

## A comparison of the adhesive strength of zinc phosphate and self-adhesive resin cement as fiber post cementation materials

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### ABSTRACT

**Background:** The use of fiber post has become commonplace among dental practitioners due to its several advantages. In accordance with the intended use of post which provides retention for coronal restoration, a cement is used that can provide high quality adhesion. Conventional resin cement has long been adopted as a cementation material for consumer fiber post. However, allowing attachment fiber post failure due to errors in the cementing procedure leads to complications. **Purpose:** This study aimed to compare the adhesion strength of zinc phosphate cement and self-adhesive resin cement as fiber post cementation material. Both consumer cements were easy to use and cheap. **Methods:** The samples used numbered up to 20 and were divided into two groups. group 1 used zinc phosphate cement, while group 2 used self-adhesive resin cement. **Results:** The value of the average adhesion strength of group 1 (zinc phosphate) was 82.65 N, whereas that of group 2 (self-adhesive resin) was 402.81 N. **Conclusion:** This study concluded that the adhesive strength of self-adhesive resin cement as fiber post cementation material was higher than that of zinc phosphate cement.

**Keywords:** adhesive strength; zinc phosphate; self-adhesive resin; fiber post

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### INTRODUCTION

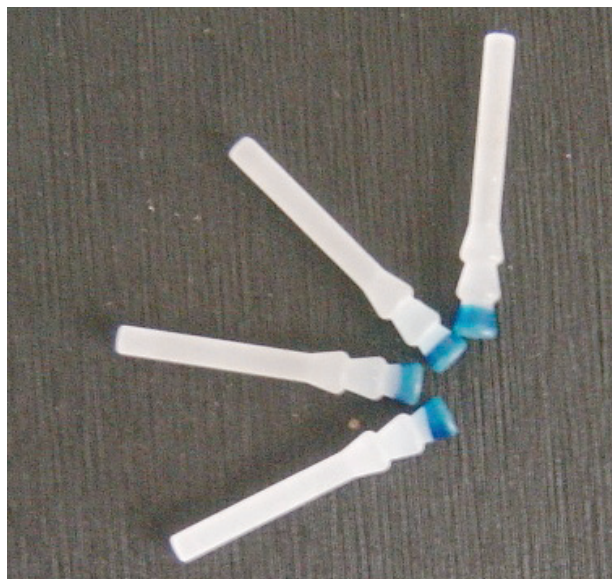
The increasing demand for aesthetic post and core crowns stimulated the development of a non-metallic post core system, especially the use of a translucent fiber post.<sup>1</sup> Prefabricated posts, especially those made from fiber glass, represent the preferred choice of many dentists. In addition to its relative ease-of-use, these types of post add high aesthetic value, especially when combined with other ceramic restorations. Clinical studies confirm the success rate of dental restoration using fiber-reinforced post as ranging from 95% to 99%. Frequent cases of failure in this study occurred because the restoration was discontinued as a result of poor retention of the fiber post in the root canals. It is further argued that such retention depends on the adhesive forces between the post material and the resin luting agent, as well as the inherent strength of the bond

between the resin luting agent and the root canal wall.<sup>2</sup> Various types of resin luting cement and associated bonding systems are recommended for the cementation of fiber post. Cementing techniques with resin cement require precision and are very complicated for most dental practitioners. The price of resin cement is relatively high when compared with zinc phosphate cement or glass ionomer cement, both of which are often used by dental practitioners. Zinc phosphate cement, first developed in the early 1900s, is widely used in dentistry and has enjoyed success as a permanent luting agent becoming the standard for comparison in the future development of cement. Burgess and Ghumann developed a list of directions for the use of various luting agents, including zinc phosphate cement, which is recommended for permanent cementing of restorations with posts, both cast posts and composite fiber posts.<sup>3</sup>

