Retention of fiber posts to the optimally and over-prepared dowel spaces

Hesham Ibrahim Othman[1,2], BDS, MS, PhD, Mohamed Ibrahim Elshinawy[3,4], BDS, MS, PhD, Khalid Mohamed Abdelaziz[4]*, BDS, MS, PhD

[1]Department of Prosthodontics, Faculty of Dentistry, Al-Azhar University, Cairo, Egypt

[2]Department of Prosthodontics, College of Dentistry, King Khalid University, Abha, Saudi Arabia

[3]Department of Endodontics, Faculty of Dentistry, Tanta University, Tanta, Egypt

[4]Department of Restorative Dental Sciences, College of Dentistry, King Khalid University, Abha, Saudi Arabia

PURPOSE. To assess the retention of glass fiber post cemented with self-adhesive resin cement into optimum and over-prepared root canals following obturation in the presence of either eugenol (EB) or calcium hydroxide (CB)-based sealers. **MATERIALS AND METHODS.** Roots of extracted premolars were endodontically-treated in 5 groups (n = 10). Roots of Group 1 (control) were left with no obturation and then optimally prepared to receive endodontic dowels. Other root canals were obturated with gutta-percha in the presence of either eugenol-based (Groups 2 and 4) or calcium hydroxide-based (Groups 3 and 5) sealer. Dowel spaces were prepared with optimal diameter in Groups 2 and 3, one size larger in Groups 4 and 5. Standardized fiber posts were luted to the prepared spaces using self-adhesive resin cement and itsretention was then tested on an universal testing machine. Both one-way ANOVA and Tukey's HSD comparisons (α=0.05) were used to identifythe significance of inter-group retention differences. Scanning electron microscopy (SEM) of both optimally and over-prepared dowel spaces was also considered to figure the nature of their interior out. **RESULTS.** The post retention was significantly higher to the non-obturated, optimally-prepared dowel spaces of Group 1 compared to the obturated, optimally-prepared ones of Groups 2 and 3. For each dowel space diameter, root canals obturated using CB of Groups 3 and 5 showed significantly higher dowel retention compared to those obturated using EB of Groups 2 and 4. Post retention to the over-prepared dowel spaces of Groups 4 and 5 was significantly higher than that recorded for the optimally-prepared ones of Groups 1-3. SEM images revealed traces of endodontic sealer and gutta-percha on the walls of the optimally-prepared dowel spaces. **CONCLUSION.** Despite the adverse effect of endodontic sealers on the retention of fiber posts, the over-preparation of dowel spaces helps to improve the retention. ***[J Adv Prosthodont 2013;5:16-20]***

KEY WORDS: Dowel space; Fiber post; Endodontic sealer; Retention; Resin cement; Over-preparation

INTRODUCTION

Using endodontic post iscurrently a routine procedure in restoring massively-destructed teeth.[1] Although this approach requires extra cutting within the already weakened tooth structure, the advances in adhesive dentistry helps to minimize its drawbacks.[2-4] Failure of this kind of restorative treatments is usually considered when the tooth root fractures or the post itself loses its retention.[5] In a step to minimize that failure, several manufacturers introduced the fiber-reinforced composite posts and many researchers[6-8] reported high clinical durability of teeth restored with those posts. The recorded success of fiber post isusually referred to its elastic modulus, which matches its root dentin, minimizing the concentration of stressand reducings the incidence of root fracture accordingly.[9]

Some factors such as; post type and design, post space preparation, type of the luting cement and the cementa-

Corresponding author:
Khalid Mohamed Abdelaziz
Department of Restorative Dental Sciences, Faculty of Dentistry, King Khalid University, PO Box. 3263, Abha 61741, Saudi Arabia
Tel. 96672418044: e-mail, bedie001@yahoo.com
Received October 1, 2012 / Last Revision January 3, 2013 / Accepted January 17, 2013

tion procedures can seriously affect the retention of the post.[7,9,10] The use of adhesive cementation would also improve the post retention and roots' fracture resistance in spite of the expected interference of the endodontic procedure and materials with the adhesion of resin-based cements.[11-13] The self-etching and self-adhesive resin cements have recently been introduced aiming to simplify the cementation procedure and to save both dentist and patients' time.[14,15] Some *in vitro* studies indicated acceptable retentive and sealing performance of those self-adhesive cements in comparison to other typesutilizing separate acid-etch adhesive system.[15,16]

