Comparative study of retention of fiber-reinforced post at middle and cervical one thirds of root canal cemented by polycarboxylate and zinc phosphate cements measured at different storage times

Saad Zabar, B.D.S., M.Sc. [(1)]

ABSTRACT

Background: The purpose of this study was to compare regional bond strength at middle and cervical thirds of the root canal among glass fiber-reinforced composite (FRC) endodontic posts cemented with different cements, using the push-out test to compare the performance (retention) of two types of luting cements; polycarboxylate cement and Zinc phosphate cement used to cement translucent fiber post and to compare the result of the push-out test at different storage times;1 week ,1month and 2 months.

Materials and methods: Ninety caries-free, recently extracted single-rooted human teeth with straight root canals was used in this study, The root canals were endodontically instrumented at a working length of 0.5 mm from the apex by means of conventional instruments for hand use (Dentsply, Switzerland) up to size 35.then root canal filling was performed followed by post space preparation up to 8mm including cervical and middle one third of root canal then the fiber post was cemented into canal post space then the root was sectioned to get cervical (4 mm in length) and middle (4 mm in length) thirds ,these thirds were examined by push out test to get values of retention of fiber post inside these canal thirds .

Results and Conclusions: The results of this study has been showed that there was no significant differences between push out bond strength between fiber post and root at cervical third as compared with middle third when using polycarboxylate cement or Zinc phosphate cement to cement the fiber post to the canal walls and the results showed that there was no significant differences in push out bond strength for polycarboxylate or Zinc phosphate cement after one and two months but there was highly significantly increase in push out bond strength for resin cements used to cement the fiber post to the root canal after one and two months

Keywords: glass fiber post, push out retention, polycarboxylate, Zinc phosphate. (J Bagh Coll Dentistry 2013; 25(2):41-46).

INTRODUCTION

Increased post retention and fracture resistance have been reported when posts are cemented with composite cements and conventional luting systems[1]. The resultant homogeneous biomechanical unit allows a more uniform stress distribution, which better preserves the weakened tooth structure and reduce microleakage at dentine-cement interface, Secondary caries and re-infection of the periapical area [2].

Various luting agents and accompanied adhesives that either follow a self-etch or etch-and-rinse approach, can be used to bond fiber posts into root canals. The actual bond strength at the post-cement-root interface is affected by many factors, among which have been described the hydration degree of the root-canal dentin, the kind of conditioning agent and accompanied cement used, the unfavorable cavity configuration of the root canal, the use of eugenol-containing sealers and the anatomical differences in density and orientation of the dentinal tubules at different levels of the root-canal areas [3].The aim of the study was to compare regional bond strength at middle and cervical thirds of the root canal among glass fiber-reinforced composite (FRC) endodontic posts cemented with different cements, using the push-out test to compare the performance (retention) of two types of luting cements .Zinc phosphate and Polycarboxylate cements when used to cement translucent fiber post and to compare the result of the push-out test at different storage times

Various methods are available to analyze the adhesive bond strength of cement and bond strength of the fiber posts. The two most commonly used techniques are the micro tensile bond strength (MTBS) and the push out test. Most scientists prefer the push out test for the analysis of fiber posts bond strength to root dentine because it has been documented that the results of this test are more reliable for posts compared to the MTBS test/By using the push out test, the premature loss of samples during the manufacturing of the specimens is reduced. Furthermore, the micro push out test enables the measurement of bond strength to very small areas such as the interior of a root canal[6].

MATERIAL AND METHODS

Sample selection

Ninety caries-free, recently extracted single-rooted human teeth with straight root canals will be used in this study. The inclusion criteria were absence of caries or root cracks, no fractures, no external resoption and X-ray will be taken to

(1) Assistant lecturer. Department of Conservative Dentistry. College of Dentistry. University of Baghdad.

confirm no signs of internal resoption ,no calcification ,single canal and absence of previous endodontic treatments. Teeth will be stored in 0.1% Thymol at room temperature.

