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ORIGINAL ARTICLE

A COMPARATIVE EVALUATION OF BOND-STRENGTH BETWEEN NORMAL DENTIN AND CARIES AFFECTED DENTIN: AN INVITRO STUDY

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ABSTRACT: INTRODUCTION: The concept of adhesive dentistry has taken leaps forward and has resulted in a concept of more conservation of tooth structure which in turn enhance the life of teeth. The bonding agent forms a hybrid layer with dentin and its other side co-polymerize with the matrix phase of dental composite, producing strong micro-mechanical bonding. **AIMS AND OBJECTIVE:** To evaluate the bond strength of adhesive agent to normal dentin and caries affected dentin and also to compare the bond strength between different bonding agents. **METHOD:** 20 mandibular molar were collected, washed and stored in normal saline. Each tooth was cut longitudinally. Healthy tooth structure of each half of the tooth represents the control group and the carious portion of the same tooth represents as experimental group. Thus, 80 samples were prepared. The groups were then further subdivided into 4 sub-groups of 4 different bonding agents. The dentin surface of all the sub groups were etched by 37% of phosphoric acid gel for 10-15 secs and respective bonding agent were used and cured for 20 secs. Cylindrical composite resin was prepared using a plastic module of internal diameter of 3mm and length 5mm. Statistical analysis was done using mean standard deviation (S.D), student 't' test and level of significance 'P'. **RESULTS:** For both the control and experimental group, 3M single bond has showed the strongest bond strength followed by Prime and Bond NT, Excite and PQ1.

KEYWORDS: Affected dentin, 3M single bond, Prime and Bond NT, Excite, PQ1, Tetric cream composite.

INTRODUCTION: The concept of adhesive dentistry has taken leaps forward in the current decade. This has resulted in a concept of more conservation of tooth structure which in turn enhance the life of teeth.

Several concepts has been proposed for bonding of adhesive resin to Dentin:

1. Bonding via resin tag formation in the dentinal tubules of etched dentin.
2. Formation of precipitate on pre-treated dentinal substrate to which adhesive resin may be chemically or mechanically bonded.
3. Chemical union to either inorganic and/or organic component of the substrate
4. Diffusion and impregnation of monomer in to the sub surface of pre-treated dentin substrates and their polymerization creating a hybrid layer of resin-reinforced dentin.

The bonding agent forms a hybrid layer with dentin and its other side co-polymerize with the matrix phase of dental composite, producing strong micro-mechanical bonding. The current bond strength of 20 MPa appears to be clinically be very acceptable. More than 20 years of clinical use detected and degradation of the mechanical bonds due to routine stress or fatigue.

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A number of new dentin bonding systems has been developed and marketed to produce increased bond strength between composite to dentin resulting, best sealing and leak free restoration.

AIMS & OBJECTIVE: To evaluate the bond strength of adhesive agent to normal dentin and caries affected dentin and also to compare the bond strength between different bonding agents.

MATERIALS & METHOD: In the present study was carried out in the Department of Operative Dentistry, Faculty of Dental Sciences, King George's Medical College, Lucknow, in collaboration with Chemical Quality Control Department, Hindustan Aeronautics Limited, Lucknow Division.

20 mandibular molar were collected, washed and stored in normal saline. After removal from normal saline, each tooth was cut longitudinally along the mesial and distal surface of the tooth into 2 halves with diamond disc with the help of straight hand piece and micromotor. (FIGURE 1)

Healthy tooth structure of each half of the tooth represents the control group and the carious portion of the same tooth represents as experimental group. Thus, 80 samples were prepared.

The samples were divided into 2 equal groups of 40 samples each: control and experimental. Control group contain normal healthy dentin and experimental group contain caries-affected dentin.

CONTROL GROUP: It consists of 40 samples that had healthy dentin surfaces. It was further divided into 4 sub-groups of 10 samples each:

A1 – Prime and Bond NT was used.
B1 – 3M Single Bond was used.
C1 – Excite was used.
D1 – PQ1 was used.

