

Effect Of A Bond Enhancing Agent Upon Shear Bond Strength Of Self Cure Direct Bonding Orthodontic Resin On Dry And Wet (Saliva Contaminated) Enamel - An In Vitro Study

Abstract

Introduction: Bonding to surface enamel is a multi-step process whereby a variation at any of the steps may affect the ultimate strength of the bond. The present study was carried out to determine the effect of a bond enhancing agent upon the shear bond strength of a self cure direct bonding agent on dry and wet (saliva contaminated) enamel. The aim of the study was to determine the efficiency of bond enhancing agent used in the direct bonding.

Materials And Method: 80 upper first premolar direct bonding preadjusted edgewise brackets (022 slot) of the same manufacturer were used. 80 extracted upper first premolar teeth were embedded in acrylic moulds and were randomly divided for the purpose of testing in to 4 groups of 20 teeth viz. Group IA: bonding on dry uncontaminated enamel surface using RELY-A-BOND. Group IB: bonding on dry uncontaminated enamel surface after applying "ENHANCE" (bond enhancing agent) using RELY-A-BOND. Group IC: bonding on wet (saliva contaminated) enamel surface using RELY-A-BOND. Group ID: bonding on wet (saliva contaminated) enamel surface after applying ENHANCE (bond enhancing agent) using RELY-A-BOND. INSTRON TENSILE TESTING Machine was used to determine shear bond strength. The comparison of the samples' means was carried out using student 't' test.

Result: the result of the study shows that statistically significant positive correlation using enhance in wet enamel surfaces.

Conclusion: Use of bond enhancing agent has no role in dry bonding conditions however bond strength increases significantly when used under moisture contaminated conditions.

Key Words

Direct Bonding, Bond Enhancing Agent, Salivary Contamination, Shear Bond Strength.

Introduction

The introduction of acid etch bonding technique has led to dramatic changes in the practice of orthodontics. The increased adhesion produced by acid pretreatment, using 85% phosphoric acid was demonstrated in 1965 by BUONOCORE. In 1965, Newman began to apply these findings to direct bonding of orthodontic attachment. Since then, the use of resin bonding agents for the placement of orthodontic brackets is widely accepted and is the prevalent technique.

Bonding to surface enamel is a multi-step process whereby a variation at any of the steps may affect the ultimate strength of the bond. The preparation of the tooth surface to receive the composite resin is crucial to establishing a strong interface between enamel and resin. Hence it is imperative that the etched enamel remains dry for bonding because moisture (mainly saliva) contamination

will adversely affect the set of the composite resin, resulting in an inferior bond between the tooth and the resin.

Bond enhancing agents (Adhesion boosters) have been introduced to orthodontic profession which are said to increase the bond strength when incorporated into the enamel preparation sequence. There are instances where any reduction in the bond strength cannot be afforded, for instance in lingual bonded retainer which are expected to remain in place for extended period of time or bonding on teeth in the vicinity of inflamed gingiva, which often becomes contaminated due to seepage of crevicular fluid or hemorrhage.

Moisture control in the oral cavity is an ever present problem, especially in certain patients or in particular areas of the mouth. If an agent could prevent reduction in the bond strength in presence of moisture contamination, it would

¹ Samir Uppal
² Dhaval Somani
³ A.F. Bhatia
⁴ Rajesh Kishnani
⁵ Falguni Mehta
⁶ Ajay K. Kubavat

¹ Professor & Head Of The Department,

² Senior Lecturer

³ Professor & P.G. Director

Dept. Of Orthodontics & Dentofacial Orthopedics
College Of Dental Science & Research Centre,
Ahmedabad Gujarat.

⁴ Professor & Head Of Department

Dept. Of Orthodontics & Dentofacial Orthopedics
Sri Aurobindo College Of Dentistry & P.G.

Institute, Indore-madhya Pradesh

⁵ Professor & Head Of Department

Dept. Of Orthodontics & Dentofacial Orthopedics
Govt. Dental College & Hospital, Ahmedabad-Gujarat

⁶ Professor & Head Of Department

Dept. Of Orthodontics & Dentofacial Orthopedics
Narsinhbhai Patel Dental College & Hospital,
Visnagar- Gujarat.

Address For Correspondence:

Dr. Samir S. Uppal.

