# 'COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH OF PORCELAIN LUTED TO ENAMEL & DENTIN WITH TWO DIFFERENT RESIN CEMENTS- AN *IN VITRO* STUDY.

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**Statement of problem**: *Self Adhesive Cement* belongs to the newly introduced category that combines the use of adhesive and cement in one single application eliminating the need of pretreatment of tooth surface. However, there is very little published data on its bond strength with tooth and ceramic. This study was thus aimed to evaluate and compare shear bond strength of porcelain luted to enamel & dentin with self-adhesive and conventional Bis-GMA resin cement.

**Methods and Material:** Forty all ceramic discs were prepared using leucite reinforced pressable ceramic. Forty human, non carious freshly extracted permanent premolars were mounted and vertical planar dentin and enamel bonding surfaces were prepared. Cementation was done under a dynamic load of 155gms. Samples were thermocycled & then subjected to shear load.

**Results**: The mean shear bond strength of porcelain luted to enamel and dentin with control cement was [26.92± 0.36 MPa] , [17.94 ± 0.50 MPa] and experimental cement was [26.75 ± 0.31MPa], [17.73 ± 0.41MPa] respectively. The difference was statistically insignificant ($p>0.05$). Failures in enamel-bonded specimens were seen as fracture near enamel resin interface but within the resin or adhesive failure between cement & ceramic interface. However most of the failures for dentin-bonded specimens were adhesive between tooth resin interfaces.

**Conclusion**: The performance of self-etching self-universal dual cure resin cement on the basis of shear bond strength test is comparable to that of conventional Bis GMA dual cure resin cement.

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## Introduction

All ceramic restorations need to be reinforced by adhesive bonding, which creates a 'MONOBLOC' between tooth, cement & restoration.[1]

Three main categories of these luting agents are self or chemical curing, Light curable and dual cure resin cements[2]. Researchers have compared the bond strength of dual-cure cements and chemically cured cements to dentin and they found that it was higher at all time intervals than that obtained for chemically activated material[3,4,5]. However, it is absolutely contraindicated to use resin-luting cements without tooth bonding procedures be-cause they have no therapeutic properties per se and their inher-ent polymerization shrinkage could cause significant marginal leakage and postoperative sensi-tivity[2]. Thus, the performance of these resin cements depends to a large extent on the success of bonding procedure. Researchers have agreed upon technique sensitive nature of enamel/dentin bonding. [6,7]

*Universal Self Adhesive Cement* belongs to the newly introduced category that combines the use of adhesive and cement in one single application eliminating the need of pretreatment of tooth surface. Although this cement has been evaluated and reported satisfactory for clinical application[8], it needs to be tested for its intended use.

With the above background of advantages, disadvantages & clinical indications of resin luting agents, this study was performed to determine comparative evaluation of shear bond strength of porcelain luted to enamel or dentin with conventional Bis GMA dual cure resin cement, **VARIOLINK II (Ivoclar Vivadent, Schaan, Liechtenstein)** i.e. Control group and the newer self etching self adhe-

sive universal resin cement **EMBRACE WETBOND Universal resin Cement (Pulpdent, USA).**

**Materials & Methods** [9, 10, 11,12,13,14]

Forty all ceramic discs of dimensions 3.5mm in diameter and 2mm height were prepared using leucite reinforced pressable ceramic (CERGO Degudent –USA). Wax sprue of diameter 3.5mm were invested with CERGO fit SPEED investment material with ratio 100g: 25ml and universal plastic investment rings. After burnout, Press programme (Multimat Touch and Press furnace) was activated with press temp. 960°C. The all-ceramic discs of dimensions 3.5mm in diameter and 2mm height were made by sectioning the rod with diamond disc using water cooling and without pressure. Discs were cleaned with steam cleaner.

Forty human, non carious freshly extracted permanent premolars specifically extracted for orthodontic treatment were collected from individuals between the ages 17-25 yrs. Teeth were scaled using hand instruments cleaned with pumice and stored in 1% thymol solution and distilled water till the laboratory procedures were completed. Retentive undercuts were made on the proximal surface of tooth root and it was mounted using epoxy resin; with their buccal surfaces upwards just above the embedding medium in the rectangular aluminium block to maintain the parallelism of long axis of the tooth during mounting, it was attached to the vertical arm of dental surveyor.

Vertical planar enamel bonding surface was prepared on enamel by sequentially abrading with wet silicon carbide paper of first 320, 400 grit.

Vertical planar dentin bonding surface was obtained by reducing surface of the tooth by metallurgical polishing wheel and wet grinding them using silicon carbide paper of 320, 400 grit.

Protocol Followed for Preparation of Samples is given in Table 1.

Dentin bonding agent used was Excite (Ivoclar, Vivadent), which is fifth-generation (i.e., "one-component"), light-activated dentin bonding agent. Bonding area was delineated by adhesive tape with a hole of 3.5 mm It was generously applied to the tooth structure (either enamel or dentin) using a scrubbing motion for 10 seconds, gently air dried for 3 seconds, and light activated for 20 seconds.