Preparation of acrylic blocks:

Each tooth was fixed inside and at the base of clear tube with sticky wax at it apex then the clear acrylic will be mix and pour inside the clear tube till the tooth will be completely embedded inside the clear acrylic, the crown portion of each tooth was sectioned perpendicularly to the long axis of the tooth at the cementum-enamel junction level, using a sectioning instrument under copious water cooling leaving 12mm root length embedded inside acrylic for further steps

Root canal preparation:

The Root canals were endodontically instrumented at a working length of 0.5 mm from the apex by means of conventional instruments for hand use (Dentsply ; Switzerland) up to size 35. After each instrumentation, root canals were flushed with 2 mL of 2.5% sodium hypochlorite and dried with adsorbent paper points. Canals were filled with cold lateral gutta-percha condensation using gutta-percha size 35 as master cones and size15as accessory cones, and Ah2 root canal sealer the sealer will be mixed, according to manufacturers' instructions. After filling the access chamber with temporary filling material, all root canals were stored in distilled water at 37C for 1 week, 1mounth and 2 month period , to study the effect of storage periods on the results of this study .

Post space preparation

Filling material of the middle and cervical thirds was then removed with Pesso drills (Maillefer-Dentsply), and the canal wall of each specimen was enlarged with low speed FRC Postecl drills (Ivoclar, Schaan, Liechtenstein) under copious water cooling, following the manufacturer's instructions, creating a 8-mm length post space (measured from cemento-enamel junction) with a no. 3 post drill, keeping at least 4mm of gutta-percha apically.

Groups

Teeth were randomly assigned into three main groups (Group A and Group B, n=30 each), depending on the type of cement will be used; Polycarboxylate cement (Dorident ; Austria) (A) , and Zinc phosphate cement (Dorident ; Austria) (B). And then each group is sub-divided into three groups (n=10 each), depending on storage period;1 week(A1 and B1), 1 month(A2 and B2) and 2 month period(A3 and B3) each root was sectioned into cervical (A1c,A2c,A3c,B1c,B2c and B3c)and middle(A1m,A2m,A3m,B1m,B2m and B3m) thirds.

Group A (A1,A2,A3)

The post space will be irrigated with distilled water and dried with paper points then the Polycarboxylate cement will be mixed according to manufacturer instruction and then will be used to cement the fiber post into post space (8mm of canal filling the middle and cervical one third of the canal space

Group B (B1,B2,B3)

The post space will be irrigated with distilled water and dried with paper points then the Zinc phosphate cement will be mixed according to manufacturer instruction and then will be used to cement the fiber post into post space (8mm of canal filling the middle and cervical one third of the canal space

Preparation of Specimens for the Push-Out Bond Strength Test

Specimen will attached to the holder to keep it fix and then with sectioning disc under cooling water the specimen will be sectioned perpendicular to the long axis under water cooling. Three slices per each root representing cross-sections of cervical (c) and, middle (m)of the bounded posts will be obtained. Each slice was marked on its apical side with marker. The thickness of each specimen was measured with vernea. The sections will be stored individually in black container with sterile water.

Push-out tests will be performed by applying a compressive load to the apical aspect of each slice via a cylindrical plunger mounted on a Universal Testing Machine managed by pc software. Because of the tapered design of the post, three different sizes of punch pin: 1.1 mm diameter for the coronal, 0.9 mm for the middle, will be used for the push out testing. The punch pin was positioned to contact only the post, without stressing the surrounding root canal walls Care will also taken to ensure that the contact between the punch tip and the post section occurred over the most extended area, to avoid notching of the punch tip into the post surface. The load was applied to the apical aspect of the root slice and in an apical-coronal direction, so as to push the post towards the larger part of the root slice, thus avoiding any limitation to the post movement. Loading was performed at a crosshead speed of 0.5 mm min) 1 until the post segment was

dislodged from the root slice [3]. A maximum failure load value will recorded (Netween) and converted into MPa, considering the bonding area of the post segments. Post diameters were measured on each surface of the post/dentine sections using the digital caliper and the total bonding area for each post segment was calculated using the formula:

$\Pi(R1+R2)\ (R1-R2)^2 + h^2$

Where: R represents the coronal post radius, r is the apical post radius and h is the thickness of the slice. All fractured specimens were carefully removed and observed under stereomicroscope at 20 and 50 magnification from the cervical as well as from the apical direction to determine, for each root third, the mode of failure, which were classified into five types[5]:

(i) Adhesive between post and resin cement (no cement visible around
(ii) Mixed, with resin cement covering 0-50% of the post diameter.
(iii) Mixed, with resin cement covering 50-100% of post surface.
(iv) Adhesive between resin cement and root canal (post enveloped by resin cement).
(v) Cohesive in dentine.

RESULTS

The results showed (figure 1 and table 1) that the group (A1c and A2c) has the highest push out bond strength while the group (B2m) has the lowest push out bond strength.

A-Push out bond strength for Zinc phosphate cement and polycarboxylate cement at middle and cervical third of root canal:

One-way ANOVA test (Table 2) showed that there was statistically significant difference among all the groups at the P value less than 0.01

LSD test (table 3) showed that there was no significant differences between push out bond strength between fiber post and root at cervical third as compared with middle third when using polycarboxylate cement and Zinc phosphate cement to cement the fiber post to the canal walls.

B-Push out bond strength for the type of cement (Zinc phosphate cement and polycarboxylate cement):

LSD test (table 4) showed that there was higher significant differences between push out bond strength between the two types of dental cements used to cement the fiber post to the root canal. The results showed that polycarboxylate cement has higher bond strength than Zinc phosphate cement .

C-Push out bond strength for Zinc phosphate cement and polycarboxylate cement at 1 week, 1 month and 2month storage periods:

LSD test (table 5) showed that there was no significant differences in push out bond strength for polycarboxylate cements used to cement the fiber post to the root canal after one and two months the same results gain when using Zinc phosphate cement .

DISCUSSION

The objective of a post endodontic restoration is to achieve normal form and function as well as the prevention of fracture of the residual root. other considerations are esthetic, prevention of caries an retention of final restoration[6]. The amount of tooth structure is a significant factor in determining the fracture resistance of an endodontically treated tooth. It has been shown that endodontically treated tooth restored with posts and cored of different materials and designs tend to exhibit similar fracture resistance when abundant tooth structure remains[7]. In this study the push out bond strength test was used to evaluate the efficiency of two types of cement used to retain the fiber post in the two thirds of root canal to support tooth structure and retained the final restoration, the finding of the present study were:

1. The effect of root thirds on bond strength of fiber post to the root canal:

The result of the present study showed that two types of cements used demonstrate a measurable adhesive property, by using Polycarboxylate cements to cement the fiber posts to canal walls the results appeared no difference of bond strength of the post to canal walls at cervical third and middle third. This results interfere with results of (Karin et al in 2008[8]) who showed that bond strength to root dentine is higher at coronal part compared to the apical part. Several factors may contribute to the reduction in the bond strength from coronal to apical direction. Some of these factors are inherited to the root dentin composition, and others are related to the restoration techniques used[9].But when using polycarboxylate cement and Zinc phosphate cement to cement the fiber posts to canal walls the results appeared no differences in values for the cervical third and the middle may be related to lack of adhesion to the fiber post while there adhesion mechanism to root dentine at the same values for cervical and middle thirds.

2. The effect of type of cements on bond strength of fiber post to the root canal:

The result of this study showed higher bond strength gain when Polycarboxylate cement was

used as compared with Zinc phosphate cement this results coincide with results of Michael et al [10] who said that the clinical performance of Zinc phosphate cement to lute alloy based restorations seems astonishing because the mechanical and biological properties of this cement are considered to be poor, the compressive strength is lower than those of resin cements. [10]

3- The effect of storage period on bond strength of fiber post to the root canal:

The result of this study showed that there was no increase in push out bond strength when using polycarboxylate and Zinc phosphate cements this may be these cements materials will reach maximum setting reaction and maximum bond strength after shorter period of time thus the different storage periods did not increase the push out bond strength of fiber post to canal walls when using these cement materials [11,12].

