Original Article / Özgün Araştırma

Pull-out Retentive Resistance of Fiber Posts Restored with Different Core Materials

Farklı Kor Materyalleri ile Restore Edilmiş FiberSite ile RelyX Fiber Postlarının Diş Dokusuna Bağlanma Dayanımlarının İncelenmesi

Can Topkara[1], Koray Yılmaz[2], Mustafa Gündoğar[3], Gülşah Uslu[4], Taha Özyürek[5]

[1]Private Practice, Samsun, Turkey
[2]Hatay Mustafa Kemal University Faculty of Dentistry, Department of Endodontics, Hatay, Turkey
[3]İstanbul Medipol University Faculty of Dentistry, Department of Endodontics, İstanbul, Turkey
[4]Çanakkale Onsekiz Mart University Faculty of Dentistry, Department of Endodontics, Çanakkale, Turkey
[5]İstanbul Medeniyet University Faculty of Dentistry, Department of Endodontics, İstanbul, Turkey

Abstract

Objective: This study aimed to assess the pull-out bonding resistance of FiberSite and RelyX Fiber posts constructed from core structures using various resin cement.
Materials and Methods: Sixty mandibular premolar teeth were horizontally sectioned to create a root canal length of 15±1 mm. Up to size #40, samples were prepared and obturated with gutta-percha and root canal sealer. Three groups of specimens (n=20) were formed. FiberSite posts were luted and built-up using Clearfil DC Core Plus in Group 1, RelyX Fiber posts were luted and built-up using Clearfil DC Core Plus in Group 2, and RelyX Fiber Posts were luted and built-up using Filtek Bulk Fill Posterior in Group 3. Each specimen was vertically positioned in a universal testing machine and rotated at 0.5 mm/min until it dislodged. One-way ANOVA and post hoc tests were used to evaluate the data.
Results: The bonding strength of FiberSite posts was higher than that of RelyX Fiber posts ($p<0.05$). Clearfil DC Core Plus-built RelyX Fiber Posts exhibited higher bond strength than Filtek Bulk Fill Posterior-built posts ($p<0.05$).
Conclusion: FiberSite posts provide better root canal dentin retention than RelyX Fiber posts with different core materials.

Öz

Amaç: Bu çalışmada farklı rezin simanlar ile kor yapıları oluşturulmuş FiberSite ve RelyX Fiber Post sistemlerinin kök kanalına bağlanma kuvvetlerinin incelenmesi amaçlanmıştır.
Gereç ve Yöntemler: Altmış adet mandibular premolar diş, 15±1 mm kök kanal uzunluğu elde etmek için yatay olarak kesildi. Örneklerin kök kanalları #40'a kadar prepere edildi ve guta-perka ve kanal patı kullanılarak kök kanal dolguları yapıldı. Örnekler daha sonra 3 gruba ayrıldı (n=20). Grup 1'de FiberSite postları Clearfil DC Core Plus ile simante edildi. Grup 2'de RelyX Fiber postlarının simantasyonu ve kor yapıları, Clearfil DC Core Plus ile yapıldı. Grup 3'te, Clearfil DC Core Plus ile simante edilen RelyX Fiber postlarının kor yapıları Filtek Bulk Fill Posterior ile yapıldı. Tüm örneklere, universal test cihazında kırılma gerçekleşinceye kadar dikey yönde 0,5 mm/dak sabit kuvvet uygulandı. Verilere tek yönlü varyans analizi yapıldı ve post hoc testleri ile analiz edildi.

Keywords
Pull-out test, endodontics, fiber post, post retention, resin cement

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Çekme testi, endodonti, fiber post, post retansiyonu, rezin siman

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Address for Correspondence/Yazışma Adresi:
Gülşah Uslu Assoc. Prof.,
Çanakkale Onsekiz Mart University Faculty of Dentistry, Department of Endodontics, Çanakkale, Turkey
Phone : +90 286 218 00 18-1475
E-mail : gulsah.turkkan@hotmail.com
ORCID ID: orcid.org/0000-0003-3176-1251

Bulgular: FiberSite postlarının bağlanma dayanımı, RelyX Fiber postlarından anlamlı ölçüde daha yüksek bulunmuştur ($p<0,05$). Clearfil DC Core Plus ile kor yapıları oluşturulan RelyX Fiber postları, Filtek Bulk Fill Posterior ($p<0,05$) ile kor yapısı oluşturulan RelyX Fiber postlarından daha fazla bağlanma dayanımı göstermiştir.
Sonuç: FiberSite postları, farklı rezin simanlar ile kor yapıları oluşturulan RelyX Fiber postlarından kök kanal dentinine daha yüksek bağlanma kuvvetine sahiptir.

