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THE EFFECTS OF DIFFERENT ROOT CANAL SEALERS ON THE BONDING STRENGTH OF DIFFERENT FIBER POST SYSTEMS

Mustafa Gündoğar DDS,PhD
Asistant Professor, Department of Endodontics,
Faculty of Dentistry, Medipol University,
İstanbul, Turkey

Nimet Gençoğlu, DDS, PhD
Professor, Department of Operative and Restorative Dentistry,
Faculty of Dentistry, Marmara University,
İstanbul, Turkey

Correspondence
Mustafa Gündoğar DDS,PhD
Department of Endodontics,
Faculty of Dentistry,
Medipol University
Tem Avrupa Otoyolu Göztepe Çıkışı no:1 Bağcılar 34214 İstanbul,
Turkey
Phone:+90 212 4607777
Fax : +90 212 4607070
E- mail: mustafagundogar@msn.com

ABSTRACT

Background and Aim: The aim of this study was to evaluate the effects of 4 different root canal sealers on the bonding strength of different fiber post systems to adhesive resin cement.

Materials and Methods: One-hundred-twenty extracted maxillary central anterior human teeth were prepared by using a Protaper rotary system. Specimens were randomly divided into 4 groups (n= 30) and obturated by using lateral compaction with 4 different sealers (AH Plus, Kerr, Epiphany, EndoREZ). After 7 days, the teeth in each group (n= 10) were implanted with 3 different fiber post systems (DT Light, TransLuma, everStick) with Duo-Link resin cement. The roots were embedded in acrylic resin blocks and sectioned in 3 slices (apical, middle, and coronal). A push-out test was performed in universal testing machine and failure modes were examined under a stereomicroscope. One way ANOVA and Post Hoc Tukey tests were used to analyze the data statistically.

Results: The results revealed that the Kerr sealer demonstrated a lesser bonding strength than other sealers ($p < 0.05$). While teeth implanted with the DT Light fiber post system showed the highest bonding strengths obturated with AH Plus sealer in apical third, and the DT Light fiber post system showed the lowest bonding strengths with Kerr sealer in coronal third ($p < 0.05$). The ever Stick fiber post system showed the highest bonding strengths when obturated with EndoREZ sealer in coronal third ($p < 0.05$).

Conclusion: The chemical content of the root canal sealer and type of fiber post can potentially affect the bonding strength of fiber posts retained with resin cement.

Key words: Bonding Strength, Fiber Post System, Push-Out Test, Root Canal Sealers.

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FARKLI KÖK KANAL DOLGU PATLARI İLE DOLDURULMUŞ DİŞLERE UYGULANAN FARKLI FİBER POST SİSTEMLERİNİN BAĞLANTI KUVVETLERİNE KARŞI DİRENCİNİN *IN VITRO* OLARAK İNCELENMESİ

Mustafa Gündoğar
Yar. Doç. Dr., Medipol Üniversitesi, Diş Hekimliği Fakültesi,
Endodonti Anabilim Dalı,
İstanbul, Türkiye

Nimet Gençoğlu,
Prof. Dr., Marmara Üniversitesi, Diş Hekimliği Fakültesi,
Restoratif Diş Tedavisi Anabilim Dalı,
İstanbul, Türkiye

Sorumlu Yazar
Mustafa Gündoğar
Medipol Üniversitesi,
Diş Hekimliği Fakültesi,
Endodonti Anabilim Dalı
Tem Avrupa Otoyolu Göztepe Çıkışı no:1 Bağcılar 34214 İstanbul,
Turkey
Telefon: +90 212 4607777
Faks: +90 212 4607070
E- mail: mustafagundogar@msn.com

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ÖZET

Amaç: Bu çalışmanın amacı; endodontik tedavide sıklıkla kullanılan rezin ve çinko oksit ojenol (ZOE) esaslı kök kanal dolgu patları ile doldurulmuş dişlere değişik fiber post sistemi uygulayarak dentine bağlanma kuvvetlerinin push-out testi ile incelemektir.

