and dried with an air spray. The etched surface became chalky white in appearance.

In the group 2 the teeth were immersed in APF gel (Vishal Pharma Ahmedabad) for 4 minutes. The treated teeth were removed from the APF gel and left untouched for 30 minutes. Subsequently the gel was washed off with a 1 minute water spray. The enamel of each tooth was etched for 15 seconds with acid solution for bonding. The buccal surfaces of the teeth were abundantly washed with a water spray for 10seconds then dried again etched enamel and bracket base were coated with a sealant and the composite resins immediately applied to the bracket base. The brackets were accurately pressed to the demarcated etched buccal enamel with a placement scalar.

De-bonding procedure

To test the shear strength the acrylic blocks with Hounsfield Universal Testing Machine specimen tooth was mounted such that the bracket slot were perpendicular to the floor. Stainless steel ligature wire (.009) was threaded through the bracket and passed and passed upward to the movable cross head and twisted tightly. So that the load would be applied directly over the center of the base. The cross head speed of 2mm/minute was used. The force at which the bond failed was recorded as breaking load and the bond strength. The values were recorded and statistically evaluated

Scanning Electron Microscopic Study

The debonded interface in each group were observed with an SEM. The samples were coated all over to a thickness of about 20pm with gold as the conducting material. The specimens were observed on the screen at various magnification and the photographs were taken for evaluation



Figure 1



Figure 2



Figure 3

3. Results

Forty specimens were equally divided into two groups.
Group I - Control (Normal bonding)
Group II - APF application before acid etching group.

The Hounsfield universal testing machine was used for this study. Breaking load at which bond failure occurred was recorded and the strength values were calculated for each specimen. The mean and standard deviation were found. The shear strength was calculated using the following equation.

$$\text{Bond Strength} = \frac{\text{Breaking load}}{\text{Nominal area of bonding}}$$

The Table 1 shows shear strength of control and experimental specimens. The Mean shear strength of control group (Group I) 10.76 MPa

Group II APF application before acid etching 10.55 MPa

Table 1: Shear Bond Strength (in MPa)

S. No.	Group I	Group II
1.	10.9	10.5
2.	11.7	11.3
3.	10.1	10.8
4.	9.9	10.2
5.	11.6	11
6.	10.3	11.3
7.	12.1	10.1
8.	10.8	10
9.	9.5	9.9
10.	9.9	10.5
11.	10.7	11.4
12.	10.2	10.2
13.	11.4	11.2
14.	11.5	10.8
15.	9.8	10.1
16.	11.2	9.7
17.	10.9	10.3
18.	10.5	9.4
19.	11.3	11.3
20.	10.9	11
Total	215.2	211.0
Mean	10.76	10.55

4. Discussion

The bands, brackets and the different orthodontic elements make most of the patient find it difficult to brush properly even with excellent brushing habit. As a result plaque readily accumulates around the brackets and the acidic nature of this material can enamel demineralization and white spot lesion. The dematerialized surface enamel is considered to be early lesion of enamel caries. The demineralization is not a continuous process. A series of cycles between demineralization and remineralization of enamel adjacent to orthodontic brackets presents in the clinical situation(22)Despite efforts to educate and motivate patients undergoing orthodontic treatment the presence of decalcification remains a problem because the preventive oral hygiene maintenance program rely heavily on patient compliance White spot lesion after orthodontic treatment with fixed appliances may present an esthetic problem even 5 years or more after the treatment.

This persistent problem has speculated a search for a preventive procedure program for the prevention of decalcification and caries one or more of the following factors are responsible for the prevention program fluoride has a remarkable ability to reduce the incidence of dental caries by increasing the resistance of enamel to acid, increasing the maturation rate of enamel and interfering with the metabolism of microorganism. Recent evidence shows that fluoride may facilitate the demineralization of white spot lesion.

