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# The Effect of Resin Cement Type and Cementation Technique on Bond Strength of Fiber Posts

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## Abstract

**Background:** Resin cements are widely used for cementation of FRC posts, but their bond strength can be influenced by cement type and cementation technique. The aim of this study was to determine the effect of type of resin cement and cementation technique on the bond strength of fiber posts.

**Methods:** Forty five extracted mandibular premolars with a minimum root length of 14 mm were cut from 1 mm above the CEJ and root canal therapy was performed on them. Based on the type of cement, they were randomly divided into three groups: 1- Permacem, 2- Totalcem and 3- Breeze. Each group was divided into three subgroups based on cementation technique: 1- paper point, 2- lentulo and 3- tip. The push out test was carried out on 2-mm sections of cervical, medial and apical areas in the universal testing machine with a speed of 1 mm/min.

**Results:** The highest mean of bond strength among cements was in Breeze cement, but this finding was not statistically significant. In terms of different cementation techniques, the highest strength was found for lentulo technique. The bond strength showed no significant difference at different sections of root based on the type of cement and cementation technique.

**Conclusion:** Cement type has no significant effect on bond strength. The use of lentulo enhances bond strength significantly. No difference was observed in bond strength of different sections of the root in different cements. The greatest fracture mode was adhesive fracture between post and cement.



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## Introduction

Reconstructing an endodontically treated tooth by applying a crown can prevent the fracture of the root and the remaining walls (1). The decision to insert a post is based on the amount of the remaining crown tissue (2). Simplicity of the technique and its speed are among advantages of pre-fabricated posts (3). Theoretically, when FRC posts are used with composite and resin cement, a homogenous structure forms. All these components (dentin, post, and cement) act as a single unit. Using FRC posts decreases catastrophic fractures (fractures under the bone level and longitudinal fracture) (4-7).

Resin cements are widely used in fixed prosthesis. The bond strength of these cements is significantly influenced by the cementation method (8, 9). Recently by introducing self-adhesive cements, which do not need adhesive systems and etching the post space, advantages of different cement classes are all gathered in one product. These cements are dual cure and suitable for a variety of restoration bonds. Substitution of regular resin cements by these cements facilitates the procedure and saves time (4, 6, 10). In a study by Farina et al. (2016), by comparing different types of cement, higher bond strength in self-adhesive cements has been reported (11). Cement should fill all the dead spaces inside the canal because these voids lead to periodontal inflammation start via the lateral canals. In order to fill the canal with cement, lentulo, cement tube, exclusive syringe and impregnating the post surface are applied (12). Different factors affect the bond strength of fiber posts, for instance post's diameter, length, and shape, post and dentin surface treatment, canal area, post type, cement type, thickness, etc. (13-15).

The present study was carried out to determine the effect of three types of automix, self-adhesive, and dual cure resin cements and three post cementation techniques on bond strength of fiber posts reinforced with resin. The null hypotheses tested were: 1. No significant difference in bond strength exists among different resin cements and 2. No significant difference in bond strength exists among different cementation techniques for each of the cements.

## Materials and methods

This is an in vitro study performed on 45 recently extracted mandibular premolars which had been extracted due to orthodontic reasons or periodontal problems. The selected teeth had straight roots and they were without decays, cracks, and prior root canal therapy with a minimum root length of 14mm. The teeth were thoroughly washed after being extracted and kept in sodium hypochlorite solution (Golrang, Iran) for 24 hours. Next, they were completely rinsed and preserved in normal saline until the time of examinations.

Teeth crowns were cut 1 mm above CEJ perpendicular to tooth longitudinal axis by a low-speed diamond disk and using water. The access cavity was prepared with a round diamond bur (Teeskavan, Iran) by applying a high-speed turbine and water. The root was prepared by a rotatory file (RaCe, UK) up to the file number 30 ISO taper of 0.06 and it was rinsed with normal saline. In order to eliminate the smear layer, each canal was rinsed by 1 cc of EDTA solution (Aria Dent, Iran). After 1 minute, it was bathed by normal saline. Then, it was rinsed by 5 cc sodium hypochlorite 2.5% (Golrang, Iran) and after 5 minutes, it was again rinsed by normal saline. Canals were filled with gutta percha (Meta bio med, South Korea) and AH26 sealer (Dentsply, UK) applying lateral condensation technique. The whole process was carried out by the same person (4).

The teeth were kept inside normal saline for one week at room temperature. Next, in all teeth, 10 mm of gutta percha was removed by numbers 4 and 5 gates glidden drills and numbers 3 and 4 peeso reamers (Mani, Japan), in a way that at least 5 mm gutta percha remained in the canal (16). Then, the post space was prepared with a special drill (Hahnenkratt, Germany). Walls of the post space were checked via radiography to examine any residual gutta percha. The post space was rinsed with normal saline and dried by paper point.

