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Araştırma/ Research Article

COMPARATIVE EVALUATION OF ROOT CANAL SEALERS AND RESIN CEMENTS ON FIBER POST-DENTIN BOND STRENGTH

KÖK KANAL PATLARI VE REZİN SİMANLARIN FİBER POST-DENTİN BAĞLANTISINA ETKİLERİNİN KARŞILAŞTIRMALI DEĞERLENDİRİLMESİ

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ÖZET

Purpose: The present study evaluated fiber post bond strength in root dentin using various root canal sealers and resin cements.

Material and Methods: After root canal preparation, teeth were divided into 5 distinct groups [(Sealapex (calcium hydroxide-based); AH Plus (resin-based); Tubli-Seal (eugenol-based); BC Sealer (bioceramic-based) and No Sealer (control)] according to root canal sealer used. After root filling, post space preparations were done. Five main groups were sub-divided into 3 groups (self-etch, etch-and-rinse, and self-adhesive) corresponding to the resin systems applied. After post cementation, 3 slices were obtained from different regions (coronal, middle, apical) for push-out testing. SEM images of specimens were obtained to evaluate for debonding failures. Differences in bond strength were evaluated by ANOVA and Post-hoc Tukey HSD methods.

Results: It was observed that in Tubli-Seal, BC Sealer and Sealapex groups the bond strength was significantly decreased ($p < 0.01$). No significant difference ($p > 0.05$) in bond strength values was observed between the AH Plus and control groups. It was also observed that the bond strength values were similar ($p > 0.05$) in different resin cement systems.

Conclusion: Root canal sealers affect bond strength between fiber posts and the root canal dentin, whereas different resin cement systems have no effect on the bond strengths.

Keywords: Bond strength; fiber post; push-out; resin cement; root canal sealer.

ABSTRACT

Amaç: Bu çalışmada farklı kök kanal patları ve resin simanlar kullanılarak fiber postun kök dentinine olan bağlanma dayanımı değerlendirildi.

Gereç ve yöntem: Kök kanal preparasyonu yapıldıktan sonra kullanılacak kök kanal patına göre dişler 5 farklı gruba [(Sealapex (kalsiyum hidroksit esaslı); AH Plus (rezin esaslı); Tubli-Seal (öjenol esaslı); BC Sealer (biyoseramik esaslı) ve kontrol grubu(kök kanal patı kullanılmadan)] ayrıldı. Kanal dolguları uygulandıktan sonra post boşluklarının preparasyonu gerçekleştirildi. Beş grup, post yapıştırılmasında kullanılacak rezin siman tipine göre, 3 alt gruba (self-etch, etch-and-rinse ve self adeziv) ayrıldı. Postların yapıştırılmasını takiben push-out testi için farklı bölgelerden 3 adet kesit (koronal, orta, apikal) alındı. Test uygulanan örneklerden bağlanma başarısızlıklarının değerlendirilmesi amacıyla SEM görüntüleri elde edildi. Bağlanma dayanımı farklılıkları ANOVA ve Post-hoc Tukey HSD testleri ile değerlendirildi.

Bulgular: Bağlanma dayanımının Tubli-Seal, BC Sealer ve Sealapex gruplarında anlamlı derecede düşük ($p<0.01$) olduğu saptandı. AH Plus grubu ve kontrol grubu arasında anlamlı bir farklılık olmadığı ($p>0.05$) tespit edildi. Farklı resin siman sistemlerinde de bağlanma dayanımı değerlerinin benzer ($p>0.05$) olduğu görüldü.

Sonuç: Kök kanal patları fiber post ile kök dentini arasındaki bağlanmaya etki ederken, farklı rezin siman sistemlerinin bağlanma dayanımı üzerine bir etkisi yoktu.

