Comparative evaluation of the shear bond strength of adhesive and self-adhesive resin luting agents to three commercially available composite core build-up materials: An *in vitro* study

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**Abstract**

**Aim:** The aim of the study was to evaluate the shear bond strength of adhesive and self-adhesive resin luting agents (RLAs) to three commercially available composite core build-up materials (CBMs).

**Settings and Design:** Comparative *-in vitro* study.

**Materials and Methods:** Sixty samples, 20 each of self-cure (Incore, Medicept: Group I), light cure (Light-Core, Bisco: Group II), and dual cure (LuxaCore Z-Dual, DMG America: Group III) composite CBMs were made in the lower mold space of a customized stainless steel jig. They were further subdivided into subgroups A and B for bonding with the adhesive (RelyX Ultimate, 3M ESPE) and self-adhesive (RelyX Unicem, 3M ESPE) RLAs respectively. For specimens in subgroup A, the bonding agent (Scotchbond Universal Adhesive, 3M ESPE) was rubbed onto the surface for 20 s prior to bonding with the adhesive RLA. For specimens in subgroup B, no pretreatment of the surface was carried out. The CBM-luting agent sample was tested for the shear bond strength in a universal testing machine.

**Statistical Analysis Used:** ANOVA, Tukey’s multiple comparison, and independent t-test.

**Results:** Adhesive RLA showed the highest shear bond strength to light cured composite CBM. Self-adhesive RLA showed the highest shear bond strength to dual-cured composite CBM. Adhesive RLA showed higher shear bond strength to all three composite CBMs as compared to the self-adhesive luting agent. This difference was statistically significant for the self-cure and light cure composite CBMs.

**Conclusion:** Adhesive RLA showed greater shear bond strengths to all the three groups of composite CBMs as compared to self-adhesive RLA.

**Keywords:** Composite core, core build-up materials, resin luting agent, shear bond strength

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INTRODUCTION

When the lost tooth structure is restored with a core build-up material (CBM), the bond strength between the CBM and the luting agent becomes significant for the retention, longevity, and esthetics of the restoration. Differences of the CBM can affect the bond strength of luting agents. Adhesive luting agents allow for increased crown retention that is independent of preparation geometry. Resin luting agents (RLA) are a popular choice because of their ability to adhere to multiple substrates, high strength, insolubility in the oral environment, and shade-matching potential.

Adhesive RLA requires the use of an adhesive agent to condition the tooth surface or the surface of the composite core material prior to the cementation procedure. Self-adhesive RLA do not require any pretreatment of bonding surface prior to cementation procedure, thereby reducing the technique sensitivity.

One of the reasons of failure of the indirect restorations is due to poor bond between the luting agent and the tooth/core material. Thus, this study was carried out to compare and evaluate the shear bond strength between adhesive and self-adhesive RLA to three composite CBM having different mechanisms of polymerization: self-cure, light cure, and dual cure.

MATERIALS AND METHODS

The materials used in the study are listed in Table 1.

Methodology

Preparation of the composite core build-up samples

A total of 60 samples were fabricated; 20 for each of the self-cure (Group I), light cure (Group II), and dual cure (Group III) composite CBM, using a customized stainless steel jig [Figures 1 and 2].

It had two metal plates with a sliding mechanism. The lower plate had a detachable sample holder with a mold space of diameter 5 mm and thickness 4 mm. This was movable in the vertical direction so as to contact the opposing plate, having a corresponding mold space of similar dimensions, and held in place with the help of a screw. Holes of smaller dimensions on the other side were used to engage rods for testing of samples in the universal testing machine.

