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EVALUATION OF THE SHEAR BOND STRENGTH OF FOUR COMMERCIALLY AVAILABLE RESIN CEMENTS:AN INVITRO STUDY

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ABSTRACT:

The cementation process is vital for the clinical success of all-ceramic restorations. It has been purported that some all-ceramic restorations may be cemented with zinc phosphate, glass ionomer, or resin composite cements. The success of the cementation process may depend on the composition of the ceramic material. When zinc phosphate or glass- ionomer cements are used, adequate retention form of the preparation is necessary. More over these cements are not having any chemical bonding ability with ceramic restoration. When this is compromised, adhesive luting systems are tried widely to improve the bonding ability
Aim And Objectives :To compare and evaluate the shear bond strength of four commercially available resin cements with their respective bonding system to human teeth.

Keywords: resin cements, laminates, shear bond strength

INTRODUCTION:

Dental restorations using all-ceramic materials in association with adhesive cements have become popular because of esthetic properties such as translucence, fluorescence, and opalescence that better simulate the appearance of natural dentition [1]. A stable bond between the hard tissues of the tooth and the adhesive cement and that between the adhesive cement and the restoration increases both the retention and the fracture resistance of the abutment and the restoration and thereby it reduces the incidence of micro leakage.[2-3]

The tests most widely used to examine the bond strength of composite resin to dentin are shear and tensile tests [4, 6, 7-9]. In addition to the specific in vitro examination parameters, the chemical composition of the selected cementing

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agent and the related adhesive system influence dentin bonding.

In this in vitro study an attempt was made to compare and evaluate shear bond strength of four commercially available resin cements in combination with an adhesive and the prepared natural tooth surface.

MATERIALS AND METHODS:

The resin cements which are used in this study are having different bonding mechanisms as specified by the manufacturers.

Material	Type	Bonding system	Number of application steps/approach
RelyXUlOO (3MESPE, Seefeld, Germany)	Dual-polymerizing self-adhesive universal resin cement	No bonding system	
Variolink N (IvoclarVivadent, Schaan,Liechtenstein)	Dual curing/light curing resin cement	Excite DSC	Two-step/etch and rinse.
Calibra (Dentsply caulk, Milford, DE 19963, USA)	Dual-polymerizing resin cement	Prime & Bond NT	Two-step/etch and rinse
SeTPP (SDI, Victoria, Australia)	Self -etching, self-adhesive resin luting cement	No bonding system	

SILANE COUPLING AGENTS:

Monobond-S (IvoclarVivadent, Schaan, Liechtenstein)

Calibra (Dentsply caulk, Milford, DE 19963, USA)

CERAMIC ETCHANT:

IPS Ceramic etching gel (IvoclarVivadent, Schaan, Liechtenstein)

Methodology:

I. **TOOTH PREPARATION**

Freshly extracted, non-carious permanent human incisors, canines and molars that were not endodontically treated were selected for this study. All teeth were stored in 0.1% thymol solution at room temperature immediately after extraction.

Preparation of tooth surfaces was carried out by first preparing a flat surface in dentin on stationary disk using SiC sandpaper and water-cooling. The buccal/labial surfaces of teeth were ground to make it parallel to the long axis of the tooth.

After that each tooth was placed in to a silicone mold (2cm*2cm*2cm) and embedded in auto-polymerizing methylmethacrylate resin (DPI, Mumbai, India). After hardening the resin in a

pressure pot for 10 min, the specimens were wet-ground sequentially to 600-grit using SiC sandpaper, to obtain a flat surface in superficial dentin. The tooth surfaces were kept moist throughout the procedure of specimen preparation (FIG. 1)

II. LAMINATE FABRICATION

Once the tooth has been prepared Silicone separating media is applied on the surface. Then Wax pattern is fabricated using Electronic wax Carver with Occlusal wax (FIG. 2) on individual tooth samples so as to closely adapt to the tooth surface with uniform thickness of 1.0 mm.