Anahtar kelimeler: bağlanma dayanımı; fiber post; kök kanal patı; push-out; rezin siman

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INTRODUCTION

Endodontically treated teeth often require a radicular post due to extensive structural damage as a result of fractures, previous restoration, and carious lesions.[1] Prefabricated and cast metal posts have been traditionally applied for the retention of final restoration; however, because of these posts' mechanical properties, such as elastic modulus and flexural strength, root fractures could be occurred.[2] The elastic modulus and flexural strength of fiber posts are comparable to dentin. These properties provide homogeneous stress distribution and thus probability of root fractures is reduced.[3,4] Glass fiber posts are aesthetically pleasing and can be adhesively cemented to the root canal.[4-6]

The most frequently encountered fiber post failure is loss of retention.[7,8] Both the length and design of fiber posts and the types of adhesive system and endodontic sealer used can influence the retention of fiber posts over time.[9-13]

Various adhesive systems are employed to cement fiber posts to a root canal. Even if the positive effects of the adhesive system favors the retention of fiber posts,[14] several problems can occur, such as hardness from light polymerization in the post space, difficulty in providing a homogeneous adhesive layer in the post space, a high configuration factor (C-factor), and negative effects from endodontic irrigants and endodontic sealers.[13,15-17] "Conventional" or "self-adhesive" resin cements can be applied in the process of fiber post cementation. In 2002, self-adhesive resin cement was produced which did not require per-conditioning of the tooth surface. Reduced sensitivity and chemical and micromechanical retention to the tooth surface give self-adhesive resins distinct advantages relative to conventional resin cements. However, bond strength studies that comparing these resin cements have contradictory results.[17-19]

Another factor that affects fiber post retention is the formulation of the endodontic sealer. There are two different conclusions regarding eugenol-containing sealers. One is that eugenol results in a significant decrease in resin cement bond strength as a result of the fenolic content which inhibits the polymerization of resin.[20,21] The other is that no decrease in the bond strength values of resin cements has been observed.[22,23] In addition, the effects of other endodontic sealers with various resin cement bond strength studies comparing these resin cements have provided contradictory results.[17-19] Demiryürek *et al.*[12] concluded that either resin or eugenol-based sealers have no adverse effect on the bond strength of resin cement, but that calcium hydroxide-based sealers show results similar to those in a control group. Özcan *et al.*[24] observed that calcium silicate and resin sealers have no effect on bond strength, but resin cement bond strength is reduced by eugenol-based sealers.

Therefore, the effects of endodontic sealers and resin cements on fiber post-dentin bonding are unclear. This research was undertaken to evaluate the influence of endodontic sealers, which contain resin, calcium hydroxide, calcium silicate, and eugenol, on the bond strength of glass fiber posts to root canal dentin with the use of three distinct adhesive systems. The null hypothesis is that there are no differences in post retention for the different types of endodontic sealers and resin cements.

MATERIAL AND METHODS

In the present study, 150 single-rooted human premolar mandibular teeth were used. The criteria for inclusion in the study were as follows: single canal and the absence of internal resorption (confirmed using bucculingual and mesiodistal radiographs), the absence of caries, no prior endontic treatment, the absence of root cracks, and root length > 14 mm. Distilled water was used to store teeth. A low-speed, water-cooled, diamond disk (Isomet 1000; Buehler Ltd., Lake Bluff, IL, USA) was used to decoronate the teeth below the cementoenamel. The working length was determined by subtracting 1 mm from the root length that had been measured by introducing a #10 K-file visible from the apical foramen following preparation of the endodontic cavity. The crown-down technique was used for the root canal preparation with the Protaper NiTi rotary instrument system. The apical preparation was extended using an F3 Protaper file. 5.25% sodium hypochlorite (NaOCl) was used for irrigation of the root canal during instrument changes. Final irrigation consisted of 17% EDTA solution, 5.25% NaOCl, followed by a distilled water rinse.

Paper points were used to dry the root canals, which were subsequently divided into five groups for evaluation of different fillings: no sealer(gutta-percha points only-control group), calcium hydroxide-based sealer group (Sealapex Kerr, Romulus, MI), resin-based sealer group (AH Plus, Dentsply DeTrey GmbH, Konstanz, Germany), zinc oxide eugenol-based sealer group (Tubli-seal, SybronEndo, Glendora, CA, USA), and bioseramic-based sealer group (BC sealer, Brasseler USA, Savannah, GA, USA). The cold lateral condensation technique was used to obturate the root canals. A temporary filling material (Cavit G; 3 M Espe, Seefeld, Germany) was used to seal the endodontic access cavities.