Composite CBM discs were made in the lower mold space [Figure 3].

| Table 1: List of materials used in the study |
| Group | Material | Brand Name |
|-------|----------|------------|
| Group I | Self-cure composite core build-up material | Incore, Medicept |
| Group II | light cure composite core build-up material | Light-Core, Bisco |
| Group III | Dual cure composite core build-up material | LuxaCore Z-Dual, DMG America |
| Subgroup A | Adhesive RLA | RelyX Ultimate, 3M ESPE with Scotchbond Universal Adhesive, 3M ESPE |
| Subgroup B | Self-adhesive RLA | RelyX Unicem, 3M ESPE |

RLA: Resin luting agents
Flushing of the composite core build-up samples with the sample holder

To simulate clinical treatment of cores, the excess material on the bonding surface was finished with a diamond finishing bur in an airotor handpiece [Figure 4]. A flat bonding surface with a uniform surface roughness for all the specimens was obtained, cleaned with air-water spray and dried with air for 10 s.

Division of the samples

Groups were further subdivided \((n = 10)\) for bonding with adhesive and self-adhesive RLA into Subgroups A and B, respectively.

Application of the bonding agent

For specimens in Subgroup A, the bonding agent was rubbed onto the surface for 20 s, and a gentle stream of air was blown over the surface for 5 s [Figure 5].

For specimens in Subgroup B, no pretreatment of the surface was carried out.

Preparation of the composite core build-up - luting agent samples

The jig was assembled, the sample holder raised to contact the upper plate so that the bonding surface lay at the interface of the upper and lower plates and the screw was tightened to secure it in this position. The respective RLA for the two groups was placed in the upper mold space and polymerized by light curing for 40 s [Figure 6].

Testing for shear bond strength in a universal testing machine

The samples were tested for the shear bond strength in a universal testing machine (cross-head speed: 5 mm/min, certified range: 0–1 kN, rate of increase of applied force: 0.05 kN) by sliding the two plates of the jig [Figure 7] until the sample fractured [Figures 8 and 9].

Null hypothesis

There is no difference in the shear bond strengths of adhesive and self-adhesive RLA to the self-cure, light cure, and dual-cure composite CBM.

Alternate hypothesis

There is a difference in the shear bond strengths of adhesive and self-adhesive RLA to the self-cure, light cure, and dual-cure composite CBM.

Figure 4: Composite core flushed to sample holder

Figure 5: Application of bonding agent to samples in Group IA, IIA, and IIIA

Figure 6: Alignment of the upper and lower mold spaces, adaptation of cellulose acetate strip and light curing of the resin luting agent

Figure 7: Testing of the samples in a universal testing machine
RESULTS

The peak load at failure was recorded in Newtons (N), and shear bond strength in Megapascals (MPa) was calculated by dividing it by the surface area (mm²) of the bonding surface. Since the diameter of the samples was 5 mm, the surface area was 19.643 mm².

Formula: $\sigma = \frac{F}{A}$; where, “$\sigma$”-bond strength (MPa), “F”-load required for specimen failure (N), “A”-adhesive area of the specimen (mm²).

The mean shear bond strength in MPa for each group was calculated [Table 2 and Graph 1].

Statistical analysis

On statistical analysis [Tables 3-6] using ANOVA, Tukey’s multiple comparison, and independent $t$-test; since the $P$ value for the $t$-test was <0.05, significant difference in the shear bond strengths was seen for Groups IA and IB and Groups IIA and IIB. Thus, the proposed null hypothesis was rejected, and the alternative hypothesis was accepted.

DISCUSSION

As self-adhesive RLA is becoming popular, more studies targeted at evaluating their bond strength when bonded to a variety of prosthodontic substrates are required.[1] No study comparing the shear bond strength of adhesive and