Previous studies proved that the type of root canal sealer affects the retention of endodontic posts.[17,18] Although some researchers[19] reported that fiber posts obtained the highest bond strength to roots obturated using calcium hydroxide-based sealers, others[20,21] did not recognize that privilege. Instead, they noticed no difference in post retention to root canals sealed with either eugenol or calcium hydroxide-based sealers.

Based on the aforementioned literature, the effect of luting cement and root canal sealer on the retention of endodontic post have been extensively examined, but only few studies did focus on the influence of cement thickness and the role of over-preparing the dowel spaces in offsetting the expected adverse effect of sealers.[22-24] Therefore, the present *in vitro* study aimed to assess the retention of glass fiber post cemented with self-adhesive resin cement with optimally and over-prepared root canals, following obturation with gutta percha, in presence of either eugenol (EB) or calcium hydroxide (CA)-based sealers.

MATERIALS AND METHODS

Fifty freshly-extracted (for orthodontic purposes), single-rooted, caries and crack-free premolars were considered after all hard and soft deposits has been cleaned. Every tooth were disinfected in 5.25% sodium hypochlorite for 8 h, washed up under running tap water and incubated in normal saline solution at 37 ± 1℃ until their use. The coronal portion of each tooth was cut off 2 mm above the cervical line using a double-sided diamond disc (Edenta AG, AU/SG, Switzerland) mounted to a low-speed handpiece under copious water coolant. The roots were gently notched along their sides using size 169L high-speed carbide bur to help their retention to self-cured acrylic cylinders (Technovit 4000; Heraeus Kulzer, Hanau, Germany) 3 cm in diameter and height. These cylinders aided the handling of roots at the time of root canal preparation and helped their attachment and orientation into the metal jig of the testing machine at the time of retention testing (Fig. 1). Dental surveyor (Degussa-Ney, Yucaipa, CA, USA) was used to help centralize and ensure vertical positioning of the roots into the acrylic mass. All root canals were endodontically prepared using Pro-taper (Dentsply Maillefer, Ballalgues, Switzerland) rotary endodontic system following the adjustment of coronal access. The prepared teeth were then classified randomly into 5 groups (n = 10) relative to the following protocol and before obturating the root canals:

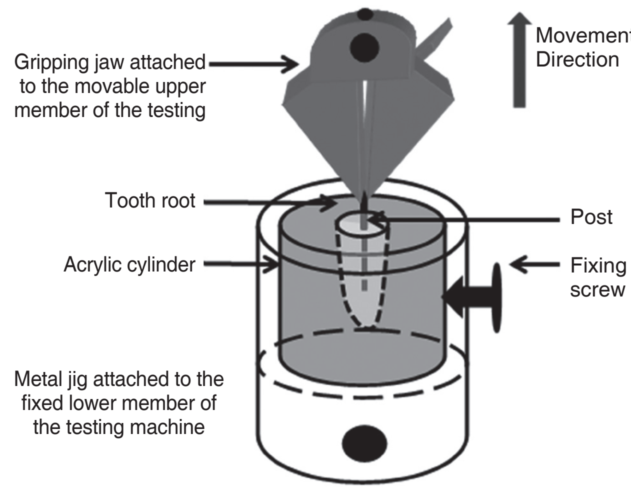

Fig. 1. Schematic drawing showing the attachment and orientation of test specimen at the time of retention testing.