Following storage at 37 °C and 100% humidity for 7 days, the temporary filling was removed. The root canal filling was removed at 10 mm depth using a #2 Peeso reamer (Mani Inc, Tochigi, Japan). A #2 drill of post system (Rely X glass fiber post, 3M ESPE, Seefeld, Germany) was used for post space preparation. A stereomicroscope (Novex, Arnhem, Holland) was used to assess the root canal to insure complete removal of the filling material. After preparation, the post space was irrigated with distilled water then dried using paper points.

Posts were luted using one of three different resin cement systems: the Rely X ARC (3M ESPE, Seefeld, Germany) dual-polymerized etch-and-rinse resin cement system, the Panavia F 2.0 (Kuraray, Okayama, Japan) dual-polymerized self-etch resin cement system, and the Rely X U200 (3M ESPE, Seefeld, Germany) dual polymerized self-adhesive resin cement system. The manufacturers' instructions were used to guide the application of cements to the root canal using a lentulo spiral. Slight finger pressure was used to seat the posts to full depth and an LED curing unit was used to polymerize the resin cement (3M ESPE Elipar, Freelight 2, Seefeld, Germany). Specimens were incubated at physiologic temperature (37 °C) and humidity (100%) for one day. A water-cooled, low-speed, diamond disc (Isomet 1000, Buehler, IL, USA) was used to cut each root canal horizontally after 24 hours. Six slices were obtained, each of approximately 1 mm thickness: the first two slices were termed coronal, the second two middle, and the third two apical. 2., 4. and 6. slices processed to push-out test. The push-out was conducted by applying force at 0.5 mm/min using a metalic plunger in the apical to coronal direction until the post was freed. A universal testing machine (Instron, USA) was used to measure push-out force and the maximum load at the time of failure was expressed in Newtons (N), and megapascals, accounting for the bonding area (mm^2) of the distinct post segments. A digital caliper was used to measure the area of the post/dentin sections; area was calculated as $\pi(R+r)[h^2+(R-r)^2]^{0.5}$, with h = slice thickness, R= coronal post radius, and r = apical post radius.

Debonded specimens were examined under SEM (JSM5600 JEOL SEM, Jeol Co., Tokyo, Japan) for fracture analysis. The following types of failure were used to classify the specimens:[25] (1) adhesion between the resin cement and the post with no cement visible, (2) mixed, with resin cement over 0–50% of the post surface area, (3) mixed, with resin cement over 50-100% of the post surface area (4) adhesion between the root canal and the resin cement (post lodged in resin cement), and (5) cohesive in dentin. Differences in bond strength results using the aforementioned sealers and cements were evaluated by two-way ANOVA (SPSS, IBM SPSS 20, SPSS Inc., Chicago, USA). Statistically significant interactions were further evaluated by one-way ANOVA and the Tukey post hoc test. A p-value of 0.05 or less was considered statistically significant.

RESULTS

Mean bond strength values with standard deviations are shown in Table 1. Statistically significant difference was observed in mean bond strength of endodontic sealers ($p < 0.05$), however there were no significant differences observed among the three resin cement systems ($p > 0.05$). Moreover, the two-way ANOVA indicated interactions between cement types and endodontic sealers ($p<0.05$) (Table 2).

Table 1. Mean bond strength and standard deviation (in MPa) for sealers and resin cements. Different superscripts indicate statistically significant difference ($p < 0.05$).

	N	Mean	St.D.	*p*
Sealapex	90	5.20[b]	2.91	
AHplus	90	7.14[c]	3.36	
Tubliseal	90	3.41[a]	2.10	
BC Sealer	90	3.45[a]	2.12	
Control	90	8.14[c]	3.65	
Total	450	5.47	3.46	.000
U200	150	5.57[a]	3.30	
PANAVIA	150	5.38[a]	3.39	
ARC	150	5.45[a]	3.70	
Toplam	450	5.47	3.46	.918

Table 2. Two-way ANOVA test output.

