**International Journal of Current Advanced Research**
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 7; Issue 3(C); Macrh 2018; Page No. 10639-10642
DOI: http://dx.doi.org/10.24327/ijcar.2018.10642.1812

**Research Article**

# GADDALAY S ET AL.: A COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH OF FLOWABLE COMPOSITE WITH THERACAL LC, BIODENTINE AND MINERAL TRIOXIDE AGGREGATE: AN IN- VITRO STUDY

**Sunanda Gaddalay., Godavari Nagargoje*., Anita Kale., Shruti Hariramani., Madhuri Agrawal and Akshay Gelda**

MIDSR Dental College, Latur, Maharashtra, India

**A R T I C L E I N F O**

***Article History:***

Received 16th December, 2017
Received in revised form 21st January, 2018 Accepted 05th February, 2018
Published online 28th March, 2018

***Key words:***

Pulp capping agents , shear strength, universal testing machine, universal adhesive.

**A B S T R A C T**

***Introduction***: Vital pulp therapy is a domain of interest in endodontics in recent years to preserve pulp vitality in young permanent teeth, the calcium-based cement is reported to preserve pulp vitality, promote pulp healing and provide a natural substitute for dentine through bioactive stimulation of the dentin-pulpal complex. This study aims to evaluate and compare bonding ability of flowable composite with three different pulp capping material.

***Materials and method***: Sixty cylindrical acrylic blocks with hole of 3mm in diameter and 1.5 mm in height were prepared and divided randomly into 3 groups containing 20 samples each based on the material used i.e. TheraCal LC ( Group I), Biodentine (Group II), Mineral trioxide aggregate (Group III). Over the pulp capping material, flowable composite was applied by means of plastic cylinder with height and diameter each of 2 mm. Shear bond strength was tested with universal testing machine at crosshead speed of 1mm/min.

***Result***: Data were analyzed using ANOVA "F" and the post hoc Turkey's test,Group I (Flowable composite- TheraCal LC) showed highly significant Shear bond strength values in comparison with group I and group II ($P<0.001$), whereas group II showed significant values in comparison with group III ( $P=0.001$)

***Conclusion:*** The flowable composite resin to resin component of Theracal LC bond fared better than the flowable resin to calcium silicate based materials MTA and Biodentine when used as pulp capping agent.



## INTRODUCTION

Direct pulp capping procedure involves placement of a dental material over the exposed pulp in an attempt to act as a pulpal barrier, protection of the dentine pulp-complex and preservation of its vitality, for that purpose pulp capping material should possess bioactivity, biocompatibility and remineralization ability. Extensive research has been taking place in generating bioactive restorative materials with a potential for remineralization Bioactivity refers to ability of material to form apatite. While bio-mineralization is the ability to get anchored to the underlying dentin by the formation of a mineral-rich interfacial layer and a tag-like structure extending to the dentinal tubules from the interfacial layer.[1] The calcium-based cement is reported to display novel bioactive properties and can achieve biomimetic mineralization within the depths of a carious cavity. The use of bioactive liners beneath flowable resin composite would clinically be more advantageous than using GIC liners as they are biologically well-tolerated by the pulp tissue [2] and have comparatively higher remineralizing ability [3].

**Corresponding author:* **Godavari Nagargoje**
MIDSR Dental College, Latur, Maharashtra, India

The success of these intermediate restorations depend not only on the bond strength of the pulp capping material to the dentin but also on the quality of bond between pulp capping material and overlying flowable composite. Traditionally, calcium hydroxide was used in such treatments but has not been widely accepted because of unpredictable results such as non-adherence to dentin, higher dissolution and formation of dentin bridges with multiple tunnel defects (4). Thus, novel dental biomaterials are being used instead of calcium hydroxide such as Mineral trioxide aggregate (MTA), Biodentine, TheraCal LC and calcium enriched mixture (CEM) cement. MTA has attracted considerable attention because of its desired properties such as biocompatibility, low solubility. When applied directly onto the pulp, MTA as a bioactive material with high sealing ability stimulates the formation of dentinal bridge and helps in pulpal healing, yielding high clinical success rate. However, MTA has certain disadvantages such as long setting time and poor handling properties also original gray MTA has been associated with discoloration [5, 6].

