

Evaluation of shear bond strength of composite resin with Vitrebond and TheraCal using two different adhesive system- An in vitro study

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Abstract:

Background: The success of vital pulp therapy depends on the choice of pulp capping agent and the seal provided by coronal restoration. The liners besides protecting the pulp also act as stress buffers for polymerization shrinkage. Various studies have shown variations in resin dentin interface depending on multiple factors of which the choice of adhesive and underlying liner plays a major role.

Objective: To evaluate the shear bond strength of composite resin with Vitrebond and TheraCal using total-etch and self-etch adhesive system.

Materials and Methods: - Forty customized rectangular acrylic blocks, each containing 4×4mm slots were divided into two groups and filled with TheraCal and Vitrebond. Each group was further divided into two subgroups for two different adhesive systems. Total and self-etch bonding system were applied to test material followed by placement of composite resin and were light cured. Instron machine was used to measure the shear bond strength.

Results: Statistical significance was seen between two different bonding system using one way ANOVA and Tukey Post Hoc test ($P < 0.05$). The results suggested that the total-etch adhesive system achieved a stronger bond of composite to TheraCal and Vitrebond as compared to self-etch adhesive system.

Conclusion: Adhesive plays important role in achieving proper seal in vital pulp therapy as compared to pulp capping agent.

Key Word: Adhesive, TheraCal LC, Vitrebond, shear bond strength.

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I. Introduction

In recent years, significant attention has been paid to vital pulp therapy in dentistry¹. VPT is defined as a treatment which aims to preserve and maintain pulp tissue that has been compromised but not destroyed by caries, trauma, or restorative procedures in a healthy state². Previously, this treatment was carried out using calcium hydroxide but due to its unpredictable result, it is not widely accepted³. The advent of new dental biomaterials, backed by appropriate scientific evidence, has led to increased application of VPT now a days⁴.

The failure of all vital pulp therapy procedure is attributed to poor control of pathogens. The poor marginal seal and loss of restoration due to inadequate bonding leads to micro leakage and reinfection thus compromising the therapy. Hence, appropriate seal is required to bond the restorative material with pulp capping agent⁵.

Before the introduction of Vitrebond and TheraCal, calcium hydroxide was used widely as pulp capping material. To overcome some failures of calcium hydroxide, like tunnel like defects in dentinal bridge, low elastic modulus and compressive strength and high solubility, there was a need to invent newer pulp capping materials⁶. Vitrebond is resin modified GIC. It is also used as pulp capping agent with fluoride releasing capacity. Vitrebond has an advantage of overall chemically curing glass ionomer systems in the handling stage. Not only does it set on command, but also its properties develop in a shorter time frame. This is especially important for the development of strength⁷. TheraCal LC is a recently introduced light cured resin modified calcium silicate which can be used as pulp capping agent and also as a liner beneath composites, amalgam and other base materials and cements. It shows physiochemical bond to dentin and faster apatite formation as compared to calcium hydroxide based materials⁸.

Increased demand for adhesive system in dentistry has led to the development of different systems to enable adequate bonding to enamel and dentin with fewer steps. Available dentin adhesives include 3-step, 2-step and one-step adhesives depending on the method of incorporation of the three main constituents of etching, priming, and bonding. Many researchers have attempted to improve the efficacy of dentin bonding agents. Now

that adhesives have reached an acceptable level of bond strength, attempts have focused on reducing the application steps since the use of multi-step agents in children is difficult and time-consuming. Simultaneous enamel and dentin etching systems by using two step 5th generation bonding agents have shown favorable clinical efficacy⁹. Currently, 7th generation self-etch systems combine an etchant, primer and adhesive in one container compared to total-etch or etch and rinse systems, whereby separate etchant, primer, and adhesive monomers are utilized. Thus, they were time saving and shows less microleakage and can be a boon for un-cooperative children¹⁰.

Another factor for successful vital pulp therapy is choice of restorative material. It should eliminate the pathogens, create adequate seal, and should induce mineralization¹¹. Therefore, this study aims at assessing the shear bond strength of composite resin with Vitrebond and TheraCal using total-etch and self-etch adhesive system.

II. Material And Methods

Forty Rectangular self cure acrylic blocks were customized having a central slot of 4×4mm which then were randomly divided into two groups – T and V. In group T TheraCal LC (Bisco Dental) was placed in 2mm thickness. It was placed in 1mm increments and light cured (1200mW/cm²,unicorn Dentmart) according to manufactures instructions. In group V for placement of Vitrebond (3M), powder and liquid of this material was mixed on oil impervious paper and was placed in 2mm increments into acrylic blocks and was light cured according to manufactures instructions. Then groups T and V were further divided into group T5, T7 and V5, V7 respectively depending on the adhesive used.