Based on the applied cement, 45 samples were randomly divided into the 3 groups (n=15):

1. Permacem cement (DMG, Germany)

2. Totalcem cement (Itena, France)

3. Breeze cement (Pentron, USA). The characteristics of cements have been presented in table 1.

**Table 1.** Luting agents used in the present investigation

| Material | Manufacturer | Type | Composition |
|---|---|---|---|
| **Permacem** | DMG, Germany | Dual-polymerized self-adhesive resin cement | Barium glass in a Bis-GMA-based matrix of dental resins, pigments, additives, catalysts, Filler |
| **Totalcem** | Itena, France | Dual-polymerized self-adhesive resin cement | Urethandimethacrylate Oligomer, Triethyleneglycoldimethacrylate, 4 Methacryloxyethyltrimellitic acid, Co-initiator, Photoinitiators, Barium aluminoborosilicate glass |
| **Breeze** | Pentron, USA | Dual-polymerized self-adhesive resin cement | bis-GMA, UDMA, TEGDMA, HEMA, 4-MET resins, silane-treated bariumborosilicate glasses, silica with initiators, stabilizers, UV absorber, organic and/or inorganic pigments, opacifiers |

Based on the applied method, each group was divided into the following subgroups (n=5):

1. Automixing cement and inserting it into the canal by paper point (Meta bio med, South Korea) no.30 (12, 17).

2. Automixing cement and inserting it into the canal by lentulo (Mani, Japan) no.30 (16).

3. Automixing cement and inserting it into the canal by the cement-exclusive tip (18).

The three cements applied in this study were self-adhesive, auto mix, and dual cure resin cements. After cementation in order to coronal seal, the cervical area was filled with the composite (Diadent, Netherland) (4, 7) and all samples were kept in normal saline and at room temperature for one week (7).

Teeth were blocked in autopolimerized acryl (Acropars, Iran) using a condensation putty silicone mold (Coltene, Switzerland), so that the samples had similar dimensions to be placed in slicer and testometric machine. Then, the blocks were cut to three 2 ± 0.1 mm-pieces (in apical, medial, coronal) by a slicer (Vafaie Industrial Factory, Iran) with a 0.6 mm-stainless disk by water rinsing perpendicular to teeth longitudinal axis. In order to prevent incorrect interpretations, a 1mm-piece was removed from coronal and then the main cuts were made. In each cut, nearly 0.6 mm of the tooth, equal to the thickness of a disk, was missed.

In order to examine the push out compressive strength, universal testing machine (DBBMTCL-1000; Rochdale, UK) was used. For this, 2mm-samples were placed in a custom made jig with a 3mm- diameter central hole. A 1mm-diameterstainless steel piston was connected to the machine and was placed tangent to the apical area of the post, exactly on the center of post, then a pressure with a speed of 1mm/min in apico-cervical direction was applied until the post piece was removed. The maximum force needed to remove each post piece was registered in N and because of the difference in post diameter in various cross sections, by dividing the force (F) to the cross section (A), it was turned to MPa. The cross section area was calculated by the following formula:

$$A = \pi(R + r)[(h)^2 + (Rr)^2]^{0.5}$$

Where, $\pi$=3.14, R=radius of the coronal fragment of fiber post (mm), r=radius of the apical fragment of the fiber post (mm), and h=the length of the post (mm).

The fractured samples were observed under a ×40 stereomicroscope (Nikon, USA) to identify their fracture mode. Firstly, type of fracture was divided into two adhesive and cohesive categories. In adhesive class, three fracture types of post-cement, cement-dentin, and mixed were categorized and in cohesive category, three fracture types of cement, dentin, and mixed were classified.

In the present study, the bond strengths of three resin cements were measured by three different methods of inserting cement in canal and in different root sections. After gathering data, using ANOVA test and dual examination, groups were studied by applying HOC Tukey and with significance level of lower than 0.05.

## Results

The findings are as follow:

The highest bond strength among cements was observed in Breeze cement followed by Totalcem and Permacem respectively; however, differences were not statistically significant (p>0.05, Table 2).

In term of various cementation techniques which were examined in this study, the highest strength was found for Lentulo technique.

Bond strengths in various cross sections were not significantly different among different cements and different cementation techniques (Table 2).

**Table 2.** Means (MPa) and standard deviation of test groups

| | Breeze | | Totalcem | | Permacem | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **Lentulo** | 15.72 | 5.57 | 12.56 | 4.92 | 12.53 | 4.0 | 13.6 | 5.0 |
| **Paper point** | 8.95 | 5.22 | 12.59 | 7.23 | 11.09 | 3.53 | 10.88 | 5.62 |
| **Tip** | 13.39 | 6.17 | 10.42 | 9.08 | 10.5 | 2.95 | 11.43 | 6.56 |
| **Apical** | 11.67 | 5.35 | 12.13 | 10.11 | 12.89 | 3.99 | 12.23 | 6.85 |
| **Medial** | 13.78 | 7.09 | 13.25 | 5.06 | 9.87 | 3.48 | 12.3 | 5.57 |
| **Cervical** | 12.61 | 6.36 | 10.18 | 5.39 | 11.36 | 2.58 | 11.38 | 5.02 |
| **Total** | 12.69 | 6.22 | 11.85 | 7.18 | 11.38 | 3.55 | 11.97 | 5.84 |

The results of ANOVA tests and groups' dual examination in post HOC Tukey test obtained with level of significance less than 0.05.

