Comparative Study of Retention of Fiber-Reinforced Post Retention At Middle and Cervical Thirds of Root Canal Cemented by Different Luting Cements

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Abstract:

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 luted with different cements, using the push-out test. To compare the performance (retention) of two types of luting cements polycarboxylat cement and Glass ionomer cement used to cement translucent fibre post. and To compare the result of the push-out test at different storage times;1 week ,1month and 2 months.
Sixty caries-free, recently extracted single-rooted human teeth with straight root canals will be used in this study, The Roots endodontically instrumented canals were 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 fibre 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 .The results of this study 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 to cement the fiber post to the canal walls but there was highly significant differences between push out bond strength between fiber post and root at cervical third as compared with middle third when using glass ionomer cement also the results showed that the glass ionomer cement. The results also shwed that the push out bond strength for GIC was higher than that of PCC and that the push out retention of GIC incrases with time,while no such changes occur with PCC.
Keywords: glass fiber post, push out retention ,glass ionomer, polycarboxylate

الخلاصة:

ترمي هذه الدراسة إلى معرفة مدى تأثير نوعين من المواد الاسمنية على ثبات الوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن في المنطقة العلوية والمنطقة الوسطية لجذر الأسنان وخلال فترات حفظ مختلفة (أسبوع واحد وشهر واحد وشهرين).
أظهرت النتائج انه لا يوجد اختلاف بين ثبات الوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن في المنطقة العلوية والمنطقة الوسطية لجذر الأسنان عند استخدام مادة البولي كربوكسليت الاسمنتية في حين هناك اختلاف كبير بين ثبات الوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن في المنطقة العلوية فهو أكثر ثبات من المنطقة الوسطية لجذر الأسنان عند استخدام مادة الكلاس اينمير الاسمنتية. وكذالك أظهرت النتائج أن هنالك فرقاً كبيراً أكثر ثباتاً للوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن عند استخدام مادة الكلاس اينمير الاسمنتية مقارنة بثبات الوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن عند استخدام مادة البولي كربوكسليت الاسمنتية. وكذالك أظهرت النتائج ان جفظ العينان لفترة أطول قد زاد ثبات الوتد الشفاف المعزز بالألياف داخل عاج قناة جذر السن عند استخدام مادة الكلاس اينمير الاسمنتية فقط.

Introduction

For many years, cast post and core restoration were the primary option for root canal treated teeth (Maria *et al* ., 2011).However, a great variety of disadvantages associated with metallic posts have led to a controversial discussion about these systems .More precisely, the high number of root fractures and the lack of translucency compared to natural teeth are considered to be the main disadvantages. Moreover, corrosive products and the risk of root perforation during post removal have raised doubts about their use (Maria *et al* ., 2011 ;Teston *et al* .,1993).Since cast posts may reduce the fracture resistance of a restored tooth, they should only used in teeth with little or no reaming mechanical retention(Bystom *et al* ., 1981). Therefore new post systems have been developed e.g. ,glass fiber posts (Maria *et al* ., 2011 ; Bateman *et al*.,2003). The combination of an adhesive bond to the root canal dentine with a resin core buildup allow the restoration of non vital teeth while preserving the remaining tooth structure[1]. The adhesive bond of fiber posts can stabilize the tooth substrate. Another advantage of adhesively cemented fiber posts is the prosthetic restoration of wide root canals (Qualtrough *et al* ., 2003). In contrast to cast posts, factors like post length, post diameter, or taper of the posts do not significantly influence the adhesion and long term behavior of glass fiber posts. Taken together, fiber reinforced posts seem to be superior compared to cast posts, especially regarding their physical properties, for example modulus of elastisticity, that is similar to root dentine(Maria *et al* ., 2011; Qualtrough *et al* ., 2003). In addition, the parallel bundled fibers may act as a guide for rotating instrument. This may facilitate the removal of glass fiber posts if necessary, e.g. in case of an endodontic revision or after a post fracture, Moreover, glass fiber posts are biocompatible and do not corrode, finally an important advantages of fiber posts is high esthetic appearance, with no risk of gingival discoloration or alteration of the root surface by corrosive products especially in anterior reign (Maria *et al* ., 2011).

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 luted with different cements, using the push-out test ,to compare the performance (retention) of two types of luting cements glass ionomer cement and Polycarboxylate cement when used to cement translucent fibre post and to compare the result of the push-out test at different storage times.

Material and methods:

Methods;

Sample selection:

Sixty 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 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 was mixed and poured inside the clear tube till the tooth was completely embedded inside the clear acrylic ,then the crown portion of each tooth was sectioned perpendicular to the long axis of the tooth at the cemento-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 absorbent 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 was 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, 1month and 2 months 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 two main groups (Group A and Group B, n=30 each), depending on the type of cement to be used; Polycarboxylate cement (Dorident ; Austria)(A) and glass ionomer cement(Medicem,Promedica; Germeny). (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 was irrigated with distilled water and dried with paper points then the polycarboxylate cement was mixed according to manufacturer instruction and then was 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 was irrigated with distilled water and dried with paper points then glass ionomer cement was 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 was 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 was 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 (Vano *et al* .,2006) **.** 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 his 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 (Perdigao *et al* .,2006)**:**

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

Results :

The results showed (figure 1 and table 1)that the group (B3c) has the highest push out bond strength while the group (A3c) has the lowest push out bond strength .

