A Comparative Study of the Shear and Tensile Bond Strength using three types of Direct Bonding Adhesives on Stainless Steel Brackets - An In Vitro Study

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ABSTRACT

Background: The purpose of this study was to compare the shear and tensile bond strength of three adhesive systems with increasing concentrations of filler for bonding brackets.

Materials & Methods: The study was carried out on 120 extracted human premolars; randomly divided into six groups, three groups for shear bond strength & three for tensile bond strength, each subgroup consisting of 20 teeth; using light cured adhesive systems: Group 1: FORTIFY Unfilled, (unfilled penetrating resin) Group 2: ALITEF Low Filled (filler load 58% by weight) Group 3: PYRAMID Highly Filled (filler load greater than 80% by weight) with metal brackets (TP 256-650. TP orthodontic inc. Po.box 73,La Porte 46350,USA).

Results: The findings showed that in vitro tensile bond strength and shear bond strength of PYRAMID [9.88/11.46 MPa resp.] is significantly greater than ALITEFLO[5.34/9.50 MPa resp.] and FORTIFY [2.65/5.39 MPa resp.].

Conclusion: Using the same bracket and force mode but different adhesive filler concentrations revealed increased shear and tensile bond strength with increased filler concentration.

Key Words: Shear Bond Strength, Tensile Bond Strength, Filler Concentration.

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INTRODUCTION

The essence of direct bonding system is due to the introduction of the acid etching technique by Buonocore[1] in 1955.

It was Newman[2] in 1965 who introduced the acid etching technique in orthodontics. One of the most dramatic changes in Orthodontic specialty was the intr-oduction of composite resin in the year 1970s. In 1977 Zachrisson[3] first used bonded brackets, since then it has become routine procedure. The chemically cured composite resins were the first systems developed for orthodontic bracket bonding. Recently light cured composites have been introduced. Bassiouny and Grant[4] in

1978 first reported clinical use of visible light cured composite resin. Tavas and Watts[5] in 1979 claimed that visible light cure resin material had sufficient strength for use in bonding brackets.

Direct bonding of attachments has revolutionized Orthodontics because of the decrease in gingival irritation, improved esthetics, and the ability to maintain better oral hygiene, the elimination of band occupying interdental space, and the decreased chance of decalcification caused by leakage beneath bands.[6]

The purpose of this study is to evaluate which filler concentration gives clinically acceptable shear and tensile bond strength in vitro for three types of light cure resin unfilled, low filled and high filled with stainless steel brackets using natural teeth.

MATERIALS & METHODS

The sample consisted of 120 extracted human premolars (n=120).These teeth were randomly divided into six groups; three groups for shear bond strength testing & three for tensile bond strength. (Each subgroup consists of 20 teeth). The following light cured adhesives were used in this study:

Fig. 1: Instron Universal Testing Machine

Group 1: FORTIFY

Unfilled[7], (low viscosity, unfilled penetrating resin)

Group 2: ALITEFLO

Low Filled (filler load 58% by weight)

Group 3: PYRAMID

Highly Filled (filler load greater than 80% by weight)

Each bracket was used only once. The standardized procedure described in Bishara et al[8] was used. The shear and tensile bond strength tests were conducted in the laboratory (3M Innovation Centre, Electronic City, Bangalore). An Instron Universal Testing machine (Figure 1)[9-10] No.4467 was used in this study to record the shear and tensile bond strength.

The jig holding the tooth for shear test was positioned so that force could apply to the bond parallel to the facial or buccal surface of the tooth using a surveyor. When the specimen was positioned at right angles to the pulling force of the testing machine, a tensile force was generated to evaluate tensile strength.

The load at which the bracket debonded was recorded in kilograms and subsequently calculated into Mega Pascals using the formula.