Table 2: Shear bond strength

| Serial number | Group I A | Group I B | Group II A | Group II B | Group III A | Group III B |
|---------------|-----------|-----------|------------|------------|-------------|-------------|
| 1             | 23.92     | 11.96     | 21.07      | 16.86      | 27.94       | 13.30       |
| 2             | 21.57     | 12.72     | 23.26      | 13.78      | 18.30       | 14.89       |
| 3             | 18.01     | 15.46     | 24.69      | 14.21      | 21.06       | 22.40       |
| 4             | 23.09     | 13.91     | 21.65      | 13.42      | 19.90       | 17.41       |
| 5             | 19.95     | 15.06     | 19.95      | 22.89      | 12.87       | 16.16       |
| 6             | 22.35     | 15.51     | 21.25      | 16.82      | 20.85       | 12.07       |
| 7             | 25.29     | 15.36     | 17.84      | 16.61      | 27.93       | 22.15       |
| 8             | 23.94     | 15.86     | 26.14      | 21.35      | 22.14       | 18.06       |
| 9             | 20.00     | 16.46     | 25.04      | 12.22      | 19.89       | 21.52       |
| 10            | 25.79     | 12.72     | 26.89      | 19.29      | 26.47       | 21.80       |
| Average       | 22.39     | 14.50     | 22.77      | 16.74      | 21.73       | 17.97       |

Table 3: Test of normality

| Groups       | Kolmogorov-Smirnov* Statistic df P | Shapiro-Wilk Statistic df P |
|--------------|------------------------------------|----------------------------|
| Shear bond strength (MPa) Group IA | 0.130 10 0.200* | 0.961 10 0.796 |
| Group IIA    | 0.151 10 0.200 | 0.964 10 0.830 |
| Group IIIA   | 0.166 10 0.200* | 0.922 10 0.375 |
| Group IB     | 0.240 10 0.107 | 0.893 10 0.184 |
| Group IIB    | 0.187 10 0.200* | 0.935 10 0.501 |
| Group IIIIB  | 0.221 10 0.183 | 0.903 10 0.236 |

*Lilliefors Significance Correction, *This is a lower bound of the true significance. Interpretation: Since $P$ value for the Kolmogorov–Smirnov test and Shapiro–Wilk test is >0.05, it indicates that data is normally distributed. Therefore, we used ANOVA to test the significance of the difference between groups.

Table 4: ANOVA test

| Groups                     | Sum of squares | df | Mean square | F     | P   |
|----------------------------|----------------|----|-------------|-------|-----|
| For groups IA, IIA, IIIA   | 5,560          | 2  | 2,780       | 0.227 | 0.798 |
| Between groups             | 330.711        | 27 | 12.249      |       |     |
| Total                      | 336.271        | 29 |             |       |     |
| For groups IB, IIB, IIIIB  | 62.050         | 2  | 31.025      | 3.124 | 0.060 |
| Within groups              | 268.124        | 27 | 9.931       |       |     |
| Total                      | 330.174        | 29 |             |       |     |

Interpretation: Since $P$ value for the ANOVA is >0.05; it indicates no significance of difference. To test the exact significance, Tukey’s Multiple comparison test is used.

Figure 8: Fractured samples in the jig

Figure 9: Failure curves produced for the sample
The biomechanical behavior of the remaining tooth structure and crown is influenced by the mechanical properties of the post and core.

Cast post and cores, silver amalgam, glass ionomer, resin-modified glass ionomer, and composite resin are used as CBM. Composite CBM is widely used and may be chemical, light, or dual-cured. Their physical and handling properties may lead the clinician to favor one material over another. Composite CBM representative of each of these groups was included to study their interaction with the luting agents.

Luting is the final step in the sequence of clinical procedure for indirect restorations. Several studies have demonstrated that luting agents improve the durability of restorations. Composite resin core and resin cement combinations were superior to all other cement and core combinations tested in a study by Nayakar et al. Thus, adhesive RLA with the recommended bonding agent was used in the present study. RLA with dentin bonding agents is recommended as the luting agents of choice for ceramic, metal, and indirect composite restorations as they provide increased crown retention and fracture resistance of core/crown complex.

Recently introduced self-adhesive RLA was aimed at simplifying the clinical procedures and eliminate the need for etching, priming, and bonding as separate steps. Its multifunctional monomers with phosphoric acid groups simultaneously demineralize and infiltrate enamel and dentin. Their bond strength to enamel was reported to be lower compared to conventional RLAs, whereas significant differences were reported in bonding to dentin. A customized stainless steel jig with a circular test interface designed by Hammad and Stein in 1990 was used to ensure a specific path, prevent possible rotation of samples during testing, direct stresses mainly at the metal-ceramic interface to ensure a uniform distribution of the shear forces across the bonding surface on account of its sliding mechanism.

