Apical Leakage of Endodontic Posts Cemented with Adhesive Resin

Adeziv Rezinle Simante Edilen Endodontik Postların Apikal Sızıntısı

Banu Önal[1] H. Asuman Eroğlu[2] Ayşegül Kaya[1] Figen Sevgican[3]

[1] Ege Üniversitesi, Dişhekimliği Fakültesi, Diş Hastalıkları ve Tedavisi AD, Konservatif Diş Tedavisi BD, İzmir
[2] Acıbadem Hastanesi, Endodonti Bölümü, İstanbul, [3] Ege Üniversitesi, Dişhekimliği Fakültesi, Diş Hastalıkları ve Tedavisi AD, Endodonti BD, İzmir

Abstract

Objective: The aim of this study was to compare the apical dye leakage of the posts cemented with RelyX ARC resin cement or zinc phosphate cement.

Materials and Methods: Forty extracted human maxillary anterior teeth were instrumented and randomly divided into 4 groups of 10 roots each. The experimental groups were obturated as follows: Group 1, posts cemented with zinc phosphate cement; Group 2, posts cemented with RelyX ARC adhesive cement. Groups 3 and 4 were negative and positive control groups, respectively. After the post cementation, all samples were covered with two layers of nail varnish, with the exception of the apical 2 mm, the specimens were immersed in 2% methylene blue solution for 7 days at 37°C. The roots were sectioned vertically and dye penetration was evaluated using a stereomicroscope at x20 magnification. Leakage was measured independently by two evaluators in a blind-folded fashion.

Result: After dye penetration, more leakage was observed in the zinc phosphate group. Statistical analysis showed a significant difference between zinc phosphate and RelyX ARC groups ($p<0.05$).

Conclusion: This study demonstrated that posts cemented with RelyX ARC showed significantly less leakage than zinc phosphate group.

Keywords: Endodontic post cementation, resin cements, microleakage.

Özet

Amaç: *Bu çalışmada amaç, RelyX ARC rezin siman ve çinko fosfat siman kullanılarak simante edilen postlar çevresinde oluşan apikal sızıntıyı boya yöntemi kullanarak karşılaştırmaktı.*

Gereç ve Yöntem: *Kırk adet üst kesici diş, kanal tedavileri yapıldıktan sonra her biri 10 diş içerecek şekilde rastgele 4 gruba ayrıldı. Grupların dağılımı şöyledir: Post simantasyonu 1. grupta çinko fosfat siman ile; 2. grupta ise RelyX ARC adeziv siman ile yapıldı. Grup 3 ve 4 ise negatif ve pozitif kontrol gruplarını oluşturdu. Kanal içerisine postların yerleştirilmesini takiben, tüm örnekler apeksleri 2 mm açıkta kalacak şekilde iki kat tırnak cilası ile kaplandı ve %2'lik metilen mavisi solüsyonunda 7 gün bekletildi. Daha sonra vertikal olarak kesilen kök parçaları x20 büyütmede steromikroskopta 2 araştırmacı tarafından tek kör olarak değerlendirildi.*

Bulgular: *Yedi günlük boya penetrasyonu sonrasında çinko fosfat ile simante edilen 1. grupta daha fazla sızıntı gözlendi. İki grup arasındaki fark istatistiksel olarak da anlamlı bulundu ($p<0.05$).*

Sonuç: *Bu çalışmada; post simantasyonunda RelyX ARC kullanımının çinko fosfat simana oranla önemli derecede daha az sızıntıya yol açtığı gösterilmiştir.*

Anahtar sözcükler: *Endodontik post simantasyonu, rezin siman, mikrosızıntı.*

Kabul Tarihi: 13.02.2004

Introduction

Endodontically treated teeth often need a post and core as foundation for the final restoration[1]. The primary function of a post is to help provide resistance to horizontal fracture and to provide retention of the core that is necessary for restorative treatments.

