Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2245-2250 | ISSN:2251-6727

"Evaluation of shear bond strength of a composite resin to biodentine with three different bonding systems-an in vitro study"

Dr Abhipsha Lahiri, M.D.S. (Conservative Dentistry and Endodontics)
Tutor, Department of Conservative Dentistry and Endodontics, Siddhpur dental college and hospital, Dethali Siddhpur - 384151
(corresponding author)

Dr. Nimisha Chaudhary
M.D.S(Conservative Dentistry & Endodontics)Associate Professor Dept of Endodontics Siddhpur dental college & hospital Dethali, Siddhpur 384151

Dr. Thanmai Taduri
MDS (Prosthodontics) Lecturer , Department of Prosthodontics Faculty of Dental Sciences Dharmsinh Desai University College Road, Nadiad Gujarat, India 387001

(Received: 02 October 2023 Revised: 10 November Accepted: 27 December)

KEYWORDS
Biodentine, Etch and rinse adhesives, Self etching adhesives, Shear bond strength

Abstract
The purpose of the study was to evaluate the bond strength of composite resin to Biodentine using three different bonding systems.
Method: 60 cylindrical acrylic blocks with central hole measuring 4mm in diameter and 2mm in depth was prepared and Biodentine was placed and divided into three groups.
In **Group A**, the surface of the Biodentine was etched with 37% phosphoric acid and then adhesive (Adper single bond 2, 3M ESPE, USA) applied. In **Group B** a self etching adhesive (Clearfil SE Bond, Kuraray, Japan) was used, and **Group C**, an all in one system (G Bond, GC Corporation,Japan) was used . A composite resin (Filtek Z350 XT, 3M ESPE, USA) of the dimension 2mm diameter and 2mm length was placed on the Biodentine in all three groups. The polymerized specimens were stored in 100% relative humidity at 37^{o} C for 7 days in an incubator.

These specimens were secured in a holder placed on platform of the universal testing machine for shear bond strength testing. A knife edge blade of the dimension 2mm was used to apply a vertical loading force at a cross head speed of 1.0mm/min until the failure of the bond between the composite and biodentine was seen. The peak at which this failure occurs was recorded. The bond strength was calculated in kilonewton and divided by specimen area and subjected to one-way analysis of variance (ANOVA) and Tukey's post hoc test.
Results: Group A showed a bond strength of 0.024 kN/mm^2 , Group B 0.015 kN/mm^2 and in Group C 0.020 kN/mm^2 bond strength was recorded.
Conclusion: Group A i.e. etch and rinse system showed the highest bond strength followed by Group C i.e. all in one bottle system and lowest bond strength was recorded with Group B i.e. self etching adhesives.

Introduction

Pulp capping procedures are recommended to maintain the vitality of the pulp. After placement of pulp capping agents, a final restoration is mandatory. Proper adhesion between the restorative material and pulp capping agent will lead to less

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2245-2250 | ISSN:2251-6727

microleakage , less ingress of oral fluids and bacteria along the dentinal wall and reduces clinical problems such as post operative sensitivity and results in better durability[1].

Various pulp capping agents such as calcium hydroxide, which was introduced by Hermann in 1920, MTA , introduced by Dr. M. Torabinejad in 1993, were earlier frequently used. In the year 2009, a novel calcium silicate based cement Biodentine manufactured by Septodont (Saint-Maur-des-Foss´es Cedex,France), was introduced in the market. This was described as a bioactive and biocompatible replacement of dentine[2].

For final restoration the most common material used is composite. An adequate bonding between the capping agent and composite will lead to less microleakage and a gap free restoration. To achieve this various bonding agents are available, most commonly used are fifth, sixth and seventh generation. Proper bond strength will help in resisting the contraction stresses that develop in restorative material and produce a margin free of gaps[3].

Biodentine is recommended for use under composite restorations, but the bond strength between composite and biodentine has not been thoroughly evaluated.

Material and methods

Using a putty impression material mould, 60 acrylic cylinders were prepared with a central hole of 2mm depth and 4 mm width. Biodentine (Septodont,Saint-Maur-des-Foss´es Cedex,France) capsules were opened and mixed according to manufacturer's instructions in an amalgamator. The central hole in the acrylic blocks were completely filled with Biodentine, and was allowed to set for 12minutes.

Figure 1: 60 acrylic cylindrical blocks with a central hole of 4mm diameter and 2mm depth

Then the cylinders were randomly divided into three groups of 20 each.