Source	Sum of Squares	Mean	F	*p*
Sealer	1318.117	329.529	41.053	.000
Cement	2.064	1.032	0.129	.879
Sealer * Cement	209.383	26.173	3.261	.001
Error	2769.274	8.027		
Total	15063.503			

No significant difference was found between the resin based sealer and the control group according to the post-hoc Tukey test ($p > 0.05$). In the eugenol- and calcium-silicate based sealer groups, bond strengths were significantly reduced relative to the control group. Lower bond strength values were observed in the calcium hydroxide-based sealer group than the resin-based sealer and control groups ($p < 0.05$).

With the self-adhesive resin cement system, the apical, middle, and coronal root regions showed similar bond strengths ($p > 0.05$). However, in the self-etch and etch and rinse systems, statistically significant differences among the root regions were observed. Significantly higher bond strength values were observed ($p < 0.05$) in the coronal regions relative to the apical and middle regions (Table 3).

The predominant failure modes for sealers and cements were mixed and adhesive in cement-dentin interface. No cohesive dentin failures were observed.

Tablo 3. Mean bond strengths and standard deviation (in MPa) in different root regions.
Different superscript letter indicates statistically significant difference ($p < 0.05$).

	ARC		PANAVİA F		U200	
	Mean±St.D.	*p*	Mean±St.D.	*p*	Mean±St.D.	*p*
CORONAL	$7.13^{b}\pm4.22$		$6.65^{b}\pm3.61$		$6.06^{a}\pm3.54$	
MIDDLE	$5.09^{a}\pm3.55$		$5.38^{a,b}\pm3.61$		$5.76^{a}\pm3.48$	
APICAL	$4.24^{a}\pm2.65$		$4.13^{a}\pm2.40$		$4.88^{a}\pm2.81$	
Total	5.49±3.71	.001	5.38±3.39	.003	5.57±3.30	.256

DISCUSSION

The present research evaluated the effect of resin cements and sealers on fiber post root dentin bond strength. Bond strengths were significantly decreased in the eugenol-based, calcium hydroxide-based, and calcium silicate-based sealer groups, while no significant difference was observed in resin-based sealer group. There were no significant differences among the resin cement groups. Thus, the null hypothesis was rejected for endodontic sealers and confirmed for resin cements.

Many techniques, such as tensile, microtensile, or push-out have been used for the evaluation of post retention. The push-out test was used in the present research as it provides several advantages over the other methods; this method facilitates uniform force distribution along the bonded interface by using small-sized specimens, allowing for the precise evaluation of localized differences in adhesive properties at different regions within the root canal, resulting in fewer premature failures, and it is the most practical test method.[26-28]

Some studies indicate that the bond strength of eugenol-based sealer is decreased when used in association with resin cements.[3,20,24] Residual eugenol on the dentin surface could affect the polymerization of resin cements, and the diffusion of eugenol into the dentin tubules could dramatically decrease adhesive efficiency.[29] The lowest bond strength values in the current study were occurred after use of the eugenol sealers, however, no significant difference was observed in bond strength between calcium silicate and eugenol sealer, in contrast to results reported in Özcan *et al.*[24] Calcium silicate-based sealers show an approximate 20% expansion, and removal of these sealers with conventional re-treatment methods is not possible. The remains of calcium silicate-based sealers in dentin tubules may prevent adhesion and decrease resin cement bonding.

In the present study, bond strength was not adversely affected by the use of resin-based sealers with resin cements. These results are in agreement with several previous studies.[20,21,23] Cecchin *et al.*[20] proposed that the epoxy resin component of resin-based sealers may have increased affinity for various components of the resin cement. However, in contrast to studies by Cecchin *et al.*[20,21], the calcium hydroxide-based sealer group in the present study was associated with lower bond strength values relative to control and resin-based sealer groups. This result, compatible with results in a study by Teixiera *et al.*,[30] is due to the composition of Sealapex, which contains isobutyl salicylate; salicylate is known to react with calcium solubilized by the dissolution of Sealpex. This results in a physiochemical barrier that can interfere with the adhesion of the resin cement.[31]

