Effect of dowel length on the retention of 2 different prefabricated posts

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Objective: To compare in vitro the retentive values of stainless steel, parallel-sided posts to quartz-fiber, tapered posts for 2 different dowel lengths (5 and 10 mm). **Method and Materials:** Both post systems were cemented with a dual-cure adhesive resin cement. Single-rooted extracted human teeth (n = 40) were decoronated and randomly divided into 4 groups of 10 samples each. Posts of 5 and 10 mm in length were luted with the resin cement. Each sample was placed on a universal testing machine, and using a push-out method, a vertical load was applied at a crosshead speed of 2 mm/min. The amount of force required to dislodge the post was recorded. The effect of post type and length was evaluated using a 2-way analysis of variance. **Results:** A statistically significant main effect was found for post length ($P < .001$), with the 10-mm posts of both post systems requiring greater force to dislodge than the 5-mm posts. There was no interaction between post length and post type ($P > .05$). **Conclusion:** It is concluded from this study that there is no statistical difference in retention between quartz-fiber, tapered posts and stainless steel, parallel-sided posts when they are cemented with the same resin cement ($P > .05$). The study also concludes that adequate retentive values are achieved with both post systems at the shorter, 5-mm post length. *(Quintessence Int 2007;38:173.e164–168)*

Key words: post and core, post retention, quartz-fiber post, root canal therapy, stainless steel post

While it was once thought that a post was required to reinforce a weakened endodontically treated tooth,[1] this concept has been disproved.[2] The primary reason a corono-radicular post is placed in an endodontically treated tooth is to provide retention for a core.[3–6] Post systems over the years have evolved from the early cast metallic posts to prefabricated metallic posts to the most recent esthetic fiber post designs. As the use of fiber posts increases, because they are bonded with resin cements, the question of adequate post length for retention must be addressed.

Numerous studies[1,3,7] have suggested that the length of the post has a significant effect on retention and that the more apically the post is placed in the root, the more retentive it is. These studies have also stated that smooth-surface tapered posts are not as retentive as serrated and nonserrated parallel-sided posts. Unfortunately, these studies were conducted with metal, nonbonded tapered posts. Metallic post systems have many inherent disadvantages, including susceptibility to fatigue failure, high corrosion potential, removal difficulties, and poor stress

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distribution.[8,9] The newer fiber post systems, on the other hand, have many advantageous properties, including high impact resistance, the ability to attenuate and soften vibrations, shock absorption, and increased fatigue resistance.[8]

The design or shape of post systems has been evaluated by many studies.[1,10,11] These studies found that parallel-sided, passive metallic systems had better retentive characteristics than other designs such as tapered post systems, which are now common among the new fiber posts. It must be recognized that these studies evaluated the different post designs using nonadhesive, nonresin cements. Recently, it has been well documented[3,5,6] that resin-based adhesive cement systems exhibit greater retention of both metallic and fiber post designs.

The purpose of this study was to test, in vitro, the effect of post type and design and post length on retentive strength using a contemporary resin cement.

METHOD AND MATERIALS

Retention values of 1.14-mm-diameter, parallel-sided, serrated, stainless steel posts (ParaPost, Coltene/Whaledent) and size 2 quartz-fiber, tapered posts (D. T. Light-Post, Bisco) were compared. The post lengths studied were 5 mm (short) and 10 mm (long). The tapered fiber post diameters were 1.00 mm at the tip and 1.13 mm at the 5-mm length and 1.53 mm at the 10-mm length. Both post systems were luted with a dual-cure adhesive cement (Duo-Link, Bisco).

Forty intact maxillary central incisors of similar root diameter and length were used for this study. The coronal portion of each tooth was sectioned perpendicular to its long axis at or near the cementoenamel junction to produce a root of standardized length (15 ± 1 mm). This was accomplished with the use of a carbide bur in a high-speed handpiece and copious water irrigation. The canals were cleaned and shaped with a modified crown-down technique using Protaper series files (Dentsply/Tulsa Dental) and an electric-driven handpiece with copious irrigation (5.25% sodium hypochlorite). Apical gauging was conducted using stainless steel K files (Dentsply/Maillefer) to determine the final size of the apical preparation. All specimens were obturated using a warm vertical compaction technique with gutta-percha and an epoxy resin sealer (ThermaSeal Plus, Dentsply/Tulsa Dental).