Resin cement is divided into two subgroups, depending on the adhesive system used to prepare the tooth before cementation. The first group uses etch-and-rinse adhesive systems (e.g. VarioLink, VarioLink II, Ivoclar-Vivadent, Schaan, Lichtenstein, Calibra, Dentsply Caulk, Milford, DE, USA; Nexus, Kerr, Orange, CA, USA). In the second group, enamel and dentine are prepared using primary self-etching (e.g. Panavia 21, Panavia F and Panavia F 2.0, Kuraray Medical Inc., Tokyo, Japan; Multilink, Ivoclar-Vivadent).<sup>4</sup> Self-adhesive resin cement was introduced in 2002 as a new subgroup of resin cement (e.g. RelyX Unicem, 3M ESPE, St Paul, MN, USA) designed to overcome certain deficiencies of conventional cement (zinc phosphate, polycarboxylic and glass ionomers) and resin cement, as well as combine favorable characteristics from various classes of cement in a single product. Self-adhesive resin cement is easy to apply which fulfills clinicians' desire for a straightforward cementation technique. Compared to the more complex cement of resin etch-and-rinse and self-etching procedures, self-adhesive resin cement provides a more promising cementation result because the possibility of error during the process is extremely limited or even absent.<sup>4</sup> The purpose of this research was to identify differences in the attachment attributes of fibers cemented with zinc phosphate cement and those using self-adhesive resin cement.

## MATERIALS AND METHODS

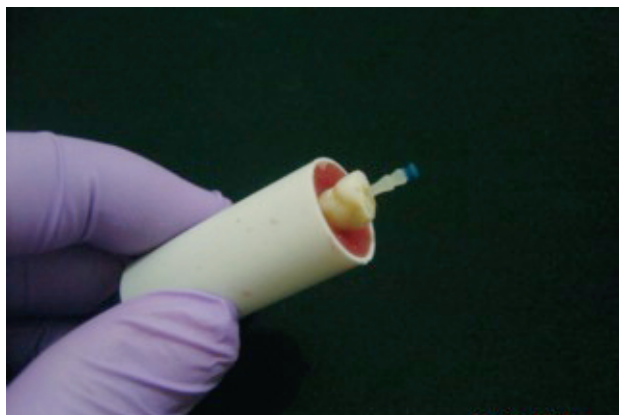
The research sample was drawn from a number of maxillary first incisors collected from various dental practices and clinics in Bandung. Selection of its subjects was based on the criteria of their being almost equal in size and free of caries, restorations, root canal treatment and fractures. The length of each tooth was measured using a sliding thread from the apex to a point in the labial center of the cemento-enamel junction. The teeth were then cut horizontally with the point of incision 2mm from the cemento-enamel junction of the proximal and treated root canals. Root canal preparation was performed by means of Protaper (Dentsply) hand use up to F1 size. Root canal filling used Roekoseal paste (Roekoseal endodontic sealer, Coltene Whaledent) as a sealant with obturation involving the use of gutaperca point (Protaper, Dentsply) size F1. From the examination results obtained, a sample of 20 teeth that had undergone root canal treatment was produced which was subsequently divided into two groups. The first consisted of ten first maxillary incisors to be mounted on fiber posts with zinc phosphate cementation (group 1). The second comprised ten maxillary first incisors mounted on fiber post with self-adhesive resin cementation (group 2). Root canal preparation was performed on all samples using a 1.5 mm diameter drill included in the fiber stick kit (FiberKleer 4X Smooth Surface Parallel Post System Kit 1.5 mm diameter, Pentron) to a depth of 9 mm (Figure 1).



