

Comparative Evaluation Of The Shear Bond Strengths Of Different Adhesive Systems To Pulp Chamber Dentin In Comparison To Superficial And Middle Dentin.

Abstract

The present in vitro investigation evaluated the shear bond strength of superficial, middle and pulpal dentin restored with composite resin in conjunction with 3 different dentin bonding agents namely Excite, Clearfil Liner Bond 2V, and Prompt-L-Pop.

Research on bond strength values against pulpal dentin with self etching primer is scarce. The aim of this study was to evaluate the effect of endodontic treatment on performance of bonding to pulpal dentin in comparison to normal dentin at various levels.

54 freshly extracted non carious intact human maxillary and mandibular teeth were selected for this study. They were divided into 3 groups of 18 teeth each. The occlusal surface of the teeth were ground to prepare flat dentin surface at three different levels i.e. group 1, superficial dentin; group 2, middle dentin; group 3, pulpal dentin. Each group was further divided into subgroups of 6 teeth each depending on the bonding agents used. In all the 3 groups, the different dentin bonding agents were used on the flat dentinal surfaces according to the manufacturer's instructions. Cylinders of composite resin were built on the prepared surface using Teflon mould. The prepared specimen were then embedded on an acrylic jig of suitable dimension & transferred to Instron machine for shear bond strength analysis. Shear bond strengths were measured at a cross head speed of 0.03mm/sec.

This investigation concluded that superficial dentin fractured at the highest mean shear load while pulpal dentin fractured at the lowest value with all three dentin bonding systems. Highest mean shear bond value was observed in Clearfil liner Bond 2V followed by Excite and Prompt-L-Pop

Key Words

Pulpal dentin, Shear bond strength, Self etching primers

Introduction

The concept of bonding a restorative material to dentinal surface is by no means a new idea. Even at the time of Buonocore using phosphoric acid to bond Enamel, the idea of bonding to dentin was considered^[1].

We can no longer imagine modern dentistry without adhesives. The use of composite resins has become widely accepted for the treatment of both anterior and posterior teeth. Several clinicians in general practice prefer to use composite resins for all sort of clinical situation that includes conventional class III, angle build ups, class V situations as well as class I and class II posterior situations^[2]. The dentin bonding systems have also become an integral part of composite resin technology. The dentin bonding systems have been developed over the years and have become of particular interest to the success of tooth colored restorative materials that include ceramics, composites and compomers^[3].

Amalgam is the most commonly used final restorative material to fill the access opening after endodontic treatment. Recently the opportunity of restoring endodontically treated non vital teeth with resin composite has increased due to the development of better dentin bonding systems^[4]. Bonded resins permit transmission of functional stresses across the bonded interface to the tooth, with the potential to reinforce weakened tooth structure^[5]. A resin composite restoration thus enables non vital teeth to be restored by replacing only the lost tooth structure because the dentin bonding system can reinforce the remaining tooth structure^[6]. Isolated studies have indicated that these chemical irrigants do adversely affect the bond strength of resin composite to dentin stored after endodontic treatment. The successful use of dental adhesive materials relies on their proper selection and on understanding their properties, in particular their curing mechanism and application technique.

¹ Shamina Bawa

² Divakar, K.P.

³ Mithra N.Hegde

⁴ Priyadarshini Hegde

¹ Reader

² Senior Lecturer, Dept Of Cons & Endodontics
D.A.P.M.R.V.Dental College, J.P.Nagar, Bangalore

³ Prof & Hod

⁴ Proffesor, Dept Of Cons & Endodontics
A.B.Shetty Memorial Institute Of Dental Science Mangalore

Address For Correspondence:

Dr. Shamina Bawa, Reader
Department Of Cons & Endodontics
D.A.P.M.R.V.Dental College, 24th Main,
1st Phase, J.P.Nagar, Bangalore -78
Fax : 080-26658411

Mobile No. : 99801 00839

Email ID : shammbawa@rediffmail.com

Submission : 17th September 2013

Accepted : 13th August 2015

Quick Response Code



Enamel adhesion by means of acid etching has become an accepted technique in restorative dentistry. Adhesion to dentin, however is still under investigation. Limited information exists covering dentin bonding to non-vital teeth in general and pulpal dentin in particular. Research on bond strength values against pulpal dentin with newer generation self etching primer is scarce. The aim of this study was to evaluate the effect of endodontic treatment on performance of bonding to pulpal dentin in comparison to normal dentin at various levels.

