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Influence of various luting agents on the bond strength of fiber post to radicular dentin: An invitro study

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Abstract

Context: Evaluating the bond strength of fiber post to radicular dentin using different luting agents.

Aims: To evaluate the influence of various luting agents on the bond strength of fiber post to radicular dentin and to evaluate the push-out bond strength in three different root regions.

Methods and Material: Forty-five single-rooted mandibular premolar human teeth were taken and randomly selected and grouped as follows according to the luting agents used. Group 1 (Coltene solocem), Group 2 (3M Rely X-U200)) and Group 3 (Ivoclar Multilink). The data were analyzed statistically using one-way ANOVA and Tukey's post hoc tests.

Results: The root means square values and bond strength values were highest for group I when compared with group II and group III, which were statistically significant.

Conclusions: In the apical third region, the mean push-out bond strength of Solocem was highest followed by Rely X-U200. The Lowest push-out bond strength was seen for Multilink speed. For the cervical third region mean push-out bond strength was highest for Rely X U200 followed by solocem. The lowest mean push-out bond strength was seen for Multilink speed. In the

middle third region, the mean push-out bond strength of Solocem was highest followed by Rely X-U200. The lowest push-out bond strength was seen for Multilink speed.

Keywords: Fiber post, Push out bond strength, Luting material, Post and Core.

Introduction

Posts and cores are commonly used in endodontically treated teeth suffering from excessive loss of coronal tooth structure. The selection of an appropriate restoration for endodontically treated teeth is guided by both strength and aesthetics. The increasing demand for aesthetic posts and cores has led to the development of metal-free post-and-core systems, specifically the usage of zirconia and fiber posts. The major advantage of fiber-reinforced composite posts is that the modulus of elasticity is similar to that of dentin. Fiber posts can be cemented using conventional dual cure resin-based cement in combination with total etching or self-etching adhesives, or using the recently formulated self-adhesive cements that allow simultaneous bonding between the intra-radicular dentin and the post.[1-4]

The actual bond strength at the post-cement-root interface is affected by many factors including the degree of dehydration of the root canal dentin; the type of conditioning agent and accompanying cement used; the unfavorable cavity configuration of the root canal; the use of eugenol-containing sealers; and the anatomic differences in density and orientation of the dentinal tubules at different levels of the root canal areas.[5,6] Furthermore, the difficulty in controlling moisture and the lack of direct viewing into the root canal can affect the bonding procedures. Micro tensile and push-out tests have been used to measure post-retention in different regions of post-space.[7-13] A better estimate of the bond strength can be achieved by the push-out test compared with the conventional shear test because the fracture occurs parallel to the dentin bonding interface in the push-out test, which makes it a true shear test.[11] Additionally, for bonded posts, the push-out test has been considered more reliable for the micro tensile test because of the high number of premature failures that occur during specimen preparation, and the large data distribution associated with micro tensile testing.[12]

The present study aimed to evaluate the influence of 3 luting agents on the bond strength of fiber post to radicular dentin (Coltene solocem,3M Rely X-U200 and Ivoclar Multilink).

Aim of The Study

To evaluate the bond strength of three fiber posts to radicular dentin when luted with various self-etching, self-adhesive dual-cure resin cements and to evaluate the push-out bond strength in three different root regions i.e cervical third, middle third, and apical third.

Materials and Methods

Forty-five single-rooted mandibular premolar human teeth extracted for orthodontic reasons were used in this study, which were collected from the Department of Oral and Maxillofacial Surgery.

Inclusion criteria

1. Intact, straight single rooted lower premolar with single root canal
2. Teeth with complete root formation
3. Teeth with patent canals
4. Teeth without anatomic variations
5. Teeth free of dental caries.

Exclusion criteria

1. Teeth with open apices
2. Calcified canals
3. Multi-rooted teeth
4. Variations in radicular anatomy.

All soft tissue and debris on the teeth were removed using an ultrasonic scaler. Teeth were
stored in 0.9% normal saline to prevent dehydration till the further period of study.

Preparation of specimens

Teeth were decoronated 1 mm above the cementum-enamel junction (CEJ) with a diamond disk. Root canals were cleared of pulp using barbed broaches. The Patency of an apical foramen was determined by passing a No. 10 K-file into the root canal until the tip of the file was visible at the apical foramen, and then 1 mm was subtracted from that length. Teeth were instrumented to a No. 30 size master apical file up to the apical foramen.