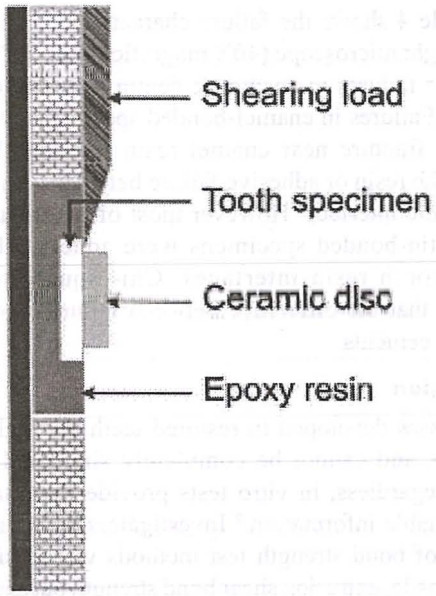
Both the cements were mixed in 1:1 ratio of base to catalyst with mixing pad and plastic spatula. Cementation area was delineated by adhesive tape

**Table 1: Protocol Followed For Preparation of Samples**

| Cement | Tooth surface treatment | | Ceramic treatment |
|---|---|---|---|
| Bis-GMA resin cement (Control) | Enamel | Acid etching (37% phosphoric acid) | Etching with 9.6% HF Silanation |
| | | Dentin Bonding agent (Moist bonding) | |
| | Dentin | Acid etching (37% phosphoric acid) | |
| | | Dentin Bonding agent (Moist bonding) | |
| Self Adhesive Resin Cement (Experimental) | Enamel | Only acid etching (37% phosphoric acid) | Etching with 9.6% HF |
| | Dentin | None | |

with a hole of 3.5 mm. Cementation was done under a dynamic load of 155gms. All samples were stored in distilled water for 24 hrs. at room temperature of 37$^0$ C. Afterwards they were thermocycled at 5°C and 55$^0$ C for 600 cycles with a dwelling time in each for 28 sec.

Following thermocycling all samples were subjected to shear load using Universal Instron testing machine at crosshead speed of 0.5mm/min. (Fig. 1)




**Observations & Results**

The null hypothesis tested in this study was that there is no statistically significant difference in the bond strength of the two samples. The shear bond strength on enamel with cement as a variable was compared. The shear bond strength on dentin with cement as a variable was compared. There was no comparison between enamel & dentin as they were treated as two independent variables. Hence, statistical analysis was performed using unpaired 't' test.

Summary statistic showing comparison of shear bond strength (MPa) of porcelain luted to enamel & dentin with two resin cements using unpaired 't' test is given in tables 2 & 3.

Thus, the null hypothesis is accepted and hence there is no statistically significant difference between the shear bond strength of porcelain luted to enamel and dentin with both control (Variolink II) and experimental cement (Embrace wetbond Universal Resin Cement) ($p>0.05$).

**Table 2: Summary statistic showing comparison of shear bond strength (MPa) of porcelain luted to Enamel with two resin cements using unpaired 't' test**

| Cement | Mean | N | SD | DF | p Value | Inference |
|---|---|---|---|---|---|---|
| Bis-GMA resin cement (Control) | 26.92 | 20 | 0.36 | 38 | 0.1163 | Accept $H_0$ ($p > 0.05$) |
| Self Adhesive Resin Cement (Experimental) | 26.75 | 20 | 0.31 | | | |

**Table 3: Summary statistic showing comparison of shear bond strength (MPa) of porcelain luted to Dentin with two resin cements using unpaired 't' test**

| Cement | Mean | N | SD | p Value | Inference |
|---|---|---|---|---|---|
| Bis-GMA resin cement (Control) | 17.94 | 20 | 0.5071 | 0.1562 | Accept $H_0$ ($p > 0.05$) |
| Self Adhesive Resin Cement (Experimental) | 17.73 | 20 | 0.4178 | | |

Table 4 shows the failure characteristics noted under light microscope (40X magnification).[12] True cohesive failures in enamel & dentin were not observed. Failures in enamel-bonded specimens were seen as fracture near enamel resin interface but within the resin or adhesive failure between cement & ceramic interface. However most of the failures for dentin-bonded specimens were adhesive between tooth resin interfaces. Chi- square test showed that the difference between failure modes for two cements.

**Discussion**

Stresses developed in restored teeth are highly complex and cannot be completely simulated in vitro. Regardless, in vitro tests provide important and valuable information.[7] Investigators have used variety of bond strength test methods viz. tensile, microtensile, extrusion shear bond strength but shear stresses are believed to be the primary cause of in vivo bond failure. [8-11]

Lisa Knobloch et al & Van Noort et al [12, 13] emphasized the fact that even though the bond strength of cement to tooth and restoration can be evaluated individually, their combined strength as a complex may be less.

