Original Article

Effect Of Salivary Contamination On The Shear Bond Strength Of Two Resin Cements And Dentin-A Comparative Evaluation

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Abstract

Introduction – Indirect restorations are frequently luted to the remaining tooth structure with new age self-adhesive resin cements. Use of these advanced single step cements reduce chair side time for the clinician. In clinical practice it is not possible to achieve complete isolation in the oral cavity. Contamination during bonding procedures is inevitable, however shorter the time taken to perform the bonding procedure more effective the moisture control by conventional means. This contamination may alter the binding capacity of the cement to the dentine and thus affect the retention of the prosthesis.

Aim – To compare and evaluate the Shear Bond Strength of Two Self adhesive Resin Cements and Dentin with and without salivary fluid contamination. The null hypothesis states that there is no difference exists in the SBS after salivary contamination at the dentine interface.

Materials and Method – 40 freshly extracted premolar teeth were grounded occlusally and embedded in acrylic blocks. The 40 blocks were randomized into 4 groups. Each group was bonded with either resin cement before or after salivary contamination. All samples were tested using the Universal Testing Machine at a cross head speed of 0.5mm/min. The force of dislodging was noted. The data was then subjected to paired and unpaired t test.

Results – On analysis no statistically difference in SBS was noted between A1,B1 and A2,B2. On comparing the groups A1 and A2(after salivary contamination) and B1 and B2(after salivary contamination) $p<0.05$ was noted which was of statistical significance.

Conclusion -Salivary Contamination reduced the SBS between the resin cements and dentin. The individual resin cements showed no statistical difference in shear bond strength.

Keywords – Resin, Saliva, Shear Bond, Adhesive, Fixed Partial Dentures

I. Introduction

Fixed Partial Dentures (FPDs) are a means of indirect restorations which are routinely used in dental practice. Retention is the property of a restoration which resists dislodging forces which are parallel to its path of placement.[1] Retention in FPD depends on a wide array of factors like force factors, size of the abutment teeth, geometry of the prepared abutment, roughness of the bonding surface, luting agents used and the film thickness of the luting agent.[2]

Dental luting agents provide the link between a FPD and the supporting prepared tooth structure. Traditionally, zinc phosphate cement has been the most popular, despite its disadvantages particularly solubility and lack of adhesion. Nevertheless, many alternative materials have been introduced such as poly-carboxylate, glass-ionomer and the recently introduced resin cements. Resin cements have become popular as the problems associated with solubility and lack of adhesion have been addressed. Inspite of the cumbersome cementation procedure resin cements are a popular choice because it offers advantages such as better esthetics, lower solubility and enhanced marginal seal.[3,4,5,6] An initial means to evaluate the adhesive strength is by testing the shear bond strength(SBS) to tooth substrates.[7] Self-adhesive resin cements have been recently developed, they are polymerizing cements which bond largely to dentin without any need for pre-treatment hence reducing the chair side time required.[8]

In clinical practice it is not possible to achieve complete isolation in the oral cavity. Contamination during bonding procedures is inevitable, however shorter the time taken to perform the bonding procedure more effective the moisture control by conventional means. This contamination may alter the binding capacity of the cement to the dentine and thus affect the retention of the prosthesis.

The null hypothesis states that there is no difference exists in the SBS after salivary contamination at the dentine interface.

II .MATERIALS AND METHODS

A comparative evaluation of the SBS of two resin cements and dentine was undertaken in the Department of Prosthodontics at Bharati Vidyapeeth Deemed University Dental College and Hospital Katraj, Pune. The research was conducted after approval and clearance from the Research and Ethics Committee of the institution.

40 freshly extracted premolar teeth were collected and stored in 10% formalin solution. The teeth were prepared occlusally to expose the dentine using a diamond point(Figure 1).

The whole tooth was embedded in the acrylic bock only exposing the cut dentinal surface. Modelling wax was used to prepare the mold for embedding(Figure 2).

The samples were randomly divided into 4 groups labelled as A1, A2 and B1, B2 respectively.

The groups were assigned as follows-

A1- Cementation of GCemLink Ace without any contamination

A2- Cementation of GCemLink ACE with Salivary fluid contamination

B1 - Cementation of RelyXU200 without any contamination

B2- Cementation of RelyXU200 with Salivary fluid contamination.

Cement blocks of 3mm height were cemented individually on each tooth. A plastic mold was used to make the cement cylinder (Figure 3). The samples were light cured using QHL light (Figure 4) cure for 20 seconds each. For group A2 and B2 saliva was painted on the tooth using an applicator tip. The excess was dried out using a filter paper. The cement was then bonded to the cut surface in a similar manner as done in A1 and B1.

