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In Vitro Effect of Luting Cement on Fracture Resistance of Primary Maxillary Central Incisors with Fiber Posts

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A B S T R A C T

Objectives: The use of fiber posts in endodontically treated primary maxillary central incisors improves the retention of composite resin restorations. The purpose of this study was to evaluate the effect of 4 different luting cements on fracture resistance of primary maxillary central incisors with fiber posts.

Materials and Methods: In this in vitro study, 40 primary maxillary central incisors were endodontically treated and obturated with Metapex. They were then randomly divided into four groups (n=10) for cementation of fiber posts with GC Fuji I glass ionomer luting cement, Panavia F2.0 dual-cure luting cement, Panavia SA Luting Plus cement (self-adhesive), and TotalCem self-adhesive cement. After 1000 thermal cycles, the fracture resistance was measured. Data were statistically analyzed using ANOVA (alpha=0.05).

Results: The mean fracture resistance was 267.07±130.01N in TotalCem, 257.27±102.56N in Panavia F2.0 dual-cure cement, 227.82±110.40N in Panavia SA Luting Plus self-adhesive cement, and 220.89±59.96N in GC Fuji I glass ionomer group. There was no statistically significant difference in fracture resistance among the four groups (P=0.714).

Conclusion: Type of luting cement had no significant effect on fracture resistance of primary maxillary central incisors with fiber posts. Nonetheless, TotalCem yielded the highest fracture resistance. Considering its self-adhesive property and easy workability, it can be a good option for cementation of fiber posts in endodontically treated primary central incisors.

Keywords: Composite Resins; Flexural Strength; Dental Cements; Tooth, Deciduous; Incisor

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INTRODUCTION

Dental caries is among the most common chronic diseases of the childhood [1]. Most primary incisors affected by early childhood caries have lost most or all of their coronal structure when the patient seeks treatment. Extraction used to be the only treatment option for such teeth [2]. However, parents currently prefer to restore primary anterior teeth of their children rather than extracting and replacing them with prosthetic restorations [3].

Fiber posts are commonly used to provide retention and resistance in restoration of teeth that have lost a large portion of their coronal

structure. These posts provide retention and resistance for the restorations by distributing intraoral forces along the root. An ideal post system should provide a higher fracture resistance than the mean masticatory forces applied to the teeth [4]. In addition to improving retention, cements improve fracture resistance and stress distribution pattern [5]. Thus, it appears that proper cement selection plays a key role in improving the prognosis [6].

GC Fuji I glass ionomer luting cement is commonly used for cementation of fiber posts in primary teeth. However, some other materials such as resin cements have also been proposed for use in permanent teeth [3]. Studies on the effect of cement type on fracture resistance of primary teeth with fiber posts are limited. Thus, the purpose of this study was to evaluate the effect of 4 luting cements on fracture resistance of primary maxillary central incisors with fiber posts.

MATERIALS AND METHODS

This in vitro study was approved by the human ethics review committee of Shahid Sadoughi University of Medical Sciences (IR.SSU.REC.1396.114). Forty primary maxillary central incisors with approximately the same root canal diameter were chosen. The teeth had at least two-thirds of root structure remaining, one-third of intact crown remaining, and no previous pulp treatment. The teeth had been extracted due to caries, infection, or trauma, and were irreparable. For disinfection, the teeth were stored in 0.5% Chloramine T for 7 days [7]. They were then stored in distilled water at room temperature. The coronal part of the teeth was cut 1 mm above the cementoenamel junction by a diamond fissure bur (Teeskavan, Tehran, Iran). Afterwards, pulpectomy was performed for all teeth. The working length was determined 1mm shorter than the apical foramen, and the canals were instrumented with #60 K-file and irrigated with saline. After drying the root canals with paper points, Metapex (Metabiomed, Chungbuk, Korea) was injected into the canals. Self-cure glass ionomer (GC Fuji I; GC Corporation, Japan) with 1mm thickness was applied to separate the obturating material from the post space. After 2 minutes (to allow cement setting), the canals were washed and prepared for cementation of fiber posts.

A #3 fiber post (Q.P. fiber post, Inoo, Dentalco Ltd., Korea) was placed such that 3mm of it was inside the canal, while 3mm of it was outside the canal to strengthen the restoration. To remove the superficial contaminations of fiber posts, their surface was etched with 37% phosphoric acid (Diatech, Korea) for 10 seconds; it was then washed and dried. The teeth were then randomly divided into four groups (n=10).

In the first group, self-cure glass ionomer luting cement (Fuji I; GC, Japan) was mixed according to the manufacturer's instructions; then, the fiber post was coated with the cement and inserted into the canal.