In group 1 (control), the prepared root canals were left with no obturation. Standardized 10 mm deep dowel spaces were prepared to the optimum diameter using RelyX Fiber Post sequential drills (3M ESPE, St. Paul, MN, USA) sizes 0, 1 and 2 with diameters of 1.1, 1.3, 1.6 mm. In groups 2 and 3, the prepared canals were obturated using laterally-condensed gutta percha in presence of eugenol and calcium hydroxide-based sealers (Endofil, Promedica, Neumünster, Germany and Sealapex Xpress, Kerr Corp, Orange, CA, USA) and left to set for 24 h before drilling in, to create dowel spaces having the same criteria listed above. Root canals of groups 4 and 5 were also obturated following the same protocol of groups 2 and 3; however, the dowel spaces were prepared one size larger (size 3, 1.9 mm in diameter) than that of the post to be cemented. Dentin surfaces of all the prepared dowel spaces were subjected to 1 min chemical treatment using 17% EDTA and then irrigated with distilled water before cementing size 2 (1.6 mm in diameter) RelyX Fiber Post (3M ESPE, St. Paul, MN, USA) by the aid of Rely-X Unicem (3M ESPE, St. Paul, MN, USA) self-adhesive resin cement.

The prepared dowel spaces were dried with absorbent paper point (Sure-endo, Suredent Co, Gyeonggi-do, Korea). The self-adhesive RelyX Unicem cement aplicap (3M ESPE, St. Paul, MN, USA) was automatically activated for 15s using CapMix amalgamator (3M ESPE, St. Paul, MN, USA) and introduced deeply into the prepared dowel spaces by the aid of the elongation tips and following the manufacturer's recommendation. The selected posts were then inserted, twisted slightly and pushed apically with the hand pressure to reach the deepest point of the preparation. The excess cement was removed using an explorer and the exposed cement surfaces were cured using LED light curing unit (LEDition, Ivoclar Vivadent, Schaan, Liechtenstein) for 40 s.

All roots were incubated in distilled water at 37 ± 1℃ for 24 h before testing the posts' retention on an universal testing machine (WP 300 universal material tester, G.N.U.T Gerätebau GmbH, Fahrenberg, Germany) running at a crosshead speed of 0.5 mm/min. All specimens were mounted vertically in a special metal jig to ensure vertical dowel dislodgement. The bared post lengths were gripped with a metal jaw attached to the moving upper member of the testing machine (Fig. 1) and stressed on tension until the post has been completely detached. The maximum forces at dislodgement were recorded in Newton (N) and subjected to statistical analysis using both 1-WAY ANOVA and Tukey's HSD comparisons (α=0.05) to stand on the significance of differences detected between different test groups.

Some extra specimens were specifically prepared to examine the interiors of the prepared dowel spaces. Four endodontically-treated tooth roots with optimally and over-prepared dowel spaces (n = 2) were sectioned for scanning electron microscope (SEM) examination. One root from each category was horizontally sectioned 3 mm below the Cement-enamel junction to show roots' cross section. The other 2 roots were vertically hemi-sectioned to show roots' longitudinal section. The cut surfaces were then smoothened up with 220-800 grit sandpapers (Wetordry, 3M Collision Repair, St. Paul, MN, USA), sputter-coated with gold and examined at ×22 using JEOL SEM (JCM-5000, NeoScope, JEOL Ltd, Tokyo, Japan).

RESULTS

Table 1 summarizes the results of dowel dislodgement for all test groups. Statistical analysis of the recorded results revealed significant differences among the tested groups. The retention values of dowels cemented to optimally-prepared spaces prepared in obturated canals were lower than those recorded for the non-obturated canals. (Tukey's comparisons, P<.05, for Groups 1-3). However for each dowel space diameter, root canals of groups 3 and 5 obturated using calcium hydroxide-based sealer showed higher dowel retention in comparison to those obturated using eugenol-based sealer in groups 2 and 4 (Tukey's comparisons, P<.05). The retention of fiber dowels to the enlarged root canal spaces (Groups 4 and 5) was significantly higher than that recorded for dowels cemented to the optimally-prepared root canal spaces of groups 1-3.