Furthermore, studies in which focus was on porcelain- composite interface or composite-enamel/ dentin interface using pre-cured composite cylinders, the critical behaviour of the bonded complex has been ignored. According to Cenk cura, Stacey [14, 15] this model fails to simulate the clinical situation because there is only a thin layer of composite luting agent between the closely fitting dental substrate (enamel or dentin) & porcelain.

Thus, the preparation of specimen for this study was attempted to evaluate the behavior of enamel or dentin-composite -porcelain complex under shearing load.

Results of shear testing are in agreement with previous studies which compared shear bond strengths of self etching adhesive cement with the conventional dual cure resin cement.[16,17]

Results of failure mode analysis on enamel are in agreement with previous studies, which emphasize that true adhesive resin- enamel failures do not occur since the resin-enamel bond exceeds the cohesive strength of resin cement and resin ceramic bond is also weaker as compared to resin enamel bond.[12, 15, 18]

For dentin results are in accordance with Strub and Beschnidt[19] who also got the similar results. According to them it does not indicate failure to form the hybrid layer but the fact that composite had higher bond strength to ceramic material than prepared dentinal surface.

**Table 4: Failure analysis of tested specimens is shown as follows:**

| Cement | Tooth substrate | Cohesive in tooth C-T | Pure adhesive failures at tooth/resin cement interface T-R | Cohesive failures in resin cement C-R | Resin cement/ ceramic R-C |
|---|---|---|---|---|---|
| Bis-GMA resin | Enamel (20) | 0 | 0 | 12 | 8 |
| cement (Control) | Dentin (20) | 0 | 14 | 4 | 2 |
| Self Adhesive | Enamel (20) | 0 | 0 | 14 | 6 |
| Resin Cement (Experimental) | Dentin (20) | 0 | 15 | 3 | 2 |

The differences observed between bond strengths in enamel and dentin although not statistically compared, can be attributed to the differences in the composition of the two substrates. Enamel is almost a completely mineralized tissue, whereas dentin exhibits a lower mineralisation, presenting an organic matrix with a moist surface due to fluid present in the dentinal tubules. Thus, adhesion to enamel is typically stronger and stable than adhesion to dentin [7].

Enamel has more inorganic component than dentin and thus self-etching adhesive alone fails to create an ideal etch pattern on enamel necessitating an additional step of acid etching prior to its application. In the present study, surface pretreatment with phosphoric acid 35% has been done on enamel as recommended by the manufacturer the bond strength values are in agreement with the study by De Munck J.[20]

In principle, multi functional acrylate monomers[21,7] can generate self-adhesion. The same principle employed in this self-adhesive resin cement. The acidic nature of the phosphorulated methacrylates allow for demineralization of the tooth surface and penetration of the cement into the tooth surface. Once polymerized, micromechanical retention is achieved between the cement and the tooth. It has been postulated that self – adhesive universal resin cement monomers react with basic salts and tooth apatite through functional groups modified by phosphoric acid. Water is formed in this neutralization. This step increases hydrophilicity, improving adaptation of the cement to the tooth structure and moisture tolerance.The water is reused by reaction with acidic functional groups and during the cement reaction with ion-releasing basic filling bodies. This allows two distinct advantages of self-adhesive universal resin cement an intelligent switch to a hydrophobic matrix, and the verifiable release of fluoride ions. However, these chemical reactions need to be further investigated.

## CONCLUSION

Thus, on the basis of in-vitro shear bond strength testing & failure mode analysis the newly introduced self adhesive resin cement performed equivalent to the conventional resin cement. Although separate etching and bonding steps were combined in one, it did not reduce the shear bond strength of the complex. Therefore, it can be used instead of the conventional resin cement for luting of all ceramic restorations without fear of inferior performance. The elimination of need to apply separate bonding agent certainly makes the procedure less technique sensitive, leading to more predictable bonding in clinical situation.

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## The New Executive Director - PFA



**LAURA FLEMING DOYLE, CAE**

The Board of Trustees of the PFA Foundation is delighted to inform the PFA Fellows across the globe of the selection of Laura Fleming Doyle, CAE, of Herndon, Virginia, as its new Executive Director. After an ex-haustive search, underway since December 2008, and the review of many resumes by the Search Committee, chaired by Dr. Kevin Roach of Canada, with the addition of Drs. Michael Perpich of Minnesota, James Englander of Wisconsin, and Howard Mark of Connecticut, and the interview of three finalists in Chicago on June 26-27, 2009, by the Board of Trustees, Ms. Doyle was unanimously chosen to assume this position. The enthusiasm for this fine lady was most palpable and allowed the Board a collective sigh of relief as it ended this most important task.

Fellows of India Section welcome Loura Fleming Doyle to the assignment of Executive Director and send their greetings.