

Efficacy of Fiber Post Bonding To Root Dentin after Different Obturation Techniques and Cementation Timings: In Vitro Study

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Abstract

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OBJECTIVE: The aim of this in vitro study was to assess the effect of obturation technique and cementation timings on the bonding of fibre-reinforced posts to the root canal walls.

METHODS: Twenty extracted teeth were randomly allocated to two groups according to the obturation technique and cementation timing. Central incisors with single canals were used after being decoronated. Every extracted tooth of the (vertical compaction group) (VC) group (n = 10) had been obturated using the (E & Q plus obturation system) with posts cemented in the same day; The other (CO) conventional group (n = 10) teeth were obturated using the conventional lateral compaction technique and posts cemented after one week. "SF" Fiber posts were used after bonding and cementation using Rely X ARC resin cement with all the endodontically treated teeth. The push-out test was performed in a universal testing machine. Data were analysed by 2 way analysis of variance with Statistical significance was set to 0.05.

RESULTS: Heat softened gutta percha group showed more push out the bond strength of the bonded posts than the conventional obturation group (p < 0.05). In the middle region, there was no statistical significance between the two groups while there was significance in the coronal and apical thirds.

CONCLUSION: The vertical compaction technique and early cementation improved the bond strength of the resin posts in comparison to the conventional obturation technique with late cementation.

Introduction

When the dentist performs endodontic treatment for teeth, the possibility of mechanical failure and fracture increases [1]. It is well known that after endodontic treatment there is mainly: loss of tooth structure due to caries, fracture, endodontic treatment access hole, lost water content and collagen cross-linking, decreased dentin thickness in the root canal, leading to the increased possibility of fracture [2]. Posts are the suggested line of treatment to restore the coronal tooth structure when there is not enough remaining tooth structure to retain the core

buildup [3] [4]. Non-metallic posts had been introduced into dentistry offering more esthetic solutions, less possibility of fracture and also more biocompatibility. Meyenberg et al., [5] in 1995 developed the strong zirconia posts. Many types of research showed that they are stronger than other post and core combinations [6] [7]. Zirconia posts were used after its use in other medical branches proving that it is strong, biocompatible and being not soluble [6] [7] [8]. Those ceramic posts have a value near that of the tooth structure and so gives enhanced esthetic results especially under all-ceramic restorations [9] [10]. But these ceramic posts are brittle, and there are many reports about their fracture clinically [10] [11] [12]. So, there was a need for a post

with less possibility of fracture and still giving good esthetic results; which is the fibre post [10] [12]. The fibre post has a modulus of elasticity similar nearly to dentin (18-22 Mpa), so any load will be uniformly distributed along the post –cement-tooth interface. So there is minimal concentrated stresses and possibility of fracture root. Therefore, we have a much better and safer line of treatment for endodontically treated teeth [13] [14] [15]. Clinical researches showed success rate from 95-99% for fibre posts without fractures during the studies periods [15] [16] [17] [18].

Retrospective clinical researches showed that the unretained post is its main problem. So the use of adhesive cement has been suggested to solve this problem. Also, the type of endodontic sealer and obturation technique may affect the retention of the post [19] [20].

Material and Methods

Twenty single rooted permanent human freshly extracted teeth were collected from the dental clinic at the National Research Centre.

The teeth were decoronated by sectioning the coronal part of each tooth using a sectioning disc (Toolouip, Germany) mounted on a low-speed handpiece accompanied with water coolant. The same operator as following carried out preparations of the teeth:

1. The root canals were instrumented with the pro taper nickel-titanium rotary system; each canal was enlarged to size F4.
2. During instrumentation, 1ml of 5.25% NaOCl was used to irrigate the canal between file sizes.
3. Canals were dried with absorbent paper points before obturation.

Samples were classified according to the obturation technique into two groups:

Group 1: Canals obturated with warm vertical compaction using (E&Q plus) and Backfill technique and AD Seal sealer (Meta Biomed, Inc.).

Group 2: Canals obturated with gutta-percha and ADSeal sealer (Meta Biomed, Inc.) using lateral condensation multiple cone technique.