Observing fracture types under the stereo microscope revealed that the most common type of fracture was of adhesive type; in adhesive fracture group, the most significant one was the fracture between the post and cement (Figure 1).

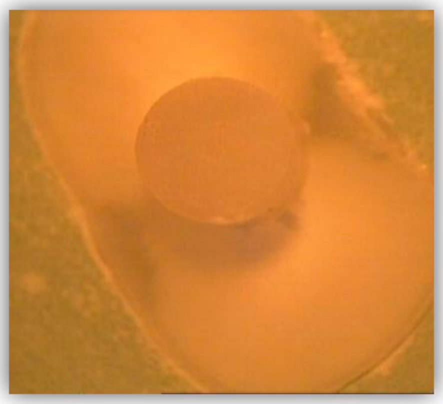

**Figure 1.** Adhesive fracture between the post and cement

## Discussion

In the current study which was performed on three self-adhesive, Breeze, Totalcem, and Permacem resin cements, bond strength of Breeze cement was higher than the other cements; though, it was not statistically significant. In a survey by Shiratori et al. (2013) on Biscem, Breeze, and Maxcem resin cements, bond strength was significantly higher in Breeze cement group (4). However, these findings contradict the results of Pereira et al. (2014), Aksornmuang et al. (2014) and Chang et al. (2013) reporting that cement type has significant influence on posts' bond strength (5, 19, 13).

It should be mentioned that the resin cements used in the mentioned studies were different from ours, and in none of the similar studies, our three cements have been compared with one another.

In Breeze cement group, applying lentulo technique resulted in significantly higher bond strength in comparison to other techniques and by applying paper point it was much lower. The reason can be attributed to the cement viscosity as well as failing to suitably and uniformly distribute cement inside the canal using paper point.

Moreover, in all cement groups, lentulo technique caused significantly higher bond strength which was similar to the study by Shiratori et al and D'Arcangelo et al (4, 20). The reason is proper distribution of the cement inside the canal and forming a uniform layer of cement using this technique.

In a survey by Shiratori et al. (2013), lentulo, point tip, and centrix techniques were used to cement the posts in three cement types. In Breeze, Biscem and Maxcem cement groups, lentulo and centrix subgroups had respectively higher strengths (4).

However, in a study by D'Arcangelo et al., no significant difference was observed in strength among various cementation techniques. D'Arcangelo et al. applied three cementation techniques of lentulo, cement-injection syringe, and impregnating post surface with cement (18).

In a survey by Kim et al. (2010), three techniques of lentulo, impregnating post surface and elongation tip were used and in using elongation tip, bond strength turned out to be higher in comparison to applying lentulo technique (6).

Bond strength was examined in cervical, medial, and apical cross sections in different cement and technique groups. Bond strength in various sections of the root using different cements and techniques was not statistically different, which is in line with the results obtained by D'Arcangelo et al, Almufleh et al, and Gomes et al (20, 21, 22).

Nevertheless, in studies by Kim et al, D'Arcangelo et al, Silva et al, and Onay et al on various sections of the root, bond strength was different which contradicts our findings. In the surveys by Kim et al. (2010) and D'Arcangelo et al. (2007) bond strength was significantly higher in apical section (6, 18). But, in the studies by Onay et al. (2010) and Silva et al. (2007), bond strength was significantly higher in cervical cross section which was attributed to the hybrid layer and a long and dense resin tag (17, 23).

In a study by Pereira et al. (2013) on self-adhesive resin cements, no difference was seen in bond strength of various sections of the root, but regarding dual cure resin cements, there was a significant difference. The reason was known to be the difficulty in creating an acceptable bonding with 3-step adhesive systems in case of dual cure in apical section and also lack of hybrid layer in this section (7).

In our research, all three cements were self-adhesive.

Samples' analysis under ×40 stereo microscope revealed that the most common fracture mode was adhesive. In addition, in adhesive group, the fracture between post and cement was significantly higher than others. In cohesive group, fracture in dentin was more common, but it was not statistically meaningful.

The most common fracture type in our study was in contradiction with the results by Shiratori et al. (2013) and Fonseca et al. (2006); they reported adhesive fracture between cement and dentin as the most common fracture (4, 24). The reason can be attributed to the treatment performed on post surface in these studies.

## Conclusion

The findings of the current survey showed that:

- Cement type did not significantly affect bond strength.

- In Breeze cement, using lentulo significantly improved bond strength.

- In general, using lentulo led to significantly higher bond strength was in comparison to other cementation techniques.

-No difference was observed in bond strength of various root sections in different cement groups.

-The most commonly observed fracture mode was the adhesive type between the post and cement.

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