Inadequate cementation of a post can result in the movement of oral fluids and microorganisms into voids in the obturated root canal and the induction of a periapical inflammatory reaction.[2] Therefore, the technique used for cementation of the post is regarded as an important factor for long-term clinical success.[3] Retention is not the only criterion for the selection of a suitable luting cement. It is important that the material should be insoluble and also prevent microleakage.[4] If the cement seal of the coronal restoration breaks down, leakage of fluid and microorganisms may extend to the post-tooth interface. Fatigue forces acting on the post and core generate microcraks within the cement. These cracks may coalesce to contribute to ultimate failure of the restoration. Microleakage at the interface of post and tooth may lead to failure of the root canal treatment and the development of apical periodontitis. It is for this reason that chemically active materials have been introduced as luting cements.[4]

A number of studies have investigated the effects of different cements around the posts on microleakage.[5-7] Although luting agents, including zinc phosphate, polycarboxylate, glass ionomer, and filled and unfilled resin cements have been investigated extensively, the literature does not consistently suggest that one is superior to another.[8]

While some clinical studies have shown a significant increase for post retention with resin cements,[9,10] others have not confirmed these findings.[8,11]

Bachicha *et al.*[12] observed that the use of different types of posts had no effect on microleakage. However, a significant difference in microleakage was recorded in relation to the different cements used to lute the posts. A material that bonds chemically to both the tooth structure and the metal from which the post is made has considerable advantages over those which rely entirely on mechanical means for retention.[8] Unlike the traditionally used zinc phosphate cement, the adhesive cements have the bonding potential between the inner surface of the canal and the metal post.[13] Fogel[6] reported less microleakage around posts cemented with resin cements compared with those cemented with zinc phosphate or glass ionomer cements. Nevertheless, evaluation of the microleakage results with a fluid filtration system showed that none of the post/cement combinations tested was capable of consistently achieving a fluid tight seal.[14] A similar result was reported by Tjan *et al*[15], who used dental adhesives of the second generation and found that all teeth showed leakage.

There are two potential problems with the use of resin agents as a luting agent for posts: They are technique-sensitive because of their short working time and they are more adversely affected by improper root canal preparation than other cements.[8] According to the activation mode, resin cements are usually divided in three groups: chemically-activated (self_cured), photo-activated and dual-cured cements.[16] Braga *et al.*[17] found that dual-cure cements had greater bond strength values than the chemically activated cements.

RelyX™ ARC (3M, St Paul, Minn.) adhesive resin cement is a permanent, dual-cure, paste-paste resin cement developed to be used with the Single Bond (3M™) dental adhesive system. Used in this combination, the system is indicated for bonding direct restorations and for endodontic post cementation.

RelyX ARC resin cement provides a dual-cure system that has approximately 2 minute working time. It has a self-cure set time of 10 minutes from the start to mix. The material can also be light cured to accelerate the set time of the reaction for applications where light is accessible to the cement. RelyX ARC resin cement contains a new polymeric component dimetacrylate polymer that modifies the rheology or handling of the material.

The goal of this *in vitro* study was to compare the apical dye leakage of posts cemented with RelyX ARC resin cement or zinc phosphate cement.

Materials and Methods

Forty, freshly extracted, permanent human maxillary anterior teeth with mature root apices were used in this study. The teeth were cleaned from attached

debris with a sharp knife and stored in distilled water containing thymol crystals in the room temperature until use. To facilitate instrumentation and to standardize the working length, the anatomic crowns of all teeth were sectioned horizontal to the long axis, at the cemento-enamel junction, with the use of a water-cooled diamond fissure bur (ISO size 014) in a high speed hand piece. The root canals were prepared chemomechanically. Gates-Glidden drills (Maillefer, Ballaigues, Switzerland) with ISO sizes 070 and 090 were used to obtain straight-line access in the coronal and the middle third of all specimens. The working length was determined by placing a size 10 K- type file (Kerr Sybron, Romulus, MI) until it was first seen at the apical foramen and then 1 mm was subtracted from this length. Silicone stoppers were placed around the file shaft to control the working length of the files. Step-back preparation of the root canals was performed by using 15 to 45 K-type files. A size 30 file was used as MAF to establish the apical stop. The instrument was used with a half turn reaming action until the file became loose with in the canal. Step-back flaring of the canal was performed using larger files at 1 mm intervals manipulated in a filling action. The file used to prepare the apical stop was used to recapitulate. Step-back preparation was completed after the use of three files larger than the file used to prepare the apical stop. Two milliliters of freshly prepared 5.25% of sodium hypochlorite (NaOCl) was used as the irrigation solution after each file. When the preparation was completed, each canal was finally irrigated with 10 ml of 5.25% NaOCl. The root canals were dried with paper points and obturated using lateral compaction of gutta-percha and AH26 eugenol-free sealer (DeTrey; Konstanz, Germany). The depth of the post space was 2/3 of the total working length leaving 4 mm of root canal filling in the apical portion of the root canal. In post space preparation, the coronal part of the root filling was removed by using a heated plugger. The post spaces were irrigated again with the same disinfecting solutions used during root canal preparation.

