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The Study of Shear Bond Strength with Acidulated Phosphate Fluoride Applied after Acid Etching - Sem Investigation

Dr. G. Viswanathan MDS

Assistant Professor, Dental Department, Government Sivaganga Medical College & Hospital Sivaganga, Tamilnadu, India
Email: *gviswanathan1990[at]gmail.com*

Abstract: ***Introduction: The most significant development in the field of orthodontics is the acid etches technique that has been used in the direct bonding of orthodontic brackets. In patients with poor oral hygiene decalcification and decay have been observed around the bonded brackets. . The 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 after etching. The fluoride application may affect the bond strength. Hence the study is to evaluate the shear bond strength with acidulated phosphate fluoride after acid etching and detect the changes on the enamel surface after debonding with scanning electron microscope. Materials and Methods: Forty human premolar teeth were extracted from teenagers (9 to 16 years of age). The teeth were divided into two groups of 20 teeth each. One for control group and the other for evaluating shear strength after acid etching. The specimens were mounted on an acrylic block of dimension (4x2x1cm) to make it compatible to the jigs of the Hounsfield universal testing machine. Beggs bracket with the bracket base measurement of 3mm X 3mm manufactured by TP orthodontic Inc (USA) were used in this study. 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 water for 10 seconds and dried with an air spray. The etched surface became chalky white in appearance. In the group II the etchant was applied for 15 seconds, rinsed and dried as in the control group. However the crowns of the teeth were immersed in APF gel for 4 minutes after etching. 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. The brackets were accurately pressed to the demarcated etched buccal enamel with a placement scalar and to test the shear strength, the blocks were mounted with the bracket slots perpendicular to the floor. Stainless steel ligature wire (.009) was threaded through the bracket 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. 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. Results: The Mean shear strength of control group Group I is 10.76 MPa. Group II APF application after acid etching is 7.405 MPa. Conclusion: The results showed that there is significant decrease in bond strength with APF application after acid etching compared to the control group. In the SEM APF gel produced surface coating appeared to consists of densely packed small spherical globular structure present after acid etching***

Keywords: Shear bond strength, APF, After acid etching, SEM

1. Introduction

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 (19) incorporation of fluoride in the etching solution and topical application of fluoride in the etched surface before bonding.

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 micro-organisms. The fluoride deposits in hydroxyapatite to form fluorapatite. However the fluoride application may affect the bond strength Hence the study is to evaluate the bond strength with acidulated phosphate fluoride after acid etching and detect the changes on the enamel surface after debonding with the fluoride application after acid etching.

2. Materials and Methods

Forty human premolar teeth were extracted from teenagers (9 to 16 years of age). The teeth were divided into two groups of 20 teeth each. These group were divided into two groups one for control group and the other for evaluating shear strength after acid etching The specimens were mounted on an acrylic block of dimension (4x2x1cm) to make it compatible to the jigs of the Hounsfield universal testing machine. Stainless steel mini-mesh curved Beggs bracket with the bracket base measurement of 3mm X 3mm manufactured by TP orthodontic Inc (USA) were used in this study. 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 II the etchant was applied for 15 seconds, rinsed and dried as in the control group. However the crowns of the teeth were

immersed in APF gel for 4 minutes after etching. The buccal surfaces of the teeth were 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. The brackets were accurately pressed to the demarcated etched buccal enamel with a placement scalar and to test the shear, the blocks was mounted with the bracket slots 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 and 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