The fabricated Wax pattern is kept in water for 10 minutes in order to relieve the residual stress. Then the Wax pattern is sprued and invested with phosphate bonded investment using auto mixer machine Then the investment is painted on the pattern Once the wax/pattern is fully painted, the final pouring of the investment material is done The ceramic pressing machine and the plunger and ceramic button is shown in The investment is allowed to set for 45 minutes before keeping in for burn-out procedure. The Wax burn out (FIG. 3) is done at temperature around 930 degrees centigrade.

Once the temperature reaches the above said degree, the pressable ceramic furnace) is started for pre-heating one hour before scheduled pressing. The preheating temperature in the furnace is about 700 degree centigrade. After burn-out is completed, the ring is immediately placed in the pressing machine with ceramic button and plunger. The pressing is started. The pressing temperature reached by the machine is shown in

The overall time period for the Pressing is 30minutes. In the initial 5rninutes there is constant temperature rise of 40 degree centigrade per minute and once the temperature reaches 920 degree centigrade the pressing is started which takes around 21 minutes.

Once the pressing is over the ring is taken out of the machine immediately and left for bench cooling. The laminates are then recovered from the investment and cleaned with the sandblasting procedure.

The laminates were then finished and polished

III. CEMENTATION OF VENEERS TO THE TOOTH SAMPLES

Before the cementation procedures, the tooth samples are cleaned with pumice flour with the polishing cup with the help of contra angle handpiece in order to remove debris, smear layer etc(FIG.4). All the tooth surfaces are etched with 37% phosphoric acid gel and all the laminates are etched with Hydrofluoric acid gel.

a) CEMENTATION OF LAMINATES WITH RELY X U100

Since the cement is Self-Adhesive universal resin cement, there is no re-treatment necessary for bonding. The laminates are etched with IPS Ceramic etching gel (<5%HF) and the tooth is

etched with 37% Phosphoric acid gel for 20 seconds. After the stipulated time, the laminates and the teeth rinsed with water and air dried. The cement is dispensed from the clicker. One click is enough for one laminates on the mixing pad and it is mixed according to the manufactures instructions. The laminated are then loaded with cement and then placed on the tooth surface. It is light cured for 2 seconds and the excess cements is removed from the periphery and then finally light cured for 1 minute.

b) CEMENTATION OF LAMINATES WITH VAIORLINK- N

The Excite DSC total etch adhesive is applied on the tooth surface and Monobond-S silane coupling agent is applied on to the laminates.

Then both are cured according to the manufactures instructions. The base and catalyst are then dispensed with auotmixing pad in the ration of 1:1 ratio. Then it is mixed for 10 seconds and then applied on to the laminates and finally placed on the tooth surface. Then cured for two seconds and excess is removed from the periphery and then final cure is done for 20 seconds after applying Oxygen -blocking gel (glycerin gel).

c)CEMENTATION OF LAMINATES WITH CALIBRA

The bonding systems for Calibra are Two-step /Etch and rinse type. After etching and rinsing thorough with water, Prime and Bond NT and Self- cure Activator are mixed in 1:1 ration and applied on the surface of the tooth which is allowed for 20 seconds. Then it is air-dried for 5 seconds and light polymerized for 10 seconds.

The Calibrasilane coupling agent is applied on the ceramic laminates. The base and the catalyst are dispensed on the mixing pad and mixed using a hard plastic spatula, at a base to catalyst ration of 1:1.

After mixing the laminate is luted to the tooth surface light cured for two seconds and excess is removed from the periphery and finally cured for 20 seconds.[1]

d)CEMENTATION OF LAMINATES WITH SET PP

As the cement is Self-etching, Self-adhesive resin cement, it requires no pre-treatment for the tooth. It is dispensed from the tube and mixed on to the mixing pad for 10 seconds.

It is then applied on to the laminates and then the laminates are placed on the tooth surface. Then it is light cured for 2 seconds and the excess is removed and finally light cured for 20 seconds.