Prepared teeth were randomly divided into 4 groups of 10 teeth each: group A, quartz-fiber cemented 10-mm posts; group B, stainless steel cemented 10-mm posts; group C, quartz-fiber cemented 5-mm posts; and group D, stainless steel cemented 5-mm posts. For each post system, the appropriate post space drills were used according to the manufacturer's directions to provide consistent post space. All post spaces were etched with 38% phosphoric acid for 20 seconds, rinsed with water using an endodontic irrigating syringe, and dried with paper points. Using a microbrush, the canal walls were coated twice with a combination primer/adhesive (One-Step, Bisco); excess primer/adhesive was removed from the canal with dry paper points, and the primer/adhesive was photopolymerized for 40 seconds. All posts were also coated with the primer/adhesive, lightly dried with an air syringe, and the primer/adhesive photopolymerized for 40 seconds.

Equal amounts of the dual-cure adhesive cement catalyst and base (Duo-Link) were mixed to a uniform paste and injected into the canals with a unit-dose needle-tip device to ensure that the cement filled the entire post space. All posts, coated with cement, were seated into the canals and held with apical pressure for 10 seconds. Excess cement was removed, and the tooth was photopolymerized for 40 seconds by placing the light tip on the coronal end of the post. A uniform 3-mm coronal portion of each post remained above the prepared root surface. The test samples were stored in a 100% humidity environment at 37°C for 2 weeks.

To position the specimens so that the vertical load to be applied on the apical surface of the posts would be as parallel as possible to the long-axis of the universal testing machine (Instron 5500R, Instron), the specimens were embedded in acrylic resin blocks and

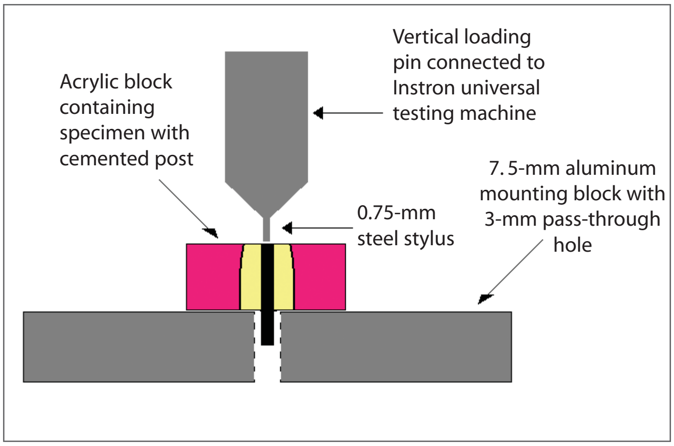

Fig 1 Schematic drawing of a mounted specimen with cemented post and vertical loading apparatus.

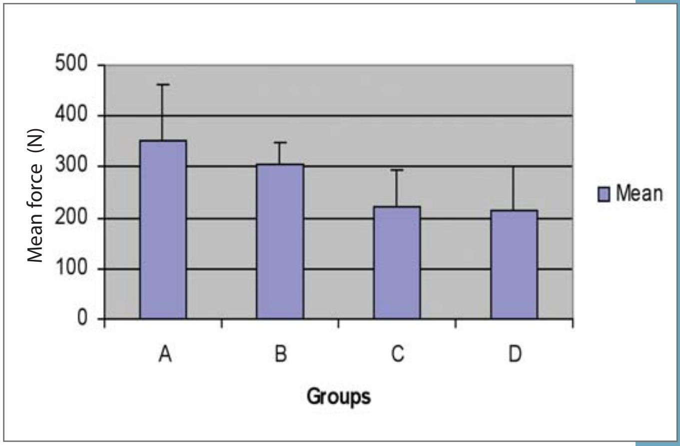

Fig 2 Mean force (N) required to dislodge posts in each group. The height of each bar represents the mean and the brackets represent ± SE.

trimmed to the level of the apical extent of the post within the tooth (Fig 1). The universal testing machine was used to determine the retention of each cemented post. Using a 0.75-mm-diameter steel stylus with a crosshead speed of 2 mm/min, a vertical load was applied to the apical end of each specimen. The force necessary to loosen the post was automatically recorded using the Instron software package (Instron version 5.6).

