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Microleakage along Glassix glass fibre posts cemented with three different materials assessed using a fluid transport system

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Abstract

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Aim To evaluate the microleakage along Glassix fibre posts cemented with three different materials.

Methodology The root canals of maxillary central incisor teeth were filled and restored with Glassix posts (Harald Nordin sa, Chailly/Montreux, Switzerland) cemented with either a zinc-phosphate Harvard cement (Richter & Hoffmann, Harvard Dental GmbH, Berlin, Germany), Fuji PLUS cement (GC Corporation, Tokyo, Japan) or Variolink II cement (Vivadent, Schaan, Lichtenstein) in three groups of 15 canals each. Twenty unrestored canals served as a control group, 10 filled with gutta-percha and sealer (negative control group), the remaining 10 with gutta-percha only (positive control group). Coronal microleakage was evaluated using a fluid transport system. The movement of an air bubble in a capillary glass tube connected to the apex of the experimental root section was measured over 5-min periods. Measurements were performed four times for each specimen and the mean values recorded. ANOVA and Duncan's test were performed.

Results The positive control group had the highest values of microleakage. Amongst experimental groups, the highest values of microleakage occurred in the group with the posts cemented with Harvard cement, followed by Fuji PLUS and Variolink II cements. Groups with Fuji PLUS, Variolink II and the negative control group had significantly ($P < 0.00001$) less microleakage compared with the Harvard cement group and the positive control group.

Conclusion Canals with Glassix posts cemented with Variolink II and Fuji PLUS cement had the least leakage when assessed using a fluid transport system.

Keywords: coronal microleakage, fluid transport system, Glassix glass fibre posts.

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Introduction

The prognosis of root-filled teeth can be improved by restoring them as soon as possible after the completion of root canal treatment (Fox & Gutteridge 1997, Heling *et al.* 2002). The purpose of a post-and-core system is to make a unit from several different materials: tooth structure, post material, core build-up material and luting cement. This system must be a sealed unit (Fogel 1995) that can resist cyclic chewing forces (Sorensen & Engelman 1990, Raygot *et al.* 2001). The interfaces of the various materials or tissues are the sites of possible leakage (Fogel 1995), but the air entrapped in a luting cement could also be the way for oral fluids and microorganisms to pass along the root and into the periradicular tissues (Wu *et al.* 1998).

It is recognized that the seal achieved by a coronal restoration is as important for the prognosis of root-filled teeth as the apical seal (Khayat *et al.* 1993, Bachicha *et al.* 1998). If the coronal seal is disrupted, the remaining apical root filling that is normally 3–5 mm

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in length may not be a sufficient barrier to apical leakage. It is known that microorganisms in canals proliferate (Sjögren & Sundqvist 1987) and it may take only a few days for bacteria to pass through the remaining apical filling (Torabinejad *et al.* 1990, Miletić *et al.* 2002). One of the important factors in evaluating the success of a post-and-core system is microleakage from the canal space (Bachicha *et al.* 1998). Recent studies (Fogel 1995, Bachicha *et al.* 1998, Mannocci *et al.* 2001, Görgül *et al.* 2002, Reid *et al.* 2003) reported microleakage of root-filled teeth restored with different posts and different luting cements.

In considering microleakage of a post-and-core system, the following factors are considered to be relevant (Šegović *et al.* 2003):

1. Morphology of canal system.
2. Post space preparation.
3. Type of intracanal post and material for core buildup.
4. Type of luting cement.
5. Manipulation technique with the material.
6. Luting process.
7. Clinical conditions (contamination of the post space with saliva.)
8. Removal of the sealer or temporary restorative material from the post space.
9. Location of the tooth in the dental arch.

Glassix glass fibre composite posts (Harald Nordin sa) (Fig. 1) provide strength with superior aesthetics for use in anterior restorations (http://www.nordin-dental.com/top_products.htlm). The manufacturer claims these posts have comparable elasticity, hardness and shear resistance to the natural tooth structure (http://www.nordin-dental.com/top_products.htlm). Glass fibre is a braided plait in a multi-axial arrangement giving better resistance to bending and torsion forces than fibres in an ordinary axially parallel arrangement. The glass fibre provides resilient that has the potential to prevent fracture and reduce the transmission of stress to the dentine; it has approximately the same elasticity as dentine (http://www.nordin-dental.com/top_products.htlm).

Zinc-phosphate cement does not adhere to the tooth structure, whereas glass–ionomer forms chemical bonds with tooth structure (Mount & Bryant 1998). Using resin as a cementing agent will provide adhesive bonding within the root canal space with polymer dentine-bonding agents and resin cement of similar flexibility (Duret *et al.* 1996, Mount & Bryant 1998).

The aim of this study was to evaluate the microleakage along Glassix fibre posts cemented with Harvard, Fuji PLUS and Variolink II cements using a fluid transport system.

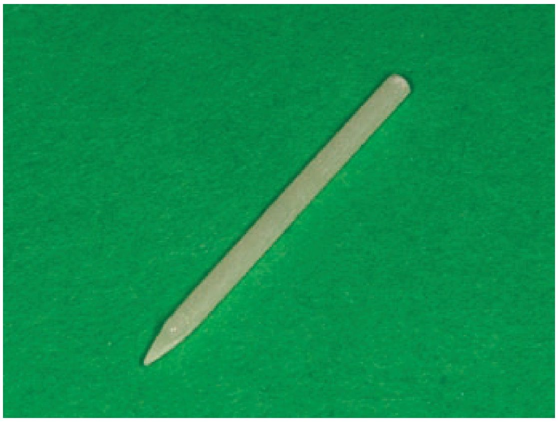

Figure 1 Glassix glass fibre post.

