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Orthodontic adhesives versus anterior restorative materials for bracket bonding

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Abstract

Two hundred and forty Begg orthodontic brackets prewelded to a Dyna-Bond pad were bonded to bovine incisors using four orthodontic adhesives and four anterior restorative materials. Then samples of each material were tested after one day, three months, and six months immersion in lactic acid utilizing the Instron Universal Testing Instrument. The mean bond strength of each material at each time interval was compared to the mean bond strength of each of the other materials at each time interval. The Newman-Keuls a posteriori *Test was used to determine whether there was a significant difference in mean bond strength at each time interval and in the materials overall. Solo Tach (OA) showed a significantly better mean bond strength overall than any material tested, although it was not significantly the best at each interval. Concise (AR) showed the highest bond strength among the anterior restoratives. Superfil (AR) had the lowest bond strength tested at each time interval. The remaining materials were grouped depending upon their mean bond strengths and degrees of non-significance when compared to each other.*

Introduction

The acid etch procedure, since its introduction in 1955 by Buonocore,[1] has been adapted from use in many areas of dentistry. One current modification is its use in direct bonding attachments for tooth movement. There are many products on the market designed for the purpose of direct bonding. The profession also has the restorative materials to be used with the acid etch technique. The chemical composition of orthodontic adhesives and the anterior restorative is basically the same. It should be the goal of each practitioner to utilize the best material for each procedure. There have been studies comparing the different materials designed exclusively for the bonding of bracket and attachments.[2-9] There has been little done with anterior restoratives used for bonding purposes.

The purpose of the study was to compare the bonding strengths of the anterior restorative materials to the bond strengths of the orthodontic adhesives. The information from the study should be useful to the practitioner in selecting the material to best suit his needs.

Methods and Materials

Two hundred and forty bovine incisors were selected for use in the study because of support of other research and availability.[4,10,11] These teeth were extracted using an anterior forcep No. 1. Following extraction, all teeth were placed in a 10% formalin solution and stored at room temperature. The entire root of each tooth was embedded in acrylic to facilitate handling.

The sample teeth were divided into eight groups of thirty teeth each for use with one of the eight materials to be tested. Each thirty tooth sample was then placed in a labeled jar containing lactic acid at pH 6.8, to simulate the slightly acid pH of the oral cavity. The jars were labeled according to the product to be utilized.

The products to be tested were: (a) Concise Enamel Bond (3M), (b) Superfil (Bosworth), (c) Restodent (Lee Pharmaceuticals), (d) Powderlike (S.S. White), (e) Unique (Lee Pharmaceuticals), (f) Dynabond (Unitek), (g) Concise Orthodontic Bonding System (3M), and (h) Solo Tach (Caulk). All materials were received from the manufacturers within two months of testing. Each of the eight materials employed an acid etching technique and was used according to the manufacturer's recommendations.

At the time of bonding, each tooth was: (1) pumiced with a non-fluoridated prophylaxis paste for one

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minute, (2) dried, (3) etched with the acid provided, (4) rinsed and dried, (5) sealed when indicated. The adhesive was applied to the bracket base, and the bracket was attached to the enamel surface.

A Begg bracket (Unitek) pre-welded to a Dyna-Bond Pad (Unitek) was bonded to the labial surface of each tooth with its appropriate material. All brackets were pressed flat against the labial tooth surface with cotton pliers, with the Begg bracket parallel to the long axis of the tooth in the mid-portion of the clinical crown. All bonded teeth were allowed to polymerize for twenty minutes at room temperature to insure complete setting of all samples before being stored.

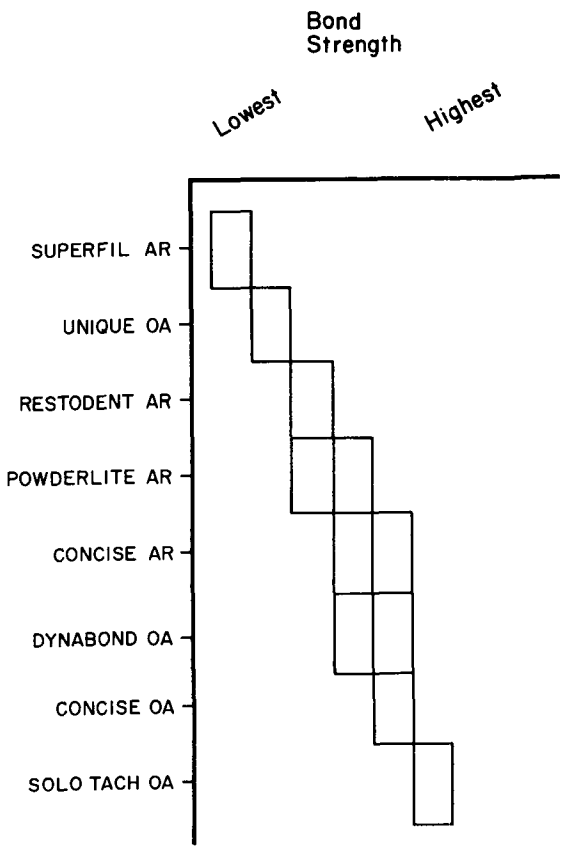
Each bonded sample was thermally cycled one hundred times from 4°C and 60°C at one minutes intervals, prior to testing. Thermal and drying cycling during storage would have better simulated the oral condition.

Ten tooth samples for each material were then tested with the Instron Universal Testing Instrument in the tension mode after the bonded brackets and teeth had been in the lactic acid solution for twenty-four hours, three months, and six months. The Instron was calibrated prior to each sample testing session. A fifty pound load cell and a cross head speed of 0.02 inches per minute were employed. The recording graph was operated at a chart speed of one inch per minute and a full scale definition of fifty pounds.