Shear bond Strength (MPa) =

$$\frac{\text{F (debonding force in kilograms)}}{\text{D x L in mm}^2\text{ (bracket base area)}}$$

Where D = width of bracket base and

L = height of bracket bas

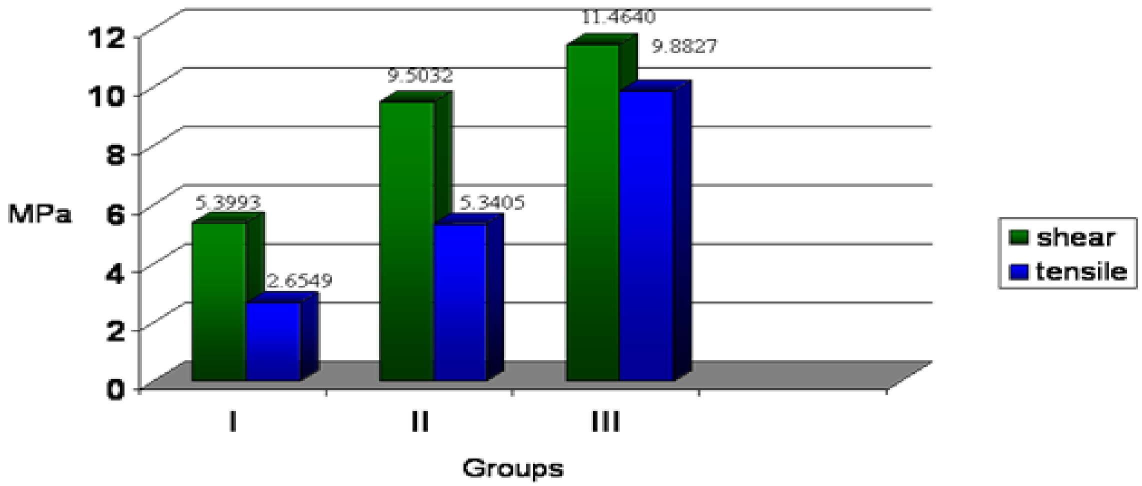
RESULTS

The findings of the present study showed that in vitro tensile bond strength and shear bond strength of PYRAMID (high filled) were significantly greater than FORTIFY (unfilled) and ALITEFLO (low filled).

The mean tensile bond strength and shear bond strengths of FORTIFY was 2.65MPa and 5.39MPa respectively. (Graph 1)

The mean tensile bond strength and shear bond strength of ALITEFLO was 5.34 MPa and 9.50 MPa respectively. (Graph 1)

The mean tensile bond strength and shear bond



Graph 1: Comparative Evaluation of Shear and Tensile Bond Strengths in Group I, II, III

strengths of PYRAMID was 9.88 MPa and 11.46 MPa respectively. (Graph 1)

Statistical inference reveals that there is a highly significant statistical difference in the mean values of MPa of six groups (by using ANOVA test for shear F = 50.808, P<0.000 for tensile bond strength F = 94.371, P< 0.000) (Graph 1).

Duncan's multiple range tests shows that, the mean MPa values of group-3 are significantly higher than the mean MPa values of group-1 and group-2. The mean MPa value of group-1 is significantly less than the mean MPa value of other two groups.

DISCUSSION:

The attachment of brackets to the teeth plays a key role in orthodontic treatment. Formerly, this was achieved by banding the teeth, but with the introduction of acid etching of enamel and the direct bonding of brackets, it has led to changes in the practice of orthodontics. In the literature, mostly shear bond strength values of adhesives have been published.[8,10-12] Fewer articles have evaluated tensile bond strength.[13-14] In this study, when natural teeth were tested in vitro there were no failures at the enamel-adhesive interface. In vivo, however, more failures may be observed at this interface because of difficulties with isolation and access. Because of salivary contamination, ideal bonding to enamel is much more difficult to achieve in vivo[15]

Most bonding studies use commercially available adhesive systems that have different filler particle sizes and concentrations.[15-16] This study was designed to evaluate the influence of adhesive filler concentration on bond strength, keeping the filler particle size constant. The filler particle size chosen was 2 to 8 μm.

In this study we evaluated the tensile bond strength and shear bond strength in vitro for three types of light cure resins FORTIFY (unfilled), ALITEFLO (low filled) and PYRAMID (high filled) with stainless steel brackets. A comparison of the different groups using the same bracket and force mode but different adhesive filler concentrations revealed increase in shear and tensile bond strength with increased filler concentr-ation.These finding are in accordance with the studies done by Buzzitta, Hallgren, Powers Ostertag, Dhuru, Ferguson, and meyer.[15-16] Bond strength levels of 5 to 8 MPa have been re- ported to be adequate for bonding orthodontic brackets to teeth.[17-21]

CONCLUSION

1. The tensile bond strength was less than the shear bond strength for all the materials tested. But the difference was not significant.
2. Using the same bracket and force mode but different adhesive filler concentrations revealed increased shear and tensile bond strength with increased filler concentration.

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