Introduction

Intracanal posts are commonly utilized to improve the retention of prosthetic crowns against remaining dental tissue (1). Prefabricated or cast metal posts, in addition to their unattractive look, may induce untreatable vertical or horizontal root fractures due to their higher modulus of elasticity than dentin (2). As an alternative to metal posts, fiber-reinforced composite (FRC) posts with a better aesthetic appeal have been created (3). Because the modulus of elasticity of FRC posts is closer to that of dentin, the risk of root fracture following their use should be reduced than that of metal posts (4).

The RelyX Fiber Post (3M ESPE, Seefeld, Germany) system has a strong mechanical structure due to its resin content and unevenly distributed fiber structure. Furthermore, this solution does not require silanization and has a strong bond with dentin due to the microporous structure of its surface. Furthermore, its radiopacity makes it easier to alter the post's location (5).

FiberSite (Mega Dental, Partanna, Italy) post is built of fiberglass-reinforced epoxy resin and is manufactured as a monoblock with a post and core structure. This technique resembles the basic structure of prepared teeth and can be used to restore single- and multiple-root teeth. In endodontically treated teeth, the combination of core and post structures lowers tooth restoration time.

After post-cementation, a variety of composite resins are proposed for building the core structure (6). Clearfil DC Core Plus (Kuraray Medical Inc., Tokyo, Japan) is a resin cement that can be used to construct the core structure as well as after it has been cemented. Because this cement has a dual-cure property, it offers advanced polymerization, bonding, and physical properties. Filtek Bulk Fill Posterior (3M ESPE, St. Paul, USA) is a light-cure composite resin with a nanofiller that can be utilized in cavities up to 4 mm thick in a single step (7).

Debonding of the post due to insufficient bond strength was one of the most common reasons of post and core restoration failures in teeth (8). As a result, the goal of this study was to assess the pull-out bond retention of FiberSite and RelyX Fiber Posts that were rebuilt using different core materials. The study's null hypothesis was that there would be no difference in bonding strength across the various post systems.

Materials and Methods

Specimen Selection

A power calculation was performed using software (G*Power 3.1: Heinrich Heine University, Dusseldorf, Germany) based on a prior work (9). According to the calculations, the sample size should be at least 20 teeth. After receiving approval from the Ondokuz Mayıs University Clinical Trials Ethical Committee (decision number: 2017/252, date: 22.06.2017), 60 mandibular premolar teeth were chosen for extraction due to periodontal or orthodontic reasons. All of this work was done in conformity with the principles of the Helsinki Declaration. The patients were informed about the study before extraction and their written and verbal consents were obtained. Extracted teeth were placed in a 6 percent NaOCl solution (CanalPro; Coltene, Whaledent Switzerland) for 5 minutes following extraction and then preserved in a 0.9 percent saline solution at room temperature for 3-6 months (10). Hand scalers were used to remove soft and hard tissues from the roots. The teeth were examined at a magnification of 20 times and radiographs were collected from various buccolingual and mesiodistal angles. The number of canals and the integrity of the roots were assessed. Teeth with cavities, fractures, resorption, or previous endodontic treatment were excluded. All teeth received one root canal with a curve of less than 5° (11) and 2 times greater dimensions in the bucco-lingual direction than the mesio-distal direction to standardize techniques and materials (12). Under water cooling, the crowns

of the teeth were reduced until a total tooth length of 15±1 mm was achieved.

Root Canal Preparation and Filling

A size 15 K-file was placed into the canal and progressed until it reached the apex (VDW, Munich, Germany). The working length was established by subtracting 1 mm from this distance when viewed. The ProTaper Next NiTi file system was used to widen root canals up to X4 files (Dentsply Sirona, Ballaigues, Switzerland). During the preparation, a total of 10 mL of NaOCl solution (Coltene/Whaledent) was employed. 2 mL NaOCl, 2 mL 17 percent EDTA, and 5 mL distilled water were used for the final wash. X4 suitable paper points were used to dry the root canals. Using the single cone procedure, the root canals were filled with X4 gutta percha (size 40, 0.06 taper) and AH Plus sealer (Dentsply Sirona).

