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Research Article

EVALUATION OF TENSILE BOND STRENGTH OF DIFFERENT DENTIN BONDING AGENTS USED TO SEAL RESECTED ROOT APICES (NON CONTAMINATED V/ S CONTAMINATED) – AN *IN-VITRO* STUDY

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ABSTRACT

Aim: The aim of this study is to evaluate and compare tensile bond strength of different dentin bonding agents on contaminated and non contaminated root surfaces.

Materials and Methods: Group A: 10 teeth with resected root surfaces received amalgam bond

Group B: 10 teeth with resected root surfaces received Scotch bond multipurpose

Group C: 10 teeth with resected root surfaces received Prime & Bond 2.0

Specimens were subjected to tensile load and breaking point were noted. The same samples were resurfaced and contaminated with blood and the above mentioned procedure was repeated and the groups were divided as A1, B1, C1

Results: After statistical evaluation using ANOVA and t test, the mean shear bond strength values of the group are as follows, Group A- 8.81 MPa, Group B- 15.14 MPa, Group C- 15.03 MPa. Group B showed highest value and Group A showed lowest value in non contaminated groups. Group A1- 7.99 MPa, Group B1- 5.75MPa, Group C1- 9.78 MPa. Group C1 showed highest value and B1 showed least values among the contaminated groups.

Conclusion: Within the limitations of the study, Prime & Bond 2.0 dentin adhesive gave the best tensile values in both contaminated and non contaminated specimens.

Keywords: Adhesion, Dentin Bonding, Shear Bond Strength, Blood Contamination

INTRODUCTION

Three dimensional cleaning, shaping and obturation of root canal system may not be possible in cases of bizarre anatomy of root, non negotiable separated instruments in the canal. This leads to surgical intervention for successful management of the root canal system¹. Many retrograde materials have been tried in the past like silver amalgam, cavit, gold foil, Intermediate restorative material (IRM), glass ionomer cements^{2,3}. Biocompatibility, cavity preparation, retention of restoration and seal ability affects the longevity of these restorations. Achieving an absolute isolation in the retrograde region is often difficult, so contamination is a major cause of failure with the restorative materials. With the availability of newer bonding systems which bond to the dentin with minimal tooth preparation, bond even in presence of blood contamination, helps in periodontal regeneration, thereby decrease micro leakage. Because of these qualities of dentin bonding agents, this may be tried as new retrograde sealant^{4,6}.

We aimed to evaluate the tensile bond strength of these commercially available dentin bonding agents on contaminated and non contaminated resected root surfaces.

MATERIALS AND METHODS

Thirty freshly extracted non carious, human maxillary central incisors extracted for periodontal reasons were collected. Care was taken to exclude teeth with fracture, caries, multiple canals, incomplete root formation and curved root. All the specimens were cleaned free of debris, calculus and stored in distilled water.

Specimen preparation

The procedure for preparation of the teeth was standardized and carried out by a single operator through the study. Access cavity preparation was carried out in all the specimens and working length was measured with No. 15 K file till the tip was visible from the apical foramen and 1mm was reduced and canals were enlarged upto No.50 file till the working length. Canals were irrigated with 0.5% sodium hypochlorite.

Remaining canal was prepared with gates glidden drills No. 3-5 and K file upto No.70 using step back technique to complete the canal preparation.

Canals were obturated with gutta percha using lateral condensation method using AH plus sealer. Access cavity was sealed with glass ionomer cement. All the specimens had their apical 3 mm resected perpendicular to the long axis of the root with high speed tapered fissure bur.

The procedure was divided into two parts, the first part consisted of specimens with non contaminated surfaces (A,B,C) and restorative procedure was done, tensile load was applied and values recorded. The same specimen were resurfaced and used after blood contamination in the second part (A1, B1 C1).The non contaminated group specimens were then randomly divided into three subgroups of 10 samples each. The resected root surfaces of group A, group B and group C samples were treated with amalgam bond, scotch bond multipurpose and prime and bond 2.0 respectively in strict accordance to the manufacturer’s instructions.

Then these specimens were restored with approximately 2mm thick hybrid composite resin and cured for 40 seconds to the bonded surfaces of the resected root, now cylindrical straw matrix of 8mm length was used to hold the rest of the composite covering 2mm of the resected root surface. In the samples where matrix used, were found to be more in length than the standard length covering the root. The operator saw that a minimum of 6mm length of composite buildup was made and same was maintained in these cases throughout the study. A 0.7 gauge stainless steel hook (1.2 inch length) was then inserted into the center of the composite resin within the matrix keeping it parallel to the long axis of the root up to 4mm and three directional light curing was done.