54 freshly extracted non carious intact human maxillary and mandibular teeth were selected for this study. They were divided into 3 groups of 18 teeth each. The occlusal surface of the teeth were ground on a water cooled trimming wheel to prepare flat dentin surface at three different levels i.e. group 1, superficial dentin; group 2 ,middle dentin; group 3, pulpal dentin. Superficial dentin was defined as the dentin 1.5mm deep from the cuspal tip of the tooth; Middle dentin was defined as the dentin 2.5mm deep from the cuspal tip of the tooth. Pulpal

dentin is the dentin obtained after removal of the roof of the pulp chamber. A small round bur, with markings at 1.5 mm & 2.5 mm respectively on the bur shank was used to determine the depth of the ground dentin from the cuspal tips in group 1 & 2.

Each group was further randomly subdivided into subgroups of 6 teeth each depending on the bonding agents used. In subgroup A, adhesive system Excite (Vivadent), in subgroup B Clearfil liner Bond 2V (KURARAY) and in subgroup C, Prompt-L- Pop (ESPE) was used. In all the 3 groups, debris from the prepared tooth surface was removed using water spray and then air dried. The different dentin bonding agents were used on the flat dentinal surfaces according to the manufacturer's instructions.

In sub group A, where Excite was used, the prepared flat dentinal surface was etched using 35% phosphoric acid for 15 seconds. It was then cleansed and dried using oil free water spray. Dentin bonding agent was then applied and cured according to the manufacturer's instruction. This was followed by packing of composite resin over the prepared dentinal surface using Teflon mould measuring 3X3 mm and cured layer by layer.

In subgroup B, where Clearfil Liner Bond 2 V was used, primer liquid A and B were mixed and then applied to the prepared dentinal Surface. It was dried with mild air stream and left for 30 seconds. Primer was not washed. Bonding agent was applied and light cured for 20 seconds. After curing the bonding agent, composite resin was packed using Teflon mould and cured according to manufacturer's instruction.

In subgroup C, one step self etching primer Prompt-L-Pop was used. Here the liquid from the red blister was transferred into the yellow blister which was then transferred into the green blister which has the applicator tip. Using this applicator tip, the bonding agent was applied to the prepared dentinal surface with moderate finger pressure. Stream of air was used to evenly disperse the material into thin film. The material was then cured for 20 seconds. Composite resin was packed over this prepared surface using Teflon mould and cured layer by layer.

The prepared specimen were then

Group			N	Mean
Excite	shearbond Strength	Superficial	6	14.7037
		Middle	6	10.7963
		Pulpal	6	4.7796
Clearfil Liner	shearbond Strength	Superficial	6	19.5370
		Middle	6	13.7963
		Pulpal	6	7.2222
Prompt-L- Pop	shearbond Strength	Superficial	6	13.5556
		Middle	6	9.2963
		Pulpal	6	4.2963

embedded on an acrylic jig of suitable dimension & transferred to Instron machine for shear bond strength analysis. Shear bond strengths were measured at a cross head speed of 0.03mm/sec.

Results

According to the results analyzed, the highest mean shear strength value was produced by Clearfil Liner Bond 2V (19.53 MPa), followed by Excite (14.7 MPa) and Prompt-L-Pop (13.55MPa). Inter-comparison among groups was done using Boneferonni't' test. In group I & II comparison between bond strength values of Excite & Prompt-L-Pop was not significant. The comparison between the bond strength values of Excite & Clearfil Liner Bond 2V was very highly significant. Very highly significant results were observed when Clearfil Liner Bond 2V was compared with Prompt-L-Pop.

Discussion

Conventional endodontic therapy begins with access cavity preparation and ends with obturation. Coronal leakage is an important cause of failure of root canal treatments^{[7], [8]}. Swartz et al^[9] found that the failure rate was almost twice as high in cases without an adequate restoration compared with cases that were properly restored. Therefore several materials have been used within pulp chamber in an attempt to provide a second line of defense against the leakage of bacteria, if the sealing quality of the material used to close the access opening fails. The access cavity when conserved with minimum involvement, the usual choice as access restorative material is composite resins. The utilization of resins as access restorative material in combination with newer generation dentin bonding agents is almost routine in clinical practice.

Resins as restorative material is nothing new. However, clinicians have hesitated using 4th and 5th generation dentin

ANOVA				
Class		F	Sig.	
Superficial	Between	37.783	.000	VHS
	Groups			
Middle	Between	40.076	.000	VHS
	Groups			
Pulpal	Between	17.843	.000	VHS
	Groups			

bonding systems basically because of the time involved and the number of steps involved in the procedure^[10]. The technique sensitiveness in utilizing these materials also have reduced the use of these materials in day to day practice. Because bonding procedures require multiple step clinical approaches, clinical success with these adhesive systems sometimes depend on technique sensitive and material related factors.