Temporary filling was used to plug the canal orifices (Cavit G; 3M ESPE, St. Paul, MN, USA). The specimens were stored at 37 °C and 100% humidity for 2 weeks to allow the root canal sealant to solidify completely. The samples were sorted into three groups (n=20) at random, and the following procedures were carried out:

Group 1

Burs from FiberSite posts were used to create post cavities with a diameter of 1.6 mm and a depth of 10 mm, leaving 5±1 mm gutta-percha apically. Clearfil S3 Bond Plus (Kuraray Medical Inc.) was delivered to the post space and polymerized for 40 seconds using a light curing system (Elipar S10; 3M ESPE, Seefeld, Germany). Clearfil DC Core Plus cement was then injected into the space after being mixed for 20 seconds. A small amount of cement was applied to the post before it was inserted into the cavity with finger pressure. A sond was used to remove any excess cement that had protruded coronally. For 40 seconds, light was used to polymerize cement perpendicular to the post. In the absence of light, the cement polymerized completely in 6 minutes.

Group 2

The same size of post space as in Group 1 was produced with the RelyX Fiber post kit burs, leaving a similar amount of gutta-percha at the apex. Clearfil S3 Bond Plus was applied to the prepared post space and polymerized for 40 seconds with light. After stirring for 20 seconds, the Clearfil DC Core Plus cement was injected into the gap. A small amount of cement was put to the post, and it was gently inserted into the post space using finger pressure. A sond was used to remove the excess cement around the coronal section of the posts. Light activation for 40 seconds polymerized cement perpendicular to the post.

In the absence of light activation, complete polymerization of the cement took 6 minutes. Clearfil DC Core Plus was utilized to construct the teeth's core structure. Light polymerized the cement for 40 seconds. Without the use of light, complete polymerization of the cement was achieved in 6 minutes. The core preparations were finalized with a 1.2 mm butt shoulder and a 6-degree wall convergence.

Group 3

RelyX Fiber Posts were used in 20 teeth, much like in Group 2. Filtek Bulk Fill was used to generate the fundamental elements of the posts in this group. The cement was polymerized by exposing it to light for 40 seconds, and the core was prepared with a 1.2 mm wide shoulder and 6 degrees of convergence.

Pull-out Test

Pull-out tests were performed on all 20 samples in each group. A parallel meter was used to set the teeth in acrylic resin blocks within a metal ring. The crosshead pull-out test was run at 0.5 mm/min along the long axis of the samples on the universal test instrument (Instron Corp, Norwood, MA, USA). The force needed to displace the posts was measured in Newtons.

Statistical Analysis

The Shapiro-Wilk test was used to see if the data met the assumption of normality. On the data that appeared to be regularly distributed, a one-way analysis of variance and a post hoc Tukey test were used. The analysis was carried out using software (SPSS 21.0; IBM-SPSS Inc, Chicago, IL), with a level of significance of 5%.

Table 1. The means and standard deviations of forces required for post dislodgment (N)

Group	Force (N)
Group 1	429.8±51.6[a]
Group 2	312.6±43.7[b]
Group 3	267.3±39.4[c]
P-value	<0.05

*Different superscript letters indicate statistically difference at 5% significant level

Results

Table 1 shows the averages and standard deviations of the groups' pull-out strength. Group 1, Group 2, and Group 3 had the highest and lowest pull-out strength values, respectively ($p<0.05$).

Discussion

In teeth with limited coronal tissue and a history of root canal therapy, post and core restorations are employed to establish sufficient retention between the residual root structure and the final replacement (13). To improve the retention between root and coronal structures, post systems come in a variety of configurations. The FiberSite technology is unique in that it integrates the post and core constructions into a single monoblock. No studies have looked at the pull-out bond strength of FiberSite posts, according to a literature search. As a result, we compared the bonding strength of FiberSite, which combines core and post structure, and RelyX Fiber Post, which uses different resin materials to construct core structures, to root canals in this study.