All samples were tested using the Universal Testing Machine at a cross head speed of 0.5mm/min.(Figure 5)

III. Results

The in-vitro SBS of two commercially available self- adhesive resin cements to dentin was tested.

Mean Shear bond Strength of each group is reported in Table 1. Comparison of the SBS A1,B1(without contamination)(Table 2) and A2,B2 (with salivary contamination) (Table 3) was done using unpaired t test. Within the inter-group analysis it was noted that both A1 and B1 had similar SBS and the difference was not statistically significant. Similarly A2 and B2 were compared using the unpaired t test and the difference in the SBS after salivary contamination was not statistically significant. T- test was used for intra group analysis, on comparison of A1 and A2 p was noted to be 0.00004 which is less than $p<0.001$ hence the difference was highly significant. On comparison of B1 and B2 using the t-test p was noted as 0.0004 which is <0.001 hence the difference was highly significant. Thus the effect of salivary contamination on both the cements was highly deleterious to the SBS of GCemLinkAce and RelyXU200.

IV. Discussion

With the advent of newer materials for indirect fixed restorations newer type of luting agents are being continuously developed and used for bonding of newer ceramic and metal restorations to the tooth structure. Dental Cements are designed to retain restorations, appliances, post and cores in a stable and long lasting position in the oral-environment.[37]

Retention of any prosthesis still remains the most critical factor for patient satisfaction and fulfilment. As studies have proved that retention is a multifactorial entity and type of the cement has a pivotal role to play in retention of the prosthesis.[1]The ultimate goal of any luting agent is to closely adapt the restoration to the tooth surface. Retention mechanisms can be chemical, mechanical and micromechanical.[37]

Traditional luting cements for definitive restorations consists of an acid –base reaction thus to form salt and water. Due to the presence of ions these cements are largely susceptible to sorption within the oral fluids.[38] Traditional luting agent Zinc phosphate lutes on the principle of mechanical interlocking by flowing into the irregularities of the tooth and the casting surface. Even though it has been in use since over a century its disadvantages such as lack of chemical bonding to the tooth, ease of solubility and pulpal irritation. This major disadvantage of lack of adhesion lead to the development of Glass ionomers. GIC exhibits several advantages such as physiochemical bonding to the tooth structure, fluoride release and low coefficients of thermal expansion however it has low mechanical strength and water sorption during early part of the setting reaction process. Despite these disadvantages GIC remains the only material that is self adhesive to the tooth without any surface pretreatment.

Major difference between Glass ionomers and self- etch resin approach being that GIC are self-etching through the use of high molecular weight polycarboxyl-based polymer, whereas resin-based self –adhesives use acidic low molecular weight monomers.[37]

Resin cements boast of higher bond strength and thus greater retention abilities. Resin cements are available in multiple forms those which include the self-etch or etch and rinse type. The self-etch resin cements have become popular as they are less cumbersome to use. Furthermore, resin cements have excellent aesthetic qualities and less micro leakage. Self-adhesive resin cements have become a popular choice due to a single step procedure these cements etch, prime and bond in a single step.[22] A.K Luhrs concluded in his study that the SBS of self-adhesive resin cements to dentin was inferior compared to conventional composite resin cements.[20]Although the bond strength has been reported to be less it is within permissible clinical limits hence the advantages of self-adhesive resin cements out-way its demerit of having a marginally lower amount of bond strength thus they are gaining popularity .

Unlike the etch and rinse adhesive systems wherein 30-40% phosphoric acid is used to remove the smear layer. Self-etch adhesives dissolve smear layer only partially and do not demineralize dentin as deep as etch and rinse adhesive.[34] This maybe due to the difference in the length of the resin tag formation, as stated by Holiel et.al. i.e when enamel was etched with phosphoric acid penetration to a depth of 1µm was noted but when self-etch adhesives were used only a depth of 0.6-0.7µm were noted.[41]These superficial resin tags may prevent post-operative sensitivity that occurs with etch and rinse adhesives hence lesser post-operative sensitivity makes the self-adhesive cements more patient friendly.

All luting cements show reduced mechanical properties when contaminated by moisture or foreign substances during the cementation procedure. Moisture maybe in form of the patients saliva, blood and foreign substances such as medicaments used in retraction cords. Steps for isolation need to be followed for all cementation procedures. Techniques such as rubber dam application, cotton roles, salivary suctions and anti-sialogouges may be used.