Among the various modifications to overcome the drawbacks of MTA, MTA Angelus was introduced in 2001 which contains 80% Portland cement and 20% bismuth oxide, has a

lower radiopacity than white MTA and Grey MTA. Absence of dehydrated calcium sulfate makes the material setting time 10 to 15 minutes (14.28 + 0.49 min), which is lower than setting times of WMTA and GMTA [7, 8]. Biodentine is another calcium silicate–based material used for direct and indirect pulp capping by virtue of its mineralizing ability and better marginal sealing by adhering to both enamel and dentin, the liquid contains calcium chloride with a water-reducing agent. The addition of calcium chloride results in shorter setting time, as it also accelerates the rate of early strength development. Thus, the main advantages of Biodentine over MTA are its greater viscosity and its shorter setting time (10 min Initial setting time)[9, 10].

TheraCal is a new light-cured, resin-modified, calcium silicate–based material used as pulp capping material underlying restorative material because of its unique apatite stimulating ability makes it ideal for direct and indirect pulp capping and as a protective base/liner.[6] Hashem AA. [11] demonstrated that the coronal restorations over pulp capping agents should have low condensation forces as pulp is exposed. The use of an intermediate restorative materials has been emphasized between the pulp capping agent and final restorative materials, flowable composite (FC) used in this study as intermediate restorative material because of favorable properties like non-stickiness, fluid inject ability, high flexural strength to provide less stress to the underlying material.

Evaluation for bonding durability is important since the long‑term clinical success might be dependent on the stability of the bond at interface. (Between intermediate restorative material and pulp capping material) [12] Therefore, the purpose of this study was to measure and compare the shear bond strength of flowable composite with three different pulp capping material. The null hypothesis tested was that there is no significant difference in the shear bond strength amongst the three groups.

## MATERIAL & METHODS

This in vitro study was conducted in the Department of Conservative Dentistry & Endodontics, MIDSR Dental College & Hospital, Ambajogai Road, Latur, Maharashtra, India after getting approval from ethical committee. This study was conducted between august 2016 to October 2016. Sixty acrylic blocks (acrylic block for with a hole (3mm in diameter and 1.5mm in height) was prepared and then divided into 3 groups of 20 teeth each. The division was as follows:

***Group I***: TheraCal LC (TheraCal LC TM, Bisco Inc, Shamburg, IL, USA)
***Group II***: Biodentine (Biodentine TM, Septodont, Saint-Muar-des-Fosses, Creteil, France)
***Group III***: Mineral trioxide aggregate (MTA angelus, Londrina, PR, brazil)

All materials were used according to manufacturer's instructions. In Group I, holes were filled with TheraCal LC, Group II with Biodentine and lastly, GROUP III with MTA. All the surfaces were not polished to mimic clinical scenario.
As TheraCal LC is light cured material bonding agent, Universal adhesive, (Single Bond Universal TM, 3M ESPE, St. Paul, MN, USA) was applied immediately after curing on surface rubbed for 20s followed by gentle air drying with oil-free compressed air for approximately 5s to evaporate the bonding agent and was light cured after placing the polyethylene tube (2-mm diameter, 2-mm height) for 10 seconds as per the manufacturer's instructions. Procedure of adhesive application repeated for group II and group III except bonding agent was applied after initial setting reaction. Then Flowable composite (3M ESPE, St. Paul, MN, USA) was placed in the tube and light-cured with a light-emitting diode light-curing unit (Blue phase, Ivoclar Vivadent, Schaan, Lichtenstein) with an intensity of 1,200 mV/cm2 for 20s. After the completion of composite build-up, the polyethylene tubes were removed with scalpel blade no.12. All the three groups did not show any pre-test failure that might affect the result. All specimens were stored at 100% relative humidity at 37∘C for 24 hour.