The canal was then prepared by step back technique and flaring of the canal was done, followed by circumferential filing using H-files. 10 ml of sodium hypochlorite was used as an irrigant in between successive filing. Recapitulation with smaller-size files was done during biomechanical preparation. The smear layer was removed by irrigation with 10ml sodium hypochlorite and 10 ml of 17% EDTA solution, each for 3 min. The final rinse was done with 10 ml of sterile water. All canals were dried with paper points. They were obturated with lateral condensation of gutta-percha with AH Plus sealer. Root canals were prepared with peeso reamers to the depth of 10 mm, followed by cementation of the fiber posts. The roots were then mounted in an auto-polymerizing acrylic resin. Then the teeth were randomly assigned to 3 groups containing 15 each.

• Group 1: Posts were luted with Solocem.

• Group 2: Posts were luted with Rely X- U200

• Group 3: Posts were luted with Multilink Speed.

The roots mounted in acrylic were sectioned perpendicular to the long axis with the diamond disc at a low speed with water spray. Slices of 2mm thickness were obtained, one from the cervical third (approximately 1 mm below CEJ), one from the middle third, and another from an apical third of the post (Fig1). The obtained 3mm sections were then fixed to the lower part of the universal testing machine (Fig2). The post cemented into the root canal was positioned exactly in line with the central orifice. The coronal side of each sectioned slice was positioned in contact with the base. The push-out strength was performed at a speed of 1.0 mm/ min until the dislodgement of a post. This was confirmed by the appearance of a sharp drop along the load/time curve recorded by the universal testing machine.

Statistical analysis

Data were analyzed using SPSS version 22. Tests performed were an independent t-test for inter-group comparison, Paired t-test for intra-group comparison & One Way ANOVA with a post hoc test for overall comparison. The P value < 0.05 is considered statistically significant.

Results

The present study was conducted to evaluate the push-out bond strength of three fiber post systems at different post-space regions (Cervical third, middle third & apical third) of root dentin using three different resin cements using ANOVA. The mean values of the loads (N) ranged from 49.4±8.9 to 120.3±12.7 (Figure3). For the Apical region mean push-out bond strength was highest for Solocem (120.57 ± 32.52) followed by Rely Xgroup (76.68 ± 17.01) and Multilink speed (63.32 ± 25.90) which were statistically significant. Similarly in the middle region mean push-out bond strength of Solocem was highest (83.39 ± 23.49) followed by Rely X U200 (76.74 ± 25.48), and Multilink speed (49.07 ± 27.89) which were statistically significant. In the cervical region mean push-out bond strength of highest in Rely X

U200 (66.95 ± 14.23) followed by Solocem (65.14± 21.93) and Multilink speed (53.9322.34) which were statistically not significant. (Table1)

When compared within the groups in different regions of a root, In the coronal region there is no statistically significant difference between groups 1 and 2, 1 and 3, 2 and 3. In the middle region, there is no statistically significant difference between groups 1 and 2, there is a statistically significant difference between groups 1 and 3(0.001), and groups 2 and 3(0.005). In the apical region, there is a statistically significant difference between groups 1 and 2(0.01), and in groups 1 and 3(0.01), there is no statistically significant difference between groups 2 and 3. (Table2)

Discussion

The success of an endodontic therapy depends on appropriate post-endodontic restoration to make pulp less teeth function as an integral part of the masticatory apparatus. Pulp less teeth possess various challenges of the restorative problems such as loss of tooth structure by caries, fracture, and previously existing defective restorations.[8,9,10] The introduction of the intra-coronal post in endodontically treated teeth serves primarily to retain the core structure and later restoration[11]. Posts can be broadly classified as metallic and non-metallic. In recent years, non-metallic posts with biological and physical properties similar to that of dentine have been introduced. For post-endodontic restorations, various luting agents and adhesives systems have been proposed to bond fiber posts to root canal dentin, according to the way they interact with the smear layer current adhesives are attributed to one of the three bonding strategies/techniques.[14] Etch-and-rinse adhesives with a separate acid etching step to remove the smear layer, self-etch adhesives include acidic monomers (the Smear layer permeable without removing it), and self-adhesive resin cements, which show a different cement/dentin interface. Compared to coronal dentin bonding within the root canal is still a challenge due to morphological characteristics and unfavourable conditions regarding the application of adhesive techniques within the root canal. The high cavity-configuration factor (C-factor)[15] inside the root canal is crucial regarding polymerization stress due to volumetric shrinkage. As a result of high shrinkage stress and lower bond strength de-bonding can occur.[16]