REFERENCES

1- O'Keefe KL, Miller BH, Powers JM. In vitro tensile bond strength of adhesive cements to new post materials. Int J Prosth 2000; 13: 47-51.
2- Reid LC, Kazemi RB, Meiers JC. Effect of fatigue on core integrity and post microleakage of teeth restored with different post systems. J Endod 2003; 29:125-31.
3- Vano M, Cury AH, Goracci C, Chieffi N, Gabriele M, Tay FR, et al. The effect of immediate versus delayed cementation on the retention of different types of fiber post in canals obturated using a eugenol sealer. J Endod 2006; 32:882-5.
4- Maria D, Husamettin G, Werner G, Anne K. Push out strength of fiber posts depending on the type of root canal filling and resin cement. Clin Oral Invest 2011; 15: 273-81(IVSL).
5- Perdigao J, Gomes G, Lee IK. The effect of silane on the bond strengths of fiber posts. Dental Materials 2006; 22: 752-8.
6- Perel ML, Muroff FL. Clinical criteria for posts and cores.J Prosth Dent 1972; 28: 405-11.
7- Raygot CG, Chai J, Jameson DL. Fracture resistance and primary failure mode of endodontically treated teeth with a carbon fiber reinforced resin post system in vitro. Int J Prosthodont 2001; 14: 141-5.
8- Karin K, Lutz F, Bemd K, Norbert H. Influence of endodontic post type (Glass fiber, Quartz fiber or Gold) and luting material on push out bond strength to dentin in vitro. Dent Mater 2008; 5(24): 660-666 (IVSL).
9- Lopez GC, Ballarin A, Baratieri LN. Bond strength and fracture analysis between resin cements and root canal dentin. Aust Endod J 2012; 38(1):14-20.
10- Michael B, Martin R, Jutta W, Reinhold L, Carola K, Ralf B, Gerhard H. Self-adhesive resin cement versus Zinc phosphate cement luting material: A prospective clinical trial begun 2003 Dental Materials 2009; 25: 601-604 (IVSL).
11- Feng L, Suh BI. The effect of curing modes on polymerization contraction stress of a self adhesived composite. J Biomed Mater Res B Appl Biomater 2006; 76(1):196-202.
12- Graig RG. Restorative dental materials. St. Louis: The CV. Mosby Co; 1985.