In an effort to simplify the bonding procedure, several new adhesive systems rely on simultaneous etching of enamel and dentin with phosphoric acid or self etching primers. The self etching primer systems combine the tooth surface etching and priming steps to treat enamel and dentin simultaneously. The self etching primers which dissolve the smear layer and demineralise the dentin is an aqueous mixture of acidic functional monomers with other constituents^{[11],[12]}.

Although the most reliable conclusion about the performance of dentin bonding system in the oral environment must be derived from the long term clinical trials, laboratory tests are still necessary to evaluate the different dentin bonding systems.

Variation in dentin depth and permeability can significantly influence the bond strengths of direct resin based restorative systems. Regional structural differences such as caries affected dentin; sclerotic dentin and root dentin are important factors that can affect bond strength to dentin^{[13],[14]}. However, there is little information about the bonding performance of bonding systems to floor of pulp chamber dentin. Few studies have been conducted to evaluate the sealing capabilities of resins against enamel and coronal dentin while little research has been done on adhesion of resins to the floor of the pulp chamber dentin especially with the 6th generation self etching primers.

In the present investigation, we have made an attempt to evaluate a globally accepted self etching primers system, ClearFil Liner Bond 2V in comparison

with more recently introduced self etching primer Prompt-L-Pop.

If one considers characteristics of the endodontically treated tooth, one should accept that the endodontic treatment performed changes the actual composition of the remaining tooth structure. The tooth structure that remains after endodontic treatment is undermined and weakened by caries, fracture, tooth preparation and restoration. Endodontic access into the pulp chamber destroys the structural integrity provided by the coronal dentin of the pulpal roof and allows for greater flexing of the tooth under function^[15].

Nikaido et al^[16] discussing bonding to non-vital teeth are of the opinion that the decreased strength seen in endodontically treated teeth is primarily due to loss of coronal tooth structure and is not a direct result of endodontic treatment.

Akagawa H. et al^[17] evaluated the shear bond strength of coronal dentin and pulpal dentin and came to a conclusion that the bond strength to superficial dentin were within anticipated limits where as bond strengths to deep dentin and floor of the pulp chamber were significantly lower.

The results of the present investigation revealed lower shear bond strengths generally with all the three dentin bonding systems against pulpal dentin. This is in agreement with most of the previous studies including that of Toba S. et al^[18]

In this ongoing investigation, even though we could produce highest shear bond strength values with ClearFil Liner Bond 2V for each of superficial, middle and pulpal dentin region, we could demonstrate a mean shear bond strength value of 19.5 Mpa against superficial dentin and to an extent of 7.2 Mpa against pulpal dentin. Comparatively lower shear bond strength values were obtained against superficial, middle and pulpal dentin with Prompt - L-Pop, a self etching primer and Excite a 5th generation single bottle adhesive system.

Among the self etching primers available in the market, and the first in the series to be globally accepted is ClearFil Liner Bond 2V, a well experimented material and has a long track record. With the manufacturers coming out with a newer generation of self etching primer each time the researchers pointed out the deficiencies in the new products introduced.

The results in our study demonstrated that the self etching primers provided good bonding performance to endodontically treated dentin as well as to normal dentin. It was also found that all of the 3 systems used in this study recorded lower strength values against pulpal dentin. If the intent of the use of adhesive resins inside the pulp chamber is to seal the root canal and to prevent micro-leakage of oral micro-organisms and their products, then high bond strengths are not required. Hence the clinicians should select a material that is simple and technique sensitive.

Akagawa et al studying the shear bond strength to coronal and pulp chamber floor dentin observed that SEM observation of the dentin surfaces treated with phosphoric acid were quite different from those with self etching primers. For phosphoric acid etching, the smear layer overlaying the intertubular dentin was completely removed and the dentinal tubules were opened widely, where as with Clear Fil Liner Bond 2V, the smear layer was removed, however, the smear plugs partially remained because of the weaker demineralization. Such morphological differences are believed to be due to the different acidity of each solution, with phosphoric acid having a pH less than 1.0 and Clearfil Liner Bond 2V has a higher pH of 2.0.

Seema Belli et al^[14] in their study on the regional strengths to adhesive resin to pulp chamber dentin suggested that clinicians should choose an adhesive system that is simple, easily retrievable and technique insensitive.

In the present study, the results indicated that, ClearFil Liner Bond 2V would be a good choice since it produced fairly high bond strength values and is less technique sensitive.

With the introduction of self etching primers and newer adhesive resin system and bonding techniques it is hoped that in future these can be adapted for use within pulp chamber to provide second layer of defense against micro leakage and at the same time have sufficient bond strength values to pulpal dentin so that there is no scope of de-bonding of access restoratives.