SEM images (Figs. 2 and 3) revealed some traces of both gutta-percha and endodontic sealer on the interior walls of both optimally and over-prepared dowel spaces. However, the incidence of these traces was higher with optimally-prepared dowel spaces case the, and root canal irregularities were mostly located with over-prepared case. Walls of the irregularity-free, over-prepared dowel spaces did not show any of the sealer or gutta-percha traces.

Table 1. Mean dowels' dislodging forces

Test groups (n = 10)		Dislodging force (N)
1	No sealer-optimum dowel space (Control)	247.15 ± 10.4[a]
2	Eugenol-based sealer, optimum dowel space	184.29 ± 10.3[b]
3	Calcium hydroxide-based sealer, optimum dowel space	222.56 ± 11.1[c]
4	Eugenol-based sealer, enlarged dowel space	273.73 ± 10.2[d]
5	Calcium hydroxide-based sealer, enlarged dowel space	300.51 ± 6.8[e]

Different superscripts indicate the significance of differences between the test groups

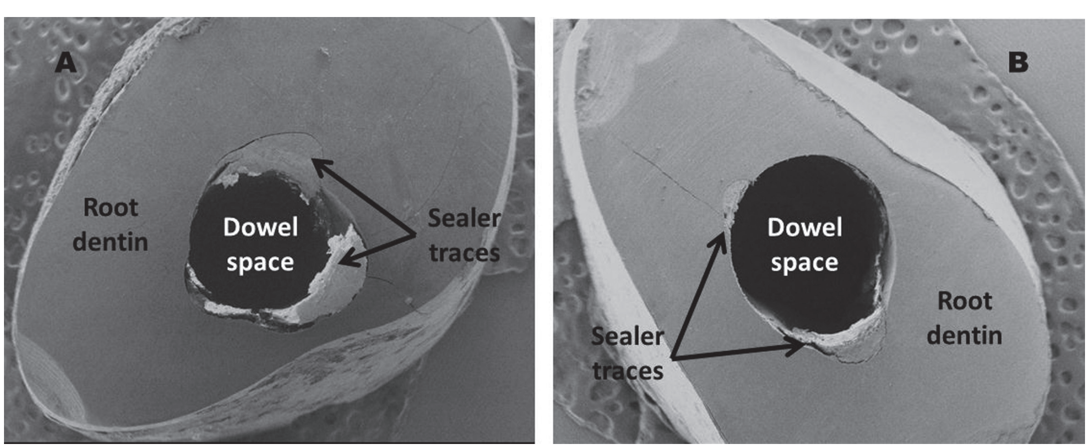

Fig. 2. SEM of roots' cross-section following optimal (A) and over (B) preparation of dowel spaces.

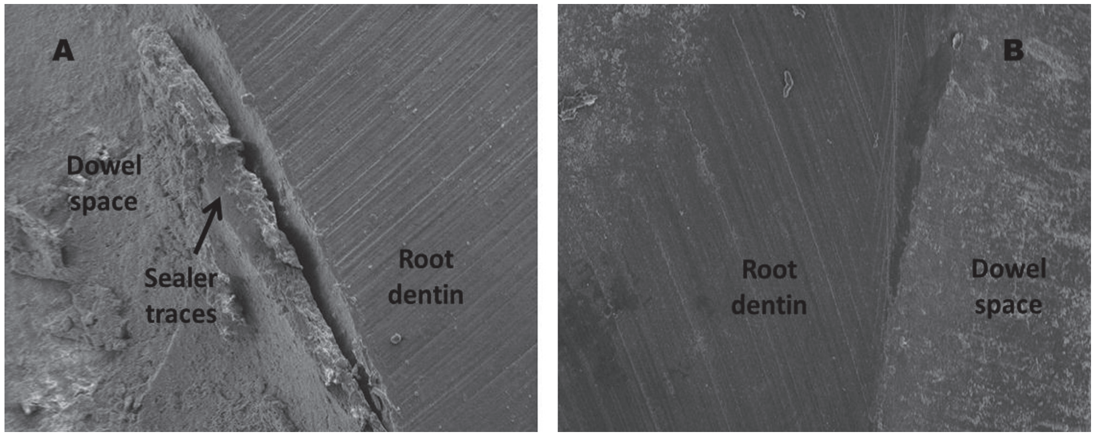

Fig. 3. SEM of roots' longitudinal-section following optimal (A) and over (B) preparation of dowel spaces.