Different adhesive techniques are used to bond resin cements to dentin. Conventional adhesives are generally divided into two groups: etch-and-rinse and self-etch. In 2002, self-adhesive resin-based cements, that do not require preconditioning of dentin, were introduced in the market, greatly simplify the procedure. The known mechanism of bonding is both chemical and micromechanical in self-adhesive cement as a result of the interaction between hydroxyapatite and monomer acidic groups.[30] Rathke *et al.*[17] have published a report indicating that self-adhesive cement is associated with lower bond strength relative to conventional systems. In contrast, Bitter *et al.*[33] reported increased bond strength relative to conventional materials using self-adhesive resin cement. No significant differences were observed in bond strength associated with the use of different resin cements. While the root regions did not differ significantly in bond strength for self-adhesive resin group, bond strength was progressively decreased from the coronal to the apical region in both the self-etch and etch-and-rinse resin cement groups. This difference could derive from the technical sensitivity and the different bonding mechanisms associated with standard resin cements relative to self-adhesive resin cement.

Fracture analysis revealed that adhesive failure was most common in the eugenol, calcium hydroxide, and calcium silicate-based sealer groups; mixed failure was noted for the control and resin-based sealer groups. This indicates that the bond between the resin cement and dentin was affected less in the control and resin-based sealer groups.

Within the limitations of this research, it was determined that eugenol-, calcium silicate-, and calcium hydroxide-based root canal sealers have adverse effect on the bond between resin cement and root canal dentin; however, resin-based sealer does not affect the strength of the bond between resin cements and root canal dentin. The type of resin cement does not affect the bond strength. While the canal region did influence the bond strength of etch-and-rinse and self-etch resin cements, self-adhesive resin cement had no such influence in this study.

Although the present study was performed under *in vitro* conditions, the findings should prove beneficial to clinicians. Further evaluation of different protocols for post space irrigation to remove the remains and smear that could affect the bond strength are needed, as well as long-term studies to evaluate the effectiveness of the adhesion of fiber posts.

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KAYNAKLAR

1. Morgano SM. Restoration of pulpless teeth: application of traditional principles in present and future contexts. J Prosthet Dent 1996; 75: 375-80.
2. Vire DE. Failure of endodontically treated teeth: classification and evaluation. J Endod 1991; 17: 338-42.
3. Asmussen E, Peutzfeldt A, Heitmann T. Stiffness, elastic limit, and strength of newer types of endodontic posts. J Dent 1999; 27: 275-8.
4. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod 2004; 30: 289-301.
5. Solomon CS, Osman YI. Aesthetic restoration of the compromised root: a case report. SADJ 2003; 58: 370, 373-6, 381.
6. Kıvanç BH. Application of posts in endodontically treated teeth. J Dent Fac Atatürk Uni 2006; 18-23.
7. Purton DG, Love RM. Rigidity and retention of carbon fibre versus stainless steel root canal posts. Int Endod J 1996; 29: 262-5.
8. Cohen BI, Pagnillo M, Musikant BL, Deutsch AS. Comparison of the retentive and photoelastic properties of two prefabricated endodontic post systems. J Oral Rehabil 1999; 26: 488-94.
9. Qualtrough AJ, Chandler NP, Purton DG. A comparison of the retention of tooth-colored posts. Quintessence Int 2003; 34: 199-201.
10. Standlee JP, Caputo AA, Hanson EC. Retention of endodontic dowels: effects of cement, dowel length, diameter, and design. J Prosthet Dent 1978; 39: 400-5.
11. Kurtz JS, Perdigao J, Geraldeli S, Hodges JS, Bowles WR. Bond strengths of tooth-colored posts, effect of sealer, dentin adhesive, and root region. Am J Dent 2003; 16 Spec No: 31A-36A.

