Fracture Resistance of Endodontically Treated Roots with Oval Canals Restored with Oval and Circular Posts

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Abstract

Introduction: The aim of the present study was to evaluate the effects of post space preparations with circular and oval post drills and the placement of oval and circular posts on the fracture strength of roots with oval canals. **Methods:** Seventy mandibular premolars with oval root canals were decoronated. Fourteen teeth were used as a control group (group 1), and the root canals of the remaining teeth were prepared up to size #30. The root canals were filled, and the samples were randomly divided into 4 experimental groups as follows: post space preparation with circular-shaped drills (group 2), post space preparation with oval-shaped drills (group 3), circular post placement (group 4), and oval post placement (group 5). A fracture strength test was performed on each specimen, and the data were statistically evaluated using 1-way analysis of variance and Tukey post hoc tests. **Results:** The fracture strengths of the circular posts–placed group were higher than those of the oval post–placed group ($P < .001$). The post space preparation using oval-shaped drills significantly decreased the fracture strength of the roots compared with the control group ($P < .001$). **Conclusions:** Within the limitations of the present study, oval posts did not provide a higher fracture resistance to endodontically treated roots with oval canals compared with circular posts. Therefore, clinicians should be aware that oval posts are similar to circular posts in terms of enhancing the fracture resistance of roots with oval canals. *(J Endod 2015;41:539–543)*

Key Words

Endodontically treated tooth, fiber post, fracture strength, oval fiber post

Insufficient coronal structure of a tooth because of serious damage by decay and/or traumatic dental injury commonly requires the placement of a post system inside the root canal after adequate endodontic treatment to provide a retentive medium for core and coronal restoration (1). Practitioners frequently use prefabricated or custom posts made of metal, which increases the risk for unfavorable vertical root fracture because of their elastic modulus being above the dentin (2). However, fiber-reinforced composite posts have elastic properties similar to those of dentin, which makes fractures restorable (2–5). Moreover, this type of post eradicates the corrosion problems associated with metal posts (6). These properties of fiber-reinforced composite posts makes them advantageous in restoring endodontically treated teeth (7).

Cement thickness is 1 of the main factors affecting the retention of post systems (8). Uzunoglu et al (8) evaluated the effect of 2 different post space diameters and related resin cement film thicknesses on the bond strength of fiber posts and found that increases in post space diameter significantly reduced the bond strength of fiber posts to root dentin for both groups. Similarly, Gomes et al (9) evaluated the effect of resin cement thickness on the bond strength and gap formation of fiber posts bonded to root dentin, and they reported that a lower resin cement thickness resulted in better fiber post adhesion (ie, higher bond strength and less gap formation). Effective bonding can contribute to reducing stress generated on the root canal walls, thereby strengthening the remaining tooth structure and decreasing the risk of fracture (10, 11). Another issue affecting the stress distribution is the post type. Okada et al (12) found that fiber posts showed a lower stress value when compared with metallic posts (titanium and stainless steel).

Various adhesion strategies for fiber-reinforced composite posts have been used in root canals, and etch-and-rinse adhesives in combination with dual-cure resin cements were found to give the most reliable results (13). However, the use of simplified adhesives, such as etch-and-rinse 2-step and single-step self-etch adhesives, simplifies the handling. As far as resin cements are concerned, conventional dual-cured resin cements require prior application of adhesive systems. However, self-adhesive cements do not require any surface treatment of the root canals. They are easier to handle and have a clinically effective bond strength (14). The chemical reaction between phosphate methacrylates in self-adhesive cements and hydroxyapatite in dentin provides bonding (15).

Endodontically treated roots are more susceptible to fracture because of their weakened structure. Endodontic treatment procedures, including access cavity preparation, root canal instrumentation, irrigation, post space preparation, and obturation, could be considered as possible predisposing factors (16–20). Recently, oval posts with their oval-shaped ultrasonic drills (Ellipson Tip; RTD/Satelec, Merignac, France)

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have been introduced for use in teeth with oval root canals. The manufacturer claims that this system results in fewer root fractures (21). The aim of the present study was to evaluate the effect of post space preparations with circular and oval post drills and the placement of oval and circular posts on the fracture strength of roots with oval canals. The null hypothesis was that there are no significant differences in fracture strength among the groups.

Materials and Methods

A total of 70 single-rooted, freshly extracted, noncarious human mandibular premolar teeth with similar dimensions were used for this study. The reason for extraction was not related to the study. To disinfect the teeth, they were immersed in 0.5% Chloramine-T solution (Merck, Darmstadt, Germany) for 48 hours, and soft tissue and calculus were mechanically removed from the root surfaces using a periodontal scaler. The specimens were radiographed in both the buccolingual and mesiodistal directions, and they were classified as oval if the buccolingual diameter of the root was 1.6 times greater its mesiodistal diameter at a level of 5 mm from the root apex (22). The exclusion criteria were as follows: teeth with more than a single root canal, previous root canal treatment, internal/external resorption, immature root apices, caries/cracks/fractures on the root surface, or a root canal curvature of more than 10°. The teeth were stored in distilled water at room temperature until use. The samples were decoronated to obtain a standardized length of 15 mm.