EXPERIMENTAL GROUP: It also consists of 40 samples that had caries affected dentin surface. It was also further divided into 4 sub-groups of 10 samples each:

A2 – Prime and Bond NT was used.
B2 – 3M Single Bond was used.
C2 – Excite was used.
D2 – PQ1 was used.

GENERAL PROCEDURE FOR BOTH THE CONTROL AND EXPERIMENTAL GROUP: The samples were kept in saline. Each sample contained healthy dentin on one surface and affected dentin on the other surface. The samples were cleaned and made smoothened by sand paper. The dentin surface were etched by 37% of phosphoric acid gel for 10-15 secs.

After completing the etching procedure respective bonding agent were used in each group and cured for 20 secs with the help of light cure unit.

Cylindrical composite resin was prepared using a plastic module of internal diameter of 3mm and length 5mm. Orthodontic wire was inserted into pre-cured resin for help in testing the bond strength of composite in the instron machine.

Similar procedure was carried out for each control and experimental sub-groups.

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INSTRON UNIVERSAL TESTING INSTRUMENT: it is a highly accurate instrument proving an outstanding versatility of material testing at loads upto 5kN in tension, compressive and flexural strength.

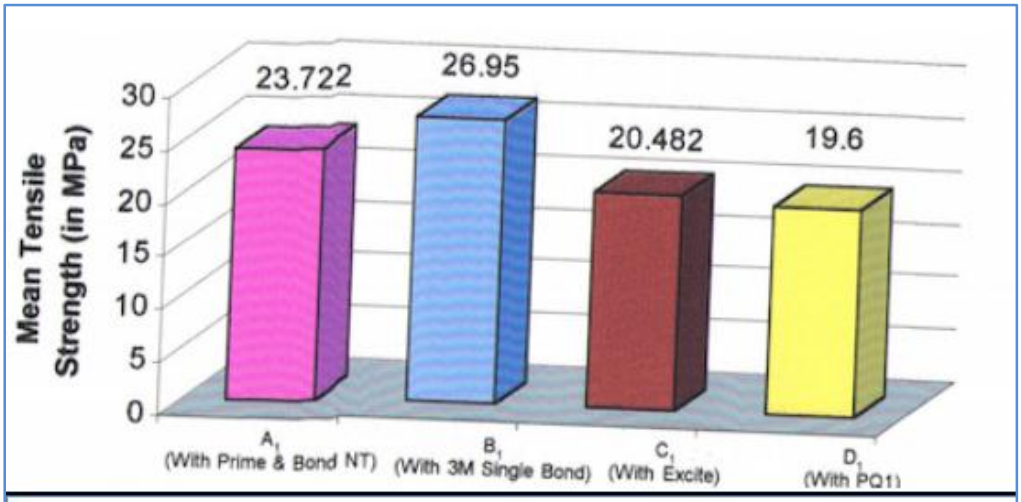
STATISTICAL ANALYSIS: It was done using mean standard deviation (S.D), student 't' test and level of significance 'P'.

RESULT: A summary of the results can be concluded as:

- **Control group:** 3M single bond has showed the strongest bond strength followed by Prime and Bond NT, Excite and PQ1
- **Experimental group:** 3M single bond has showed the strongest bond strength followed by Prime and Bond NT, Excite and PQ1.

Comparison	't' value	'p' value
NT Vs. 3M	4.1683	P<001
NT Vs. Excite	6.0812	P<001
NT Vs. PQ1	6.3329	P<001
3M Vs. Excite	8.7334	P<001
3M Vs. PQ1	8.8594	P<001
Excite Vs. PQ1	1.4453	NS

Table 1: Comparison of tensile strength in healthy dentin (Control Subgroup)



GRAPH 1: COMPARISON OF TENSILE STRENGTH IN HEALTHY DENTIN (CONTROL SUBGROUP)