Professor & Head Of Department,

Dept. Of Orthodontics & Dentofacial Orthopedics,

College Of Dental Science & Research Centre,

Bopal - Ghuma Road, Manipur. Ahmedabad.-382115.

Mobile No. +91 9825199924

Email. dr_samiruppal@hotmail.com

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certainly be of value to the orthodontist. Hence the present study was carried out with the following aims:

1. To determine the effect of bond enhancing agent upon the shear bond strength of a self cure direct bonding agent on dry (uncontaminated) and wet (saliva contaminated) enamel surface.
2. To determine the effect of salivary contamination on the shear bond strength of direct bonding agent.

Materials And Methods

The present study was carried out using the following materials.



Fig. 1 Adhesive System Rely-A-Bond (Reliance Orthodontics Inc., U.S.A.)



Fig. 2 Bond Enhancing Agent Enhance (Reliance Orthodontics Inc., U.S.A.)

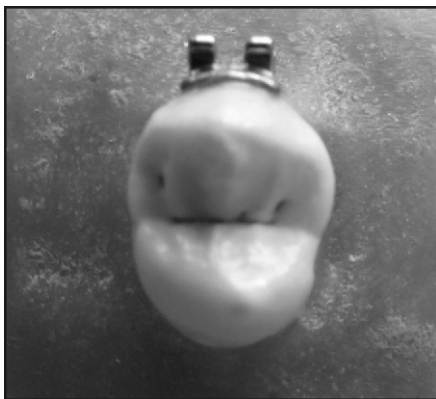


Fig. 3 Shear Bond Strength Testing Specimen

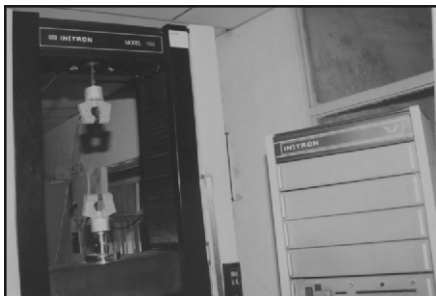


Fig. 4 Instron Testing Machine

Materials

1. Adhesive (Fig. 1)

A fluoride releasing no mix orthodontic adhesive.

RELY-A-BOND (Reliance Orthodontics Inc. U.S.A.)

1. Bond Enhancing Agent (Fig. 2)

ENHANCE (Reliance Orthodontics Inc., U.S.A.)

1. Brackets

Preadjusted Edgewise Bracket (MBT

022 slot)

1. Teeth

80 human maxillary first premolar teeth which had been extracted for orthodontic purpose.

1. Saliva

Fresh whole human saliva of a single person was used.

Method:

Only the upper first premolar, which were non-hypoplastic, non carious, without any cracks or fractures and having normal morphologic characteristics were selected for this study.

For the testing of the bonded tooth, the tooth is required to be embedded in a strong medium for the purpose of holding the tooth in the testing machine for which brass moulds (2x1x1cm.) were fabricated.

These moulds were kept on a porcelain tile and pink cold cure acrylic resin was added poured into each of them. Teeth were removed from the distilled water and embedded in the acrylic such that the crown portion of the tooth was exposed and the root portion remained embedded in the setting cold cure acrylic resin. (fig. 3)

80 upper first premolar direct bonding preadjusted edgewise brackets (022 slot) were used.

Fresh whole human saliva was collected prior to the commencement of the direct bonding procedure.

The selected 80 teeth embedded in the acrylic moulds were randomly divided for the purpose of testing in to 4 groups of 20 teeth viz.

1. Group IA for: bonding on dry uncontaminated enamel surface using RELY-A-BOND
2. Group IB for: bonding on dry uncontaminated enamel surface after applying " ENHANCE" using RELY -ABOND
3. Group IC for: bonding on wet (saliva contaminated) enamel surface using RELY-A-BOND
4. Group ID for: bonding on wet (saliva contaminated) enamel surface after applying ENHANCE using RELY-A-BOND.

Bonding Procedure

Bonding On Dry Uncontaminated Enamel Surface Using Rely-A-Bond:(Group IA for testing)

Each acrylic block with embedded tooth was removed in a series and polished on its buccal surface using rotary brush on low speed headpiece using a slurry of unfluoridated pumice and water. Then the teeth were cleaned with a jet of distilled water via a syringe followed by drying in oil and moisture free air and placed in order of series.