DISCUSSION

The clinical durability of teeth restored with post-core-crown system is known to be a multifactorial situation in which post retention plays an important role. Although, the effect of root canal sealers on the retention of root canal dowels have been examined in previous studies, their influence in over-prepared dowel spaces has not hitherto been confirmed.[7,19,22]

The current study assessed the retention of endodontic fiber posts cemented to optimally and intentionally over-prepared dowel spaces of obturated root canals using different types of sealers. In comparison to the non-obturated canals, Results of this study confirmed the adverse effect of root canal sealers on the resistance of post dislodgementof optimally-prepared dowel spaces. These finding matches those of some previous studies[19] and could be referred to the possible contamination of root canal dentin with sealer remains, which limits the intimate contact with the self-etch, self-adhesive resin cement also reducing its retentive quality. However, the adverse effect of calcium hydroxide based-sealer on post retention seemed to be minimal when compared to that of eugenol-based sealer regardless the diameter of dowel spaces. The presence of free eugenol contaminant on dentinal walls and within the dentinal tubules may inhibit the polymerization of the resin-based cement; this would reduce its bonding quality to dentin.[17-19] These results came in agreement with some previous studies[11,12,14,15,25] and disagreement with others[17,18] that utilized new generations of dentin bonding systems.

Regardless the type of sealer used at the time of root canals obturation, the increase in dowel space diameter and cement's film thickness were associated with an increase in dowel's resistance to dislodgement. This finding could be referred to the lower incidence of air inclusions at the dowel-cement-dentin interfaces which is reflected positively on the bonding surface area. The minimal incidence of air inclusion is the normal result of the expected reduction in the hydrostatic pressure developed at the time of dowel insertion. On the other hand, the limited increase in cement's thickness has also been proved to have no significant reflection on the value of the contraction stresses encountered as a result of cement's polymerization.[26] These factors are supported with some previous studies.[27-30] However, others come in contrary.[25] The contamination of dentinal walls with some traces of both sealer and gutta-percha used at the time of root canal obturation was more obvious in the photomicrographs of the optimally-prepared dowel spaces (Figs. 2 and 3). These traces once more reduce the cement-dentin area of contact and their chemicals deteriorate the polymerization of the resin-based cement. The aforementioned findings surely support the outcomes of this study, however the retention of fiber posts cemented to the over-prepared dowel spaces together with the resistance of roots to fracture are still in need for further assessment following thermocycling and cyclic loading.

CONCLUSION

In spite of the adverse effect of endodontic sealers on the retention of fiber posts to root canals, the over enlargement of dowel spaces improves that retention when self-adhesive resin cement is used for luting.

REFERENCES

1. Erdemir A, Ari H, Güngüneş H, Belli S. Effect of medications for root canal treatment on bonding to root canal dentin. J Endod 2004;30:113-6.
2. Sahafi A, Peutzfeldt A, Asmussen E, Gotfredsen K. Bond strength of resin cement to dentin and to surface-treated posts of titanium alloy, glass fiber, and zirconia. J Adhes Dent 2003;5:153-62.
3. Ari H, Yaşar E, Belli S. Effects of NaOCl on bond

