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Dr. Shahnaz
Lecturer Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Dr. Mohammad Arif Lone
Arif lone Lecturer department of Prosthodontics Govt dental College and Hospital Jammu and Kashmir, India

Dr Ajaz Masoodi
Lecturer Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Riyaz Farooq
Professor Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Dr. Aamir Purra
Associate Professor, Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Dr. Fayaz Ahmad
Assistant Professor Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Correspondence
Dr. Shahnaz
Lecturer Department of Conservative Dentistry and Endodontics Govt Dental College and Hospital Srinagar Jammu and Kashmir, India

Comparison of push out bond strength of two adhesive systems on fibre posts: An *in vitro* study

Dr. Shahnaz, Dr. Mohammad Arif Lone, Dr Ajaz Masoodi, Riyaz Farooq, Dr. Aamir Purra, Dr. Fayaz Ahmad

Abstract
Aim: Is to evaluate the regional push-out bond strength of a fiber-reinforced post system, using two resin cements.
Materials and Methods: 20 maxillary central incisors were decoronated and the roots were endodontically treated. Following post space preparation, the roots were divided into two groups of 10 specimens each. Fiber-reinforced composite posts were cemented with two resin cement systems: (a) Self-etch system (RelyX U100, Gcem, Speed Cem) and (b) conventional system (Multilink N resin cement). Three slices of each root, with a thickness of 3 mm, were prepared. The push-out test was performed with a universal testing machine at a crosshead speed of 1 mm/ minute, and bond strength values were calculated. The data were analyzed with a two-way Analysis of variance (ANOVA) and Scheffe tests (a=.05).
Results: There were no significant differences between the mean push-out bond strengths of two experimental groups but there were significant differences between the mean push out bond strengths of the root dentin regions (P<0.001).
Conclusion: Under the conditions of this study, there was no significant difference between the mean push out bond strength of self-etching and the conventional resin cement systems

Keywords: Dentin; luting agents; resin cements

Introduction
Teeth treated endodontically have a large amount of coronal tooth structure missing, and frequently require the placement of a post inside the root canal, for retention of core for definitive restoration [1-3]. The choice of appropriate restoration for these teeth is influenced by strength and esthetics [4]. Clinical studies have reported success rates of 95 to 99% for teeth restored with fiber-reinforced posts, with no occurrence of root fracture during the study periods [5, 6]. The most common cause of failure reported in these studies is not from the root fracture, as occurs with metal or cast posts, but rather from the pull out of the cement, post restoration assembly, as a result of lack of retention of the fiber posts [7, 8]. The retention of fiber posts in the roots depends on the bond strength between the post material and a resin luting agent, as well as the bond strength between the resin luting agent and post space dentin [9, 10]. Several *in vitro* studies have reported controversial results regarding bond strengths of different luting agents to endodontic posts and root canal dentin [11-13]. Selecting an appropriate adhesive and luting procedure for bonding posts to root dentin is an important challenge [14-16]. According to adhesive dentistry, two strategies can be used to allow the bonding agents to react with the dentin [17]. Some systems use etch-and-rinse with phosphoric acid to eliminate the smear layer and demineralize the underlying dentin. This step is followed by application of a hydrophilic monomer that penetrates the conditioned dentin surface. Other systems use self-etching primers, with no rinsing step, which cause less aggressive demineralization and are followed by the application of an adhesive resin [18]. Therefore this study was carried to compare the push out bond strengths of two different adhesive systems on fibre posts.

Materials and Methods
40 human maxillary central incisors extracted for periodontal reasons, were selected. The specimens were free of cracks, carious lesions, fractures, and resorption, with fully developed

apices and without previous endodontic treatments, posts, or crowns. The teeth were sectioned below the cemento-enamel junction with a diamond blade (Isomet 2000, Buehler, Lake Bluff, IL, USA) under water cooling. The roots were randomly assigned into 2 groups according to the luting cement used. Coronal access was made with a K‑ file #15 (Dentsply Maillefer, Ballaigues, Switzerland) inserted into the canals until it was visible at the apical foramen. Then, the working length was set 1 mm short of this length. K files 15–40 were used for making the stop at 1 mm from the apical foramen. The canals were instrumented with K‑ files #15–40 and irrigated with 5 mL of 5% NaOCl and 5 mL of 17% Ethylenediaminetetraacetic acid and finally irrigated with 5 mL of distilled water. And the teeth were stored in 100% humidity for one week at 37°C, to allow the sealer to set. After one week, the gutta-percha was removed from the coronal aspect of each root with a Gates Glidden drill #3 (Dentsply-Maillefer, Ballaigues, Switzerland) leaving 4 mm gutta percha in the apices, to preserve the apical seal. The post spaces were prepared to a depth of 10 mm with the appropriate drills (Fibio, Anthogyr, Sallanches, France. All posts were marked at a distance of 10 mm from the apical end, and were cut to that size with diamond disks. The shortened posts were cleaned with 70% ethanol for 60 seconds, rinsed with distilled water, and air dried. Before the cementation procedures, the post surfaces did not undergo any pretreatment. The prepared roots were randomly divided into two groups of 10 specimens each for cementation procedures. In group 1, the posts were luted with (Rely X U100, Gcem, Speed Cem after conditioning the dentin for 60 seconds, using amicrobrush. The post space was gently air-dried and the excess primer was removed with paper points (Aria Dent). In group 2, (Multilink N resin cement) was used as the luting agent. The canals were etched using 35% phosphoric acid (Ultra-Etch, Ultradent, South Jordan, UT, USA) for 15 seconds and rinsed with distilled water. Excess water was removed from the post spaces with a gentle stream of air and paper points. The bonding agent was polymerized with a halogen light unit, with 500-mW/cm2 intensity (Coltolux 50, Coltene, Altstatten, Switzerland), for 20 seconds, with the tip of the light unit directly in contact with the canal orifice. For cementation of fiber posts, equal amounts of luting pastes were mixed and applied onto the surface of the posts and into the root canals with a Lentulo spiral instrument (Dentsply/ Maillefer). The posts were inserted into the canal, to a full depth, by using gentle finger pressure, and the excess was immediately removed with a disposable brush. After the cementation procedures, all specimens were stored in sterile saline in a light-proof box for one week at 37°C. Next, each root was sectioned perpendicular to the long axis with a diamond disk at low speed under constant distilled water cooling to create 3 mm-thick slices. In this manner; from each root, three post/dentin sections (coronal, middle, and apical) were obtained. Due to the tapered design of the fiber posts, post diameters were measured on each surface of the post/dentin sections, using digital calipers (Electronic digital caliper, Minova Co, Japan), with 0.01 mm accuracy. The push-out test was performed by using the universal testing machine (TLCLO, Dartec Ltd., Stourbridge, England) at a crosshead speed of 1 mm/ minute, using a pin (diameter, 1.0 mm) on the center of the apical aspect of the post surface in an apical-coronal direction, without stressing the surrounding post space walls. The peak force (N) required to extrude the post from the root slice was recorded. To express the bond strength in MPa, the load at failure (N) was divided by the area of the bonded interface, which was calculated with the following formula:

$$A = \pi(r_1 + r_2)\sqrt{(r_1 - r_2)^2 + h^2}$$

where π was the constant 3.14, *r1* was the coronal post radius, *r2* was the apical post radius, and *h* was the thickness of the slice in millimeters. The collected data were analyzed (SPSS/PC 20.0; using two-way analysis of variance (ANOVA) and Post Hoc Scheffe tests at $P<0.05$ levels of significance.

Table 1: Descriptive statistics of push-out bond strength values (MPa) of two groups in different root canal regions

cement	Root canal region	mean	Standard deviation	95% confidence limit	
				Lower bound	upper bound
Group 1	Coronal	17.12	5.37	14.789	19.45
	Middle	12.87	3.31	10.539	15.02
	Apical	7.78	2.60	5.444	10.10
Group 2	Coronal	16.20	3.49	13.87	18.53
	Middle	12.60	4.06	10.26	14.93
	Apical	8.68	2.39	6.3	11.01

Results

The mean push-out bond strength values (MPa) of the test groups in different root canal regions are shown in Table 1. The two-way ANOVA showed no significant differences between the mean push-out bond strength values recorded for two experimental groups (two types of cement systems) and there was no interaction between the type of resin cement system and different root canal regions (P=0.920 and P=0.731, respectively). Otherwise, significant differences were observed among the bond strength values of the root dentin regions (P<0.001). The lowest bond strength values were obtained in the apical regions. The Post Hoc Scheffe test revealed that in both resin cement systems, there were significant differences between the coronal and apical regions [Table 2].

Table 2: Scheffe test for push-out bond strength values (MPa) of two groups in different root canal regions

cement	Root canal region	Subset for alpha=0.05	
		1	2
Group 1	Apical	7.7	
Group 2	Apical	8.6	
Group 2	Middle	12.6	12.6
Group1	Middle	12.8	12.8
Group 2	Coronal		16.2
Group 1	Coronal		17.1
	Sig	0.106	0.202

Discussion

Results are in agreement with some previous studies [17, 10, 19, 20]. Noirrit *et al.* [17] stated that the hybrid layer and resin tags that resulted from both bonding systems (selfetch and total-etch) were nearly the same, although the conditioning of the canal walls was different. Micro morphological investigations showed that etching the dentin with phosphoric acid (PH≈2) (as used in the 'etch-and-rinse' systems) completely dissolved the smear layer and exposed the tubule apertures, collagen fibrils, and interfibrillar spaces, while the use of self-etch bonding systems had a variable effect on the smear layer [17, 9, 21]. Bitter *et al*. [21] found a significant difference between these two types of luting agents when used as luting glass fiber reinforced composite posts on root canal dentin. They noted that the hybrid layer appeared thinner with the 'self-etch' system, than with the 'etch-and-rinse' system. They concluded that demineralization by phosphoric acid led to a deeper penetration of the adhesive than did a selfetch system, which could not completely penetrate the smear layer. Akgungor and Akkayan [9] and Yoshiyama *et al*. [22] stated that a system with a selfetching primer and light-polymerized bonding agent provided a significantly higher bond strength to root canal dentin than the self-etching bonding agents and the strength of this bond was not dependent on the hybrid layer thickness. It has been shown that tubule density is greater in the coronal and middle thirds than in the apical region of the root canal [23]. and the diameter of the tubules decreases in the apical direction [24]. The difference in the number of tubules may explain why the strongest adhesion is achieved in the most coronal regions. In the presence of a greater number of tubules per mm^2 a stronger bond will be expected, because the adhesion may be enhanced by the penetration of the resin into the tubules [25]. Furthermore, it is shown that dentin hybridization is not uniform in the apical region of the root canal dentin and the lateral branches of the resin tags are not observed in the apical part of the interface postadhesive system [23]. In this study, the mode of pushing out fiber posts was not evaluated. The specimens were prepared with no coronal tooth structure. However, it was suggested that the amount of remaining coronal tooth structure played a major role in the longevity of the restoration of endodontically treated teeth [24].

Conclusion

Within the limitations of this *in vitro* study, the following conclusions were drawn:

1. There was no significant difference between the push-out bond strengths of glass fiber reinforced composite posts for self-etching and conventional resin cements
2. The coronal region of the root dentin showed a significantly higher bond strength of the glass fiber reinforced composite post than the apical region.

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