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Evaluation of Bond Strength: An *In vitro* Study using Pro Seal

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Abstract:

Background: Fluoride releasing bonding agent were introduced to take care of white spot lesions. However, their clinically handling properties are less than ideal, deterring many practitioners. Reliance orthodontic products (Itacs, I11) recently released an enamel sealant named Pro Seal to be used with bonding agents. Hu and Featherstone showed Pro Seal significantly decreased enamel demineralization. Hence, this study was undertaken to study the bond strength using Pro Seal.

Materials and Methods: A total of 60 freshly extracted first premolars were collected and were randomly divided into two groups. Group 1 (Control group): Included 30 premolars where brackets bonded conventionally. Group 2 (Experimental group): Included 30 premolars where brackets bonded using of Pro Seal. Debonding procedures: All the teeth were mounted on a metallic mold. Debonding procedure was carried out for each tooth after a rest period of 5 min.

Results: The results from this study show that the mean of bond strength in Group 1 was 24.9 N and in Group 2 was 21.1 N. There was statistical significant difference in bond strength when compared using *t*-test of Group 1 and Group 2. The study showed that Group 2 showed significantly less bond strength than Group 1. There was statistical significant difference in bond strength when compared using *t*-test, Group 2 showed significantly less bond strength than Group 1.

Conclusion: The study showed that use of Pro Seal provided adequate bond strength, but when compared with conventional bonding agents there was a significant decrease in bond strength.

Key Words: Bonding, bond strength, Pro Seal

Introduction

Many benefits can be derived from orthodontic treatment, including improvements in a patient's dental function, aesthetics and overall self-esteem and attitude.¹ However, the positive effects of orthodontic treatment can be overshadowed by demineralization of tooth enamel adjacent to fixed

orthodontic appliances, this compromises both aesthetics and oral health of the patient.¹

Due to the increase difficulty in adequately removing bacterial plaque around orthodontic appliances, adjunctive fluoride therapy is commonly used to help prevent demineralization. However, effective protection with fluoride requires appropriate patient compliance.¹

Fluoride releasing bonding agent were introduced to overcome the problem of patient's compliance and to take care of white spot lesions. However, their bond strength properties are less than ideal, deterring many practitioners. Reliance orthodontic products (Itacs, I11) recently released an enamel sealant named Pro Seal. Hu and Featherstone showed significant decrease in enamel demineralization on teeth treated with Pro Seal.²

Hence, this study was undertaken to study the bond strength using Pro Seal with light cure bonding agents.

Materials and Methods

Sixty freshly extracted first premolars were collected, which were mainly extracted for orthodontic purpose and having intact buccal surface. Teeth with heavy restorations, caries and pre-treated with any chemical agent were discarded. All the teeth were stored in a solution of 0.1% (wt/vol) thymol.

All the 60 teeth were randomly divided into two groups:

- Group 1 (Control group) – included 30 premolars
- Group 2 (Experimental group) – included 30 premolars.

After cleaning the buccal surface of all the 60 premolars with pumice powder and dried with oil – free air source, they were etched with 37% phosphoric acid gel for 30 s.

On premolars in the control group a thin layer of primer (3M Transbond XT) was applied on enamel and bracket base, whereas on premolars in the experimental group a thin layer of Pro Seal was applied on enamel and bracket base. Pro Seal is a highly filled light cured sealant with following contents, ethoxylated bisphenol A diacrylate (10-50%), Urethane acrylate ester (10-40%) and polyethyleneglycoldiacrylate (10-40%) and a proprietary catalyst. The exact percentages of the products are a trade secret. The adhesive (3M Transbond XT) was then applied on the bracket base of both groups (3M Unitek – 0.022" Roth prescription) and bonding done with light cure for 20 s using light-emitting diode source.

Debonding procedures

All the teeth were mounted on a metallic mold provided in the universal testing machine (UTM). Debonding procedure was carried out for each tooth after a rest period of 5 min. Brackets were debonded by a wire attached to measuring gauge on UTM and bond strength was measured.

Results

The results show that the mean of bond strength in Group 1 was 24.9 N and in Group 2 was 21.1 N. There was statistical significant difference in bond strength when compared using *t*-test of Group 1 and Group 2. The study showed that Group 2 showed significantly less bond strength than Group 1 (Tables 1 and 2).

Discussion

Every coin has two sides. Bonding along with its advantages has its own disadvantages too. There are studies showing that patient undergoing orthodontic treatment has difficulty in oral hygiene maintenance, resulting in plaque accumulation around the banded or bonded teeth. This may lead to formation of white spot lesions.³

Efforts have been taken to overcome these problems, by many as use of fluoride mouth rinses by Hirschfield in 1978,⁴ pit and fissure sealants, fluoride tooth paste by gaard in 1980,⁵ fluoride gel by Bounoure and Vezin in 1980.⁶ However, the effectiveness of these products is directly related to the patient’s compliance.