The coronal half of the tooth was embedded in a jig containing acrylic resin such that the resected root end with composite was perpendicular to the direction of the tensile force. The specimens were left for 1 hour in the humidior at 37° C and were mounted in an Instron universal testing machine (Model 6025, instron corporation) with cross head speed of 1.00 mm/minute to test the tensile strength of the bond. After the composite/dentin bonding agent failed values were noted.

Now the apical dentinal surface of each group was resurfaced with taper tungsten fissure bur removing 1mm of root end and values of root surface area was determined on a traveling microscope and values noted, the resurfaced areas were then conditioned prior to contamination of root surface using fresh human blood for 5 minutes period during which the specimens were placed in humidior at 37° C. The resected contaminated surface was then cleansed of blood with saline irrigation and dentin bonding agents were reapplied to their respective groups followed by the bonding of hybrid composite to the resected root surfaces using cylindrical straw matrix and tensile testing was done as described previously and values noted. Data in each group were pooled and statistically evaluated using Student’s t test, one way analysis and Duncan multiple range test.

RESULTS

Table 1 shows the mean bond strength values and standard deviations between different groups in non contaminated specimens. Bond strength is maximum with Group B (15.14 ±1.18 MPa) followed by Group C (15.03±0.86 MPa) and Group A (8.80±1.05 MPa). Group A showed significantly lower bond strength when compared to Group B and C.

Table 1: Comparison of bond strength between different subgroups in non contaminated group

Groups		Bond strength (MPa)			‘F’ value*	Significance of Difference**		
		Mean .	S.D.	S.E		A	B	C
A	Amalgam bond	8.81	1.05	0.33	60.69	-	P<.05	P<.05
B	Scotch bond Multi Purpose	15.14	1.18	0.57		-	-	N.S
C	Prime and Bond 2	15.03	0.86	0.27		-	-	-

*: ANOVA -F TEST, P<.05: Significant, N.S: No significance, **: Students range test (MSR=1.6 MPa)

The results of ANOVA revealed that groups exhibited different tensile bond strength (F=60.69; P<0.01). In order to determine which group differed from other, minimum significant range was calculated which was found to be 1.6 MPa.

Table 2 shows the mean bond strength values and standard deviations between different groups in contaminated specimens. Bond strength is maximum with Group C1 (9.97±0.98 MPa) followed by A1 (7.59±0.96 MPa) and B1 (5.75±0.55 MPa). Group C1 was superior in bond strength followed by Group A1 and B1.

Table 2: Comparison of bond strength between different subgroups in contaminated group

Groups		Bond strength (MPa)			‘F’ value*	Significance of Difference**		
		Mean .	S.D.	S.E		A1	B1	C1
A1	Amalgam bond	7.99	0.96	0.30	55.96 P<.01	-	P<.01	P<.01
B1	Scotch bond Multi Purpose	5.75	0.55	0.17		-	-	P<.01
C1	Prime and Bond 2	9.78	0.98	0.31		-	-	-

The results of one way ANOVA indicated that all the three groups showed significantly different tensile bond strength (F=55.96; P<0.01). Minimum significant range was found to be 1.05 MPa.

Table 3 shows the tensile bond strength between non contaminated and contaminated groups. The mean tensile bond strength of Group A (8.80±1.05 MPa) is slightly higher than A1 (7.99±0.96 MPa) which is statistically not

significant. The Group B (15.14±1.18 MPa) is significantly higher than B1 (5.95±0.55 MPa). The bond strength in Group

C (15.03±0.86 MPa) is significantly higher than C1 (9.78±0.98 MPa).

Table 3: Comparison of bond strength between non contaminated and contaminated groups

Groups	Bond strength (MPa)		Decrease % Reduction in Tensile bond strength	‘t’ value	Significance*
	Non contaminated (Mean ± S.D) (A, B, C)	Contaminated (Mean ± S.D) (A1, B1, C1)			
Amalgam bond	8.808 ± 1.05	7.99 ± 0.96	9	1.18	NS
Scotch bond Multi Purpose	15.142 ± 1.18	5.95 ± 0.55	61	15.3	P<0.001
Prime and Bond 2	15.030 ± 0.86	9.78 ± 0.98	35	12.8	P<0.001

* Students ‘t’ test

DISCUSSION

In non contaminated group the bond strength of scotch bond multipurpose (Group B) was slightly higher when compared to Prime and bond 2.0 (Group C) but statistically no difference was seen. Similar results have been reported in few other studies.^{1 6-9 1} The probable reasons could be to hydroxyl HEMA which increases the surface energy and wettability of dentin surface, BIS-GMA which has a high affinity towards resin helps in better bonding¹⁰.