### MEASUREMENT OF SHEAR BOND STRENGTH

The specimens were attached to the universal testing machine (ACME Engineers, India.). For shear bond strength SBS testing, the specimens were secured in a holder placed on the platen of the universal testing machine and then sheared with a knife-edge blade on a universal testing machine at a cross-head speed of 1.0 mm/min until bond failure occurred. The load at point failure occured was recorded in N/mm sqaure and then values converted to MPa.

### RESULT

Mean shear bond strength values and standard deviations are shown in table below, Data were analyzed by SPSS version 16 Chicago release 2007, ANOVA "F" Test was used for intergroup comparison and Tukey post Hoc test was used for multiple group comparison. Intergroup comparison showed highly significant difference in all three groups.

**Table 1** Inter-group comparison of shear bond strength of flowable composite to three different pulp capping materials: thercal LC, biodentine and mineral trioxide aggregate (ANOVA 'F' TEST)

| Shear bond strength | Mean | Std. Deviation | F | P Value, Significance |
|---|---|---|---|---|
| Group I : Theracal LC | **6.11** | 0.84 | 98.794 | <0.001, highly significant |
| Group II : Biodentine | **3.01** | 0.79 | | |
| Group III : Mineral trioxide aggregate | **1.7** | 0.45 | | |

p<0.05 –significant, p<0.001 – highly significant

**Table no 2** Tukey's post –hoc analysis: for multiple individual comparisons

| | Group | Mean difference | 'p' value and significance |
|---|---|---|---|
| Group i (theracal lc) | Group ii (biodentine) | 3.10 | <0.001, highly significant |
| Group i (theracal lc) | Group iii (mta) | 4.41 | <0.001, highly significant |
| Group ii (biodentine) | Group iii (mta) | 1.3 | 0.001, significant |

p<0.05 –significant, p<0.001 – highly significant

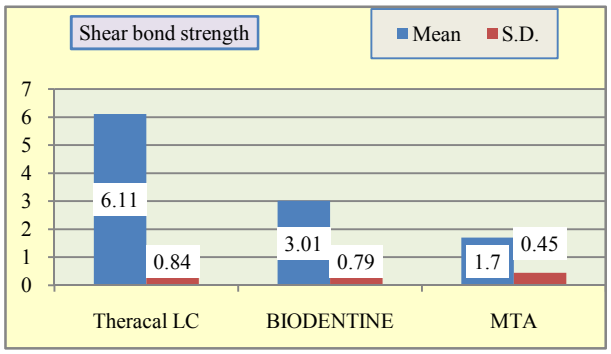


**Table no 3** mean (mpa) and standard deviation

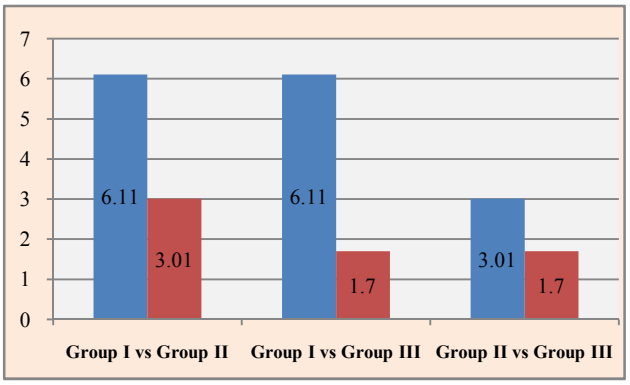


**Table no 4** multiple individual comparison

## DISCUSSION

Adhesion in dentistry could be stated as the relationship between bonding and stress. The restoration would be successful if the bonding will be able to withstand the stress. Strong and durable bonding at the interface (between flowable composite and pulp capping material) are essential when judging the clinical success.

To assess the bond strength of restorative materials, various tests have been presented. Shear bond strength test is easy to perform, comparatively simple, and reproducible and most common laboratory test for analyzing the performance of adhesive restoration [13, 14]. And therefore is considered for evaluation of bonding ability at flowable composite and pulp capping material interface.