ER system pure titanium posts were used in this study. Root canals were prepared with the assorted instruments of the size 1 Titanium posts (Komet, Germany) before the cementation of the posts immediately after the obturation. The roots were then randomly divided into 4 groups of 10 root each; two experimental groups and two control groups.

In group 1, the posts were cemented with zinc phosphate cement (SS White, NJ, USA). The posts in group 2 were cemented with an adhesive system (Single Bond Dental Adhesive System) and dual-polymerizing resin (RelyX ARC) according to the manufacturers' instructions.

A small amount of the cement mix was picked up on a lentulo spiral and introduced into the post space with a slow-speed handpiece. After the cement is placed in the canal, the post is coated with the same luting agent and inserted.

All samples were coronally sealed with a direct composite restorative material (3M Valux Plus) and the roots of the experimental groups were coated with two layers of nail varnish (Ellen Betrix 193, Betrix, Frankfurt, Germany) exception of the apical 2 mm and allowed to dry. The positive control samples were instrumented as previously described and left unobturated. The entire root of the negative controls was completely coated with the nail varnish to ensure the blocking of the penetration of the dye. After 1 hour of drying, all specimens were then apically immersed in 2% methylene blue dye solution (pH 6.8) (Fisher Scientific, Fairlawn, NY) in individual glass vials. All glass containers were placed in an incubator at 37°C for 7 days. After this period, the specimens were rinsed for 25 minutes under tap water and nail varnish was removed with a razor blade and the teeth were soaked in acetone for 1 h to remove residues of nail polish.

Two opposing longitudinal grooves were made into the dentin on the root surfaces and the roots were split with a hammer and a chisel. Dye penetration of each half specimen was evaluated independently by two examiners using a stereomicroscope (Bausch and Lomb, Inc., Rochester, NY) at x20 magnification. Dye penetration was measured from the apex to the most coronal extent of dye visible on the filling material or root canal walls, and scoring was made as follows:

Score 0 : leakage <0.4cm.
Score 1 : leakage between 0.4 and 1.0 cm.
Score 2 : leakage>1.0cm.

A non-parametric ANOVA test (Kruskal-Wallis) was used to determine if there was any significant difference among the groups. Pair of groups was then compared using Mann Whitney-U test.

Results

The apical leakage results of the four groups are listed in Table 1. Statistical analysis indicated a significant difference between zinc phosphate group and RelayX ARC group ($p<0.05$). More leakage was observed in the zinc phosphate group. Positive controls demonstrated dye penetration throughout the length of the root canals, whereas there was no dye leakage in the negative control teeth.

Table 1. Apical leakage scores of the groups.

Groups		Apical Leakage Score		
		0	1	2
1	Rely X ARC	6	4	0
2	Zinc phosphate	0	5	5
3	Negative Control	0	0	0
4	Positive Control	0	0	10

Discussion

Leakage studies include colored dye penetration, bacterial leakage, analysis of radiolabeled tracer penetration, dissolution of hard tissue, clearing of teeth, spectrometry of radioisotopes, electrochemical methods and gas chromatography. Among these methods, dyes are most commonly preferred since this is simple to use, cheap, safe, easy to handle and widely available.[18] The oral environment, however, has many variables and is much more complex than a simple dye leakage test. Shearing, rotational and cyclical forces are also placed on teeth and restorations. Temperature changes, as well as other factors, may affect the properties of cement materials. Although the clinical relevance of dye leakage studies has been questioned, microleakage tests can evaluate the ability of materials to prevent fluid penetration. The leakage marker used in this study was methylene blue, because of its comparable leakage to butyric acid, which is a metabolic product of microorganisms,[19] and its low molecular weight, enabling deeper penetration along root-canal filling.[19]

However, during scoring, 4 mm from the root tip was excluded from evaluation, and the leakage was determined from that level above. This procedure may have a blurring effect in final determination of leakage since the absence of leakage in the apical 4 mm does not provide the same effect of the luting cement. When there was leakage in the apical 4 mm of root canal treatment, the sealing ability of the luting cement was investigated. On the contrary, when the reserve condition was present, it was hard to speculate that the luting cement was efficient in prevention of leakage.