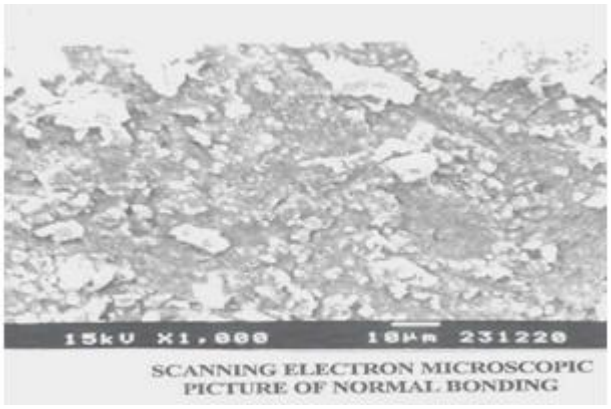

Figure 3

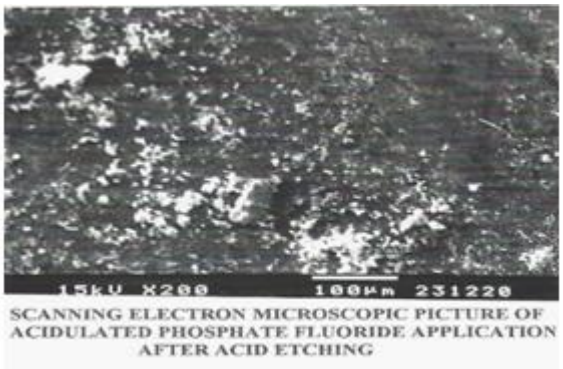

Figure 4

3. Results

Forty specimens were equally divided into two groups.
Group I- Control Normal bonding
Group II- APF Application after acid etching

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. Statistical analysis of the finding was done by applying the student 't' test.

The bond strength was calculated using the following equation.

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

The nominal area of bonding base was found to be 0.09 sq.cm
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 after acid etching **7.405 MPa.**

Table 1: Shear Bond Strength (IN MPa)

S. No.	Group I	Group II
1.	10.9	8.3
2.	11.7	7.8
3.	10.1	8
4.	9.9	7.7
5.	11.6	8.6
6.	10.3	6.8

7.	12.1	7.6
8.	10.8	7.5
9.	9.5	7.5
10.	9.9	8.1
11.	10.7	7.3
12.	10.2	6.8
13.	11.4	7.2
14.	11.5	7
15.	9.8	6.9
16.	11.2	7.2
17.	10.9	6.9
18.	10.5	7.1
19.	11.3	6.9
20.	10.9	6.9
Total	**215.2**	**148.1**
Mean	**10.76**	**7.405**

4. Discussion

Proper oral hygiene compliance in orthodontic patients has always been difficult to maintain. The plaque accumulates around the brackets and the acidic nature of this material can cause enamel demineralization and white spot lesion. The demineralization is not a continuous process. 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.

This 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.

The 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 depositefluoride 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. For the study one forty specimens were divided intotwogroups 20 each. The houns field universal testing was used to record the breaking load.

The 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) shear strength is10.76 MPa

In the experimental group II APF application after acid etching the shear strength was 7.405 MPa.

In group II APF application after acid etching the bond strength decreased compared to the control group.

The topical fluoride fills the interprismatic spaces occupied by $Ca_5 (PO_4)^3$ and the formation of CAF2 after etching capacity of adhesives. This reaction product could be the cause of a reduction in resin bond strength.

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 and after acid etching. The recent research (6) 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.

The application APF after acid etching will have an adverse effect on orthodontic bond strength of human enamel.

5. Conclusion

An experimental study was undertaken to evaluate the shear bond of orthodontic brackets with acidulated phosphate fluoride application after acid etching.

A SEM study was also conducted to detect the changes on the enamel surface after de-bonding with the fluoride application after etching.

The results showed that there is significant decrease in bond strength with APF application after 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 after acid etching.

6. Financial Support and Conflicts of Interest

There are no financial support & conflicts of interests.

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Author Profile

Dr G Viswanathan received BDS & MDS (Orthodontia) degree from Tamilnadu Government Dental Collegein 1990 & 2001respectively He joined Government service in 1994 and worked at various hospitals in and around south Tamilnadu at present he is in education side as an Assistant professor of dental surgery at Government Sivaganga Medical College &Hospital Sivaganga Tamilnadu