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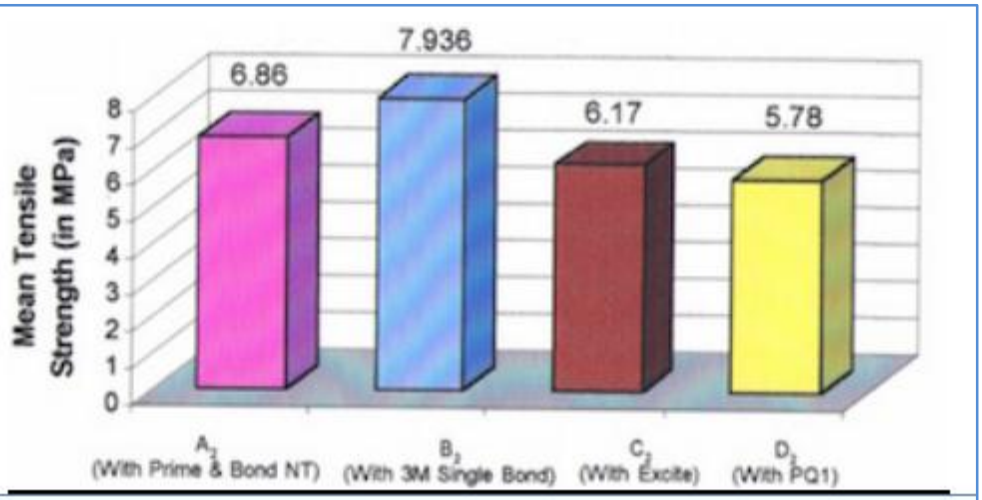
Comparison	't' value	'p' value
NT Vs. 3M	2.5377	P<.02
NT Vs. Excite	1.2247	NS
NT Vs. PQ1	2.1182	P<.05
3M Vs. Excite	3.5782	P<.01
3M Vs. PQ1	4.9923	P<.001
Excite Vs. PQ1	0.6887	NS

Table 2: Comparison of tensile strength in affected dentin (Experiment subgroups)



GRAPH 2: COMPARISON OF TENSILE STRENGTH IN AFFECTED DENTIN (EXPERIMENTAL SUBGROUPS)

FIGURE 1: LONGITUDINAL SECTIONS OF PREPARED SAMPLES

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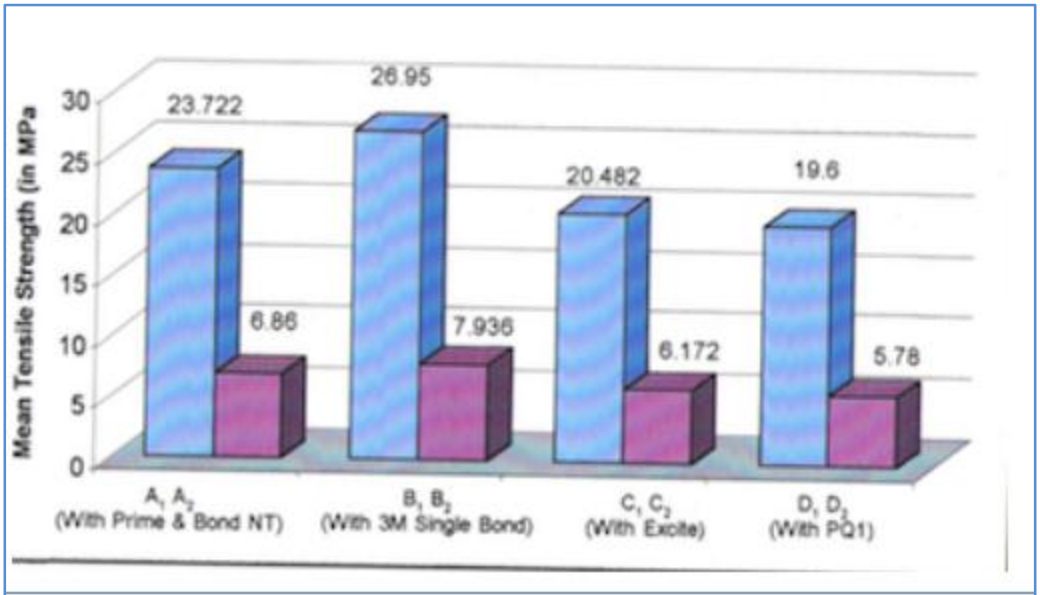

GRAPH 3: COMPARISON OF TENSILE STRENGTH BETWEEN HEALTHY (CONTROL GROUP) AND CARIES AFFECTED DENTIN IN (EXPERIMENTAL GROUP) IN AFFECTED DENTIN

DISCUSSION: Bonding agents were developed to enhance restoration better with resins. The concept of bonding agent arised from a need of a restorative material that will bond effectively to the tooth structure. The objective of dentin conditioning is to create a surface capable of micromechanically and chemically bond to the dentin bonding agent.