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

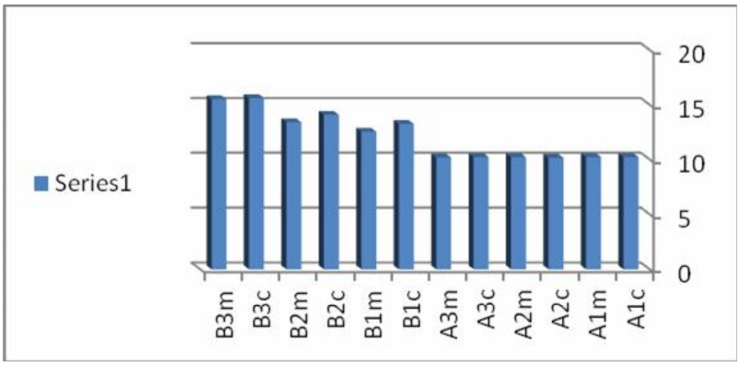

Table 1 : Mean and standard deviation (MPa) of push out bond strength of all groups of this study.

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
Glass ionomer cement (B)	Cervical (c)	1 week (B1c)	10	13.26	0.22
		1 month (B2c)	10	14.1	0.21
		2 month (B3c)	10	15.6	0.36
	Middle (m)	1 week (B1m)	10	12.5	0.16
		1 month (B2m)	10	13.4	0.14
		2 month (B3m)	10	15.5	0.14

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

LSD test (table 2) 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 to cement the fiber post to the canal walls but there was highly significant differences between push out bond strength between fiber post and root at cervical third as compared with middle third when using glass ionomer cement to cement the fiber post to the canal walls except in group at storage period of two months.

Table 2: 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	0.487
(A3c) X (A3m)	0.055	0.531
(B1c) X (B1m)	0.758	0.000*
(B2c) X (B2m)	0.696	0.000*
(B3c) X (B3m)	0.095	0.280

* significant at ($P<0.05$)

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

LSD test (table 3) 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.

Table 3: 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.

Comparism (I)Group X (J)Group	Mean differences(I-J)	Significance
(B1c) X (A1c)	3.032	0.000*
(B1m) X (A1m)	2.282	0.000*
(B2c) X (A2c)	3.952	0.000*
(B2m) X (A2m)	3.195	0.000*
(B3c) X (A3c)	5.380	0.000*
(B3m) X (A3m)	5.340	0.000*

* significant at (P<0.05)

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

LSD test (table 4) 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 but there was highly significant differences in push out bond strength for glass ionomer cement used to cement the fiber post to the root canal after one and two months

Table 4: LSD test to compare push out bond strength for polycarboxylate cement and glass ionomer cement at 1 week, 1 month and 2month storage periods.

Significance	Mean differences(I-J)	Comparism (I)Group X (J)Group
0.334	0.085	(A1c) X (A2c)
0.964	0.004	(A1c) X (A3c)
0.357	-0.081	(A2c) X (A3c)
0.855	0.016	(A1m) X (A2m)
0.561	0.051	(A1m) X (A3m)
0.690	0.035	(A2m) X (A3m)
0.000*	-0.835	(B1c) X (B2c)
0.000*	-2.344	(B1c) X (B3c)
0.000*	-1.509	(B2c) X (B3c)
0.000*	-0.897	(B1m) X (B2m)
0.000*	-3.007	(B1m) X (B3m)
0.000*	-2.110	(B2m) X (B3m)

* significant at (P<0.05)

One-way ANOVA test (Table 5) showed that there was statistically significant difference among all the groups at the P value less than 0.01

Table(5):ANOVA test for push out bond strength for P;ycarboxylate cement and glass ionomer cement at cervical and middle roots thirds with 1 week, 1 month and 2month storage periods.

P(value)	F	Mean square	df	Sum of square	
P<0.01	1252.604	47.977	11	527.749	Between groups
		0.038	108	4.137	Within groups
			119	531.886	Total

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

Discussion:

In the present, the teeth were carefully selected for standardized size and absence of any root caries and cracks. Attempts were made to simulate the periodontal ligament and tooth supporting structure, by embedding the roots directly into the acrylic resin blocks, the push out test was employed and the results were analysis to reach to this finding:

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

The result of the present study showed that both of the two cements used demonstrate a measurable adhesive property, by using glass ionomer cement to cement the fiber posts to canal walls the results showed higher values for the cervical third than the middle third.Several factors may contribute to the reduction in the bond strength from coronal to apical direction. Some of these factors are inherent to the root dentin composition, and others are related to the restoration techniques used (Lopez *et al* .,2010).But when using polycarboxylate cement to cement the fiber posts to canal walls the results revealed no differences in values for the cervical third and the middle. This,may be related to lack of adhesion to the fiber post while third- 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 glass ionomer cement was used to cement fiber post to the canal walls glass ionomer cement has been advocated for cementation of the post because it bonds the post to tooth structure with greater strength than polycarboxylate cements (Anusavice *et al* ., 1995) .

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 increased in push out bond strength for glass ionomer cements used to cement the fiber post to the root canal after one and two months this may be related to complete setting reaction of glass ionomer cement after a period of time to reach higher values providing better resistance to dislodging forces While for polycarboxylate cement will reach maximum setting reaction and maximum strength after shorter period of time thus the storage period did not increase the push out bond strength (Graig, 1985).

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