In the second group, A and B pastes of Panavia F2.0 dual-cure resin cement (Kuraray, Japan) were mixed in equal amounts. The post space was coated with ED Primer by a microbrush. After 30 seconds, excess ED Primer was removed by a microbrush and the post space was dried. Base and catalyst pastes of the cement were mixed together in equal amounts for 20 seconds. The post was then coated with the cement and placed in the canal. Excess cement was removed by a microbrush and cured conventionally using a LED curing unit (Woodpecker, China). The light intensity was ensured to be 800mW/cm^2 by repeated measurements by a LITEX light-meter.

In the third group, the fiber posts were cemented by Panavia SA Luting Plus self-adhesive resin cement (Kuraray, Japan). The pastes were mixed on a glass slab in equal amounts for 10 seconds at room temperature. The cement was applied on the root canal walls and then the cement-coated post was placed in the canal with mild vibration to prevent bubble formation in the cement. After 2 seconds of curing, excess cement was removed and finally the post edges were cured for 10 seconds.

In the fourth group, TotalCem self-etch/self-adhesive resin cement (Itena, France) was used in automix form. The mixer tip was attached to the syringe to which the intraoral FXX tip was connected. Next, the cement was injected into the canal, and the post was placed in the canal with a vibrational movement. After curing the cement for 2 seconds with a LED curing unit,

excess cement was removed. The entire surface of the cement was cured for 20 seconds.

To restore the teeth, etching was performed with 37% phosphoric acid (DEG-01; Dentex, China) for 20 seconds; the teeth were then washed for 60 seconds and dried for 10 seconds. Two layers of Single Bond etch and rinse adhesive (3M ESPE, St. Paul, MN, USA) were applied on the tooth surface and cured for 20 seconds. Z250 micro-filled composite (3M ESPE, St. Paul, MN, USA) was applied incrementally with 2mm thickness and cured. For all teeth, coronal restoration was performed with a mesiodistal width of 4mm and cervico-incisal length of 6mm. Next, all teeth were mounted in self-cure acrylic cylinders (Pars, Iran) such that they had 135-degree angle relative to the horizontal plane, and the palatal surface of the teeth faced upwards, such that the device would exert a 45-degree oblique load to the palatal surface of composite restoration.

All teeth were stored in distilled water at room temperature for 24 hours. Next, the teeth were subjected to 1000 thermal cycles (Vafaei, Iran) between 5°C and 55°C with a 60-second transfer time [8]. Fracture resistance was measured in an electromechanical universal testing machine (K-21046; Walter + Bai, Switzerland) by exerting a compressive force at 45-degree angle with a crosshead speed of 0.5mm/minute [5] to the middle third of the palatal surface of the crown (corresponding to the site of occlusal force application in the oral cavity) [2]. The maximum force causing tooth fracture and a dramatic drop in the curve was recorded in Newtons (N).

The mode of failure was also determined under a stereomicroscope (ZTE 3E; China) at x20 magnification, and categorized as adhesive, cohesive, and mixed.

To assess the normality of data distribution, the Shapiro-Wilk test was applied. Data were statistically analyzed using two-way ANOVA at 0.05 level of significance.

RESULTS

Forty teeth were studied. One tooth in group 2 was excluded due to showing an outlier.

Based on the results presented in Table 1, the minimum fracture resistance belonged to glass ionomer luting cement (220.89±59.96N), followed by self-adhesive Panavia SA Luting Plus cement (227.82±110.40N), and Panavia F2.0 dual-cure cement (257.27±102.56N). The highest fracture resistance was noted in self-adhesive TotalCem (267.07±130.01N). However, the difference among the groups was not statistically significant in this regard (P=0.714).

As shown in Table 1, the most frequent mode of failure in all groups was adhesive failure except in dual-cure group, in which mixed failure was more frequent.

DISCUSSION

Use of fiber posts in endodontically treated teeth enhances restoration retention, and is a suitable option to improve tooth function and esthetics in severely carious anterior teeth.

Resin cements enhance retention of composite posts. The advantages of dual-cure resin cements include light-initiated polymerization and its continuation in absence of light.

Table 1. Mean fracture resistance (in Newtons) of the groups and frequency of different failure modes in each group

Group	Number	Fracture resistance (mean ± SD)	Failure mode		
			Adhesive	Mixed	Cohesive
Glass ionomer luting cement	10	220.89±59.96	6(60%)	3(30%)	1(10%)
Panavia F2.0 dual-cure	9	257.27±102.56	3(33/3%)	5(55.5%)	1(11.1%)
Panavia SA Luting Plus cement (self-adhesive)	10	227.82±110.40	6(60%)	3(30%)	1(10%)
TotalCem self-adhesive cement	10	267.07±130.01	5(50%)	4(40%)	1(10%)

SD: Standard Deviation

Nevertheless, these cements are technique-sensitive, and have a high viscosity [3]. The monomer of self-etching cements can penetrate into the dentin and enamel simultaneously without any need for a separate etching step [9]. Self-etching resin cements can polymerize uniformly even at the deep cavity floor where light penetration is limited [10]. According to the present study, TotalCem automix self-adhesive cement yielded the greatest fracture resistance, although the difference in fracture resistance was not significant among the four groups. Sharaf [11] indicated that fiber posts significantly enhanced the fracture resistance, and use of composite post led to a significant increase in fracture resistance, when compared with restorations without post reinforcement.