A two-way analysis of variance (ANOVA) was performed using post type (ParaPost or D. T. Light-Post) as one factor and post length (5 mm or 10 mm) as the second factor. The statistical analysis was carried out using the SPSS 9.0 (SPSS) software package.

RESULTS

The mean force (N) required to loosen the posts in each group is shown in Fig 2. A significant main effect was found for post length ($F_{1,36}$ = 18.663, $P < .001$), with the 10-mm posts of both post systems requiring a greater force to dislodge than the 5-mm posts. There were no differences in retention between the D. T. Light-Post system and the ParaPost system ($F_{1,36}$ = 0.937, $P > .05$), and there was no interaction between post length and post type ($F_{1,36}$ = 0.544, $P > .05$). However, close examination of Fig 2 might suggest a possible retention difference, with D. T. Light-Post requiring a greater dislodgement force than the ParaPost system at the 10-mm length. A power analysis suggests that with a larger sample size (n = 22 per group), the differences in force for dislodgement at the 10-mm post length would be statistically significant.

DISCUSSION

In vitro dislodgement studies do not directly correlate with the clinical efficacy of post systems. However, they do provide information of the basic dynamics of retention of the post within the canal system. Post dislodgement forces can be generated via a pull-out testing method or a push-out approach. With a pull-out testing method, the coronal end of the post is left extruding from the root of the specimen so that the universal testing machine can be attached to it. Once attached, the universal testing machine pulls on the post in a coronal direction until the post is dislodged. The disadvantage of this approach is that subtle horizontal or transverse forces can be introduced that could affect post retention values. With a push-out testing method, the root is resected to the apical end of the post, and the universal testing machine stylus pushes the post in a coronal direction until the post is dislodged (see Fig 1). The push-out method was used in this study because it is particularly suited for brittle materials such as resin cements and it is less likely to introduce transverse forces that could skew the study results.[8,12,13]

This study demonstrated that a newer quartz-fiber, double-tapered post system has comparable retention to a stainless steel, parallel-sided post system. This effect may be directly related to the successful use of adhesive resin cements allowing for significant chemical bond between the dentin and the post itself. A number of authors[1,7,10,11] have found that the retentive strength of unthreaded, tapered posts is inferior to that of parallel-sided, threaded post systems. Many of these studies did not use adhesive resin cements and thus lacked the chemical bonding characteristic now inherent in the newer tapered fiber post systems cemented with adhesive cements. To substantiate this finding, a number of authors[3,6,14,15] found that cement had a statistically significant effect on post retention. In the study by Love and Purton,[14] the authors found a range of 26 to 340 N to dislodge a serrated, parallel-sided post system depending on the cement used. Resin-modified glass-ionomer cements had the poorest retention, while adhesive resin cements exhibited the greatest retention. A similar study by Utter et al[6] found that posts cemented with resin cements exhibited statistically significantly greater retention than posts cemented with zinc phosphate cement with or without dentin conditioning.

It has been previously suggested that, traditionally, post lengths used may be shortened when using adhesive resin cements.[3] Nissan et al found that both tapered and parallel-sided posts cemented with a resin cement demonstrated no statistically significant difference in retention when different lengths (5, 8, and 10 mm) of both types were examined.[3] Our study, on the other hand, did show that there was a statistically significant difference between retention of the long (10 mm) and the short (5 mm) posts for both post types; however, even the short posts (5 mm) had clinically adequate retentive characteristics (215 to 221 N). Our study suggests that adequate retention can be expected when a shorter, tapered fiber post is used in combination with an adhesive resin cement for the restoration of endodontically treated teeth.

CONCLUSIONS

D. T. Light-Posts cemented with adhesive resin cement had no statistically significant difference in retention compared to ParaPosts cemented with the same cement. Adequate retentive values were achieved with both post systems cemented with a resin cement even at shorter lengths (5 mm).

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