In group 1, heated gutta-percha obturation involved two main steps, namely: Vertical condensation and Backfill. Vertical condensation (Down Pack): ADSeal sealer (Meta Biomed, Inc.) was applied onto the canal with a no. 20 file, following which master point, was placed 1mm short of the working length. Then, the appropriate temperature of E&Q Pen (250 degree Celsius) was set and activated

by touching the spring switch on the handpiece. First, the excess of gutta-percha over the orifice was severed off using the activated E&Q Pen Tip. Then gutta-percha was warmed by inserting the pen tip 7 mm short of the working length. At this canal length, the activated pen tip was placed for 2-3 seconds and then deactivated for 8-10 seconds as the spring switch was released so that apical gutta-percha was uniformly warmed. Finally, the pen tip was again activated for two seconds so that gutta-percha in the coronal portion was retrieved. This procedure also prevented the retrieval of gutta-percha in the apical portion. The softened gutta-percha was compacted using the widest plugger, which led to perfect obturation of the apical area and accessory canals. Backfill: The gutta percha bar was placed into the activated Gun, and the Gun needle was inserted into the root canal up to the level of the already placed gutta-percha in the apical portion. The trigger was pulled slowly, and backfill was completed up to the root canal orifice. During backfill, Gun needle was pushed back simultaneously by gutta-percha being filled. The heated gutta-percha was compacted using a bigger plugger, which led to complete obturation of the root canal system.

In group 2, the root canals were filled with GP points. Master apical cone of size F4 was coated with the sealer and slowly inserted into the canal to the working length. A spreader #30/0.02 taper was used for lateral compaction. The spreader was inserted in the canal alongside the master cone. The pressure was applied apically to push the spreader in as far as possible. GP cones (#20/0.02 or #25/0.02 taper) were coated with the sealer and used as accessory cones until there was no more room in the canal for additional accessory cones. After sealing off all access cavities with Coltosol, all samples of group 2 were stored in a humid environment at 37°C for one week to allow sufficient time for the sealing agents to set. While for group1, the post-drilling and cementation procedure is done on the same day.

Post insertion: Removal of gutta-percha is done using Gates Glidden drills. Then the drill of number 2 post was used then cementation of smaller number 1 post. Before cementation, the fibre posts were cleaned with 70% alcohol, silanated [34], cemented with 3mm extended outside the canal to standardise 3 mm distance from the tip of the light curing unit.

After cementation procedures using Rely X ARC cement [32], all specimens were stored in sterile saline in a sealed container for one week. Each root was sectioned perpendicular to the long axis of the root using a water-cooled precision saw to obtain 2 mm ± 0.1 thick slices. The post diameters on each surface of the post/dentin sections were measured using a digital calliper (Pachymeter, Electronic Digital Instruments, China).

Push out bond strength testing: The push-out

test was performed by the universal testing machine (Model 3345; Instron Industrial Products, Norwood, MA, USA) at a crosshead speed of 1 mm/min, using a plunger of (1, 0.8 and 0.5 mm diameter) corresponding to the radicular thirds (Coronal, middle and apical) to be tested. The plunger tip was positioned to push the filling toward the larger diameter, without stressing the surrounding dentin, in apical-coronal direction.

The maximum failure load was recorded in Newton.

The bond strength was calculated from the recorded peak load divided by the computed surface area as calculated by the following formula

$$[A = (3.14 \times r_1 \times 3.14 \times r_2) L],$$

Where r_1 apical post radius, r_2 coronal post radius, $L = [(r_1 - r_2)^2 + h^2]^{0.5}$ and h is the thickness of the sample slice in millimetres.

Data were collected and analysed.



Figure 1: Sectioned root portions with cemented fibre post

Results

Two-way ANOVA showed statistically significant differences in the mean bond strength values between the conventional obturation group (CO) and the heat softened gutta percha group (HS) ($P = 0.006$). The higher pushout bond strength value was observed in the heat softened gutta percha group (HS) (11.465 ± 1.32 Mpa). Table 1.