Group A, Biodentine was etched with 37% Phosphoric acid(Ivoclar, Vivadent) and left undisturbed for 15 seconds, and then rinsed for 10 seconds and then dried with blotting paper. Three coats of etch and rinse adhesive system, i.e. fifth generation, Adper Single Bond 2(3M ESPE, USA) was applied and cured following manufacturer's instructions.

In Group B, Biodentine was coated with Primer from Clearfil SE Bond (Kuraray, Japan) and left undisturbed for 20 secs and dried. The Bond was applied after this and mild air was exposed to it to distribute it evenly on the surface and then light cured for 10 secs with LED.D (Woodpecker, China) as per manufacturer's instruction.

In Group C, Biodentine was coated with G Bond (GC Corporation, Japan), left undisturbed for 10 secs, then was dried thoroughly under maximum air pressure with a three-way syringe for 5 secs. Light curing was done for 10 secs using LED.D (Woodpecker, China) as per manufacturer's instruction.

Composite (Filtek Z350 XT, 3M ESPE, USA) over the bonding agents in all three group was done using a plastic template with inner width of 2mm and height of 2mm. It was then cured with LED.D (Woodpecker, China).

All samples were secured on a holder and placed on the platform of the universal testing machine for shear bond strength testing. A knife edge blade of the dimension 2mm was used to apply a vertical loading force at a cross head speed of 1.0mm/min until the failure of the bond between the composite and Biodentine occurred. The peak load at which this failure occurred was recorded and tabulated. The results were subjected to one-way ANOVA test and pairwise comparision was done using Tukeys Multiple Posthoc procedures, with confidence level set at 95% (P Value < 0.05).

Results

The bond strength of Group A i.e. Adper Single Bond 2 was 24.74±6.76 N/mm^2 which is the highest amongst the three groups followed by G Bond in which the average bond strength was recorded as 20.88± 5.07 N/mm^2. Bond strength of Clearfil SE

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2245-2250 | ISSN:2251-6727

was 15.79±3.82 N/mm^2, lowest amongst the three groups. Significant difference was seen between Group A and B, Group B and C. (Table 1-3) (Graph 1)

Table 1 shows the mean shear bond strength of the three groups.

Groups	Mean	SD	SE	CV
Group A	24.74	6.76	1.55	27.35
Group B	15.79	3.82	0.88	24.22
Group C	20.88	5.07	1.23	24.29

Table 2 Comparison of three groups (A, B, C) with respect to shear bond strength by one-way ANOVA test

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F-value	p-value
Between groups	2	765.03	382.51	13.2728	0.0001 *
Within groups	52	1498.61	28.82		
Total	54	2263.64			

*p<0.05

Table 3: Pair wise comparisons of three groups (A, B, C) with respect to shear bond strength by Tukeys Multiple Posthoc procedures

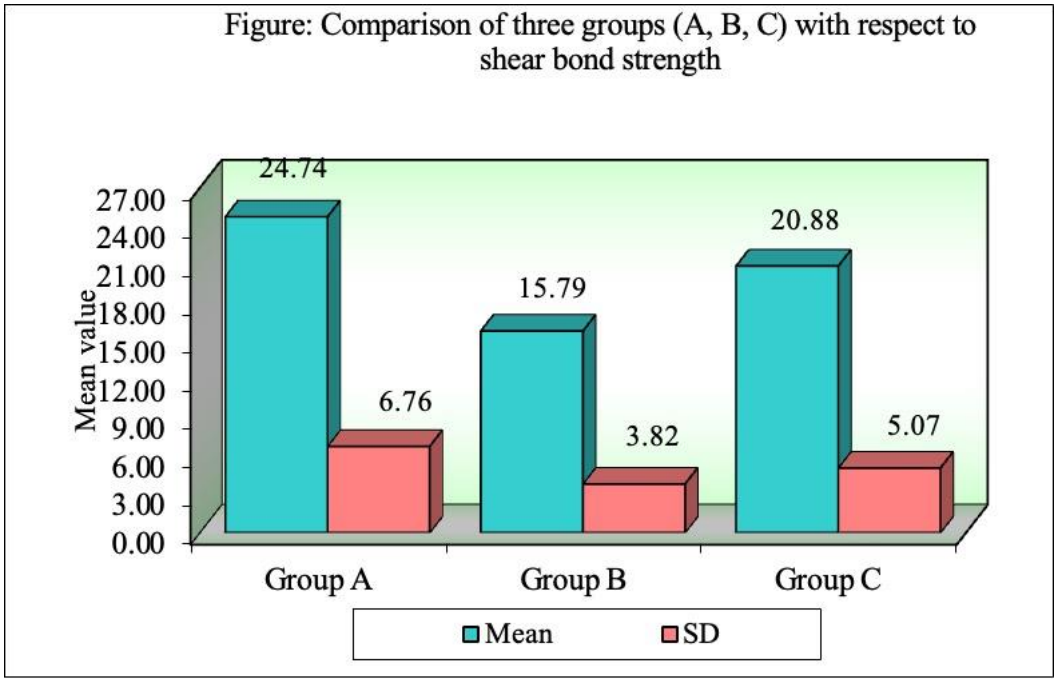
Groups	Group A	Group B	Group C
Mean	24.74	15.79	20.88
SD	6.76	3.82	5.07
Group A	-		
Group B	P=0.0001*	-	
Group C	P=0.0897	P=0.0174*	-