Gereç ve Yöntem: Çalışmada 120 adet tek köklü üst santral çekilmiş diş kullanılmıştır. Dişlerin kökleri standart kök uzunluğu18 mm kalacak şekilde kurondan ayrılarak, kök kanalları Protaper tekniği ile temizlenip şekillendirilmiştir. Dişler 4 ana gruba ayrılarak (n= 30) lateral sıkıştırma tekniği ile dört farklı kök kanal dolgu patı (AH Plus, Kerr, Epiphany, Endorez) kullanılarak doldurulmuştur. 7 gün sonra, her grubta, (n= 10) üç farklı fiber post sistemi (DT Light, Transluma, Everstick) kullanılarak Duolink rezin simanı ile yapıştırılmıştır. Post uygulanmış kökler akriliğe gömülerek, köklerin apikal kısmından 4 mm kanal dolgusu bırakılmak süreti ile (apikal, orta, kuronal) 3.00±0.06 mm olacak şekilde üç adet kesit alınmıştır. Alınan kesitlerdeki diş örneklerine push out testi uygulanmış ve elde edilen veriler istatistiksel olarak incelenmiştir. Ayrıca push out testi uygulanan her örnek stereomikroskop altında incelenerek kırık analizleri yapılmıştır.

Bulgular: Çalışmamızdan elde edilen bulgulara göre, koronal kısımda DT Light fiber post sistemi ile AH Plus kanal patı istatistiksel olarak en güçlü bağlanma kuvveti değerleri gösterirken ($p< 0.05$), apikal kısımda DT light fiber post sistemi ile Kerr kanal patı istatistiksel olarak en zayıf bağlanma kuvveti göstermiştir ($p< 0.05$). Koronal kısımda Everstick fiber post sisteminde ise, Endorez kanal dolgu patı istatistiksel olarak en güçlü bağlanma kuvveti değerleri göstermiştir ($p< 0.05$).

Sonuç: Bu araştırmanın sonucunda, endodontik tedavide son yıllarda popüler olan rezin esaslı patların ZOE esaslı patlara göre, fiber post sistemleri ile daha iyi bağlantı sağladıkları görülmüş olup, özellikle post restorasyonu gerektiren dişlerde rezin esaslı patların tercih edilmesi gerektiğini savunabiliriz. .

Anahtar kelimeler: Bağlanma Kuvveti, Fiber Post Sistemleri, Push-Out Testi, Kök Kanal Dolgu Patı

INTRODUCTION

Endodontically treated teeth may often require post and core restorations to restore missing tooth structure.[1] Traditionally used prefabricated or customized metal posts weaken roots and may lead to root fracture.[2] The rigidity of the post should be close to that of the root to distribute the occlusal forces along the length of the root.[3] Fiber posts were introduced as an alternative to cast posts and metal dowels because their modulus elasticity is closer to that of dentin; this feature reduces the risk of root fracture.[4-6] Fiber-based posts are essentially composite materials and composed of silica fibers surrounded by a matrix of polymer resin, usually an epoxy resins.[4]

The success of endodontically treated and restored teeth depends on the selection of appropriate root canal sealers, post materials, and core materials. Fiber-based post restoration relies on dental adhesion; thus, the compatibility of the chemistries of sealers, posts, and adhesives is important for the long-term success of a restoration.[6,7] Tjan and Nemetz[8] found that zinc oxide eugenol sealers (ZOE) had an adverse effect on post and resin cement. Demiryürek et al.[9] also evaluated the effect of different sealers on the bonding strengths of fiber posts to cement and found that the type of sealer affected the bonding strength of the post to the cement. However, some researchers did not find any significant effect.[10-12]

Many different types of fiber posts (carbon, glass, and fiber) have been introduced in the dental market. Although some articles have been published on the physical properties (such as the modulus elasticity and bonding strength) of different posts, the bonding strength of different types of fiber posts to cement has not been studied in root canal sealers.

The aim of this study was to evaluate the bonding strength of 4 different root canal sealers to 3 different fiber post systems.

MATERIALS AND METHODS

One-hundred-twenty extracted maxillary central incisors for periodontal reasons were used in this study. The crowns were sectioned transversally at the cementoenamel junction and the root length was adjusted to 18 mm. After endodontic access was established, the working length was determined by a direct method of subtracting 1 mm from the real root length. Biomechanical preparation was performed by Protaper Universal system (Dentsply/Maillefer, Ballaigues, Switzerland) to size #40. The canals were irrigated with 1 mm of 5.25% NaCl during instrumentation. The specimens were randomly assigned to 4 groups (n= 30) and obturated as follows:

Group 1, AH Plus (Dentsply De Trey, Konstanz, Germany);
Group 2, EndoREZ (Ultradent, South Jordan, Utah, USA);
Group 3, Epiphany (Pentron, LLC, Wallingford, CT, USA); and
Group 4, Kerr Pulp Canal Sealer (Kerr, Romulus, MI, USA) using the lateral compaction technique.