According to the results obtained in this study, the highest mean push-out bond Strength is seen in the apical region compared to the other two regions. The results of this in-vitro study show the solocem attained higher bond strengths when compared to the other two resin cements used. In this study solocem registered the highest bond strength as it contains MDP and 4-MET(A) monomers with methacrylate, zinc oxide, and dental glass which reduces the polymerization shrinkage, and the penetration of this resin cement in the dentinal tubules may be higher as this resin cement ensuring the highest bond strength in the apical region and middle region. Therefore it can be concluded that bond strengths to root canal dentin appear to be related more to the area of solid dentin than that to the density of dentinal tubules (Gaston et.al. 2001, Foxton et al 2005)

3M Relyx U200 has registered the highest bond strength in the coronal region when compared to solocem at the coronal region as it exhibits a moisture tolerance because of water formation during the neutralization reaction of phosphoric-acid methacrylate, basic fillers, and hydroxyapatite. The mean push-out bond strength in the middle and apical region was found to be less when compared to solocem, it may be because this resin cement has been mixed manually on the paper pad because it doesn't have auto-mixing elongation tips and

may cause voids or air entrapment in the root dentin which may affect the bonding of the cement to root dentin.

Ivoclar multilink speed bond strengths were lower than solocem and Rely X U200 probably due to the incomplete polymerization reaction. The presence of residual acidic monomers at the bottom of an adhesive interface may represent weak areas as they can retain their etching potential, thus jeopardizing adhesion. In These areas the presence of exposed collagen fiber, the adhesive joint would experience premature degradation, hence limiting the bonding potential of the material and reducing the service life of the restoration. Thus further studies should be performed to assess the longevity of these self-adhesive cements. Khalil aleisa et al. 2013[17] found that the multilink speed bond strengths were lower than those of Relyx unicem which is the previous generation of Rely X-U200, Anshurajj kopal et al. 2015[18] found that Multilink speed has lower bond strengths than compared to the Rely X-U200, and stated that push-out test results in shear stress at the interface between dentin and cement as well as between the post and cement and compared with the stress under clinical situations (Frankenberger et al. 1999) and also said that thermocycling also increases the bond strength of these resin cements. Bouillaguet et al. 2003, goracci et al. 2004[6,7] observed that bond strength to root canal dentin exhibit lower values compared with coronal dentin. Analysis of the failure modes in their investigation also demonstrated only isolated cohesive failures inside the root canal dentin, which indicates the bond strengths to the root canal were weaker when compared with the shear bond strength of the dentin itself, and showed that significantly more adhesive failure between the post and cement should be considered as the limiting factor of the measured bond strength values.

In this present study during the sectioning of the samples, water coolant is used to eliminate the heat generated by the diamond disc to maintain the post-resin-dentin interface which does not replicate the actual clinical situation. Within the limitations of this study, Results obtained showed that Solocem has attained the highest push-out bond strength followed by Rely X-U200 and Multilink speed in three different root canal regions.

Legend Figures and Tables:

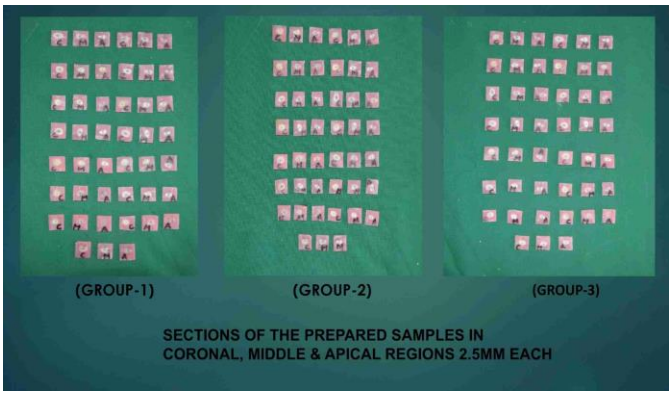

Figure 1: The roots mounted in acrylic were sectioned perpendicular to the long axis with the diamond disc at a low speed with water spray. Slices of 2mm thickness were obtained, one from the cervical third (approximately 1 mm below CEJ), one from the middle third, and another from an apical third of the post.