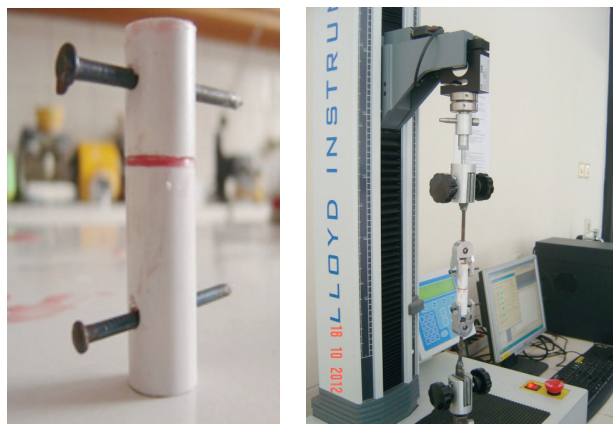
**Figure 1.** FiberKleer 4X fiber posts

All posts in group 1 were cemented with zinc phosphate (Elite Cement 100, GC Japan). The cement was stirred according to the manufacturer's instructions before being inserted in the root canal with a lentulo spiral and applied to the surface of the fiber post. All fiber posts were inserted into the root canals using tweezers, with any excess cement being cleaned away. The tooth sample was placed on a pre-prepared sample holder tube and then inserted in the press before being subjected to a 1kg load for one minute. In the group 2 sample, the fiber posts were cemented by means of self-adhesive dual cure resin cement (Breeze, Pentron) according to the manufacturer's instructions and the fiber insertion application and insertion were then performed as with group 1. Light was activated using a light curing unit (Litec) for 40 seconds. A tapered drill was used to produce retention grooves on the root surface of every tooth in each sample group before they were placed in cylindrical self-curing acrylic molds of equal size and stored until the hardening process was complete (Figure 2). The coronal part of the fiber post was also placed in a molded tube filled with self-curing acrylic. After the acrylic had completely hardened, a hole was made at both ends of the gear tube for the insertion of the sample holder's metal rod.

Samples already embedded in the resin were mounted on an additional tool made specifically for this study. The auxiliary device was then attached to the Instron instrument clip (Instron LRX Plus, LLOYD Instrument LTD) located at both the base and upper section of the sample holder (Figure 3). The test apparatus was activated and the top holder moved to exert continuous tension until the fiber post was detached from the root canal wall. The test result expressed the magnitude of the tensile force as KgF. The magnitude of the tensile force causing separation of the fiber post from the root canal wall was recorded and then calculated statistically using a t-test.



**Figure 2.** The tooth with fiber post which is placed in the tooth holder



**Figure 3.** Samples ready for testing on the Instron machine

## RESULTS

After studying two groups of samples; a group of ten maxillary first incisors mounted with fiber post using zinc phosphate cementation (group 1) and a second such group of ten maxillary mounted with fiber posts using self-adhesive resin cementation (group 2), the mean value of fiber attachment strength was calculated (Table 1). It confirmed the average values of the adhesion strength of fiber posts that had been cemented with zinc phosphate cement and self-adhesive resin cement; 82.65 N and 402.81 N respectively. The study result data was presented in tabulated form, then tested by equality 2 test average using t student statistic. The result of the statistical test confirmed there to be a contrast in adhesive strength between self-adhesive resin cement and zinc phosphate cement where the self-adhesive resin cement strength (423.92 N) was higher than that of zinc phosphate (82.65 N) cement ( $p < 0.05$ ).

## DISCUSSION

Posts are made for the purpose of providing retention for coronal restorations. There is increasing use of fiber posts due to their desirable qualities such as modulus elasticity which is similar to the modulus of dentine and its aesthetics in terms of color. An effective cement capable of attaching the fiber post to the preparation of the root

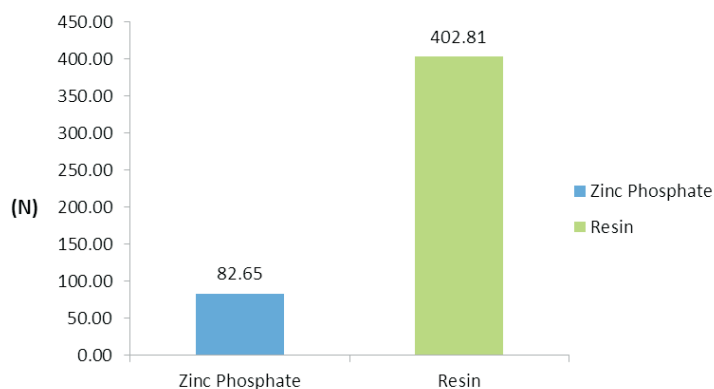
**Table 1.** Mean value of zinc phosphate cement bonding strength and cement resin self-adhesive as fiber post cementation material expressed in Newton units.

