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COMPARATIVE EVALUATION OF PUSHOUT BOND STRENGTH OF FIBER POST IN DIFFERENT REGIONS OF ROOT DENTIN USING SELF ADHESIVE AND SELF ETCH RESIN CEMENTS – AN IN VITRO STUDY

Mallikarjunan .D.Y*[1], Assmee Mohammed Noon[2], Vanita D. Revankar[3], Arun Senthamilselvan[4], Aarthi Ganapathy[5], Kaarunya Ravikumar[6]

ABSTRACT-*The present study was to compare the push-out bond strength of fibre posts to root dentin using different techniques of self -etch and self-adhesive resin cements in various regions of root canal dentin. 30 single rooted mandibular premolars extracted for orthodontic reasons with similar root dimensions were included in this study. The cleaning & shaping of root canals were done using crown-down technique in X Smart endomotor system. After 7 days of storage in 100% ambient humidity, the root canals were prepared using #2 preparation drill of fiber post system. #2 preparation drill of the post system was used and post spaces were prepared leaving 4mm of obturated point in the canal and teeth were divided into two groups of 15 each based on different techniques of cementation. In group 1 posts were luted with self adhesive cement and self etch resin cement in group 2. The test was performed in a universal testing machine at a speed of 1 mm/min. The universal testing machine induced a load in the apical to coronal direction of the post without applying any pressure to the cement or dentin. The bond strength in MPa was obtained with the formula- Bond strength (MPa) = Debonding force (N)/Total bonding area (S) (mm2). The real thickness of the slices (h) and the post diameter in coronal (r1)*

[1]*Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India, E-mail: drmallikarjunan@vmsdc.edu.in*

[2]*Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India*

[3]*Associate Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India*

[4]*Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India*

[5]*Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India*

[6]*Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamilnadu, India*

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and apical (r2) were measured and the bonding area (S) was calculated by S = π (r1+ r2) √ (h2+(r1-r2)2 in mm² for each slice. There is a significant difference in RELYX U2OO (MPa) among the different region (P<0.05). The apical region has higher mean value than the other region. There is a significant difference in MULTILINK (MPa) among the different region (P<0.05). The apical region has higher mean value than the other region and coronal region has the low mean value. Cementation of fibre post with self-adhesive cement produce high push out bond strength, especially in the apical region. Further clinical studies required to determine the mode of failure of resin cements.

Key words: *Bond strength, Resin cements, Self-adhesive*

I. Introduction

The longevity of endodontically involved teeth has been greatly enhanced by continuing developments made in endodontic therapy and restorative procedures. It has been reported that a large number of endodontically treated teeth are restored to their original function with the use of intraradicular devices.[1,2]

In cases where tooth structure is intact, conservative approaches such as core build up and full coverage restorations are satisfactory. But as most teeth show significant loss of coronal tooth structure, utilization of post and core and final restoration is necessary to achieve proper form and function. Several studies have reported the failure rate restorations with post and cores to be higher than that of restorations on vital teeth. The causes of failure include fracture or bending of posts, loss of retention, root fracture, corrosion of metallic posts etc.[3]

Introduction of fiber posts brought an evolution in the field of dentistry providing a reliable substitute to metal posts for first time, of all types. Conventional metallic posts are gradually being replaced by non metallic posts. Fiber-reinforced composite root canal posts were introduced in 1990's as an alternative. The first fiber reinforced composite posts were made of carbon/graphite. However they are black in colour demands and thus lack esthetic demands.[4]

As a result of rising demands for tooth-coloured posts, epoxy resin posts reinforced with quartz or glass fibers, zirconia posts are notable. Cementation of a post inside the root canal would provide retention for the final coronal restoration. Among the years different types of bonded posts, such as translucent fibre-reinforced posts, have been introduced. One of the main advantages is that the curing light can be transmitted through the post into the root dentin; however, significant differences in light transmission capability have been reported among fiber posts.[5]

Three categories of luting agents mainly classified as total-etch, self-etch and self-adhesive resin cements. Total-etch resin cements require the separate use of phosphoric acid followed by multi- or two-step total-etch adhesives before the application of the resin cement. This system results in higher bond strengths on coronal dentin; although weak moisture control and in complete resin inter-diffusion significantly decreases the bond strength to radicular dentin.[6]

Self-etch resin cements use an acidic primer which, without rinsing, can alter tooth structure before bonding; therefore, the clinical steps are simpler than those with total-etch cements. A new subgroup of resin cements, self-adhesive cements, was introduced in 2002. These materials were designed with the purpose of overcoming some of the limitations of both conventional and self-etch resin cements. Self adhesive cements do not require

any pretreatment of the tooth substrate: once the cement is mixed, application is accomplished in a single clinical step.[7]

On the other hand, variations in the structure of root canal dentin, such as accessory root canals, areas of resorption, embedded and free pulp stones, and varying amounts of irregular secondary dentin, may affect bonding to different regions of the root.[8] Therefore, the present study was to compare the push-out bond strength of fibre posts to root dentin using different techniques of self -etch and self-adhesive resin cements in various regions of root canal dentin.