The results of the study showed that adhesive RLA showed significantly greater shear bond strengths to self-cured and light-cured composite CBM as compared to self-adhesive RLA. Similar results with light-cured restorative composite were observed in other studies.

Compatibility between the resinous components in the matrix of luting agents and composite was partially responsible for the observed results. Solvents present in the adhesive systems may cause modification of the surface layer, enabling the monomer of the RLA to react with the nonconverted vinyl groups (−C=C) at the subsurface of the composite CBM.

Adhesive RLA showed the highest shear bond strength to light-cured composite CBM followed by self-cured and dual-cured composite CBM, while self-adhesive RLA showed the highest shear bond strength to dual-cured composite CBM, followed by light cured and...
self-cured composite CBM. However, in the present study, a significant difference in the shear bond strength was not found within the different composite CBM groups.

Limitations of the study
Only a few combinations of the CBM and luting agents could be evaluated. Larger sample size could be taken. Further studies could be done on the tensile and compressive bond strengths of these materials.

CONCLUSION
1. Adhesive RLA showed the highest shear bond strength to light cured composite CBM. The difference in the shear bond strengths between groups IA, IIA and IIIA was not statistically significant
2. Self-adhesive RLA showed the highest shear bond strength to dual-cured composite CBM. The difference in the shear bond strengths between groups IB, IIB and IIIB was not statistically significant
3. Adhesive RLA showed significantly greater shear bond strengths to self-cured and light-cured composite CBM as compared to self-adhesive RLA.