Figure 2: The obtained 3mm sections were fixed to the lower part of the universal testing machine. The post cemented into the root canal was positioned exactly in

line with the central orifice. The coronal side of each sectioned slice was positioned in contact with the base. The push-out strength was performed at a speed of 1.0 mm/ min until the dislodgement of a post. This was confirmed by the appearance of a sharp drop along the load/time curve recorded by the universal testing machine.

Figure 3: Mean bond strength of various groups at different sites.

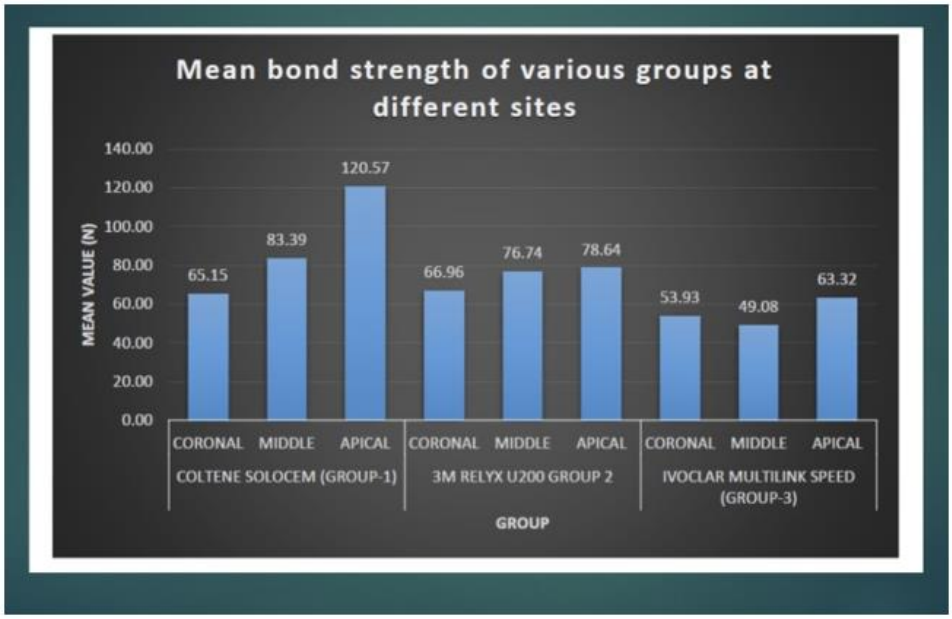

Table 1: Mean and SD of 3 different groups.

Group	Site	N	Mean	SD
Coltene Solocem(Groupi)	Coronal	15	65.14533	21.933545
	Middle	15	83.39467	23.497082
	Apical	15	120.5707	32.52376
3mrelyx U200(Group Ii)	Coronal	15	66.95873	14.231450
	Middle	15	76.74367	25.486595
	Apical	15	78.6387	17.01607
Ivoclar Multilink Speed(Groupiii)	Coronal	15	53.93207	22.349913
	Middle	15	49.07947	27.894556
	Apical	5	63.3247	25.90952

Table 2: Post hoc LSD Comparison of various groups

Dependent Variable			Mean Difference (I-J)	Significance
Coronal	Coltene Solocem (Group-1)	3m Relyx U200 Group 2	-1.813400	.804
		Ivoclar Multilink Speed (Group-3)	11.213267	.130
	3m Relyx U200 Group 2	Ivoclar Multilink Speed (Group-3)	13.026667	.080
Middle	Coltene Solocem (Group-1)	3m Relyx U200 Group 2	6.651000	.482
		Ivoclar Multilink Speed (Group-3)	34.315200*	.001
	3m Relyx U200 Group 2	Ivoclar Multilink Speed (Group-3)	27.664200*	.005
Apical	Coltene Solocem (Group-1)	3m Relyx U200 Group 2	41.93200*	.001
		Ivoclar Multilink Speed (Group-3)	57.24600*	.001
	3m Relyx U200 Group 2	Ivoclar Multilink Speed (Group-3)	15.31400	.113
* The Mean Difference Is Significant At The 0.05 Level.				

Conclusion

Within the limitations of the study, following conclusions were made. The push-out bond strength is dependent on the fiber post and luting agents used, and the bond strength value changes for different root canal regions. In the apical third region, mean push out bond strength of Solocem was highest followed by Rely X U200 and Multilink speed. In the cervical third region mean push-out bond strength was highest for Rely X U200 followed by solocem and Multilink speed. In the middle third region, mean push out bond strength of Solocem was highest followed by Rely X U200 and Multilink speed.

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