Summary & Conclusion

Fifty four freshly extracted non carious intact human maxillary and mandibular teeth were selected for this study. They were divided into 3 groups of 18 teeth each. The occlusal surface of the teeth

were ground to prepare flat dentin surface at three different levels i.e. group 1, superficial dentin; group 2, middle dentin; group 3, pulpal dentin.

Each group was further divided into subgroups of 6 teeth each depending on the bonding agents used. Sub group A- Excite, Sub group B- Clearfil Liner Bond 2V, Sub group C- Prompt L-Pop.

In all the 3 groups, the different dentin bonding agents were used on the flat dentinal surfaces according to the manufacturer's instructions. Cylinders of composite resin were built on the prepared surface using Teflon mould. The prepared specimen were then embedded on an acrylic jig of suitable dimension & transferred to Instron machine for shear bond strength analysis. Shear bond strengths were measured at a cross head speed of 0.03mm/sec.

This investigation concluded that superficial dentin (Group I) fractured at the highest mean shear load while pulpal dentin (Group III) fractured at the lowest value with all three dentin bonding systems. Very highly significant results were observed when ANOVA was applied to the results. Inter comparison was done by Bonferonni 't' test. In Group I, & Group III comparison between the bond strength values of Excite & Prompt -L- Pop was not significant. In Group II, the comparison was between the bond strength values of Excite and Prompt -L Pop, was highly significant. Very highly significant results were observed with other subgroups.

References

1. Mj Tyas, MF Burrow. Adhesive restorative materials : A review, Australian Dent Jour 2004;49 (3) : 112-121.
2. Guilherme C.P. and Luiz N.B.: "Dental adhesion" Present state of the art and future perspectives" Quint International 2002: vol 33,213-224
3. Bouillaguet S., Gysi P. and Wataha J.C.: Bond strength of composite to dentin using conventional, one step and self etching adhesive systems". Journal of dentistry 2001, vol 29:55-61.
4. Seema Belli, Y. Zhang and Patrica N.: "Regional bond strengths of adhesive resins to pulp chamber dentin" Journal of Endodontics 2001: vol 27 (8), 527-532.
5. Eakle WS. Fracture resistance of teeth restored with class II bonded composite resin. J Dent Res

- 1986;65:149-53
6. Yoshiyama M., Urayama A., Matsuo T.: "Bonding to pulpal floor dentin". Modern trends in adhesive dentistry proceedings of the adhesive dentistry forum 1999, Yokohama, Japan, 91-95.
 7. Lin LM, Skribner JR, Gaengler P. Factors associated with endodontic treatment failures. *J Endodon* 1992;18:543-9,
 8. Saunders W, Saunders E. coronal leakage as a cause of failure in root canal therapy : A Review. *Endod Dent Trauma* 1994;10:105-8
 9. Swartz DB, Skidmore AE, Griffin JA. Twenty years of endodontic success and failure. *J Endodon* 1988;14:497-501
 10. Jorge Perdigao, Ronald F. and Bruno T. : "New trends in dentin /enamel adhesion" .*American journal of dentistry* 2000: vol 13:250-300
 11. John Kanca III. Bonding to dentin. Clues to mechanism of Adhesion. *Ame Jour Dent* 1998; vol 11:154-159.
 12. Francesca G.A., Christoph K., and John M. Power: "Bond strength of self etching primers to enamel and dentin of primary teeth". *Pediatric Dentistry* 2001. vol 23, 481-486
 13. Shono Y. and Ogawa T.,: Regional measurement of resin dentin bonding As a Array" *Journal of Dentak Research* 1999: Vol 78(2), 699-705
 14. Yoshikawa T., H. Sano, M.F. Burrow, J. Tagami and D.H. Pahley: "effects of dentin depth and cavity configuration on bond strength". *Journal of dental research* 1999: 78 vol 4, 898-905
 15. Macro Ferrari, Francesco Mannocci : "Bonding to root canal: structural characteristics of the substrate". *American journal of dentistry* 2000; vol 23. 481-486.
 16. Nikaido T., Takano Y., Sasafuchi Y.,: Bond strengths to endodontically treated teeth". *American Journal of dentistry* 1999: August 12(4), 177-180
 17. Akagawa Hirotooshi, Toru Nikaido, Tsunehiko Takada: Shear bond strengths to coronal and pulp chamber floor dentin" *American journal of dentistry* 2000; vol 15(6) 383-388
 18. Toba S. Veeraparvati W. and Shimada V.,: "Micro shear bond strengths of adhesive resins to coronal dentin versus the floor of the pulp chamber" *American journal of dentistry* 2003: sept 16, Spc No 51A-56A.

Source of Support : Nil, Conflict of Interest : None declared