Table 1: Bond strength values (Mpa) of groups

Group	N	Mean	Standard deviation
Conventional obturation	10	6.155	2.64
Vertical compaction	10	11.465	1.32

T-test was used to compare between the 2 groups regarding the different root portions, in the coronal and apical regions, there were no statistically significant differences between the two groups ($p = 0.1$) and ($p = 0.35$), while in the middle root region the bond strength values of the (HS) group were statistically higher than that of the (CO) group ($p = 0.01$).

Table 2: Bond strength values (Mpa) for each group in coronal, middle and apical regions

Obturation technique	N	Coronal region		Middle region		Apical region	
		mean	Standard deviation	mean	Standard deviation	mean	Standard deviation
Conventional obturation	10	5.827	6.213	8.945	6.442	3.694	2.112
Vertical compaction	10	12.748	11.07	11.545	8.635	10.104	6.344

The obturation technique affected the push out the bond strength of the cemented post Table 3.

Table 3: ANOVA results of the significant difference between the two groups

Source of Variation	SS	df	MS	F	P-value	F crit
Sample	424.0042	1	424.0042	7.936275	0.006754	4.019541
Columns	125.7363	2	62.86817	1.176732	0.316064	3.168246
Interaction	48.97633	2	24.48817	0.458356	0.63476	3.168246
Within	2885.009	54	53.42609			
Total	3483.726	59				

Discussion

The main feature of the polymerisation process of the resin cement is the polymerisation shrinkage. The resin cement used in this study has dual polymerisation property, chemical (when base and catalyst are mixed) and light (when the light interacts with the photoinitiator) which is of course affected by the light intensity. Even when using fibre posts, light cannot reach with its full intensity to the apical region that is why polymerisation is compromised in this region. There is a hypothesis that the polymerisation shrinkage due to decreased degree of convergence is reduced in the apical third [21]. Also, the presence of multiple steps increase the technique sensitivity [22], it is also hard for the removal of the excess bonding agent and its evaporation in the apical third. All these factors decrease the bond strength to the root dentin [23]; this can explain why the apical third has the lowest bond strength values in our study. The ARC cement has a great amount of diluent monomer that is why it is preferred over other viscous cement to reach the apical third [24]. Our results were opposed by a study [33] that found that the bond strength was more at the coronal third if there is proper access to the apical third.

There are different ways to detect the bond strength, like microtensile bond strength on external root dentin [25], pull out [26] and push out test [27]. It has been found that the most reliable and accurate method is the push out test [28]. The advantage of the push put to test over the pull out that it allows testing the different portions of the root, (coronal, and middle apical) [26]. The clinical situation can be mimicked by load directed on slices as done in our study [29]. It was found that the thick root sections may cause non-uniform stress distribution with subsequent wrong

results [30]. Thin sections were done in our study.

Adhesion procedures are technique sensitive, the operator's experience plays a role in it, and the experience affected the bond strength results [31]. Experienced Fixed Prosthodontist and Endodontist did the procedures in our study.

The effect of endodontic sealers on the push out the bond strength of bonded fibre posts was studied before [35]. However, very few researchers evaluated the obturation technique [36] regarding the type of material and found that there is an effect on the bond strength of fibre posts.

Our study concerned with studying the obturation technique whether the thermal filling or the conventional technique but with main concern of the possibility of earlier cementation of the fibre posts when using the thermal filling technique due to its easiness and more time-saving properties.

In a study [37] assessing the timing of post drilling and cementation after obturation either immediate or delayed after 30 minutes and after 14 days, it was found that delaying the preparation leads to more residue in the middle and apical thirds of the prepared post space with subsequent affected bonding of the post and less bond strength. These results were by our study results.

However, opposing to our study results [38], another research evaluated the influence of timing after endodontic treatment on bond strength of fibre posts with epoxy resin obturated canals. Posts also were cemented immediately and after 7 days using the same cement Rely X ARC, sectioned, push out the test was done, but it was found that the root section whether coronal, middle or apical has no significant effect. Also, the timing showed no significant effect on bond strength. This contradiction can be explained due to the difference of the obturation material used in this study and the one that we have used.

From the limitations of our study is the number of samples, number of samples to augment the results in future studies.

It was found that the early preparation of post space and cementation of fibre post is preferred over the late procedure and this can be aided by using the thermal filling vertical compaction technique.

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