Regular use of fluoride tooth paste during fixed appliance therapy was not sufficient to inhibit lesion development

adjacent to orthodontic brackets fluoride availability should be independent of patient cooperation and that the fluoride ion should diffuse or dissolve over a prolonged period.

Even though different fluorides are used for topical application neutral sodium fluoride, stannous fluoride, acidulated phosphate fluoride are the three agents that are currently in use; In orthodontics topical fluoride are applied before acid etching, incorporation of fluoride in the etching solution and topical application of fluoride to the etched enamel surface before bonding as a preventive measure against decalcification.

The acidulated phosphate fluoride which is selected as the material for this study has 1.23% of fluoride as sodium fluoride buffered to Ph of 3-4 in 0.1M phosphoric acids. The main advantage of APF is its ability to deposit fluoride in enamel to a deeper depth than neutral NaF and long term benefits. The short term benefit is that APF acts initially as a potent reservoir of fluoride and the long term effect is the formation of fluorapatite as the retained calcium fluoride layer is dissolved away from the enamel surface.

The brackets used in this study were mesh brackets. Mesh based brackets were used as they are better than metal brackets with perforated bases. Reynolds and Fraunhotenhave reported that metallic attachments with a coarse mesh are the most suitable type for direct bonding procedure. For the purpose of study forty specimens were divided into two groups 20 each for the measurement shear bond strength. The hours field universal testing was used to record the breaking load. The bracket area was measured as 0.3 cm x 0.3 cm and calculated bracket base area was 0.09 sq.cm.

Shear stress were calculated by using the formula.

$$\text{Stress} = \frac{\text{Breaking load}}{\text{Area of the bracket base}}$$

In the control (group I) the mean shear strength calculated by using the above mentioned formula was found to be 10.76 MPa

In the experimental group (group 2) APF application before acid etching and mean shear strength was found to be 10.55 MPa.

In this study Group II APF application before acid etching no significant difference were noted in the bond strength of treated and untreated group.

In the SEM study APF gel produced surface coating appeared to consist of a uniformly thick layer of densely packed small globular particles present before acid etching. The recent research(3,13) indicate that the onetime preventive procedure at the time of bonding has little beneficial effect in reducing white spot formation but the regular and repeated use of the low concentration of fluoride reduces the incidence and severity of white-spot formation.

Hence the application of acidulated fluoride before acid etching may offer protection from decalcification or a caries attack without affecting the bond strength.

5. Conclusion

An experimental study was undertaken to evaluate shear bond of orthodontic brackets with acidulated phosphate fluoride application before acid etching. A SEM study was also conducted to detect the changes on the enamel surface after de-bonding with the fluoride application before etching. The results showed that there is no statistically significant difference in bond strength with the APF application before acid etching compared to the control group. In the SEM APF gel produced surface coating appeared to consist of densely packed small spherical globular structure present in before acid etching.