To overcome these problems bonding agents with fluoride content were introduced.⁷ These newer bonding agents provided a shield to protect the enamel from white spot lesion formation, but they were not satisfactory in providing adequate bond strength when compared with the regularly used bonding agents.⁸

Both chemical cured and light cured sealant were then introduced in aspect of decreasing the risk of demineralization. Zachrisson and Joseph showed that, chemically cured sealants,

being BisGAMA, do not effectively seal enamel surfaces, because of oxygen inhibition of polymerization when the sealant is in contact with the air in a thin layer. Only “islands” of cured sealant remain where resin pooling occurs.⁹

On the other hand, light cured sealants have been proven to cure completely on smooth enamel surfaces and prevent enamel demineralization effectively *in vitro*. The protective layer of unfilled light cure sealants is but susceptible to mechanical (tooth brushing) and chemical (acid attack). Wearing off or breaks in the continuity of the sealant layer might result in decalcification under the sealant.¹⁰

Reliance orthodontic products (Itasca III) recently released Pro Seal, a highly filled, light cured fluoride releasing sealant, specifically for orthodontic use. The manufacturer claims a final sealant polymerization of 100% without an oxygen inhibition layer, which eliminate any loss of material due to non-polymerization at the surface. They also claim that protection of enamel against demineralization, as well as high bond strength.

Hu and Featherstone in their *in vitro* study showed significant decrease in enamel demineralization on teeth treated with Pro Seal.²

Results from this study show that the mean of bond strength in Group 1 was 24.9 N and in Group 2 was 21.1 N. Standard deviation of Group 1 and Group 2 was 6.3 and 4.09, respectively. For Group 1 and Group 2, standard error was 1.15 and 0.75, respectively. The minimum and maximum values of bond strength in Group 1 were 15.3 and 41.2 respectively, whereas in Group 2 it was 15.3 and 32.4, respectively. The 95% confidence interval of Group 1 and Group 2 were between 22.9 to 26.80 and 19.1 to 23.00, respectively. There was statistical significant difference in bond strength when compared using *t*-test of Group 1 and Group 2. The study showed that Group 2 showed significantly less bond strength as compared to Group 1.

According to Reynolds IR bond strength of 8-9 MPa or above is adequate for orthodontic purpose (1 MPa = 1 N/mm²).¹¹ According to this study, Group 2 showed mean bond strength of 21.1 N. This can be adequate bond strength.

According to study conducted by Bishara *et al.* in 2005, the use of the Pro Seal protective sealant did not significantly influence the shear bond strength of the orthodontic brackets within ½ h from initial bonding.¹²

Studies by Sheykholeslam *et al.* showed that topical fluoride application fill in the interprismatic spaces produced by etching and thus reduce the bonding capacity of adhesion.¹³

Table 1: Descriptive statistics of Group 1 and Group 2.

	Group 1	Group 2
N	30	30
Mean	24.9	21.1
SD	6.3	4.09
SE	1.15	0.75
Min	15.3	15.3
Max	41.2	32.4
95% CI	22.92-26.80	19.12-23.00

SD: Standard deviation, SE: Standard error, Min: Minimum, Max: Maximum, CI: Confidence interval

Table 2: Comparison between Group 1 and Group 2 using *t*-test.

Group	t value	P value	Inference
Group 1 versus Group 2	2.77	0.007	Significant

In the present study, Pro Seal significantly reduced the bond strength of the orthodontic brackets when compared with conventional bonding agents. The contents of Pro Seal are kept as a trade secret; the manufacturer claims that Pro Seal is a fluoride releasing sealant. The decreased bond strength after application of Pro Seal in this study may be attributed to this factor.

Conclusion

The studies in the past have shown that orthodontic bonding causes enamel demineralization or white spot lesions around the bracket or sometimes it can cause enamel cracks. To prevent these white spots, lot many preventive measures have been tested, such as use of pit and fissure sealants, fluoride mouth rinse, fluoride gel, fluoride containing tooth paste etc.³

The results of these measures depended highly on patient's compliance,¹⁴ so to avoid this drawback, use of fluoride as one of the content of bonding agent itself was invented.⁷ However, these agents failed to provide bond strength as high as conventional bonding agents without fluoride content.⁸

To overcome the problem of white spots, Reliance Orthodontic products introduced a new fluoride releasing sealant, Pro Seal, which they claim can be used with both self-cure and light cure bonding agents. The manufacturer claimed high bond strength as compared with those of conventional bonding agents along with reduction in white spot lesions. This *in vitro* study was so undertaken to evaluate the bond strength of fluoride releasing sealant named Pro Seal with conventional bonding agent (3M Transbond XT).

The study showed that use of Pro Seal provided adequate bond strength but when compared with conventional bonding agents there was significant decrease in bond strength. *In vitro* studies by Buren *et al.* indicate Pro Seal to be an effective method of preventing enamel demineralization without relying on patient's compliance.

Both the *in vitro* studies have indicated that Pro Seal shows promising results (adequate bond strength and decrease white spot lesions), but to evaluate the clinical performance further investigations are needed.

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