*p<0.05

Graph 1:

Bar graph representing the mean shear bond strength and the standard deviation of each group.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2245-2250 | ISSN:2251-6727



Discussion

Biodentine, was introduced in 2009, with an intention of not only replacing the tooth structure but also to regenerate it[2]. The quality and durability of the adhesive bond between biodentine and composite resin significantly affects the longevity of the final restoration, which is affected by the type of adhesive used[4].

Shear bond strength is a method to evaluate the maximum force that can be applied to the adhesive area between two materials before the adhesive joint fractures[5]. The more the bond strength, the more force will be tolerated by the restoration before showing adhesive failure.

In this study, higher bond strength was observed with etch and rinse system, i.e. Group A (Adper single bond 2, 3M ESPE, USA). It showed a strength of 24.74 ± 6.76 N/mm^2.

The same conclusion was made in a study conducted by Yellamali et al in which they evaluated the shear bond strength of composite to White MTA using fifth, sixth and seventh generation bonding agent[6].

Several reasons have been cited for better performance of etch and rinse adhesives in comparison to self etching adhesives, some of them being-

- When acidic hydrophilic monomers are mixed with hydrophilic monomers to convert it into a single step procedure, the polymerization of the adhesive gets compromised
- The adhesive polymer has a lower strength[3]
- During the light activation of the resin monomer, the presence of oxygen inhibitor[3] causes low degree of polymerization[7]

Study conducted by Camilleri et al showed that when biodentine was etched with 37% phosphoric acid, it exhibited an etch pattern which was composed of large areas approximately 100 mm in diameter that were worn down lower than the rest of the material surface[8], this may have caused better bond strength that was recorded in this study. Kayahan et al in his study concluded that no reduction in compressive strength of Biodentine was observed when etched with 37% phosphoric acid[9]. Hence Biodentine can be etched without the risk of compromising the strength of the material.

A correlation between the pH of self-etch primer and the depth of interaction with dentin was observed as by De Munck et al[10]. ClearFil SE is a mild self etch adhesive (pH of 2) and G Bond is an ultra mild self etch adhesive (with pH > 2.5).[10] Typically higher pH self etch adhesives have been documented with relatively lower bond strength values.[11]

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2245-2250 | ISSN:2251-6727

The bond strength of seventh generation agent was significantly higher than that of sixth generation bonding agent, in this study. This is in agreement with study conducted by Nair et al where they concluded that seventh generation bonding agents showed significantly higher bond strength when compared to that of the sixth generation[12].According to Jacobsen and Söderholm, bonding systems based on water may result in lower bond strength due to incomplete polymerization of the monomers[13]. Clearfil SE only has water as a solvent whereas G Bond has water and acetone as its constituents, this may be one of the reasons for lower bond strength of Clearfil SE[14].

The content of the adhesives i.e. number of monomers, diluents, and filler load differs between products, and is not well-described in adhesive composition. Also, the affect of polymerization on the shrinkage and stiffness of these filled adhesives is largely unknown. These factors could alter the shear bond strength significantly, but is not listed by manufacturer as final formulation is proprietary secret[12]

In literature, large variations are seen in recoded bond strength data. This is attributed to difference in protocols followed[15]. Also the type of bond strength test (shear or tensile), storage media used, environmental relative humidity in substrates, complex nature of testing procedures, sensitivity of handling and manipulation of these systems and composite restorative material might be the cause of these inconsistency[16].