Group T5- TheraCal + total etch bonding agent

Group T7- TheraCal + self-etch bonding agent

Group V5- Vitrebond + total-etch bonding agent



Group V7- Vitrebond + self- etch bonding agent

In group T5, etching of TheraCal LC was done for 15 second using ScotchbondTM universal etchant (3M ESPE) followed by rinsing for 5sec and drying of tooth with water air syringe. Bonding agent 3M ESPE AdperTM single bond 2 adhesive was applied and cured according to manufacturer’s instructions (Table-1). A 2mm increment of composite resin (Z250 3M ESPE) was placed on prepared surface and light cured (1200mW/cm²,unicorn Dentmart). In group T7, bonding agent Tetric[®] N- Bond self etch (Ivoclar-vivadent) was applied on samples and light cured (1200mW/cm²,unicorn Dentmart) according to manufacturer’s instruction (Table-1). 2mm increment of composite resin (Z250 3M ESPE) was placed on prepared surface and was light cured.

In group V5 and V7, same procedure was done as group T5 and T7 with Vitrebond. All the samples were thermocycle for 700 cycles (5-55°C) before performing shear bond test.

For shear bond strength testing, the samples were sheared with a knife-edge blade on a universal testing machine (Instron, 3369) (Figure no.1) at a cross head speed of 1mm/min. Shear bond strength in MPa was calculated from the peak load at failure divided by the specimen surface area. The obtained results were statistically analyzed. The statistical tests used for analysis of the result were one-way ANOVA and post hoc tukey’s test.

Table no 1: List of materials.

	Material	Manufacturer	Composition	Steps of application
	TheraCal LC (Bisco Dental)	TheraCal LC, Bisco Inc.,Schaumburg,IL USA,1400007820	Portland cement type III, HEMA, PEGDMA, Barium Zirconate	-Inject the material into the cavity 1mm increments -Light cure each increment for 20s
	Vitrebond (3M ESPE)	3M ESPE St, Paul, MN USA	Powder- SiO ₂ , AlF ₃ , ZnO, SrO, cryolite, NH ₄ F, MgO and P ₂ O ₅ Liquid - modified polyacrylic acid, HEMA, water and photoinitiator.	mix powder and liquid (1.4:1 by weight) within 10-15s in 1-2mm increment -light cure for 30s





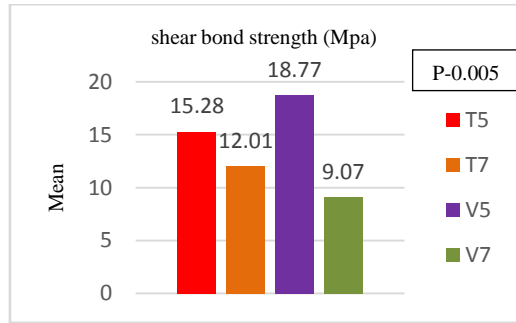
	Etchant Scotchbond™ universal etchant	-	3M ESPE St, Paul, MN USA	34% phosphoric acid with pH approximately 0.1	Apply etchant for 15s, rinse with water for 5s and drying of tooth with water air syringe.
	Bonding agent-3M ESPE Adper™ single bond 2		3M ESPE St, Paul, MN USA	Bis-GMA, HEMA, dimethacrylate, ethanol, water,	Etching (34% phosphoric acid), rinse with water, drying of tooth for 10s, apply adhesive system (30s), light cure for 15s
	Bonding agent - Tetric® N- Bond self etch		Ivoclar vivadent R59913	Phosphoric acid acrylate, HEMA, Bis-GMA, UDMA, Ethanol, catalyst.	Apply a layer of adhesive on dentin/enamel surface, apply gentle stream of air, light cure for 10s
	Composite resin (Z250 3M ESPE)		3M ESPE Dental product, St, Paul, USA	Resin matrix- Bis- GMA, BISEMA, UDMA, TEGDMA Filler loading- 60 vol% silanized zirconia/ silica particles	-Placement of composite in less than 2.5mm increment - Light cure each increment for 20s



Figure no.1: Universal testing machine

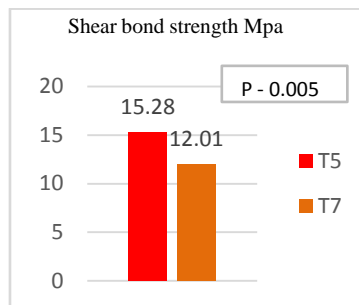
III. Result

The mean value of shear bond strength is given in Graph no1. Highest shear bond strength was obtained with V5 group (Vitrebond +total etch) (18.77Mpa) and least was found with V7 group (Vitrebond + self-etch) (9.07Mpa). When the adhesive systems were compared, total etch system gave higher shear bond value as compared to self-etch adhesive system in both the groups. Intergroup and intragroup comparison (Graph no 2-5) showed high shear bond strength of composite resin in total etch adhesive system with both TheraCal and Vitrebond and was statistically significant. There was no statistical significance found between group T5-V5 (TheraCal/Vitrebond + total etch) and T7-V7 (TheraCal/Vitrebond+self etch)

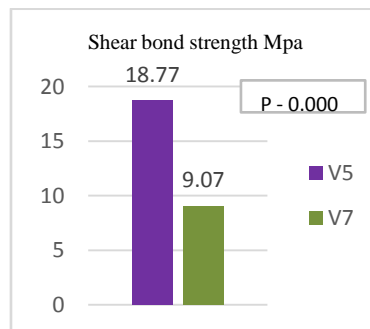


Graph no1: Mean shear bond strength of all the groups.