It is not always feasible to use rubber dam, this maybe due to the presence of subgingival finish lines or long span bridges with multiple missing teeth.[21] Similarly cotton roles are placed in the vestibule maybe an effective alternative in the maxillary arch but not as successful in maintaining isolation in the lower arch due to pooling of saliva in the vestibule due to gravitational forces. Thus maintaining absolute isolation is extremely difficult. According to an in-vitro study conducted Madhusudhana Koppolu et.al Salivary and blood contamination reduced the shear bond strength of the self-etching adhesive system. The bond strength of the control group to dentin was 4.13+-0.49Mpa and after salivary contamination was reduced to 2.07+-0.26Mpa and after blood contamination was 1.07+-0.44Mpa respectively.[28] Avoiding any type of contamination is a fundamental pre-requisite of a successful bonding procedure.

Self-adhesive resin cements have claimed to have better mechanical properties than conventional cements and they are less cumbersome to use than conventional resin cements which require multiple pre-treatment steps.

The contamination of the bonding surface alters the bond strength of the cement to the dentinal surface. In the study conducted by Duygu Tuncer et.al they compared the SBS of adhesive systems after contamination with blood and hemostatic agent, they then concluded that SBS was much lesser after contamination in case of all in one self-etch adhesive and etch and rinse adhesive systems.[34]

The present study mimics the oral conditions and compared the shear bond strength before and after Salivary contamination on the dentinal surface, in-vitro.

The Null Hypothesis states that there is no difference in Shear Bond Strength between GCEM Link Ace and 3M ESPE RelyX U200 after salivary fluid contamination of the dentinal surface. The results of the study claims to reject the null hypothesis.

The Mean Shear bond strength of GCEM LinkAce without contamination(Group A1) was 3.56MPa. The bond strength of GCEM LinkAce after salivary contamination(Group A2) was noted to be 1.15MPa .The Mean Shear bond strength of RelyX U200 without contamination(Group B1) was 3.58MPa. The bond strength of RelyX U200 after salivary contamination(Group B2) was noted to be 1.84MPa.

There is a statistically significant difference between the SBS of the control group (without contamination), Salivary contamination of each of the cements(GCem LinkAce and RelyX U200).

On the contrary there was no significant difference in shear bond strength found between the control Groups of GCEM LinkAce(Mean - 3.562MPa) and RelyX U200(Mean - 3.584MPa). Both the groups gave almost similar values of SBS. On comparison of the shear bond strength to dentin(5.94MPa) by S.Hattar et al. a slightly lesser mean was found in this study.[36]This difference could be advocated to multiple variables such as the brand of cement used, the applied force on each specimen and the viscosity of the cement during light curing for penetration of the light.

On comparing Groups A2 (GCEM LinkAce after contamination) and B2 (3M ESPE RelyX U200 after contamination) the mean Shear Bond Strength values were found to be 1.15MPa and 1.84MPa the P value of application of unpaired t test was 0.070 which is slightly greater than 0.05 so the difference is not significant.

Saliva constitutes of organic and inorganic constituents such as proteins, amino acids lipids etc. In this study a highly significant decrease was seen in the SBS between the dentin and the resin cement after salivary contamination. These tests results are in line with various studies conducted by Koppolu et.al where in the control group had a shear bond strength of 4.13+- 0.49 MPa and the specimens after salivary contamination had a SBS value of 2.93+-0.26 MPa.[26]

A similar study conducted by Sussan Hattar et.al concluded the shear bond strength of resin cement Relyx Unicem, SmartCem2 and SeT SDI to be 5.94+- 2.17Mpa,4.71+- 3.81MPa and 4.48+-4.40 to dentin. The mean shear bond strength is not similar to those in the study due to the difference in the resin cements used by Sussan Hattar and the crosshead speed at which the testing was done was 0.8mm/min unlike this study where in 0.5mm/min of crosshead speed was used.[36]

The probable reason for lower bond strength is due to the formation of a smooth layer by the salivary protein constituents on the surface and inability of the acidic monomers to penetrate the salivary film.[13]

Acid conditioning of the tooth structure and application of the bonding agent before cementation is not required for self-adhesive cements. The bonding to the tooth structure is promoted by specific functional monomers which are different for different commercially available products. RelyX U200 used MDP technology (10-methacryloxy decamethlene phosphoric acid). These functional monomers have an acid base reaction with the calcium of the hydroxyapatite crystals this chemical reaction enables the retention of the restoration.