Group C (Prime and Bond 2.0) had a better bond strength than Group A (Amalgam bond). Prime and bond is an acetone based system which is a better solvent than water for HEMA by virtue of its ability to displace water from the collagen network so that the latter can be saturated with primer. Increased hydrophilicity and low viscosity of TEGMA might have enhanced better primer penetration¹¹.

Group A (Amalgam bond) showed lowest bond strength than other systems. This could be due to the high viscosity of the resin, slow chemical polymerization, high performance additive which is known to enhance the bond strength was not utilized in this study⁷.

In contaminated groups one way ANOVA test indicated that all 3 groups showed significantly different tensile bond strength. Analysis has revealed that Group C1(Prime and bond) was superior with high bond strength followed by Group A1 and B1. The findings of present study are in agreement with the findings of other studies^{5,12,13}. Better bond strength of Group C1 could be due to presence of acetone which is found to be a better primer solvent than water for HEMA in scotch bond multipurpose because of its ability to displace water (plasma products do contain 91-91% water) from the collagen network so that the primer / adhesive can be saturated by achieving wet bonding^{11,14}.

PENTA which might have enhanced better penetration of resin monomer by its characteristic feature of adhesion promotion and weak acidic self etching primer which might have helped in removing some amount of plasma contaminants by etching¹⁵.

Group A1 (Amalgam bond) had better bond strength than B1, this could be due to 4 META which may have incorporated some of the breakdown products of plasma into its bond with collagen, the break down products may serve to enhance the wetness of the dentin and help to achieve a stronger bond with collagen⁵.

Although scotch bond multipurpose had highest bond strength in non contaminated group, it demonstrated dramatic decrease in bond strength after contamination. This may be due to the inability of the adhesive resin to infiltrate around the contaminated collagen. In water based system such as in scotch bond multipurpose, failure to remove excess water or plasma contamination could have resulted in dilution of water soluble resin components reducing the degree of conversion and bond strength^{5,13}.

Contaminated v/s non contaminated groups

Group A (Amalgam bond) has not shown any statistically significant difference between contamination v/s non contaminated counterpart. Reduction of bond strength on contamination was 9% when compared to Group B1 (Scotch bond multipurpose), where there was a reduction of bond strength by 61% and for group C1 (Prime and Bond 2.0) reduction was about 35%. These findings are in agreement with the findings of Miles *et al* and Xie *et al*^{5,13}.

Group B (Prime and Bond 2.0) showed statistically significant difference between the groups. This may be due to the blister like spaces previously occupied by water along the hybrid layer primer interface and phase separation of the primer components in the form of globular resin bodies were observed in the presence of excess surface moisture refereed as over wet phenomenon as observed by optical and SEM studies published have provided a morphological explanation for decrease in bond strength^{8,11}.

Although the bond strength obtained on a non contaminated dentin appears to be enhanced when a conditioner was used. This difference was even more apparent when contaminated dentin was bonded. This implies that the conditioner not only aid in preparing the surface for bonding but may also play a role in decontaminating the surface as suggested by Pashley *et al*¹⁶. If used in endodontic surgery sealing the apical preparation rather than obtaining a strong bond would be the primary objective. However, a test of tensile strength of these materials serves as a measure of their adhesiveness to root dentin than aids in the evaluation of their usefulness in effecting a leak proof bond to this apical area. During polymerization of resin composites, they undergo volumetric shrinkage that can develop a significant tensile force. Thus measurement of tensile force of bonding to dentin is important even though masticatory forces do not stress the root end filling. For these reasons, the evaluations of dentin bonding

agents should include measurement of both bond strength and microleakage^{5,17}.

Although in this study a light cure composite was applied to the bonding agent for testing purpose only. For root end surgery it may only be necessary to condition, prime and apply bonding resin. Now with semi filled resins into market which have shown promising results and if radiopaque bonding resin could be developed there may no need for use of composites.

As this is an *in vitro* study it is not in purview of the study to elaborate most of the vivo conditions. Therefore more elaborate studies are necessary in future to understand and comprehend the findings.

CONCLUSION

The following conclusions can be drawn from the present study

- Scotch bond multipurpose and Prime and Bond 2.0 have shown better bond strength compared to amalgam bond on the non contaminated resected root surface.
- Amalgam bond which is chemically curable has shown a better or rather a minimal drop of bond strength on contamination with blood when compared to non contaminated group.
- Prime and bond 2.0 has shown to be the better compared to amalgam bond and scotch bond multipurpose on contaminated surface in spite of 35% drop of bond strength compared to non contaminated group.
- With the improvements and advances in dentin bonding agents they can be successfully used as an alternative to other root end restorations.

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