6. Financial support & conflicts of interest

There are no financial support& conflicts

References

- [1] **Arnold M. Geiger, Leonard Gorelick, John Gwinnett. A., and Peter G. Griswold** The effect of a fluoride program on white spot formation during orthodontic treatment. *Am J Orthod Dentofac Orthop* 102: 29-37, 1988.
- [2] **Arends. J., Christoffersen J,** Nature and role of loosely bound fluoride in dental enamel, *J Dent. Res* 69: 601-5, 1990.
- [3] **Ashraf OB, Stanley RN, Jakobsen J.R.,** Fluoride release and shear bond strengths of three light cured glass ionomer cements., *Am J Orthod Dentofac Orthop* 111: 260-5 1997.
- [4] **Banks PA., Burn A. O' Bren K.,** Clinical evaluation of the effectiveness of including, Fluoride in an orthodontic bonding adhesives. *Eur J Orthod* 19: 391-5, 1997.
- [5] **Basdra E.K., Huber H., and Komposch G,** Fluoride released from Orthodontic bonding agents alters the enamel surface inhibits enamel demineralization in vitro. *Am J Orthod Dentofac Orthop* 109: 466-72, 1996.
- [6] **Berkmen, Gwinnett and Shaffler,** Effects of enamel etching time on bond strength and morphology, *J Clin Orthod* 19: 36-38, 1985.
- [7] **Bishara SE, Chan D., Adadin Er.,** The effect of the bonding strength of orthodontic Brackets of fluoride application after etching, *Am J Orthod Dentofac Orthop* 95: 259 -60, 1989.
- [8] **Bjorn Ogaard,** Prevalence of white spot lesions in 19 Year olds. A study on untreated and orthodontic ally treated persons. 5 years after treatment. *Am J Orthod Dentofac Orthop* 96: 423-7, 1989.
- [9] **Bjorn Ogaard, Felipe Rezk – Lega, Jan -Ruban and Joop Arends** Cariostatic effect and fluoride release from a visible light curing adhesive for bonding or orthodontic brackets. *Am J Orthod Dentofac Orthop* 101: 303-7, 1992.
- [10] **Bjorn Ogaard, Joop Arends, Halvard Helseth Gabrielle Dijkuman and Marjan Van derkuiji** Fluoride level in Saliva after bonding orthodontic brackets with a fluoride containing adhesive, *Am J Orthod Dentofac Orthop* 111: 199-202, 1997.
- [11] **Bjoru Ogard, Rolla. G. and Arends J,** Orthodontic appliances and enamel demineralization, *Am J Orthod Dentofac Orthop* 94: 68-73 1998.
- [12] **Borsboom P., Vander Mer H.G. Arends J.** Enamel lesion formation with and without 0.12 PPMF in solution *Caries Res* 19: 396 -402, 1985.
- [13] **Bounoure GM, Vezin J.C,** Orthodontic fluoride protection *J Clin Orthod* 25: 321 -335, 1980.
- [14] **Bowen R.L,** Adhesive bonding of various materials to enamel surfaces *J Dent Res* 110: 690 -95, 1962.
- [15] **Bronwen vorhies A., Kevin J. Donly. Robert N. Staley and James S. Wefel** Enamel demineralization adjacent to orthodontic brackets bonded with hybrid glass ionomer cements. An in vitro study. *Am J Orthod Dentofac Orthop* 114: 668 -74, 1998.
- [16] **Brannstrom M., Malmgren O and Nordenvalli KJ** The effect of various pretreatment methods of the enamel in bonding procedures. *Am J Orthod* 74: 522-530, 1978.
- [17] **Bryant. S, Retief. D.H., Bradley E.L., Denys FR** The effect of topical fluoride treatment I enamel fluoride uptake and the tensile bond strength of orthodontic bonding system. *Am J Orthod Dentofac Orthop* 87: 294-302 1986.
- [18] **Buonocore M.G.** A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res* 34: 849-853, 1955.
- [19] **Buonocore MG, Gwinnett AI** Penetration of resin dental materials into enamel surface with reference to bonding. *Arch Oral Biol* 13: 16-17 1968.
- [20] **Buyukyilmaz T., Ogaard B., Dahm.S,** The effect on the tensile bond strength of orthodontic brackets of titanium tetrafluoride application after acid etching. *Am J Orthod Dentofac Orthop* 108: 256-61, 1995.
- [21] **Buyukyilmaz T., Tangugsorn V., Ogaard B.** The effect of titanium tetra fluoride application around orthodontic brackets *Am J Orthod Dentofac Orthop* 105: 293-6, 1994.

Author Profile



Dr G Viswanathan received BDS & MDS(Orthodontia) degree from Tamilnadu Govt Dental College ,Chennai in 1990 and 2001 respectively He joined govt service in 1994 and worked at various hospital in and around south Tamilnadu Presently in education side as an Assistant professor of dental department at Govt sivaganga medical college & hospital Sivaganga Tamilnadu