Clearfil DC Core Plus was used to execute post cementations in this study. This cement is a unique dual-cure compound that may be used to cement the post as well as construct the core. It can also be used premixed, and its self-etching adhesive capabilities make it simple to use (14). Materials that cure with both self and photopolymerization reactions are regarded to be favorable (15). However, the amount of light that enters the root canals is still debatable (16).

Inadequate connection between the post and the canal dentin might cause issues such as post instability. The bond strengths of adhesive systems and posts have been tested using a variety of approaches. The push-out bond strength test is one of the most used, although it necessitates extracting multiple cross-sections from a tooth to analyze different parts of the root (17). This sectioning procedure can be time intensive, and the placement of the push-out force has an impact on the sample bond strength (18). Sample preparation takes longer in a micro tensile test, and the rate of failure during sample preparation is higher than in all other bond strength tests. Most of the stresses that restorations are subjected to within the mouth are axial. Furthermore, during debonding, FRC posts are frequently subjected to similar stressors in clinical settings (19). From a therapeutic standpoint, the use of pull-out tests in such investigations on the bond strengths of FRC posts is critical. Many samples can be evaluated in a short amount of time using pull-out testing. Furthermore, unlike push-out and micro tensile testing, the adhesive bond interface does not change during sample preparation (20). As a result, the pull-out test was used to assess the bonding strengths of the fiber posts in this investigation.

The null hypothesis was rejected in this investigation because of the variations in bonding strength values across the groups. The FiberSite posts restored samples had a stronger bond than those restored with alternative materials and the RelyX Fiber Post. The monoblock structure of the FiberSite posts could explain this discovery. When compared to other groups, the FiberSite posts' core structure fitting to the dentin displays continuity with the post structure, which may have contributed to its higher resistance to the pull-out force.

The authors of a prior study that compared the push-out bond strength values of FiberSite Posts and those of the RelyX Fiber Post (5) found that the bond strengths of these post systems were identical. The stated bonding strength could be explained by differences in the test system used. The relationship between the post system and the root canal dentin is investigated holistically during pull-out testing. The push-out test, on the other hand, examines the bonding strength of post and adhesive systems at various levels of the root. A greater understanding of the bonding strengths of these two post systems would result from the application of various test procedures.

The pull-out bond strength values of RelyX Fiber Posts restored utilizing various core materials were found to differ in this study. In comparison to the samples restored using Filtek Bulk Fill Posterior, the RelyX Fiber Post samples repaired with Clearfill DC Core Plus had a greater level of pull-out bond strength. Although filler contents in different core materials may cause mechanical qualities to differ, Filtek Bulk Fill Posterior (76.5%) and Clearfill DC Core Plus (74%), for example, have similar filler levels in weight (14, 21).

The difference could be due to the use of the same resin material (Clearfil DC Core Plus) for luting the RelyX

Fiber Post within the root canal and establishing the core structure, which, like the FiberSite Posts, formed an integrity between adhesive and core structure and contributed to improved pull-out resistance.

There are some drawbacks to this study. The oval-shaped root canals were selected based on two-dimensional radiographs taken from different angles. The experiment used teeth that were 2 times wider in the bucco-lingual direction than the mesio-distal direction. De-Deus et al. (22) advocated using micro-computed tomography to control the variability of morphological variety in teeth as well as the unequivocal distribution of samples between experimental groups. Also, before assessing the pull-out resistance of the various FRC post systems in this investigation, no thermo-mechanical aging processes were performed. As a result, caution is advised when interpreting the data clinical implications. Furthermore, when the pull-out strengths of post and core systems are compared to crown restorations, various findings may be obtained.

Conclusion

FiberSite posts had stronger retentive strength than RelyX Fiber Posts manufactured with different core materials, within the limitations of the current investigation.

Ethics

Ethics Committee Approval: Approval was obtained from the Ondokuz Mayıs University Clinical Research Ethics Committee (decision no: 2017/252, date: 22.06.2017).

Informed Consent: The patients were informed about the study before extraction and their written and verbal consents were obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: C.T., K.Y., M.G., T.Ö., Concept: C.T., K.Y., M.G., G.U. T.Ö., Design C.T., K.Y., M.G., G.U., T.Ö., Data Collection or Processing: K.Y., M.G., G.U., Analysis or Interpretation: K.Y., G.U., Literature Search: G.U., Writing: C.T., G.U.

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