Temporary filling material was used to seal the coronal orifice. The specimens were kept at 100% humidity for 1 week at 37 °C. After 1 week, Gates-Glidden burs (#3, Mani Inc., Togichi, Japan) were used to prepare the post space. The root canal space was washed with 17% EDTA (MD-ChelCream, Meta Biomed, Chungbuk, the Republic of Korea) and NaOCl (5.25%), rinsed with saline solution, and dried with paper points. Then, each group was subdivided into 3 groups (n= 10) to replace 3 different post systems:

DT Light Post (DT Light–Post, Bisco, IL, USA) (quartz fiber embedded in epoxy resin);
everStick Post (Stick Tech Ltd., Turku, Finland) (glass fiber embedded in PMMA and bis-GMA);
TransLuma Post (TransLuma, Bisco, IL, SA) (glass fiber embedded in epoxy resin).

A #2 drill (DT Light Post System, Bisco, IL, USA) was used to create a 14-mm post space. The adhesive resin cement (Duo-Link dual-cure composite resin luting cement, Bisco Inc., IL) was applied with a lentulo according to the manufacturer's instructions. A 1.8-1.0 diameter DT Light post, 1.5 mm everStick post, and ISO 120 TransLuma fiber post were inserted, and the resin cement was polymerized for 20 seconds with a light-curing unit (Hilux LED 550, Benlioglu Dental, Turkey) a distance 1 mm away from the tooth. Then, the specimens were kept at 100% humidity and 37 °C for 24 hours.

The specimens were embedded in acrylic resin and the blocks were cut perpendicular to the long axis with a low-speed saw under cold water (Isomet, Buehler, USA). Three slices (3.00±0.06 mm) were obtained from the coronal, middle, and apical sections of the roots. Push-out bonding strength was measured with a universal testing machine (TSTM 02500, Elista Inc., Konya, Turkey). For the fracture analysis, the specimens were examined under a stereomicroscope (Imaging Systems, Leica Ltd., Cambridge, England). The force required to dislodge the post was recorded in Newton (N)

and converted into MPa values. All data were analyzed with one-way ANOVA and Tukey tests.

RESULTS

The mean push-out bonding strength values are shown in Table 1 and the Tukey test results are shown in Table 2. Each canal sealer was evaluated with each post system in each tooth section with one-way ANOVA and Tukey tests ($p < 0.05$). One-way ANOVA tests revealed significant differences between the groups ($p < 0.05$).

The DT Post System: Kerr sealer showed the least bonding strength ($p < 0.05$) in the coronal sections of the canal. However, AH Plus showed the highest bonding strength in the apical and coronal sections ($p < 0.05$). No other significant difference was found among the groups ($p > 0.05$).

The TransLuma System: In the apical section, no significant difference was found between the groups ($p > 0.05$). Kerr sealer showed the least bonding strength in the middle and coronal sections ($p < 0.05$), and no other significant difference was observed between the groups ($p > 0.05$).

The everStick post system: EndoREZ showed the highest bonding strength in the coronal section ($p < 0.01$). Epiphany showed higher bonding strength than Kerr sealer ($p < 0.01$) in all sections. Additionally, the bonding strength of EndoREZ was higher than AH Plus ($p < 0.001$) and Kerr sealer ($p < 0.05$).

When the groups were compared overall, the DT Light fiber post system showed the highest bonding strength with AH Plus sealer ($p < 0.05$) in the coronal third. DT light fiber post system showed the lowest bonding strength with Kerr sealer in the coronal third ($p < 0.05$). In the everStick post system, EndoREZ showed the greatest bonding strength in the coronal third ($p < 0.05$). No other statistically significant difference was observed among the groups ($p > 0.05$).

The fracture types observed in the analyzed samples were adhesive-to-dentin, adhesive-to-post, and mixed. Cohesive fractures were not observed. Table 3 shows the results of the predominant type of failures in each group. Fractures were observed in the coronal section in all groups, except with the Kerr sealer. The everStick posts with EndoREZ and Epiphany showed no adhesive-dentin fractures. Moreover,

Table 1. Shear bonding strength values and standard deviations for all sealers and post systems (MPa).