Methods and timing of post space preparation may influence future microleakage. Haddix *et al.*[20] compared the use of heated pluggers, Gates-Glidden drills and GPX instruments as post space preparation tools. Significantly less leakage was observed when the heated plugger technique was used. This may be explained by the additional vertical condensation effect achieved through the use of heated pluggers.

Delayed post space preparation procedure may damage the sealer which has set in the apical root canal, thus damaging the apical seal.[21] Performing post space preparation immediately after root canal obturation but before the sealer cement sets may, however, mean that the apical seal remains intact.[21] Fan *et al.*[21] showed that delayed post space preparation resulted in more leakage than immediate preparation, which was in agreement with the results in previous studies.

Most apical portion of the root canal filling serves as the only barrier against penetration of microorganisms that may cause periapical inflammation. It has been demonstrated that longer filling provides a better seal.[19,22] Although the length of the post within the root canal may vary, the apical 4 mm of the root canal filling material should not be disturbed.[12]

Zinc phosphate and resin cements formulated for luting have excellent flow. Placing the luting agent both in the canal with a lentulo spiral and onto the post is the recommended method to achieve a dense cement film and therefore, a well-cemented post.[3] This process may have to be expedited because some of the resin luting agents have short working times compared with zinc phosphate. Due to short working time, resin cements may set before the post is fully sealed if placed in the post space first. Dual-cured cements were developed to

conciliate favorable characteristics of self-cured and photo-activated cements. The rationale was to have a material with expended working time and capable of reaching a high degree of conversion either in the presence or absence of light.[17]

The results of our study demonstrated that posts cemented with RelyX ARC showed significantly less leakage than zinc phosphate group. A similar study also showed more dye leakage in the zinc phosphate cement group at the post-cement interface and in the cement layer of the post.[15]

The zinc phosphate cement tested had a tendency to trap air, which left voids between the post and cement as well as within the bulk of the cement. Voids provide a weak link that may make the material more subject to microleakage and adhesive failure. Even if higher bond strengths are not required for the retention of the post, endodontic failure due to microleakage may require retreatment of the tooth.[43]

Caputo and Standlee[24] stated that posts are needed to allow the clinician to rebuild enough tooth structure to retain restorations. The price for added retention, however, may be increased risk of damaged tooth structure. In this respect, some current literature still disputes the reinforcement potential of posts.[25-27] No consensus existed on which technique and materials are best suited for use.[28]

The introduction of new resinous cements has provided an opportunity to improve the success rate of post endodontic restorations. However, because of the inordinate number of dental cements marketed, each cement should be carefully evaluated to allow selection of a cement with the greatest post retention. The success of these restorations depends on many factors, and this study provided one of the pertinent information.

Conclusion

This study demonstrated that titanium posts cemented with RelyX ARC showed significantly less leakage than the ones with zinc phosphate.