|                                   | Group 1<br>Zinc phosphate<br>cement | Group 2<br>Self-adhesive<br>resin cement |
|-----------------------------------|-------------------------------------|--|
| Average (mean)                    | 82.65 N                             | 402.81 N                                 |
| Standard Deviation<br>(std. dev.) | 23.212 N                            | 56.719 N                                 |
| number of samples (n)             | 10                                  | 10                                       |

canal and possessing strong retention force is required. This study aimed to compare the two types of cement adhesive strength to fiber posts. It did not examine the failure of cement adhesion, the lack of effective cohesive cement and cement adhesion, or the adhesion of fiber posts and cement to the canal walls. In this research, the strength test of self-adhesive resin cement and zinc phosphate cement employed a pull-out bond strength evaluation methodology. While this methodology has been used by certain researchers, it is not representative of the actual clinical situation.<sup>5</sup>

The self-adhesive resin cement form of Breeze (Pentron Clinical Technologies, Wallingford, CT, USA) consists of two pastes, namely: base and catalyst. The cement was mixed using the auto-mixing tip on the glass pad and then inserted into the root canal using a lentulo spiral. Its employment during the cementation process was also carried out on the group 1 (zinc phosphate cement). The use of lentulo spiral is very important in obtaining a uniform cement layer free of air bubbles.<sup>5</sup> The fiber post surfaces in both sample groups were also smeared with cement to ensure its being in contact with the entire surface of the fiber post.

In this study, the adhesive strength of resin cement was higher compared to that of zinc phosphate cement. This was in accordance with the results of a previous study which showed the adherence strength of zinc phosphate cement to be greater than that of Calibra and RelyX ARC resin, despite the highest adhesion force being found in the fiber posts cemented with RelyX Unicem self-adhesive resin cement.<sup>6</sup> This low strength of zinc phosphate cement bonding is due to the zinc phosphate cement bonding mechanism that relies on friction. Phosphoric acid of zinc phosphate cement causes the surface of the eroded teeth to increase in roughness and wettability. However, this cement does not have the ability to attach to dentine or enamel as with resin cement. Therefore, the zinc phosphate cement is also called “frictional prototype” cement as opposed to “adhesive” resin cement.<sup>7</sup> The brittle physical properties of zinc phosphate cement may also be the cause of the low adhesive strength values in this study, since this brittleness



**Figure 4.** The mean value of adhesion strength of fiber posts cemented with zinc phosphate cement and self-adhesive resin cement.

tends to cause the cohesive bonds of zinc phosphate cement to break easily.<sup>8</sup> This zinc phosphate cement may be used if the preparation forms have a limited path of withdrawal cast restoration in one direction and if the restoration fits its preparation.<sup>9</sup>

The test performed on the ten first maxillary upper incisors mounted with fiber posts with zinc phosphate cementation (group 1) resulted in a much smaller mean value of zinc phosphate cement bonding strength than the adhesive cement adhesive resin strength. This finding is not in accordance with that of the previous study.<sup>6</sup> This may also be due to poor adaptation of the fiber post used in this study to the root canal walls resulting from differences in the diameter of the fiber post and the drill diameter included in the Fiberkleer kit from the plant. According to the data, the diameter of the fiber post on the kit is 1.5 mm, while the size of the drill diameter included in the Fiberkleer kit according to the measurements made with ATS measurement tools diameter is 1.62 mm. Consequently, there will be a gap between the fiber post with a root canal wall of 0.12 mm. The gap between the posts and the wall of the root canal is wide enough to cause the layer of cement around the post to thicken. The gap for ideal luting cement materials should be kept to a minimum by improving the adaptation of the restoration.<sup>7</sup>

While there is no definitive measure of the thickness of a cement luting, one of 50–100  $\mu\text{m}$  is considered to be ideal. American Dental Association Specification no. 8 states that the thickness of the zinc phosphate cement layer should be between 25  $\mu\text{m}$  to 40  $\mu\text{m}$ .<sup>7</sup> A high degree of adaptation between the post and root canal preparation is required if zinc phosphate cement is used as a cementation material

for the post.<sup>10</sup> The results of other studies have shown that the root canal preparation diameter of prefabricated post placement has no effect on push-out bond strength.<sup>11</sup> In conclusion, the adhesion strength of self-adhesive resin cement as fiber post cementation material was higher than that of zinc phosphate cement.

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