In the present study the bonding agents used contained both primer and adhesive in a single bottle. Prime and Bond NT has nano fillers of partical size 7 nanometer, 100 times smaller than the fillers in composite resin. These nanofillers helps in best sealing, higher adhesion, best marginal integrity and minimum post-operative sensitivity.

3M single Bond, according to the clinical research associates is the fastest bonding agent. The presence of polyalkenoic acid copolymer has an important role in increasing its bond strength.

Excite is an acetone free, fine filled, single component adhesive in conjunction with total etch technique. The fine fillers contained in this bonding agent allows uniform coverage of dentin and enamel areas and glassy layer is achieved on the tooth surface. It is equally effective on dry and wet dentine.

PQ1 is a unique single component adhesive.

For this study Tetric cream composite was used. It is based on ACT technology. In the present study composite resin was built up in increments and each layer was cured for 40 secs. The orthodontic wire was inserted in the percured resin for testing the bond strength of bonding agent. All 4 bonding agents used in the study show that the tensile strength in healthy dentin are higher than caries affected dentin.

The mean value for bond strength of Prime and Bond NT was higher than in the normal healthy dentin (23.72±1.29 Mpa) than the caries affected dentin (6.86±1.12 Mpa).

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The mean value for 3M single bond was higher in normal dentin (26.95 ± 2.07 Mpa) than carries affected dentin (7.93±0.72 Mpa).

The mean value for bond strength of Excite was higher in the normal healthy dentin (20.48±1.07 Mpa) than caries affected dentin (6.17±1.3 Mpa).

The mean value for bond strength of PQ1 was also higher in the normal healthy denin (19.60±1.60 Mpa) than caries affected dentin (5.78±1.15 Mpa). These results can be explained as the space remains between the collagen fibrils in normal dentin that are occupied by normal calcium deficient carbonate rich apatite (Le Gros 1991). The KHN of caries affected dentin indicates that it is softer than normal dentin because of loss of apatite mineral from intertubular dentin (ShimiZu et al. 1981)

In the present study, tensile bond strength of healthy dentin in different control subgroups was found to be maximum with 3M single bond (26.95 Mpa) than Prime and Bond (23.72 Mpa) then Excite (20.48) and minimum with PO1 (19.60). This difference was probably due to degree of penetration of the resin monomers in demineralized dentin surface to produce resin hybridization od dentin (Naka bayoshi 1982). Finger et. al (1994) suggested that bond strength of adhesive resin depends on the nature of hybrid layer.

Tensile bond strength of caries affected dentin in different experimental subgroups was found to be maximum with 3M single bond (7.93 Mpa) than Prime and Bond (6.86 Mpa) then Excite (6.13 Mpa) and minimum with PO1 (5.7Mpa). This difference was primarily due to permeability of resin monomer into the demineralized dentin and the quality of hybrid layer created by the used bonding agent.

The bond strength of bonding agent to normal healthy dentin for all sub groups (control) produced high tensile bond strength than those of caries affected dentin (experimental).

The results of this study indicates that the strength of adhesion to dentin depends upon both the adhesive system and the type of dentin. This study by no means is a conclusive one. More studies with larger sample size are needed to establish a more appropriate and conclusive data.

CONCLUSION: From the present study the following conclusion were made:

1. Normal healthy dentin had higher bond strength than caries affected dentin.
2. In healthy dentin higher bond strength were found in 3M Single Bond and minimum with PQ1 compared to other bonding agents which were used in the present study.
3. In caries affected dentin it was observed that higher both strength were found with 3M Single Bond and minimum with PQ1 compared to other bonding agent that were used in the study.

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