IV. EXPERIMENTAL DESIGN

Total of 24 teeth samples were taken for the study comprising of 12 anterior teeth (Incisors and Canines) and 12 Posterior teeth (Molar)

Total 24 teeth samples were randomly divided into four groups. Each group comprises 3 anterior teeth and 3 posterior teeth.

The four groups are of the following

Group I LUTED WITH RELY X

A1-A2- A3

P1-P2-P3

Group II LUTED WITH VARIOLINK N

A4-A5-A6

P4-P5-P6

Group III LUTED WITH CALIBRA

A7-A8-A9

P7-P8-P9

Group IV LUTED WITH SET PP

A10-A11-A12

P10-P11-P12

V.MEASUREMENT OF SHEAR BOND FAILURE LOADING BY UNIVERSAL TESTING MACHINE (FIG. 5)

After storage in distilled water at 37 degree centigrade for 24 hours, the luted teeth are then thermally cycles around 5000 times between 5 degree and 55 degree centigrade (20 seconds dwelling time).A Lloyd Universal testing machine (J.J Lloyd instruments Ltd, Warsash, UK) with the Monobevelled chisel placed as close as possible to the junction between the laminate and the tooth was used for the testing (FIG. 6).

A cross Jiead speed of 1.0 mm/min was used and maximum load recorded for each specimen.

VI.STATISTICAL EVALUATION

Statistical analysis of the Maximum load recorded was done with the use of Software (SPSS Software).

Mean of all the cement group were analyzed using one way ANOVA test with maximum load as the dependent variable and the type of Resin cements as independent variable.

Unpaired T-Test was also done with O.05 to indicate significance.

Fig 1.

Fig 2.

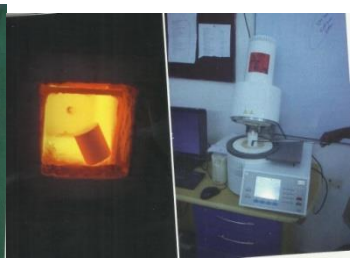

Fig 3.

Wax pattern fabricated on prepared tooth

Fig 4.

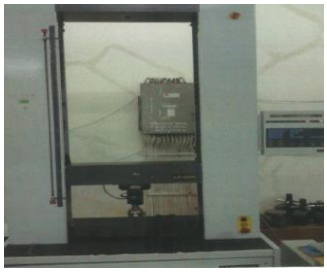

Fig 5.

Fig 6.

Preparation of tooth surface before luting

Shear loading of teeth samples using unibevel chisel in Universal testing machine

RESULTS:

- Mean and Standard deviation of Anterior teeth sample Calibrashows the highest mean load value of 464.33 and SeT PP shows the lowest value of 288.00.and For Posterior teeth sample Rely X shows the highest value of 272.97while SeT PP shows the lowest load value of 154.33. Among all the cements SeT PP shows the lowest load values.

- One Way ANOVA Test for Anterior teeth sample denotes Significance value of 0.295 which shows insignificance of load value among all the cements at 5% of confidence level ($p<0.05$)

- Shows One Way ANOVA Test for Posterior teeth sample Significance value of 0.181 which shows insignificance of load value among all the cements at 5% of confidence level ($p<0.05$)

- The T- Test for Rely X shows value of 0.726 which is insignificance of load value among all the anterior and posterior teeth sample at 5% of confidence level ($p<0.05$).

- T- Test for Variolink N shows value of 0.535 which insignificance of load value among all the anterior and posterior teeth sample at 5% of confidence level ($p<0.05$).'

- T- Test for Calibra shows value of 0.001 which significance of load value among the entire anterior and posterior teeth sample at 5% of confidence level ($p<0.05$).

- T-_Test for SeT PP shows value of 0.031 which significance of load value among all the anterior and posterior teeth sample at 5% of confidence level ($p<0.05$).

DISCUSSION:

These four resin cements Rely X U100, Calibra, Variolink N and SeT PP are having different types of surface treatment for bonding.