Etchant was applied to the tooth surface and after 30 seconds the surface was rinsed with distilled water jet and was dried with an oil/moisture free air till a dull, white frosty surface was obtained. A thin coat of primer was applied with the brush on the prepared tooth surface. A small amount of adhesive paste was applied on the bracket base. Then brackets were placed on the tooth surface and completely seated on the prepared area for 30 seconds. Slight pressure was applied on the bracket to assure the position of the bracket and also to release excess resin between the tooth surface and the bracket base. The superfluous resin was removed before it set. Similarly the brackets were bonded to another 19 teeth using the same technique

Bonding On Dry Uncontaminated Enamel Surface After Applying "Enhance" Using Rely A Bond: (Group IB for testing)

The procedure till the etching of the enamel surface was invariably the same for this group. After the enamel etching was carried out and the surface was rinsed and thoroughly dried, equal parts of enhance, part A and part B liquid were mixed for 5 seconds with a brush and was applied liberally to the etched enamel surface. After 20 seconds primer was applied and the composite was bonded as described in the earlier group (group IA).

Bonding On Wet (Saliva Contaminated) Enamel Surface Using Rely A Bond: (Group IC for testing)

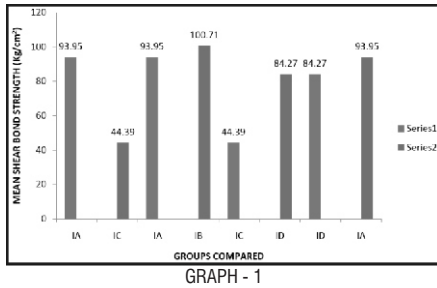
The bonding procedure till the event of acid etching the enamel surface invariably remained the same as shown earlier. After rinsing and drying thoroughly the etched enamel surface, it was contaminated with fresh whole human saliva, which was spread evenly with a brush. After 5 seconds the surface was rinsed with tap water and dried. Following this the primer was applied

contamination.

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and the composite was applied on the bracket as described earlier and the bonding procedure was completed.

Bonding On Wet (Saliva Contaminated) Enamel Surface After Applying "Enhance" Using Rely A Bond: (Group ID for testing)

The procedure for bonding is invariably the same till the event of enamel preparation and acid etching. After rinsing and drying thoroughly the etched enamel surface, it was contaminated with fresh whole human saliva, which was spread evenly with a brush. After 5 seconds the surface was rinsed with water and dried. Equal parts of the bond enhancing agent ENHANCE, Part A and Part B liquid were mixed for 5 seconds with a brush, and was applied liberally to the contaminated enamel surface. Following this the bonding sequence was followed as described earlier.

Determination Of Shear Strength

After 24 hours of storage in distilled water at 37 C after bonding the acrylic blocks with teeth embedded were removed from water and allowed to dry for 5 minutes. The testing was done on "Instron Tensile Testing" Machine (Fig. 4). The acrylic block with the tooth sample was fixed on the fixed lower cross head. A load cell with a sensitivity range of 0 to 20 Kg. was attached to the movable upper cross head to which the stainless steel wire (0.012 inch) was attached. This wire was kept constant for testing each specimen.

The cross head speed was set to move away from each other at 5mm/minute. As the wire was engaged into the bracket slot and the cross heads allowed to move away from each other at the above mentioned speed, the wire became firm. The force at this movement was shearing in nature. The load was applied till the point of fracture i.e. till the bracket detached itself from the tooth. Load was recorded in Kg. by the operator.

The process was repeated for all the samples in all the groups. All the results obtained were tabulated and the shear bonding strength were calculated using formula

$$\text{Shear Bond Strength} = \frac{\text{Breaking Load(Kg)}}{\text{Area of Mesh Base(Sq. Cm.)}}$$

Statistical Analysis

The comparison of the samples means was carried out using student 't' test to determine that two means are sufficiently far apart to have a statistically significant difference.

Results

The negative effect of salivary contamination on the shear bond strength of RELY-A-BOND is indicated by a reduction in the mean value of shear bond strength from 93.95 Kg / Sq. Cm. (Group IA) to 44.39 KG/ Sq. Cm. (Group IC) This shows a reduction in the value of shear bond strength by 49.56 Kg/cm². This negative effect on the shear bond strength is confirmed statistically by 't' test (Table III).