II. Materials and methods

30 single rooted mandibular premolars extracted for orthodontic reasons with similar root dimensions were included in this study. The teeth with extremely curved roots, teeth with fracture lines, severely calcified roots and root caries were excluded from the study. The teeth samples were stored in saline until all the required specimens were collected. The teeth samples were sectioned just below cemento enamel junction with diamond disc under coolant.

Endodontic treatment

The canal patency was checked with 10 K file. The working length was determined with a 15 K file. The file was introduced into the canal until it was seen at the apex. From that length 1mm was reduced and kept as working length. The cleaning & shaping of root canals were done using crown-down technique in X Smart endomotor system (Dentsply Maillefer, Ballaiguies, Switzerland) using Protaper rotary nickel-titanium instruments (S1-S2-F1-F2-F3; (ProTaper Universal; Dentsply Maillefer, Ballaiguies, Switzer) lubricated with 17% EDTA (Endoprep-RC) land) then irrigation was performed alternatively using 5% NaOCl (Niclor 5; Ogna, Milano,Italy) and normal saline after every change of file size. Canal preparation was performed 1 mm short of the apical constriction. The canal was dried with paper points then root canals were filled with gutta-percha points (Dentsply-Maillefer, Petropolis, RJ, Brazil) in single cone technique using endodontic resin cement (Sealer AH- 26, Dentsply-Maillefer, Petropolis, RJ, Brazil).

Root preparation

After 7 days of storage in 100% ambient humidity, the root canals were prepared using #2 preparation drill of fiber post system (TENAX FIBER TRANS, Coltene Whaledent, USA) The drill corresponding to the post diameter was used at low speed, with intermittent pressure and water cooling, to prepare the canal space at a standardized length of 10 mm. The posts were then tested into the root canal.

Embedment of roots in a resin base

#2 preparation drill of the post system was used and post spaces were prepared leaving 4mm of obturated point in the canal and teeth were divided into two groups of 15 each based on different techniques of cementation. In group 1 posts were luted with self adhesive cement and self etch resin cement in group 2. Group 1 comprised of self adhesive resin cement (n =15) (rely x u200 (3m ESPA, USA) and group 2 comprised of self etch resin cement (n =15) (Multilink N (Ivoclar vivadent). The two groups of teeth luted with post were embedded in a chemically cured acrylic resin base to keep roots and cemented posts as perpendicular as possible to the horizontal plane.

Each sample was fixed with cyanoacrylate on a metallic base of a machine and sectioned with a diamond disc under cooling spray into approximately 3 mm slices. The first cervical slice (approximately 1 mm) was discarded. Finally three sections per root were produced, resulting in 45 samples per group. For push-out testing, a metallic cylinder was attached to the machine's superior portion that coincided with the post center. The test was performed in a universal testing machine at a speed of 1 mm/min. The universal testing machine induced a load in the apical to coronal direction of the post without applying any pressure to the cement or dentin. The bond strength in MPa was obtained with the formula- Bond strength (MPa) = Debonding force (N)/Total bonding area (S) (mm2). The real thickness of the slices (h) and the post diameter in coronal (r1) and apical (r2) were measured and the bonding area (S) was calculated by $S = \pi (r1+ r2) \sqrt{(h2+(r1-r2)2}$ in mm2 for each slice. The statistical analysis done using one way ANOVA and Post hoc Tukey Kramer test for intergroup comparison at p value <0.05.

III. Results

Table: 1 Pushout bond strength in group I (RELYX U2OO)

Region	Mean	Std deviation	F-value	P-value
Coronal	11.82	2.64	2.84	0.01 Significant
Middle	14.45	3.43		
Apical	18.11	8.68		
Total	14.79	6.05		

Table 1 shows that there is a significant difference in RELYX U2OO (MPa) among the different region (P<0.05). The apical region has higher mean value than the other region.

Table: 2 Pushout bond strength in group II (MULTILINK)

Region	Mean	Std deviation	F-value	p-value
Coronal	5.07	2.28	6.49	0.001 Significant
Middle	8.66	4.02		
Apical	10.7	2.80		
Total	8.01	3.80		

Table 2 shows that there is a significant difference in MULTILINK (MPa) among the different region (P<0.05). The apical region has higher mean value than the other region and coronal region has the low mean value.

Table 3 Inter comparison of group 1 and group 2

Sub Group	Mean	Std deviation	p-value
Group 1	13.46	2.07	0.01 Significant
Group 2	8.80	0.79	

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Table 3 shows that there is a significant difference in group 1 and group 2 (P<0.05).

Table 4Tukey HSD

Dependent Variable	**(I) CODE**	**(J) CODE**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
MULTILINK	Coronal	Middle	-3.5936	1.5957	.088
		Apical	-5.6479	1.5957	.006
	Middle	Coronal	3.5936	1.5957	.088
		Apical	-2.0543	1.6481	.441
	Apical	Coronal	5.6479	1.5957	.006
		Middle	2.0543	1.6481	.441
RELYX U200	Coronal	Middle	3.483	2.599	.002
		Apical	3.652	2.599	.003
	Middle	Coronal	3.483	2.599	.001
		Apical	4.135	2.537	.005
	Apical	Coronal	3.652	2.599	.002
		Middle	4.135	2.537	.001

Table 4 shows comparison between both groups using Tukey HSD.