A special harness was designed for testing the samples. A 0.022 inch Elgiloy wire loop was soldered to a three inch piece of 0.040 inch Elgiloy wire which was then attached to the upper member of the Instron. The sample was placed in the lower member. The 0.022 wire loop was engaged in the Begg bracket and the machine was activated. The breaking force in pounds was recorded. The data for each sample was collected and analyzed statistically using the Newman-Keuls *a posteriori* Test.

Results

The results of this study are recorded in the following table and graph:



Graph 1. Newman-Keuls *a posteriori* Test summation at 0.05 significance level - significant groups.

TABLE 1. Mean shear strength in pounds and standard deviation of each material at twenty-four hours, three months, six months and overall.

	24 Hours		3 Months		6 Months		Overall	
	lbs.	S.D.	lbs.	S.D.	lbs.	S.D.	lbs.	S.D.
Concise (AR)	28.9	3.98	32.4	2.63	28.3	3.11	29.8	3.66
Superfil (AR)	5.7	3.39	5.0	3.71	9.7	2.26	6.8	3.73
Restodent (AR)	29.7	6.13	26.2	9.30	22.8	9.48	26.3	8.64
Powderlite (AR)	38.1	3.68	28.2	2.18	25.0	6.13	27.1	4.43
Solo Tach (OA)	35.7	2.59	34.6	4.14	33.3	7.31	34.5	4.86
Dynabond (OA)	28.5	3.87	29.0	3.06	32.4	3.76	29.9	3.89
Concise (OA)	30.1	4.10	29.8	5.56	32.9	3.74	30.9	4.63
Unique (OA)	12.6	3.99	17.9	5.36	19.6	3.34	16.7	5.17

Key: **(AR), Anterior Restorative Material**
(OA), Orthodontic Adhesive Material

Discussion

The purpose of this study was to compare the bonding strength of anterior restorative products to the bonding strength of orthodontic adhesives for the attachment of brackets. The mean bond strengths of eight of these materials were statistically compared to each other at one-day, three-month, and six-month intervals. The overall mean bond strengths of the materials were also compared (Graph 1).

The material that showed the highest bond strength after twenty-four hours was Solo Tach orthodontic adhesive. The material was significantly better than any of the other products tested. It is worth noting that Solo Tach does not utilize an unfilled resin prior to application of the prepared bracket. Following Solo Tach there was a group of five materials that showed no significant difference at the 0.05 level of their bond strengths. This group included two orthodontic adhesives and three anterior restorative materials. The products were Concise OA, Restodent, Concise AR, Dynabond, and Powderlite. Unique was alone as far as test significance, proving better than only one product, Superfil. Superfil had the lowest bond strength recordings.

After three months, four products showed no significant difference in bond strengths representing the best test results at this time interval. The four products were Solo Tach, Concise AR, Concise OA, and Dynabond. It is interesting to note that one of the materials in this group is an anterior restorative material, Concise Enamel Bond. With the exception of Solo Tach, each of these materials uses an unfilled resin as a sealant.

At the final test period of six-months, the products demonstrating the best results with no significant difference were Solo Tach, Concise OA, Dynabond, and Concise AR. These were the same products that tested best at the three-month interval. Concise AR weakened somewhat from the three-month to the six-month period, as did Solo Tach. Concise OA and Dynabond showed signs of increased strength from three months to six months.

Utilizing the Newman-Keuls *a posteriori* Test at the 0.05 level, the following summations can be made (Graph 1). The best overall product tested was Solo Tach. There was no significant difference between Concise OA, Dynabond, and Concise AR, however. The next group of significance included Dynabond, Concise AR, and Powderlite. There was no overall significant difference between Powderlite and Restodent. Unique was significantly better overall than only one material, Superfil. Unique had the lowest bond strength of the orthodontic adhesives tested. Superfil tested significantly lower than any other product; a finding that was consistant at each test interval.

In some offices there is a time interval varying from one day to one week or longer following bracket placement before stress is applied via the archwire. With this in mind, one might find that initial strength is not of significant importance. Thus, a material that shows an increase in bond strength values with time might serve the purpose adequately, whereas initially it might be weak.

Each product that was tested in this study is currently in use by the dental profession. From the data generated, a wide range exists among the bond strengths of these materials. With this wide variability present, one must determine the feasibility of using each of these materials as bracket bonding agents. Reynolds (1975)[12] stated that maximum orthodontic forces are unlikely to exceed eleven pounds. Each material tested exceeded this force value at each time interval with the exception of Superfil, and its values never reached this maximum force requirement. Therefore, any of the tested materials could serve adequately as a bracket bonding agent with the exception of Superfil. However, one should strive to use the best material available for each office procedure. Phillips (1966)[13] stated that the oral environment is ideally suited for destruction. This was pointed out by noting the temperature changes, forces of mastication (175 to 200 pounds), and pH fluctuations. Thus, the utilization of products with maximum strength should be our goal.

Conclusion

1. Solo Tach, under the condition of the *in vitro* study, produced the highest bond strength.
2. The materials which utilize an unfilled resin following etching do not necessarily render the highest bond strength values.
3. Of the materials tested *in vitro* not utilizing an unfilled resin after etching, Solo Tach (OA) had significantly higher bond strength.
4. Of the materials tested *in vitro* utilizing an unfilled resin after etching, Concise OA, Dynabond OA, and Concise AR are significantly better than the other materials.
5. Of the anterior restorative products tested *in vitro,* Concise AR was the only product to show bond strength data consistant with the better orthodontic adhesives.

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