strengths of resin cements to root canal dentin. J Endod 2003;29:248-51.
4. Wachlarowicz AJ, Joyce AP, Roberts S, Pashley DH. Effect of endodontic irrigants on the shear bond strength of epiphany sealer to dentin. J Endod 2007;33:152-5.
5. Bergman B, Lundquist P, Sjögren U, Sundquist G. Restorative and endodontic results after treatment with cast posts and cores. J Prosthet Dent 1989;61:10-5.
6. Ferrari M, Vichi A, Mannocci F, Mason PN. Retrospective study of the clinical performance of fiber posts. Am J Dent 2000;13:9B-13B.
7. Ferrari M, Vichi A, García-Godoy F. Clinical evaluation of fiber-reinforced epoxy resin posts and cast post and cores. Am J Dent 2000;13:15B-18B.
8. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. Int J Prosthodont 2003;16:39-44.
9. Duret B, Duret F, Reynaud M. Long-life physical property preservation and postendodontic rehabilitation with the Composipost. Compend Contin Educ Dent Suppl 1996: S50-6.
10. Stockton LW. Factors affecting retention of post systems: a literature review. J Prosthet Dent 1999;81:380-5.
11. Balbosh A, Ludwig K, Kern M. Comparison of titanium dowel retention using four different luting agents. J Prosthet Dent 2005;94:227-33.
12. Gerth HU, Dammaschke T, Züchner H, Schäfer E. Chemical analysis and bonding reaction of RelyX Unicem and Bifix composites-a comparative study. Dent Mater 2006;22:934-41.
13. Zicari F, Couthino E, De Munck J, Poitevin A, Scotti R, Naert I, Van Meerbeek B. Bonding effectiveness and sealing ability of fiber-post bonding. Dent Mater 2008;24:967-77.
14. Wang VJ, Chen YM, Yip KH, Smales RJ, Meng QF, Chen L. Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test. Dent Mater 2008;24:372-7.
15. Cantoro A, Goracci C, Vichi A, Mazzoni A, Fadda GM, Ferrari M. Retentive strength and sealing ability of new self-adhesive resin cements in fiber post luting. Dent Mater 2011;27:e197-204.
16. Bateman GJ, Lloyd CH, Chadwick RG, Saunders WP. Retention of quartz-fibre endodontic posts with a self-adhesive dual cure resin cement. Eur J Prosthodont Restor Dent 2005;13:33-7.
17. 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.
18. Menezes MS, Queiroz EC, Campos RE, Martins LR, Soares CJ. Influence of endodontic sealer cement on fibreglass post bond strength to root dentine. Int Endod J 2008;41: 476-84.
19. Demiryürek EO, Külünk S, Yüksel G, Saraç D, Bulucu B. Effects of three canal sealers on bond strength of a fiber post. J Endod 2010;36:497-501.
20. Burns DR, Moon PC, Webster NP, Burns DA. Effect of endodontic sealers on dowels luted with resin cement. J Prosthodont 2000;9:137-41.
21. 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.
22. Boone KJ, Murchison DF, Schindler WG, Walker WA 3rd. Post retention: the effect of sequence of post-space preparation, cementation time, and different sealers. J Endod 2001;27:768-71.
23. McMichen FR, Pearson G, Rahbaran S, Gulabivala K. A comparative study of selected physical properties of five root-canal sealers. Int Endod J 2003;36:629-35.
24. Al-Omiri MK, Rayyan MR, Abu-Hammad O. Stress analysis of endodontically treated teeth restored with post-retained crowns: A finite element analysis study. J Am Dent Assoc 2011;142:289-300.
25. 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.
26. Hagge MS, Wong RD, Lindemuth JS. Effect of dowel space preparation and composite cement thickness on retention of a prefabricated dowel. J Prosthodont 2002;11:19-24.
27. Alster D, Venhoven BA, Feilzer AJ, Davidson CL. Influence of compliance of the substrate materials on polymerization contraction stress in thin resin composite layers. Biomaterials 1997;18:337-41.
28. D'Arcangelo C, Cinelli M, De Angelis F, D'Amario M. The effect of resin cement film thickness on the pullout strength of a fiber-reinforced post system. J Prosthet Dent 2007;98:193-8.
29. Cecchin D, Farina AP, Souza MA, Carlini-Júnior 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.
30. Aksornmuang J, Nakajima M, Senawongse P, Tagami J. Effects of C-factor and resin volume on the bonding to root canal with and without fibre post insertion. J Dent 2011;39:422-9.