	Apical Mean ± SD	Middle Mean ± SD	Coronal Mean ± SD
AH Plus + DT Light	2.37 ± 2.14	0.99 ± 1.52	4.08 ± 2.69
EndoREZ + DT Light	0.87 ± 0.98	0.76 ±1.20	0.55 ± 0.52
Epiphany + DT Light	0.88 ± 0.1	0.67 ± 0.15	0.68 ± 0.18
Kerr + DT Light	0.19 ± 0.14	0.29 ± 0.33	0.01 ± 0.17
AH Plus + TransLuma	0.69 ± 1.74	1.65 ± 2.16	2.11 ± 2.98
EndoREZ + TransLuma	1.16 ± 1.17	0.95 ± 1.17	2.1 ± 2.13
Epiphany + TransLuma	1.42 ± 1.14	1.06 ± 1.59	0.67 ± 0.93
Kerr + TransLuma	1.38 ± 1.07	0.45 ± 0.66	0.32 ± 0.62
AH Plus + everStick	0.29 ± 0.29	0.81 ± 0.22	0.71 ± 1.99
EndoREZ + everStick	1.83 ± 2.62	2.14 ± 1.44	4.48 ± 1.81
Epiphany + everStick	0.92 ± 0.16	0.83 ± 0.12	1.8 ± 0.12
Kerr + everStick	0.46 ± 0.64	0.09 ± 0.42	0.28 ± 0.29

($p < 0.05$)

Table 2. Comparasion of bond strength between sealers and fiber posts.

Comparison (p = 0.05)	S	N.S.
(DT Light) AH Plus versus Kerr	X	
(DT Light) AH Plus versus EndoREZ	X	
(DT Light) AH Plus Epiphany	X	
(DT Light) Kerr versus EndoREZ		X
(DT Light) Kerr versus Epiphany		X
(DT Light) EndoREZ versus Epiphany		X
(TransLuma) AH Plus versus Kerr	X	
(TransLuma) AH Plus versus EndoREZ		X
(TransLuma) AH Plus versus EndoREZ		X
(TransLuma) Kerr versus EndoREZ		X
(TransLuma) Kerr versus Epiphany		X
(TransLuma) EndoREZ versus Epiphany		X
(everStick) AH Plus versus Kerr	X	
(everStick) AH Plus versus EndoREZ		X
(everStick) AH Plus versus Epiphany	X	
(everStick) Kerr versus EndoREZ		X
(everStick) Kerr versus Epiphany	X	
(everStick) EndoREZ versus Epiphany		X

($p < 0.05$)

adhesive-post fractures were observed in all groups, except with the Kerr sealer. Mixed fractures were demonstrated in all groups.

DISCUSSION

Endodontic sealers might interfere with the adhesion of a post retainer to root canal dentin resulting from their differing compositions.[6] Eugenol-containing sealers are the most commonly used sealers, and it has been indicated that eugenol has an inhibitory effect on the polymerization of adhesive resin.[8,9,13,14] This hypothesis was confirmed by the present study. Kerr sealer showed the least bonding strength with all fiber posts to root dentin. These findings were corroborated by the results of other studies.[6,11,15-17] They all observed a significant reduction in the bonding strength of fiberglass posts to root dentin cemented with self-adhesive cement when eugenol-containing root canal sealer was used.

Cecchin et al.[18] investigated the bonding strength of Endomethasone, AH Plus, Epiphany, and Sealer 26 and

Table 3. Predominant type of root fracture occurring in each group

Sealer	Post type	Region	Adhesive - Dentin %	Adhesive - post %	Mixed %
AH Plus	DT Light	Coronal	-	60	40
		Middle	40	20	40
		Apical	40	20	40
	TransLuma	Coronal	-	60	40
		Middle	-	50	50
		Apical	40	20	40
	everStick	Coronal	50	30	20
		Middle	-	50	50
		Apical	60	-	40
EndoREZ	DT Light	Coronal	-	40	60
		Middle	40	20	40
		Apical	40	-	60
	TransLuma	Coronal	-	60	40
		Apical	-	50	50
		Middle	40	20	40
	everStick	Coronal	-	60	40
		Middle	-	70	30
		Apical	-	60	40
Epiphany	DT Light	Coronal	-	40	60
		Middle	40	20	40
		Apical	40	-	60
	TransLuma	Coronal	-	60	40
		Middle	-	50	50
		Apical	40	20	40
	everStick	Coronal	-	70	30
		Middle	-	60	40
		Apical	-	50	50