Fourteen samples served as a control group, and the remaining samples were prepared as follows: a #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was moved down into the root canal until the file was just visible, the length of the file was recorded, and the working length was determined as 1 mm less than this length. Root canal shaping procedures were performed by using ProTaper rotary instruments (Dentsply Maillefer) up to an apical preparation with size #30 (F3). One milliliter of 2.5% NaOCl was used between instrument changes. The final irrigation protocol was performed using 5 mL 17% EDTA for 1 minute and 5 mL 2.5% NaOCl followed by 5 mL distilled water. The root canals were dried and filled with AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) and gutta-percha (Dentsply Maillefer) using the cold lateral compaction technique. The 56 experimental samples were then divided into 4 groups (n = 14).

Group 1 (Control Group)

Root canals were not instrumented, and post space preparation and post placement were not performed.

Group 2

The post space preparation was performed using a circular-shaped drill (size #2, 1.55 mm) (Unicore; Ultradent, Salt Lake City, UT). Post placement was not performed.

Group 3

Post space preparation was performed using an oval-shaped, ultrasonic drill (Ellipson Tip) mounted in a Suprasson handpiece (Satelec/Acteon, Merignac, France). Post placement was not performed.

Group 4

Post space preparation was performed as in group 2. A circular fiber post (size #2, 1.55 mm) (Unicore posts size 2, Ultradent) was seated to the full depth by using finger pressure.

Group 5

Post space preparation was performed as in group 3. An oval fiber post was seated (diameter of the tip of the fiber = 0.6 mm, thickness = 1.1 mm, width = 1.8 mm) (Ellipson Posts, RTD/Satelec).

The experimental design is summarized in Figure 1. In the experimental groups, the root canal filling material was removed using a heated plugger (size 2; VDW GmbH, Munich, Germany) before post space preparation. A 10-mm-deep post space preparation was performed, and the posts were cemented into the post spaces by using a self-adhesive resin luting agent (RelyX Unicem; 3M ESPE, Seefeld, Germany) according to the manufacturer's instructions. After the posts were separated above the roots, the samples were stored in distilled water for 1 day at 37°C. The samples were then mounted in the acrylic resin (Imicryl, Konya, Turkey), exposing 5 mm of the coronal part. The fracture strength test was performed by using a universal testing machine (Instron Corp, Norwood, MA) at a constant crosshead speed of 1 mm/min. The force at which fracture occurred in each sample was recorded in newtons. Statistical analysis was performed using 1-way analysis of variance and Tukey post hoc tests for the fracture strength data (P = .05) with SPSS software (SPSS Inc, Chicago, IL).

The failure type was recorded and classified as favorable (would allow repair) or catastrophic (nonrestorable). The favorable failure type was located at the cervical third, whereas catastrophic failure was located at the middle or apical thirds. The direction of the failure was also recorded as buccolingual, mesiodistal, or mesiolingual.

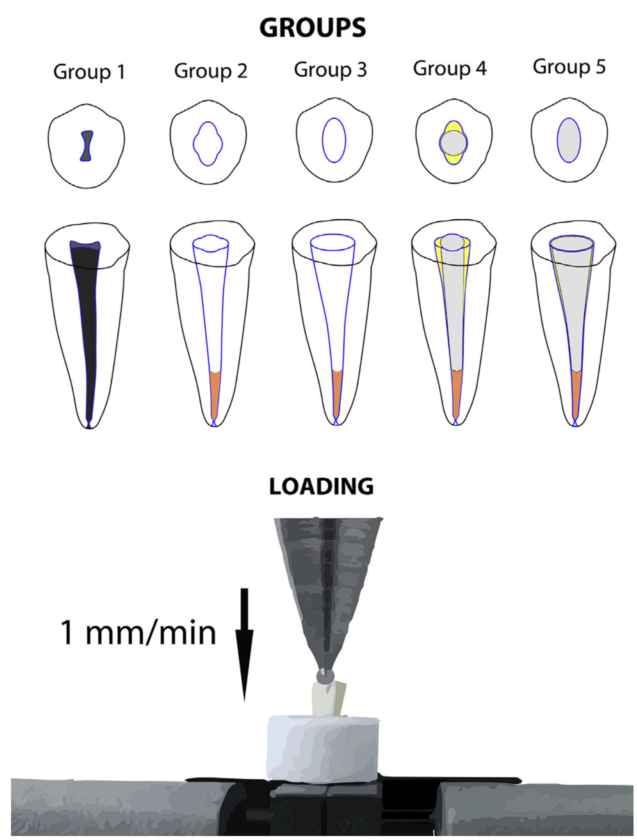

Figure 1. A schematic presentation of the procedures. Group 1: noninstrumented, group 2: post space preparation using a circular drill, group 3: post space preparation using an oval drill, group 4: circular post placement, and group 5: oval post placement. Loading was performed at 1 mm/min.