The addition of ENHANCE (bond enhancing agent) to the sequence of bonding procedure using RELY - A - BOND in a dry field does show a positive influence on the shear bond strength, by increasing the mean shear bond strength value from 93.95 kg/sq.cm (group IA) to 100.71 kg/sq.cm (group IB). This shows an increase in the value of shear bond strength by 6.76 Kg/cm². However this difference is statistically insignificant indicated by 't' test [table III].

The addition of ENHANCE TO THE SEQUENCE OF BONDING PROCEDURE USING RELY-A-BOND in a wet (saliva contaminated) field, shows a very positive influence on the shear bond strength, by increasing the mean shear bond strength value from 44.39 kg/sq.cm (Group Ic) to a high value of 84.27 kg/sq.cm (group Id). This shows an increase in the mean bond strength by 39.88kg/cm². This positive effect on the shear bond strength is confirmed statistically by the 't' test [table III].

As established earlier, there is definitely a significant positive effect of ENHANCE in a wet (saliva contaminated) field on the shear bond strength shown by an increase in the value of shear bond strength from

Table: I : Mean Values For Breaking Loads In Different Groups Of Rely - A - Bond

| GROUP I (RELY - A - BOND) | | MEAN(Kg.) | STD. DEVIATION |
|-----------------------------------|--|-----------|----------------|
| IA : DRY(20 SPECIMENS) | | 9.48 | 2.01 |
| IB : DRY + ENHANCE (20 SPECIMENS) | | 10.15 | 1.97 |
| IC : WET(20 SPECIMENS) | | 4.50 | 0.91 |
| ID : WET + ENHANCE (20 SPECIMENS) | | 8.49 | 1.75 |

Table: II : Mean Values For Shear Bond Strength In Different Groups Of Rely - A - Bond

| GROUP I (RELY - A - BOND) | | Mean (Kg./CM.2) | Std. Deviation |
|-----------------------------------|--|-----------------|----------------|
| IA : DRY(20 SPECIMENS) | | 93.95 | 19.91 |
| IB : DRY + ENHANCE (20 SPECIMENS) | | 100.71 | 19.51 |
| IC : WET(20 SPECIMENS) | | 44.39 | 8.86 |
| ID : WET + ENHANCE (20 SPECIMENS) | | 84.27 | 17.37 |

TABLE: III : Effect Of Salivary Contamination & / Or Bond Enhancing Agent On The Mean Shear Bond Strength Of Rely-a-bond

| | Groups Compared | Mean Shear Bond Strength (kg./cm ²) | S.D. | "t" VALUE |
|---|----------------------|---|----------------|-------------|
| 1 | Group Ia Group Ic | 93.95 44.39 | 19.91 8.86 | 10.17*** |
| 2 | Group Ia Group Ib | 93.95 100.71 | 19.91 19.51 | 1.09 (N.S.) |
| 3 | Group Ic Group Id | 44.39 84.27 | 8.86 17.37 | 9.14*** |
| 4 | Group Id Group Ia | 84.27 93.95 | 17.37 19.91 | 1.64 (N.S.) |

N.S. Not Significant (p ≥ 0.05)
* Significant at p ≤ 0.05
** Significant at p ≤ 0.01
*** Significant at p ≤ 0.001

44.39 kg/sq.cm to 84.27 kg/sq.cm. However it is observed that the bond produced in the contaminated field with the use of the bond enhancing agent ENHANCE was weaker than the bond produced in a dry field (group IA) with mean shear bond strength value of 93.95 kg/sq.cm This shows a difference of a

mean shear bond strength by 9.68 kg.sq.cm. This difference in the bond strength however is seen to be statistically insignificant by the 't' test (table III).

Discussion

The material used for direct attachment of brackets must be able to cope with numerous deleterious conditions in the oral cavity such as constant moisture and adherent contamination which are difficult to remove completely. Further, it must be capable of withstanding considerable masticatory as well as applied orthodontic forces.

The strength of the direct bonding material depends upon the following factors :

1. Quality of adhesive
2. Achievement of complete dry field with different isolation techniques
3. Etching solution concentration
4. Etching time
5. Bracket base material
6. Nature of the enamel structure
7. Undisturbed setting of the adhesive

If an agent is added which prevents the decrease in the bond strength in the presence of unavoidable moisture contamination, it would be of great help to the orthodontic profession.