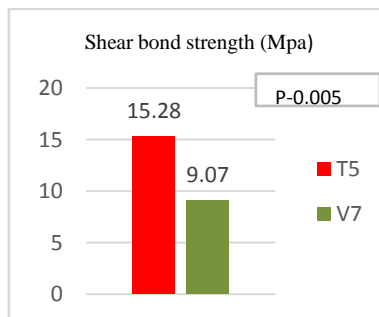
(T5-Thearcal+total etch adhesive system, T7-Theracal + self-etch adhesive system, V1-vitrebond+total etch adhesive system, V7-Vitrebond + self etch adhesive system)



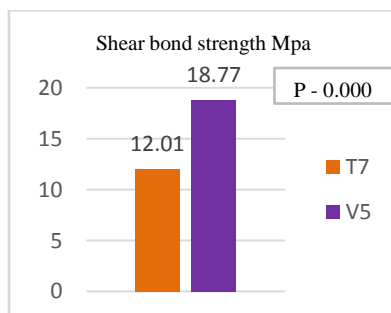
Graph no 2:Comparison of SBS between T5 and T7 group



Graph no 3: Comparison of SBS between V5 and V7 group.



Graph no 4: Comparison of SBS between T5 and V7 group.



Graph no 5: Comparison of SBS between T7 and V5 group.

IV. Discussion

A hermetic coronal seal increases the longevity and success of vital pulp therapy. It's mandatory to provide adequate marginal seal through restoration for favorable outcome. There is recommendation to use composite resin as permanent restoration because of its lower application of force on pulp capping material. The adequate marginal seal and the retention of composite restoration largely depend on its bonding with enamel, dentin, and underlying liner/base.

Though clinical trial is the most definitive way to assess adhesion quality and efficacy, in vitro testing of bond strength can help anticipate the clinical performance of newer materials in shorter time frame. The test for shear bond strength is reliable and widely used for evaluation of adhesive properties of various dental materials under laboratory circumstances^{12,13}.

In this present study, V5 group (Vitrebond + total etch) gave highest mean shear bond strength. The use of RMGIC (Vitrebond) as an intermediate bonding layer between dentin and composite resins may solve some clinical problems related to microleakage and secondary caries due to its chemical bonding and fluoride release. These formulations, however, must have some durability to withstand a range of stresses that form in the cavity, both during the curing of the composite resin and subsequent thermal and mechanical loads¹⁴.

TheraCal LC can be used as direct and indirect pulp therapy under composite, cements and other base material to protect the pulp. TheraCal LC consists of tri-calcium silicate in a hydrophilic monomer offering a substantial release of calcium, making it a very robust and strong material as a liner or base¹⁵⁻¹⁹. TheraCal LC is a hydraulic silicate material that sets by hydration. It depends on the water taken up from the pulp dentin complex and its diffusion within the material. This might affect the subsequent bonding. In substitution of TheraCal LC, other materials like, GIC, RMGIC, IRM, ZOE can be used. However, a study by Cantekin et al, [2015] showed higher bond strength of TheraCal when compared with silorane-based composites and GI cement and is contradictory to our results²⁰. A study by Deepa VL et al, [2016] showed similar shear bond strength with TheraCal LC and RMGIC when universal adhesive was used and it is similar to our results where no statistical significant difference was found between the groups when self-etch adhesive was used²¹.

Clinical success of composite restorations depends on the adhesive system and its ability to achieve a strong composite-dentin bond. In our study both groups performed better with total etch adhesives than the self-etch adhesives. The total etch technique removes smear layer completely and demineralize subsurface intact dentin whereas in self etch approach the underlying dentin is intact, the smear layer is partially demineralized and is used as bonding substrate. Morphological differences exist between the bonds of total etch and self-etch systems. One difference is in the thickness of the hybrid layer. In this study total etch adhesive (5th generation) system gave better result as compared to self-etch adhesive system (7th generation). The strong bond of total etched adhesive system is achieved by means of resin tags which aids in mechanical interlocking with etched surface, adhesive lateral branches, and hybrid layer formation²².

The reasons for the low bond strength of self-etching primers might be, the combination of acidic hydrophilic and hydrophobic monomers into a single step that may compromise polymerization process, the poor strength of the adhesive polymer, the poor polymerization of resin monomer due to inhibition of major solvent during light curing, the incompatibility between the adhesive and the restorative material. Self-etch was applied in one single coat and may also be the cause of low bond strength, as adherents have consistency, which can be strengthened by adding several adhesive coats and increasing bonding efficiency²³.

The present results have shown that the bonding of composite is majorly affected by the type of bonding agents used rather than the choice of pulp capping agent/liner/base (Vitrebond and TheraCal LC).

Limitations

This is an in vitro study, so further clinical trials are required to evaluate the efficacy of different generation bonding agents along with different restorative materials in different testing condition. Also, the mode of failure was not accounted in our study.

V. Conclusion

It can be concluded that Adhesive system plays important role in achieving proper seal and adequate resin dentin interface and within limitations of this study, total etch adhesives exhibited better shear bond as compared to self-etch adhesives.

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