Sealer	Post type	Region	Adhesive - Dentin %	Adhesive - post %	Mixed %
Kerr	DT Light	Coronal	-	40	60
		Middle	60	-	40
		Apical	70	-	30
	TransLuma	Coronal	60	-	40
		Middle	60	-	40
		Apical	40	20	40
	everStick	Coronal	60	20	20
		Middle	40	-	60
		Apical	60	-	40

($p < 0.05$)

found that Endomethasone had the lowest bonding strength, and no other difference was found between resin- and calcium hydroxide-based sealers. It was explained that when zinc oxide is mixed with eugenol, a chelating reaction occurred, and although the eugenol was embedded in the zinc eugenolate matrix, free eugenol always remained in the mass.[12,19] Moreover, eugenol sealer has a long setting time, allowing a potential opportunity for eugenol to penetrate into the dentin tubules and surrounding tooth structure, and this may affect the tooth-adhesive interface.[11] Hume[12] showed that the release of eugenol from ZOE into dentin occurred rapidly during the first 24 hours, and then decreased slowly with a detectible release present at 2 weeks. Vano et al.[20] recommended inserting the post system after a 1-week obturation of the canal, especially when zinc oxide eugenol or epoxy resin sealers are used. They concluded that delayed cementation increased post-dentin bonding strength. In the present study, although post cementation was performed 1 week after root filling, a zinc oxide eugenol-based sealer (Kerr) was found to be inferior to resin-based sealers. Menezes et al.[16] found that a ZOE-based sealer (Endo-Fill) had a negative influence on bonding strength in all regions of the canal when placed immediately following root filling. However, after 7 days this negative effect was decreased, and only found in the apical third of the canal. Additionally, eugenol residues remaining in the dentin that are not totally removed by post placement procedures might affect the retention of posts. In this study, EDTA and NaOCl were used to clean the smear layer and cleanliness was checked using a dental microscope before post insertion. On the other hand, some studies have shown no adverse effects from eugenol.[1,7,14] Mannocci et al.[21] compared leakage scores in teeth obturated by Kerr or AH 26 sealers, restored with fiber posts, and found no significant difference. Schwartz et al.[7] also indicated that the type of sealer had no effect on post retention. Demiryürek et al.[9] evaluated the bonding strength of AH Plus and Sealapex and found that a $Ca(OH)_2$-based sealer had a higher bonding strength than ZOE- and resin-based sealers, but no difference between ZOE- and resin-based sealers was observed. Hagge et al.[11] also found no difference among ZOE and other sealers. In most studies, the smear layer was not removed, and this might affect post retention. Baldisara et al.[13] advised using a resin-based sealer because their physical and chemical properties improve post retention. These findings were corroborated by this study's results. All resin-based root canal sealers resulted in higher post retention values than when Kerr sealer was used. However, when resin-based sealers were compared, it seemed that not only the type of sealer, but also the type of fiber post system affected post retention.

The DT Light fiber post system, which is composed of fiber and epoxy resin, showed the best bonding strength with AH Plus sealer, and consists of a paste-paste interface (epoxide and amine pastes). In the present study, the 2 epoxy resin-containing materials might have increased post retention. However, the everStick post is composed of glass fiber and composite material (PMMA and bis-GMA), and no difference was found among resin sealers in these groups. On the other hand, the TransLuma post is composed of glass and epoxy resin, and EndoREZ sealer demonstrated the best post retention with TransLuma posts. It seemed that EndoREZ, which is urethane dimethacrylate resin, and the monomeric composition of the sealer might be responsible for the higher adhesion to everStick posts. In the present study, the content of the sealers and posts might have affected the bonding strength of the materials.

In the present study, the predominant type of failures observed after the bonding tests were adhesive and mixed, mainly between the dentin and Duo-Link cement. DT Light and TransLuma fiber post systems showed mainly adhesive and mixed failures when luted with canal sealers. The everStick fiber post system showed a higher number of failures between the post and resinous cement when obturated with EndoREZ and Epiphany, and these results indicated that resin sealers showed better adhesion to dentin walls. However, Kerr sealer showed mainly adhesive-dentin failures, which indicated poor adhesion to dentin.

According to the results of this study, fiber posts that are primarily composed of glass or quartz fibers embedded in epoxy resin demonstrated better bonding strengths than methacrylate resin-based sealers. Further clinical studies are needed to investigate the effectiveness of the adhesion of fiber posts.

CONCLUSION

The type of the root canal sealer and post both affected the bonding strength of fiber posts retained with resin cement.

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