The wide standard deviation in the readings of mean shear bond strength of group IA in this study is in accordance with the findings of Keizer et al. However, the self cure resin used by Keizer et al showed a much higher strength (121 Kg./Sq. cm.). The bond strength obtained by Johnson et al at 24 hours was lower than that what was obtained in this study. Majjer and Smith found the mean value of 7.8 Kg. of the breaking load. This is significantly less as compared to the break load obtained for the direct bonding resin in a dry field in this study.

Lopez and Reynolds found out that optimum strength required for successful clinical bonding was 60-80 kg/sq. cm. Thus all the groups in this study, except that of salivary contamination (group IC) have higher shear bond strength values than the optimal required.

Tamer Bukylimaz et al, concluded that the bond strength of Concise to sandblasted gold alloy was significantly improved with intermediate application

of all Bond 2 primers A and B. (adhesion promoter)

George V. Newman et al carried out an in vitro study to determine the effect of adhesion promoters to measure bond strength of metal brackets. The results show a significant positive effect on the bond strength using adhesion promoters. Webster MJet al carried out a study of the effect of saliva on shear bond strengths of hydrophilic bonding systems, the results of the study show that the teeth which were moistened with artificial saliva demonstrated lowest mean bond strengths and scores. The result of the study is in accordance with this study.

Karamouzou A, Mavropoulos A, Athanasiou AE, Kolokithas G. evaluated and compared the clinical performance of a water-activated, ethyl-cyanoacrylate adhesive to a conventional composite resin the result of the study shows that the water-activated bonding material recorded a significantly higher bond failure than the composite resin.

Schaneveldt S, Foley TF. carried out a in vitro study to evaluate the effectiveness of two moisture-insensitive primers, Assure (Reliance Orthodontic Products, Itasca, Ill) and MIP (3M Unitek, Monrovia, Calif) compared with a control hydrophobic primer, Transbond XT (3M Unitek). the result of the study shows that the bond strengths for Assure and MIP were not significantly affected by saliva contamination. The mean shear-peel bond strength of the control (14.82 MPa) was significantly higher ($P < .001$) than the contaminated groups with the exception of MIP group 5 (14.02 MPa).

Cacciafesta V, Sfondrini MF, De Angelis M, Scribante A, Klersy C. carried out a study to assess the effect of water and saliva contamination on the shear bond strength and bond failure site of 3 different orthodontic primers (Transbond XT, Transbond Moisture Insensitive Primer, and Transbond Plus Self Etching Primer; 3M Unitek, Monrovia, Calif) used with a light-cured composite resin (Transbond XT). The result of the study shows that uncontaminated enamel surfaces had the highest bond strengths for conventional, hydrophilic, and self-etching primers, which produced the same strength values. In most contaminated conditions, the self-etching primer had higher strength values than

either the hydrophilic or conventional primers. The self-etching primer was the least influenced by water and saliva contamination, except when moistening occurred after the recommended 3-second air burst. No significant differences in debonded locations were found among the groups bonded with the self-etching primer under the various enamel conditions.

Murray PG, Millett DT, Cronin M. carried out a study to investigate the use of bonded molar tubes (BMTs) by specialist orthodontists. The result of the study shows that Specialist orthodontists preferred BMTs to molar bands on first permanent molars. In such conditions the use of bond enhancing agents is justifiable.

Scope Of The Study

This study might be extended to include other type of orthodontic resins like visible light cure resins.

Conclusion

1. The bond enhancing agent shows a statistically insignificant positive effect on the shear bond strength of the direct bonding orthodontic resin, when used on dry enamel surface.
2. The bond enhancing agent shows a statistically highly significant positive effect on the shear bond strength of the direct bonding orthodontic resin, when used on wet enamel surface.
3. There is a highly significant negative (weakening) effect of salivary contamination on the shear bond strength of the direct bonding orthodontic resin.
4. The use of bond enhancing agent in a wet field on the direct bonding resin increases the shear bond strength to values almost equal to those obtained, while bonding in a dry field.

In short, the bond enhancing agent is not recommended to be used routinely in cases where meticulous isolation is possible, since no significant increase in the bond strength is observed under dry condition. However in cases where salivary contamination occurs accidentally or when such a contamination is anticipated (e.g. anxious child patients or a nervous adult patient etc.), the bond enhancing agents could be included into the sequence of bonding procedure, to prevent reduction in the shear bond strength due to salivary