In the present study, the adhesive used was methacryloyloxydecyl dihydrogen phosphate (MDP)-based. This self-etch 10-MDP-based adhesive shows chemical bonding to Al, $Ca^{++}$ ions, and zirconium oxides. Silane component of this adhesive agent act as adhesion promoter by enhancing the wetting ability of the adhesive system and bonds chemically to silica-containing materials and has methacrylate functionality that allows chemical union with resinous substrate. This adhesive was selected in our study, aiming for additional chemical bonding with Ca releasing bioactive liners [1]. MTA and Biodentine cement are brittle materials, the shear bond strength test was chosen and considered as the best method for analysis in our study [15]. TheraCal is novel pulp capping material and contains 45 wt% mineral (type III Portland cement), 10 wt% radiopaque agent, 5 wt% hydrophilic thickening agent, and 45% resin. Mechanical properties analysis indicates that TheraCal has the greatest compressive and flexural strengths, whereas Biodentine has a higher stiffness and flexural modulus [16].

In this study, Groups I (TLC) showed significantly higher bond strength than Group II (BD) and group III (MTA) as TLC is resin-based calcium silicate cements that attain strength on light activation. Group II (BD) showed less mean SBS value (3.01 MPa), which may be due to low early strength of the material and this was in agreement with previous studies.[17] BD needs at least 2 weeks' time for crystallization of hydrated calcium silicate gel to attain bulk strength adequate to withstand the polymerization stresses and is also stated that it is porous material. In the present study, adhesive was applied to BD after initial setting reaction (10 minutes) to complete the single appointment clinical procedure. This might be the possible reason for low shear bond strength of BD. Altunsoy M. [18] studied SBS of self-adhering flowable composite and a flowable base composite to MTA and showed SBS of biodentine to Vertise flow & X-tra base 1.2 and 1.69. Mpa result of our study is in comparable with this study.

Bayrak S. [19] compared the SBS of composites using different adhesive systems to MTA and found that 1-step self-etch adhesive (Adper Prompt L-Pop; 3M ESPE, St Paul, MN) showed an SBS value of 5 MPa.

Osskoee SS *et al*. [20] reported that, in case the surface of MTA was not etched, Adper single bond showed an SBS value of 2.76 Mpa. In the present study, the shear bond strength of flowable composite to MTA using single bond was 1.7 Mpa which is lower in comparison to study by Osskoee.

Odabas ME. [21] evaluated the SBS of different adhesive systems to Biodentine and reported that SBS of these materials varied between 15 and 19 MPa highest shear bond strength value was obtained with self-etch adhesive systems

Neelakantan *et al*. [22] found that one-step self-etch adhesive (Clearfil S3 Bond) demonstrated higher bond strength to white MTA than did the two-step self-etch adhesive (AdheSE) and the etch-and-rinse adhesive systems (Prime & Bond NT) immediately and 24 hours after fabrication.

In the present study, the SBS values of the specimens were lower than those found in previous studies [19, 20, 21, 22] reported a higher bond strength than those found in the present study, variation obtained in previous studies may possibly arise from differences in the method used.

***Limitation***: Mode of failure after testing of shear bond strength not evaluated.

***Future prospective***: Though highest shear bond strength observed with group I TheraCal Lc, and restoration can be completed in single appointment. Questions exist regarding the efficacy of resin-containing materials such as TheraCal LC directly applied on the pulp and need to be evaluated.

## CONCLUSION

Within the limitations of this in vitro study, this could be concluded that, TheraCal LC showed higher shear bond strength values as compared to Biodentine & MTA, as TheraCal LC is light cured resin modified Silicate based material and final restoration can be placed at the same appointment.

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**How to cite this article:**

Sunanda Gaddalay *et al* (2018) 'Gaddalay s et al.: a comparative evaluation of shear bond strength of flowable composite with theracal lc, biodentine and mineral trioxide aggregate: an in- vitro study', *International Journal of Current Advanced Research,* 07(3), pp. 10639-10642. DOI: http://dx.doi.org/10.24327/ijcar.2018.10642.1812


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