Variability in the values of each of the 4 groups can be attributed to minor differences in composition of dentin of individual samples of the prepared tooth structure. Other factors which brought about variability in the results could be variation in the composition of saliva of individuals. Variation of SBS from other studies can be attributed to lack of standard testing protocols and the studies were conducted on the earlier generation of resin cements.[36] According to John C.Mitchem the length of time elapsed after extraction has only little effect on the adhesion of the cement and tooth.[40]

The monomer's degree of conversion is considered vital as it affects the physico-chemical properties such as water absorption, strength, stiffness, biocompatibility as well as color stability. Inadequate polymerization of the resin cement results is post-operative sensitivity. The use of dual-curing resin cements combines chemical and light-polymerization thus allowing polymerization to take place in deeper areas by application of shorter light irradiation time. Studies reported that when photoactivation is omitted i.e. dark-curing took place and the material was unable to attain a high degree of monomer conversion. Indeed, the degree of polymerization is still influenced when a light barrier simulating a porcelain indirect restoration is placed between the light source and the cement. Several studies showed adverse effects on the degree of conversion and microhardness of the dual-curing and light-polymerized resin cements with the increase of the thickness of the light barrier material.[19,17] A study by Areti Vrochari et.al. conducted a study where in degree of conversion of resin cement is much higher in the dual cure mode than in the self cure mode also since all restorations that are being cemented using resin cements are fixed prosthesis which are partially or completely opaque, attenuation of the curing light takes place and this has not been accounted for in this study. Vrochari also states that an increase in irradiation time may also increase the degree of conversion of the resin cement.[17]

The limitation of the study which was conducted is that the SBS tests does not confirm to clinical situations as it does not consider the three dimensional geometry of the prepared tooth structure and marginal integrity of the restoration which are key parameters in determining success of a restoration . The diameter, length and arch of rotation/path of placement play a pivotal role in the retention of the fixed prosthesis under shear loading. Bond strength of the cement is a multifactorial entity it depends on the degree of cure of the cement as well as the conditions of the dentin. Thus more studies need to be undertaken confirming to the clinical situations such as the length and diameter of the tooth structure, attenuation of the curing light, intra-oral ageing of the cemented restorations, thermal variations in the environment, variability in the pH and composition of salivary constituents etc. Also standardization of the testing protocols should be done so that further studies can be compared to the previous studies which have been conducted.

V.CONCLUSION

Salivary fluid contamination of the dentinal surface had a deleterious effect on the SBS of the self-adhesive resin cements and the dentin of the extracted teeth. But the difference in the make of the two self-adhesive cements did not influence the SBS at the resin –dentin interface. Further investigation is required taking into account the three-dimensional component of tooth preparations, ageing of the restoration, curing light attenuation etc.

VI. REFERENCES

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Figures and Tables

Figure 1 – Occlusal Preparation

Figure 2 - Embedding the tooth in acrylic blocks

Figure 3 – Plastic trough to place Cement

Figure 4 – QHL Curing Light

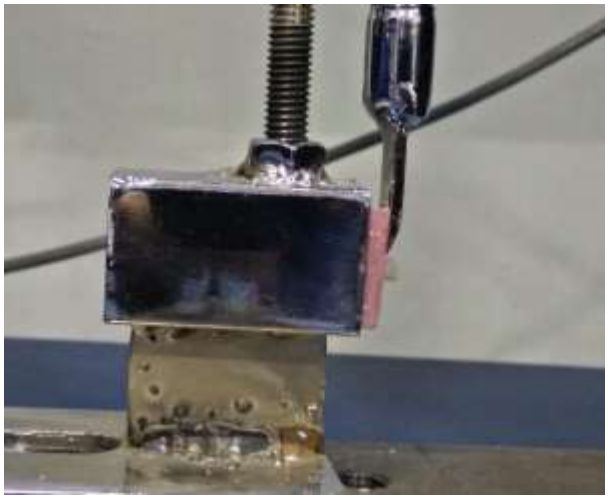

Figure 5 – Testing Samples in Universal Testing Machine

Table 1 – Mean SBS (A1,A2, B1,B2)

Group	Mean SBS (MPa)
A1	3.562
A2	1.15
B1	3.584
B2	1.84

Table 2 – Comparison of the shear bond strength {Mean (SD)} of pre contamination samples of both the cements using unpaired t test

Pre contamination Samples	**No of samples**	**Mean (SD)**
GC LinkAce cement	10	3.56 (1.4)
Rely X U200 cement	10	3.58 (1.0)
t value	**-**	**0.040**
P value	**-**	**0.968**

Table 3 - Comparison of the shear bond strength {Mean (SD)} of salivary contamination samples of both the cements using unpaired t test

Salivary contamination Samples	**No of samples**	**Mean (SD)**
GC LinkAce cement	10	1.15 (0.6)
Rely X U200 cement	10	1.84 (0.9)

t value	**-**	**1.924**
P value	**-**	**0.070**