12. Demiryurek EO, Kulunk S, Yuksel G, Sarac D, Bulucu B. Effects of three canal sealers on bond strength of a fiber post. J Endod 2010; 36: 497-501.
13. Ahmetoğlu F., Şimşek N., Yıldırım G., Polat T. Post materials in restoration of endodontically treated teeth. J Dent Fac Atatürk Uni 2014; 24: 153-7.
14. Naumann M, Sterzenbach G, Rosentritt M, Beuer F, Frankenberger R. Is adhesive cementation of endodontic posts necessary? J Endod 2008; 34: 1006-10.
15. Le Bell AM, Tanner J, Lassila LV, Kangasniemi I, Vallittu PK. Depth of light-initiated polymerization of glass fiber-reinforced composite in a simulated root canal. Int J Prosthodont 2003; 16: 403-8.
16. Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH. Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. J Endod 2005; 31: 584-9.
17. Rathke A, Haj-Omer D, Muche R, Haller B. Effectiveness of bonding fiber posts to root canals and composite core build-ups. Eur J Oral Sci 2009; 117: 604-10.
18. Radovic I, Mazzitelli C, Chieffi N, Ferrari M. Evaluation of the adhesion of fiber posts cemented using different adhesive approaches. Eur J Oral Sci 2008; 116: 557-63.
19. Dimitrouli M, Gunay H, Geurtsen W, Luhrs AK. Push-out strength of fiber posts depending on the type of root canal filling and resin cement. Clin Oral Investig 2011; 15: 273-81.
20. Cecchin D, Farina AP, Souza MA, Carlini-Junior B, Ferraz CC. Effect of root canal sealers on bond strength of fibreglass posts cemented with self-adhesive resin cements. Int Endod J 2011; 44: 314-20.
21. Cecchin D, Farina AP, Souza MA, Pereira Cda C. Effect of root-canal sealer on the bond strength of fiberglass post to root dentin. Acta Odontol Scand 2011; 69: 95-100.
22. Davis ST, O'Connell BC. The effect of two root canal sealers on the retentive strength of glass fibre endodontic posts. J Oral Rehabil 2007; 34: 468-73.
23. Hagge MS, Wong RD, Lindemuth JS. Effect of three root canal sealers on the retentive strength of endodontic posts luted with a resin cement. Int Endod J 2002; 35: 372-8.
24. Ozcan E, Capar ID, Cetin AR, Tuncdemir AR, Aydinbelge HA. The effect of calcium silicate-based sealer on the push-out bond strength of fibre posts. Aust Dent J 2012; 57: 166-70.
25. Perdigao J, Gomes G, Lee IK. The effect of silane on the bond strengths of fiber posts. Dent Mater 2006; 22: 752-8.
26. Goracci C, Tavares AU, Fabianelli A, Monticelli F, Raffaelli O, Cardoso PC, Tay F, Ferrari M. The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. Eur J Oral Sci 2004; 112: 353-61.
27. Goracci C, Grandini S, Bossu M, Bertelli E, Ferrari M. Laboratory assessment of the retentive potential of adhesive posts: a review. J Dent 2007; 35: 827-35.
28. Sudsangiam S, van Noort R. Do dentin bond strength tests serve a useful purpose? J Adhes Dent 1999; 1: 57-67.
29. Baldissara P, Zicari F, Valandro LF, Scotti R. Effect of root canal treatments on quartz fiber posts bonding to root dentin. J Endod 2006; 32: 985-8.
30. Teixeira CS, Pasternak-Junior B, Borges AH, Paulino SM, Sousa-Neto MD. Influence of endodontic sealers on the bond strength of carbon fiber posts. J Biomed Mater Res B Appl Biomater 2008; 84: 430-5.
31. Caicedo R, Alongi DJ, Sarkar NK. Treatment-dependent calcium diffusion from two sealers through radicular dentine. Gen Dent 2006; 54: 178-81.
32. Radovic I, Monticelli F, Goracci C, Vulicevic ZR, Ferrari M. Self-adhesive resin cements: a literature review. J Adhes Dent 2008; 10: 251-8.
33. Bitter K, Paris S, Pfuertner C, Neumann K, Kielbassa AM. Morphological and bond strength evaluation of different resin cements to root dentin. Eur J Oral Sci 2009; 117: 326-33.

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