Customized quartz fiber posts provide a greater strength than composite resin posts and orthodontic wire for severely decayed primary teeth [2]. Considering the relatively good fracture resistance of primary teeth with this type of post [3 8], it was selected for use in the present study. However, due to the risk of interference with physiological exfoliation of primary teeth and eruption of permanent teeth, long posts cannot be used [2]. Therefore, a post with 3mm length was used in the canal in the present study.

Various parameters affect the post retention including the length, diameter, and shape of post and different types of cement material. In this study, posts with almost the same length and diameter were used in all teeth.

Final retention of posts was obtained by cementing the post in the prepared canal. The cement used for cementation of posts enhances retention, improves fracture resistance, and results in better stress distribution [5].

The fracture resistance of different groups was not significantly different in the present study. However, the highest fracture resistance was observed in TotalCem, followed by Panavia F2.0 dual-cure cement, Panavia SA Luting Plus cement (self-adhesive), and glass ionomer cement.

Glass ionomer cement is routinely used for cementation of fiber posts in primary teeth. Chemical polymerization is among the advantages of this cement. Furthermore, it adheres to the teeth micro-mechanically and chemically.

TotalCem is a resin cement that needs no etching, priming, or bonding. It is available in self-cure and light-cure forms. The automix system (using intraoral FXX tip) of this cement decreases the chair time and ensures homogeneity of the mixture. It can also be injected directly into the root canal, accelerating its application process, which is an advantage in pediatric dentistry.

Considering the study by Amiri et al, [11] on permanent teeth, the bond strength between the fiber post and root dentin in the coronal and middle thirds of the root is greater in use of total-etch compared with self-adhesive cements. Panavia F2.0 cement was expected to show a greater fracture resistance compared to other resin cements. However, this cement with a fracture resistance of 257.27N had a similar fracture resistance to other resin cements. Nevertheless, its use is time-consuming due to several mixing steps, and may not be ideal for children.

Panavia SA Luting Plus cement is a self-adhesive resin cement, which was used in the present study. It does not need bonding or priming, contributing to a faster procedure. This cement gradually releases fluoride over time, and has low technical sensitivity. Even in presence of wet dentin and enamel, it develops a good bond strength. Therefore, application of this cement would be easier in children with poor cooperation. In the present study, its mean fracture resistance was slightly higher than that of glass ionomer cement. However, due to its high cost, it may not be preferred over glass ionomer cement.

In the present study, the fracture resistance of glass ionomer cement did not show any statistically significant difference with resin cements. In a study by Nourbakhsh et al, [12] on permanent teeth, the bond strength of resin cement to fiber post was significantly higher than that of glass ionomer cement, which was different from the current results. The length of fiber post inside the canal in their study was 10mm, which was longer than the 3-mm length of fiber posts inside the canal in the present study. Also, Maxcem (Kerr, USA) resin cement was compared

with glass ionomer and zinc phosphate cements in their study, which are different from the cements used in the present study.

Gopal et al. [13] compared three types of resin cements for permanent anterior teeth restored with fiber post, and found no statistically significant difference among the groups, which was in line with the results of the present study. Bitter et al. [14] compared the bond strength of resin cements to fiber-reinforced composite posts in permanent teeth, and found that all resin cements had acceptable bond strength to fiber-reinforced composite posts. However, there was no statistically significant difference between retention of different resin cements, which was in accordance with the present findings.

Memarpour et al. [3] compared two types of fiber posts with two types of cements. They concluded that type of cement, compared to the type of post, had a greater impact on retentive strength. Nevertheless, their results cannot be compared with the present findings since they evaluated retentive strength and not the fracture resistance.

Most studies on the effect of cement type on fracture resistance did not assess the mode of failure. In the present study, due to poor bond strength between the luting cement and dentin, adhesive failure occurred more frequently than cohesive failure, which was in line with the results of Memarpour et al [3].

CONCLUSION

Within the limitations of this in vitro study, there was no statistically significant difference in fracture resistance of the four luting cements. Thus, type of cement had no significant effect on fracture resistance of primary maxillary central incisors restored with a fiber post. TotalCem showed the highest fracture resistance. Since it is self-adhesive and easy to use, it may be suitable for post cementation in primary anterior teeth.

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CONFLICT OF INTEREST STATEMENT

None declared.

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