References

1. Koutayas SO, Kern M. All-ceramic posts and cores: The state of the art. *Quintessence Int* 1999; 30: 383-392.
2. Ari H, Yasar E, Belli S. Effect of NaOCl on bond strengths of resin cements to root canal dentin. *J Endod* 2003; 29: 248-251.
3. Ferrari M, Mannocci F. A 'one-bottle' adhesive system for bonding a fibre post into a root canal: an SEM evaluation of the post-resin interface. *Int Endod J* 2000; 33: 397-400.
4. Saunders WP. Restoration of the root filled tooth. In: Essential Endodontology. 8th ed. Padstow, Cornwall, 2002: 331-366.
5. Wu M-K, Pehlivan Y, Kontakiotis EG, Wesselink PR. Microleakage along apical root fillings and cemented posts. *J Prosthet Dent* 1998; 79: 264-269.
6. Fogel HM. Microleakage of posts used to restore endodontically treated teeth. *J Endod* 1995; 21: 376-379.
7. Madison S, Zakariasen KL. Linear and Volumetric analysis of apical leakage in teeth prepared for posts. *J Endod* 1984; 10: 422-427.
8. Stockton LW. Factors affecting retention of post systems: A literature review. *J Prosthet Dent* 1999; 81: 380-385.
9. Goldstein GR, Hudis SI, Weintraub DE. Comparison of four techniques for the cementation of posts. *J Prosthet Dent* 1986; 55: 209-211.
10. Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. *Endod Dent Traumatol* 1985; 1: 108-111.
11. Mendoza DB, Eakle WS, Kahl EA, Ho R. Root reinforcement with a resin-bonded preformed post. *J Prosthet Dent* 1997; 78: 10-14.
12. Bachicha WS, DiFiore PM, Miller DA, Lautenschlager EP, Pashley DH. Microleakage of endodontically treated teeth restored with post. *J Endod* 1998; 24: 703-708.
13. Miller BH, Nakajima H, Powers JM, Nunn ME. Bond strength between cements and metals used for endodontic posts. *Dent Mater* 1998; 14: 312-320.
14. Mannocci F, Ferrari M, Watson TF. Microleakage of endodontically treated teeth restored with fiber posts and composite cores after cyclic loading: a confocal microscopic study. *J Prosthet Dent* 2001; 85: 284-291.
15. Tjan AH, Tjan AH, Greive JH. Effects of various cementation methods on the retention of prefabricated posts. *J Prosthet Dent* 1987; 58: 309-313.
16. Braga RR, Cesar PF, Gonzaga CC. Mechanical properties of resin cements with different activation modes. *J Oral Rehabil* 2002; 29: 257-262.

17. Braga RR, Ballester RY, Daronch M. Influence of time and adhesive system on the extrusion shear strength between feldspathic porcelain and bovine dentin. *Dent Mater* 2000; 16: 303-310.

18. Chong BS, Pitt Ford TR, Watson TF, Wilson RF. Sealing ability of potential retrograde root filling materials. *Endod Dent Traumatol* 1995; 11: 264-269.

19. Hiltner RS, Kulild JC, Weller RN. Effect of mechanical versus thermal removal of gutta-percha on the quality of the apical seal following post space preparation. *J Endod* 1992; 18: 451-454.

20. Haddix JE, Mattison GD, Shulman CA, Pink FE. Post preparation techniques and their effect on the apical seal. *J Prosthet Dent* 1990; 64: 515-519.

21. Fan B, Wu M-K, Wesselink PR. Coronal leakage along apical root fillings after immediate and delayed post space preparation. *Endod Dent Traumatol* 1999; 15: 124-126.

22. DeCleen MJ. The relationship between the root canal filling and post space preparation. *Int Endod J* 1993; 26: 53-58.

23. Heling I, Gorfil C, Slutzky H, Kopolovic K, Zalkind M, Slutzky-Goldberg I. Endodontic failure caused by inadequate restorative procedures: Review and treatment recommendations. *J Prosthet Dent* 2002; 87: 674-678.

24. Caputo AA, Standlee JP. Pins and posts-why, when and how. *Dent Clin North Am* 1976; 20: 299-311.

25. Guzy GE, Nicholls JI. In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. *J Prosthet Dent* 1979; 42: 39-44.

26. Akkayan B, Canikoglu B. Resistance to fracture of crowned teeth restored with different post systems. *Eur J Prosthodont Restor Dent* 1998; 6:13-18.

27. Sornkul E, Stannard JG. Strength of roots before and after endodontic treatment and restoration. *J Endod* 1992; 18: 440-443.

28. Creugers NH, Mentink AG, Kayser AF. An analysis of durability data on post and core restorations. *J Dent* 1993; 21: 281-284.

Yazışma Adresi:

Prof. Dr. Banu ÖNAL

Ege Üniversitesi, Dişhekimliği Fakültesi,
Diş Hastalıkları ve Tedavisi AD,
35100 – Bornova / İZMİR
Tel : (232) 388 03 28
Faks : (232) 388 03 25
E-posta : bonal@bornova.ege.edu.tr