Rely X U100 is self adhesive, resin cement whereas SeT PP is self etching, self adhesive resin cement. Variolink N and Calibra have separate steps for etching, silanization and adhesive application.

The purpose of selecting the four cements, of which two cements with multistep applications and two other with single step application is to evaluate and compare the significant differences in the shear bond strength based on their bonding mechanism.

The main advantage of Dual cure type of cement is the control of working and setting times.

A previous studies[1,2,3,5,8] on the shear bond strength comparison was done on posterior teeth because they provided necessary bonding area. In this proposed study, an attempt was made to study the shear bond strength on anterior teeth

(incisor and canine tooth) and as well as posterior teeth (molar tooth). The ideology of including is that in clinical scenario, laminates are most frequently indicated for anterior teeth.

In this study, A Lloyd Universal testing machine (J.J Lloyd instruments Ltd, Warsash, UK) with the Monobevelled chisel placed as close as possible to the junction between the laminate and the tooth was used for the testing at the cross head speed of lmm/min.

In this study, Shear test was used for the following reasons. First, shear strength values are higher than those obtained by the tensile test and compression. Second, shear stress is considered to be more often representative of the clinical situation [4].

The ideology of using distilled water instead of artificial saliva for storage of prepared tooth is to simulate the effect of moisture on the resin cements; not the effect of other ions present in artificial saliva.

According to Arcoria CJ et al(1990) [9] and Ferrari M, et al(2002) [10], thermocycling is the only in vitro test for simulating thermal stress in teeth. So in this study the luted teeth are then thermally cycles around 5000 times between 5 degree and 55 degree centigrade (20 seconds dwelling time) so as to simulate intra oral condition in laboratory.

The Statistical data was analyzed by using statistical software SPEE 15.0 for the four resin cements. Mean and Standard deviation of Anterior and Posterior teeth sample group for each Cement type was done as shown in table I.

From the Statistical data, the results shows that bond strength of resin based self-adhesive cement namely SeT PP was weaker than conventional resin cements Calibra and Variolink N.

One Way ANOVA Test for Anterior teeth sample denotes Significance value of 0.295 which shows insignificance of load value among all the cements at 5% of confidence level ($p<0.05$).

One Way ANOVA Test for Posterior teeth sample denotes Significance value of 0.181 which shows insignificance of load value among all the cements at 5% of confidence level ($p<0.05$) .

Due to high standard deviation for Rely X and Variolink N, the result shows no significant differences among the all cements for maximum load failure.

Unpaired T- Test was done for intra-group comparison for Anterior and Posterior teeth samples. The test shows insignificance level for Rely X and Variolink N at p-value of 0.726 and of 0.535 at 5% of confidence level ($p<0.05$).

The test shows Significance level for Calibra and SeT PP at p-value of 0.001 and of 0.031 which shows significance of load value among all the anterior and posterior teeth sample at 5% of confidence level ($p<0.05$).

CONCLUSION:

This study was done to Compare and Evaluate the Shear bond strength of four commercially available resins cements namely Rely X, Variolink N, Calibraand SeTPP to human dental hard tissue and ceramic.

The sample was tested for maximum load failure using Universal Testing Machine. The data obtained was analyzed statistically by One Way ANOVA and Unpaired T-test.

For Anterior teeth sample Calibra shows the highest bond strength value of 464.33 and SeT PP shows the lowest value of 288.00. For Posterior teeth sample, Rely X shows the highest bond strength of 272.97 while SeT PP shows the lowest load value of 154.33.

Among all the cements SeT PP shows the lowest bond strength value.

One Way ANOVA Test for teeth sample shows insignificance of load value among all the cements at 5% of confidence level ($p<0.05$).

Within the limitation of this study following conclusions was made:

(1) There is no significance differences exist in long-term durability . To human dentin between the cementing agents with their respective bonding system.

(2) Simplifying the application procedures of the corresponding adhesives following three step total-etch, two step total-etch, one-step self-etch, or no use of adhesives, affect the effectiveness of the bond to human dentin.

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