DENTAL MATERIALS 24 (2008) 372–377

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Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test

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ARTICLE INFO

Article history:
Received 16 November 2006
Accepted 31 May 2007

Keywords:
Fiber post
Post retention
Luting cement
Push-out test

ABSTRACT

Objective. To investigate regional root canal push-out bond strengths for two fiber-reinforced post types using two adhesive systems.

Methods. The crowns of 24 recently extracted sound maxillary central incisors were sectioned transversely 2 mm coronal to the labial cemento-enamel junction, and the roots treated endodontically. Following standardized post space preparations, fiber-reinforced posts (C-POST; AESTHETI-PLUS) were placed using two adhesive systems (acid-etch ONE-STEP PLUS/C&B CEMENT; self-adhesive RelyX Unicem), in four equal groups. Push-out bond strength tests were performed at four sites in each root. Results were analyzed using split-plot ANOVA, with $\alpha = 0.05$ for statistical significance.

Results. AESTHETI-PLUS quartz fiber-reinforced posts showed significantly higher push-out strengths than C-POST carbon fiber-reinforced posts ($P < 0.0001$). The separate acid-etch adhesive system resulted in significantly higher bond strengths than the self-etch self-adhesive system ($P < 0.0001$). Bond strengths decreased significantly from coronal to apical root canal regions ($P < 0.0001$).

Significance. The quartz fiber-reinforced post placed using the separate acid-etch adhesive system provided significantly better post retention than the carbon fiber-reinforced post placed using the self-etch self-adhesive system.

1. Introduction

Previously, an endodontically treated tooth was usually restored when required with a custom-fabricated cast alloy post and core or a prefabricated alloy post and resin composite core. More recently, fiber-reinforced polymer posts are advocated due to their advantages of corrosion resistance, non-hypersensitivity, esthetic appeal, easier removal for endodontic re-treatment, and single visit office placement [1]. Fiber posts also more closely match the modulus of elasticity of sound root dentin, and numerous in vitro studies have shown that the posts distributed occlusal stresses more evenly in the root dentin, usually leading to fewer and more favorable root fractures, which were often reparable [2–4].

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doi:10.1016/j.dental.2007.05.012

A review of fiber-based post systems placed in permanent teeth found very few published clinical studies, mainly involving one type of carbon fiber post [2]. More recent clinical studies also have involved very few types of glass and quartz fiber posts [5–8]. Most of the studies were short-term and lacked metal alloy posts as controls. Failures usually occurred from debonding or, less often, fracture of the fiber posts.

Three types of tests have been used for assessing bonding to root canal dentin: the microtensile bond strength test, the push-out test, and the push-in test (which is no longer favored). The microtensile bond strength test can be used with large numbers of small beam-shaped specimens [9], but standard deviation values and premature failure rates may be high for both trimmed and non-trimmed specimens [10]. The push-out test was first advocated by Roydhouse [11], and measures the shear bond strength of relatively thick cross-sectional specimens. An early use of the push-out test in prepared root canals was to assess the shear bond strengths of a direct and indirect placement resin composite to the root canal walls [12].

'All-in-one' resin-based adhesives are widely promoted to simplify the dentin bonding procedure and to reduce the time taken to bond resins to dentin. When used to bond a glass fiber-reinforced post, a simplified dual-cure self-adhesive resin luting cement requiring no pre-treatment of the root canals showed significantly lower push-out bond strengths than a total-etch adhesive system used with a dual-cure resin luting cement [10]. It remains to be determined whether a similar result would be obtained when using the same self-adhesive resin luting cement with other types of fiber-reinforced posts.

The objective of this in vitro study was to investigate the push-out bond strengths, in coronal and apical root canal dentin sites of endodontically treated maxillary central incisor teeth, for two fiber-reinforced post types cemented using two adhesive systems. The null hypothesis tested was that the push-out bond strengths would be unaffected by post type, adhesive system and root canal dentin site.

2. Materials and methods

2.1. *Specimen preparation*

Twenty-four sound maxillary central incisors with fully developed apices were extracted for periodontal reasons. The teeth were obtained from Chinese adults who lived in the same locality, which was without water fluoridation. The teeth were cleaned and examined stereoscopically at 10× magnifications to verify the absence of caries and cracks, before being stored in 0.9% saline solution at 4 °C for no longer than 2 weeks.

Diamond disks were used to section transversely the natural crowns 2 mm coronal to the labial cemento-enamel junction. Standardized root canal preparations were completed with size four drills (Gates-Glidden, Dentsply Maillefer SA, Ballaigues, Switzerland), before placing laterally condensed gutta percha points (Dentsply International, Inc., York, PA, USA) coated with root canal sealer (AH 26, Dentsply International, Inc.) to obturate the canals. The endodontically treated roots were stored at 37 °C in 0.9% saline solution for 1 week.

Post-hole spaces or channels, 10 mm deep, were completed with #2 pre-shaping and finishing parallel-sided post drills (Bisco, Inc., Schaumberg, IL, USA) in a low speed handpiece, creating double-tapered cylindrical post preparations having two different sized diameters. Radiographs confirmed the removal of gutta percha apart from the presence of 3 mm remaining at the apical region of the roots. The post-holes were rinsed with 5% NaOCl and dried with paper points, until the last paper point drawn out was dry. The 24 prepared roots were assigned to four equal groups (A1, A2, B1, and B2) according to a table of random numbers. The root length, and the mesial–distal and labial–palatal diameters of each root at the root face, was measured to 0.02 mm with a vernier caliper (Vernier Caliper Model 93218-0654, Harbin Measuring and Cutting Tool Group Co. Ltd., Harbin, PR China). There were no significant differences in these dimensions among the four groups (Table 1).

Prefabricated carbon fiber-reinforced posts (#2 C-POST, Bisco, Inc.) were placed in group A, and prefabricated quartz fiber-reinforced posts (#2 AESTHETI-PLUS, Bisco, Inc.) were placed in group B. In groups A1 and B1 (acid-etch), the walls of the prepared post-holes were first etched for 15 s using 32% phosphoric acid gel (UNI-ETCH, Bisco, Inc.), rinsed thoroughly with water and dried lightly with paper points. Two thin layers of lightly filled resin-based adhesive (ONE-STEP PLUS, Bisco, Inc.) were applied to the walls of the post-holes, dried carefully with paper points and oil-free air for 10 s, and light cured (Variable Intensity Polymerizer Junior, Bisco, Inc.) from a coronal direction for 20 s at 600 mW/cm^2. The fiber posts also were covered with a thin layer of the light cured adhesive. Hand-mixed self-cured resin-based luting cement (C&B CEMENT, Bisco, Inc.) was then injected into the post spaces before placement of the posts, according to the manufacturer's instructions. In groups A2 and B2 (self-etch), the walls of the prepared post-

Table 1 – Mean dimensions (mm) of randomly assigned maxillary central incisor roots in each group

Post type ($N = 24$)	Adhesive system group	Mesial–distal root face width	Labial–palatal root face width	Root length
Carbon fiber	A1: acid-etch	7.27 (0.28)[a]	6.28 (0.24)	13.37 (0.86)
	A2: self-etch	7.07 (0.37)	6.27 (0.24)	13.37 (0.87)
Quartz fiber	B1: acid-etch	7.27 (0.35)	6.26 (0.50)	13.09 (0.51)
	B2: self-etch	7.09 (0.35)	6.10 (0.47)	13.35 (1.23)
P-value (one-way ANOVA)		0.62	0.82	0.93

[a] Mean (standard deviation).