Table 5 Inter comparison between group 1 and group 2

Sub Group	**Mean**	**Std deviation**	**p-value**
RELYX U2OO (MPa)	14.79	6.05	0.01 significant
MULTILINK (MPa)	8.01	3.80	

Table 5 shows significant difference between both groups (P< 0.05).

IV. Discussion

Following root canal therapy tooth becomes weaker because of loss of tooth structure during cleaning & shaping. Furthermore these teeth often have little coronal tooth structure to retain a core and final restoration. Therefore intra-radicular posts have been used to provide anchorage for coronal restoration. A post is defined as the segment of restoration inserted into the root canal to aid in the retention of the core component. The main function of post is to retain the final core and the crown.[9]

Glass fiber post was used because these post has the flexural strength and the modulus of elasticity similar to that of dentin. Various luting agents and corresponding adhesive systems have been proposed for bonding fibre-reinforced posts to root canal dentine. The etch-and-rinse strategy frequently requires a wet dentine substrate for optimal bonding. However, it is difficult to control wetness within the root canal because of limited access.

Conversely, the self-etch approach does not require rinsing and thus, the problem of substrate moisture control is solved.[10]

However, two-step self-etch adhesives showed high bond strength values and stability over time when applied to coronal dentine, the efficacy of self-etch systems to properly impregnate the intra-radicular dentine remains questionable.[11]

The action of sodium hypochlorite, hydrogen peroxide, ethylenediamine tetra acetic acid (EDTA), or other irrigants on dentin collagen, the polymerization stress of resin cement in root canals with unfavorable cavity configuration factors, and the chemical and physical properties of the posts can possibly influences the quality of adhesion at the post-cement, adhesive–dentin interfaces. Moreover, the quality of adhesion to root dentin is affected by the density and orientation of dentin tubules at different levels of the root canal walls and the accessibility of the coronal, middle, and apical third of the root during handling of the materials. [12]

To test regional differences between bond strength inside the root canal it is necessary to use *in vitro* testing methods and sectioning of the root.8. A variety of experimental designs has been described for the evaluation of post and core retention. Amongst these tests, push-out test using sections of 1-2mm in height was reported to offer reliable and convenient results. Gorracci et al[13] showed more reproducible bond strength measurements using a conical version of the push-out design than with a microtensile technique. They concluded that when measuring the bond strength of luted fiber posts, the push-out test appears to be more dependable than microtensile technique. Thin-slice push-out strength test is considered to be a valid method to evaluate fiber post adhesion to root canal walls. Therefore, this design was chosen for the present study.

In the present study dual-curing resin cements selected were divided into two groups, self adhesive resin cements, Rely X U200 (3M ESPE) and self etch resin cements Multilink (Ivoclar vivadent). 45 samples of 3 each across different regions (coronal, middle, apical) of group 1 & group 2 were tested and results were statistically analyzed using one way ANOVA and TUKEY tests. The mean push out bond strength of group 1 showed 11.82 Mpa in coronal third, 14.45 Mpa in middle third and 18.11 Mpa in apical region respectively. This cement showed statistically significant differences in coronal, middle and apical region ($p<0.01$)

The mean push out bond strength of group 2 had 5.07 Mpa in coronal third region, 8.66 Mpa in middle third, 10.07 Mpa in apical region. It also showed statistically significant differences in coronal, middle and apical region ($p<0.01$). The results of inter comparison Tukey study showed group 1 had higher mean values of bond strength 13.46 Mpa in the apical third region where p value is 0.03 ($p<0.05$) which is statistically significant. The results of our study correlates with Bruce et al[14] who studied microtensile bond strength of resin cements (Panavia 21 or C&B Metabond) at different regions of tooth. He concluded that both resin cements produced high bond strengths (12–23 MPa), and that bond strengths to the apical third were significantly higher ($p < 0.05$) than to the cervical or middle third with either cement.

Bitter et al[15] investigated the push out bond strengths of 6 luting agents (Panavia F, Multilink, Variolink II, PermaFlo DC, RelyX Unicem and Clearfil) at different regions of tooth. He concluded that RelyX showed higher bond strengths compared with other materials and the apical region of the canals was characterized by significantly higher bond strengths.

Group 2, Multilink (Ivoclar vivadent) showed least bond strength of 5.07 Mpa in coronal third region where p value is 0.001 ($p<0.01$) which is statistically significant. Cervical regions require greater volume of cementing material, increasing stress at the adhesive interface during polymerization shrinkage.

Further studies are required to evaluate the durability of the bond after aging, and long-term clinical studies are needed before any clinical recommendations.

V. Conclusion

Within the limitations of this laboratory investigation, it can be concluded that cementation of fibre post with self-adhesive cement produce high push out bond strength, especially in the apical region. Further clinical studies required to determine the mode of failure of resin cements.

VI. References

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