Clinical significance
Interactions between the CBM, luting agent, and setting reaction have a significant effect on the bond strength. Luting agents are weakest in shear bond strength. Thus, it becomes imperative to evaluate their shear bond strengths to different substrates to ensure clinical longevity.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. Capa N, Ozkurt Z, Canpolat C, Kazazoglu E. Shear bond strength of luting agents to fixed prosthodontic restorative core materials. Aust Dent J 2009;54:334–40.
2. Hewlett S, Wadenya RO, Mante FK. Bond strength of luting cements to core foundation materials. Compend Contin Educ Dent 2010;31:140-6.
3. Diaz-Arnold AM, Vargas MA, Haselton DR. Current status of luting agents for fixed prosthodontics. J Prostheth Dent 1999;81:135-41.
4. Vioni RG, Kasaz A, Pena CE, Alexandre RS, Arrais CA, Reis AF. Microtensile bond strength of new self-adhesive luting agents and conventional multisystem. J Prostheth Dent 2009;102:306-12.
5. Ferracane JL, Stansbury JW, Burke FJ. Self-adhesive resin cements – Chemistry, properties and clinical considerations. J Oral Rehabil 2011;38:295-314.
6. Alkurt M, Daymurs ZY, Gundoglu M, Karadas M. Comparison of temperature change among different adhesive resin cement during polymerization process. J Indian Prosthodont Soc 2017;17:183-8.
7. Combe GC, Shaglouf AM, Watts DC, Wilson MH. Mechanical properties of direct core build-up materials. Dent Mater 1999;15:158-63.
8. Passos SP, Freitas AP, Jamuzly S, Santos MJ, Rizekalla AS, Santos GC Jr., et al. Comparison of mechanical properties of five commercial dental core build-up materials. Compend Contin Educ Dent 2013;34:62-3, 65-8.
9. Wassell RW, Smart ER, St George G. Crowns and other extra-coronal restorations: Cores for teeth with vital pulps. Br Dent J 2002;192:499-502, 505-9.
10. Patil SM, Kamble VB, Desai RG, Arabhi KC, Prakash V. Comparative evaluation of shear bond strength of luting cements to different core buildups materials in lactic acid buffer solution. J Clin Diagn Res 2015;9:ZC84-7.
11. Kovarik RE, Breeding LC, Caughman WF. Fatigue life of three core materials under simulated chewing conditions. J Prosthet Dent 1992;68:584-90.
12. da Fonseca GF, de Andrade GS, Dal Piva AM, Tribest JP, Borges AL. Computer-aided design finite element modeling of different approaches to rehabilitate endodontically treated teeth. J Indian Prosthodont Soc 2018;18:329-35.
13. Giti R, Zarkari R. The effect of a zirconia primer on the shear bond strength of Y-TZP ceramic to three different core materials by using a self-adhesive resin cement. J Indian Prosthodont Soc 2019;19:134-40.
14. Kumar G, Shivrayan A. Comparative study of mechanical properties of direct core build-up materials. Contemp Clin Dent 2015;6:16-20.
15. Bayindir YZ, Bayindir F, Akyil MS. Bond strength of permanent cements in cementing cast to crown different core build-up materials. Dent Mater J 2004;23:117-20.
16. Kuşbaba F, Gemalaz D, Pamejeer CH, Varat A, Alcan T. Erosion of luting cements exposed to acidic buffer solutions. Int J Prosthodont 2007;20:494-5.
17. Nayakar RP, Patil NP, Lehka K. Comparative evaluation of bond strengths of different core materials with various luting agents used for cast crown restorations. J Indian Prosthodont Soc 2012;12:168-74.
18. Sindej J, Frankenberger R, Krämer N, Petchelt A. Crack formation of all-ceramic crowns dependent on different core build-up and luting materials. J Dent 1999;27:175-81.
19. Sabatini C, Patel M, D’Silva E. In situ shear bond strength of three self-adhesive resin cements and a resin-modified glass ionomer cement to various prosthodontic substrates. Oper Dent 2013;38:186-96.
20. Radovic I, Monticelli F, Goracci C, Vulicевич ZR, Ferrari M. Self-adhesive resin cements: A literature review. J Adhes Dent 2008;10:251-8.
21. Pashley DH, Carvalho RM, Tay FR, Agee KA, Lee KW. Solvation of dried dentin matrix by water and other polar solvents. Am J Dent 2002;15:97-102.
22. Abo-Hamad SE, Miller KA, Jung H, Fedulina M, Friedl KH, Schmalz G, et al. Bond strength of new universal self-adhesive resin luting cement to dentin and enamel. J Adhes Dent 2005;9:161-7.
23. De Munck J, Vargas M, Van Landuyt K, Hikiya K, Lambrechts P, Van Meerbeck B. Bonding effectiveness of an auto-adhesive luting material to enamel and dentin. Oper Dent 2004;29:693-71.
24. Hikiya K, Van Meerbeck B, De Munck J, Ikeda T, Van Landuyt K, Maia T. Bonding effectiveness of adhesive luting agents to enamel and dentin. Dent Mater J 2007;23:71-80.
25. Goracci C, Sadek FT, Fabianelli A, Tay FR, Ferrari M. Evaluation of the adhesion of fiber posts to intra-radicular dentin. Oper Dent 2005;30:627-35.
26. Monticelli F, Osorio R, Mazzetti C, Ferrari M, Toloiano M. Limited decalcification/diffusion of self-adhesive cements into dentin. J Res Dent 2008;87:974-9.
27. Hammad IA, Stein RS. A qualitative study for the bond and color of ceramometals. Part I. J Prosthodont 1990;6:36-43.
28. Fuentes MV, Escribano N, Baracco B, Romero M, Ceballos L. Effect of indirect composite treatment microtensile bond strength of self-adhesive resin cements. J Clin Exp Dent 2016;8:e14-21.
29. Caneppele TM, Zogheib LV, Gomes I, Kuwana AS, Pagani C. Bond strength of a composite resin to an adhesive luting cement. Braz Dent J 2010;21:322-6.