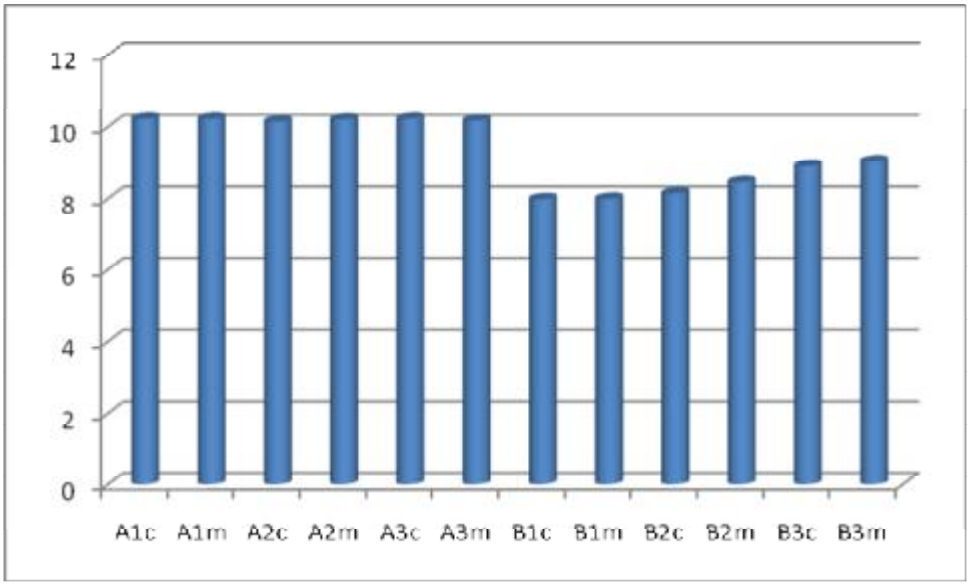

Figure 1: Push out bond strength (MPa) of all groups of this study.

Table 1: Mean and standard deviation (MPa) of push out bond strength of all groups of this study

Cement type	Root third	Storage period	N	Mean	±Sd
Polycarboxylate cement (A)	Cervical (c)	1 week (A1c)	10	10.22	0.21
		1 month (A2c)	10	10.22	0.18
		2 month (A3c)	10	10.14	0.21
	Middle (m)	1 week (A1m)	10	10.2	0.15
		1 month (A2m)	10	10.22	0.13
		2 month (A3m)	10	10.17	0.13
Zinc phosphate cement (B)	Cervical (c)	1 week (B1c)	10	8.98	0.5
		1 month (B2c)	10	8.14	0.37
		2 month (B3c)	10	8.89	0.43
	Middle (m)	1 week (B1m)	10	7.99	0.37
		1 month (B2m)	10	8.45	0.33
		2 month (B3m)	10	9.02	0.37

Table 2: ANOVA test for push out bond strength for Polycarboxylate cement and Zinc phosphate cement at cervical and middle roots thirds with 1 week, 1 month and 2month storage periods.

	Sum of square	df	Mean square	F-test	P(value)
Between groups	1253.28	33	37.98	18.482	P<0.01
Within groups	176.72	86	2.505		
Total	1430	119			

d.f.=degree of freedom P-value=probability

Table 3: LSD test to compare push out bond strength between cervical and middle third of root of tested groups

Comparism (I)Group X (J)Group	Mean differences (I-J)	Significance
(A1c) X (A1m)	0.080	0.931
(A2c) X (A2m)	-0.061	0.511
(A3c) X (A3m)	0.055	0.553
(B1c) X (B1m)	-0.01	0.941
(B2c) X (B2m)	-0.061	0.023*
(B3c) X (B3m)	-0.13	0.337

*** significant at (P<0.05)**

Table 4: LSD test to compare push out bond strength between the two types of dental cements used to cement the fiber post to the root canal.

Comparison (I)Group X (J)Group	Mean differences (I-J)	Significance
(A1c) X (B1c)	2.25	0.000*
(A1m) X (B1m)	2.23	0.000*
(A2c) X (B2c)	1.99	0.000*
(A2m) X (B2m)	1.75	0.000*
(A3c) X (B3c)	1.33	0.000*
(A3m) X (B3m)	1.15	0.000*

*** significant at (P<0.05)**

Table 5: LSD test to compare push out bond strength for polycarboxylate cement and Zinc phosphate cement at 1 week, 1 month and 2month storage periods.

Comparison (I)Group X (J)Group	Mean differences (I-J)	Significance
(A1c) X (A2c)	0.085	0.360
(A1c) X (A3c)	0.004	0.966
(A2c) X (A3c)	-0.084	0.383
(A1m) X (A2m)	0.016	0.863
(A1m) X (A3m)	0.051	0.582
(A2m) X (A3m)	0.035	0.706
(B1c) X (B2c)	-0.15	0.238
(B1c) X (B3c)	-0.91	0.000*
(B2c) X (B3c)	-0.75	0.000*
(B1m) X (B2m)	-0.45	0.000*
(B1m) X (B3m)	-1.03	0.000*
(B2m) X (B3m)	-0.57	0.000*

*** significant at (P<0.05)**