Though the bonding efficacy of bonding agents have been evaluated using MTA or Glass Ionomer cement or dentine as a substrate, the bonding has not been widely evaluated while using Biodentine. Since, Biodentine is gaining popularity and is being used frequently in dentistry and the manufacturers claim that it can be placed directly under the composite restoration; further studies need to be conducted. Also, the surface characteristics and compressive strength of Biodentine after the use of varying bonding agents has not been widely evaluated. More in vitro studies need to be conducted for the same.

Conclusion

Within the limitations of the in vitro study conducted, the etch and rinse system used i.e. Adper Single Bond 2, showed higher shear bond strength compared to the other tested adhesives when used to bond composite to Biodentine. It was also seen, that the All in one bottle system, i.e. G Bond, showed better shear bond strength compared to two bottle self etching adhesive, i.e. Clearfil SE when bond strength of composite to Biodentine was measure

Refrences

1. Robbins JW, Hilton TJ, Schwartz RS, dos Santos Jr J. Fundamentals of operative dentistry: a contemporary approach. Summitt JB, editor. Quintessence Pub.; 2006 Nov.
2. Bachoo IK, Seymour D, Brunton P. A biocompatible and bioactive replacement for dentine: is this a reality? The properties and uses of a novel calcium-based cement. British dental journal. 2013 Jan;214(2):E5.
3. Bayrak S, TUNÇ ES, Saroglu I, Egilmez T. Shear bond strengths of different adhesive systems to white mineral trioxide aggregate. Dental materials journal. 2009;28(1):62-7.
4. Hashem DF, Foxton R, Manoharan A, Watson TF, Banerjee A. The physical characteristics of resin composite–calcium silicate interface as part of a layered/laminate adhesive restoration. Dental Materials. 2014 Mar 1;30(3):343-9.
5. Atmeh AR, Chong EZ, Richard G, Festy F, Watson TF. Dentin-cement interfacial interaction: calcium silicates and polyalkenoates. Journal of dental research. 2012 May;91(5):454-9.
6. Yelamali S, Patil AC. "Evaluation of shear bond strength of a composite resin to white mineral trioxide aggregate with three different bonding systems"-An in vitro analysis. Journal of clinical and experimental dentistry. 2016 Jul;8(3):e273.
7. Borges MA, Matos IC, Dias KR. Influence of two self-etching primer systems on enamel adhesion. Brazilian dental journal. 2007;18(2):113-8.

8. Camilleri J. Investigation of Biodentine as dentine replacement material. Journal of dentistry. 2013 Jul 1;41(7):600-10.
9. Kayahan MB, Nekoofar MH, McCann A, Sunay H, Kaptan RF, Meraji N, Dummer PM. Effect of acid etching procedures on the compressive strength of 4 calcium silicate-based endodontic cements. *J Endod* 2013;39:1646-8.
10. De Munck J, Vargas M, Iracki J, Van Landuyt K, Poitevin A, Lambrechts P, et al. One-day bonding effectiveness of new self-etch adhesives to bur-cut enamel and dentin. Oper Dent 2005;30:39-49.
11. Sarr M, Benoist FL, Bane K, Aidara AW, Seck A, Toure B. Bonding effectiveness of self-etch adhesives to dentin after 24 h water storage. Journal of conservative dentistry: JCD. 2018 Mar;21(2):142.
12. Nair M, Paul J, Kumar S, Chakravarthy Y, Krishna V. Comparative evaluation of the bonding efficacy of sixth and seventh generation bonding agents: An In-Vitro study. Journal of conservative dentistry: JCD. 2014 Jan;17(1):27.
13. Jacobsen T, Söderholm KJ. Some effects of water on dentin bonding. Dental Materials. 1995 Mar 1;11(2):132-6.
14. Inoue S, Vargas MA, Abe Y, Yoshida Y, Lambrechts P, Vanherle G, Sano H, Van Meerbeek B. Microtensile bond strength of eleven contemporary adhesives to dentin. J Adhes Dent 2001; 3: 237-245.
15. Mcleod ME, Price RB, Felix CM. Effect of configuration factor on shear bond strengths of self-etch adhesive systems to ground enamel and dentin. Oper Dent. 2010;35:84–93
16. Kaaden C, Powers JM, Friedl KH, Schmalz G. Bond strength of self-etching adhesives to dental hard tissues. Clinical oral investigations. 2002 Sep 1;6(3):155-60.