Materials and methods

Sixty-five extracted human maxillary central incisors stored in 10% formalin (the time of storage was unknown) were selected according to similarities in size and shape. After mechanical cleaning, the teeth were stored in sterile isotonic saline solution with thymol crystals (SIGMA Ltd., Poole, UK) at 100% humidity and 37 °C (Miletić *et al.* 2002). The clinical crowns of the specimens were sectioned at the cemen-to-enamel junction using a diamond bur with water-cooling spray. To ensure that all specimens were of the same length, the teeth were then resected 15 mm from the apex. Their canals were instrumented using the stepback technique to a size 40 K-reamer at the apical stop, with a serial stepback up to a size 80 K-reamer (Maillefer, Ballaigues, Switzerland).

All specimens were placed into a nontransparent bag and randomly allocated into five groups (three experimental and two control groups). During cleaning and shaping, canals were irrigated with 2 mL of 2.5% sodium hypochlorite (NaOCl) solution between each reamer, using a syringe and a 27-gauge needle. After completion of the preparation, 10 mL of 2.5% NaOCl was used. Canals were dried with paper points (META Dental Corp., Seoul, Korea) and filled using the cold lateral condensation technique with gutta-percha cones (Diadent Group International, Inc., Chongju City, Korea) and AH Plus (Dentsply De Trey GmbH, Konstanz, Germany), except for the second control group in which canals were filled with gutta-percha

Table 1 The microleakage values for the experimental and control groups

Group	Number of observations	Mean ± mean error	SD	Min	Max	Coefficient of variation (CV%)
Fuji PLUS cement	15	0.85 ± 0.14	0.55	0.21	2.05	64.72
Harvard cement	15	1.96 ± 0.13	0.49	0.95	2.65	24.98
Variolink II cement	15	0.71 ± 0.06	0.25	0.20	1.25	34.99
Gutta-percha + sealer	10	1.03 ± 0.08	0.26	0.55	1.50	25.43
Gutta-percha only	10	2.06 ± 0.09	0.28	1.50	2.50	13.53

cones without sealer. Size 25 gutta-percha cones served as accessory cones for lateral condensation. Excess gutta-percha was removed with a heated hand instrument, and specimens without temporary fillings (Devčić *et al.* 2005) were stored in sterile isotonic saline solution at room temperature for 2 weeks. Radiographs of the root-filled teeth were exposed from two directions to confirm the quality of the root fillings.

Experimental groups, each containing 15-treated canals, were all prepared in the same manner except a different cement for post cementation was used in each group. The coronal portions of the filled canals were prepared using a special reamer for Glassix posts No. 3 (Harald Nordin sa) to a depth of 11 mm; 4 mm of the gutta-percha remained as the apical filling. Glassix posts were cemented with Fuji PLUS (GC Corporation), Harvard zinc-phosphate cement (Richter & Hoffmann) or Variolink II cements (Vivadent) according to the manufacturers' instructions in three experimental groups of 15 canals each. The group where specimens were cemented with Fuji PLUS was numbered as group 1, with Harvard cement as group 2 and with Variolink II cement as group 3. One type of luting cement was used to cement 15 posts in one experimental group, followed by the next luting cement in the next experimental group. Two control groups consisted of 20 unrestored canals. The first control group (group 4, negative control) included 10 unrestored canals filled with gutta-percha cones and AH Plus sealer. The second control group (group 5, positive control) included 10 unrestored canals filled with gutta-percha cones without sealer.

To allow the materials to set, all roots were stored at 100% humidity and 37 °C for the next 48 h. The lateral surfaces of the roots were then coated with two layers of nail varnish (Wu *et al.* 1998).

Coronal leakage was evaluated using a fluid transport system (Wu *et al.* 1994). The ends of a resin T-tube were warmed and fitted to the root end, the syringe and the capillary tube and then the connections were glued with cyanoacrylate glue. The seals were checked under water by placing the system under air pressure from the end of the capillary. A plastic tube filled with deionized water was connected to the coronal end of the filled root. This connection was closed tightly by twisting a piece of stainless-steel wire (diameter 0.3 mm). Water was sucked back with the syringe for the approximately 3 mm in the opened end of the glass capillary and then connected to a piece of plastic tube filled with water. In this way, an air bubble was created in the capillary. Applying a head-space pressure of 10 kPa (0.1 atm) from the coronal side of the filled root forced the water through the voids along the root canal filling, displacing the air bubble in the capillary tube by transport of water. The volume of transported fluid was measured by observing the movement of the air bubble over 5-min periods. Measurements were performed four times for each specimen, and the mean values were recorded. ANOVA and Duncan's test were performed.

Results

Table 1 presents the microleakage values for the experimental and control groups.

Microleakage occurred in all specimens.

The positive control group (canals obturated with gutta-percha cones only) exhibited the highest values for microleakages, whilst specimens with Variolink II cement exhibited the lowest microleakage values. In the experimental specimens, the greatest microleakage occurred in canals in which Glassix posts were cemented with Harvard cement followed by Fuji PLUS and Variolink II cements.

The highest coefficient of variation (CV %) within the groups tested was in the experimental group with Fuji PLUS. The lowest coefficient of variation was in the positive control group.

According to Duncan's test, the microleakage in groups 1, 3 and 4 (Fuji PLUS, Variolink II and gutta-percha/sealer) was significantly different when compared with two and five (Harvard and gutta-percha only) ($P < 0.00001$).

Discussion

In this study, posts were cemented in canals previously filled with gutta-percha and sealer, imitating the clinical situation. None of the materials tested achieved a fluid-tight seal, as fluid movement occurred in all of the specimens. The post-and-core systems in which Glassix posts were cemented with Variolink II and Fuji PLUS exhibited the lowest microleakage values. Harvard zinc-phosphate cement demonstrated the most microleakage, other than the positive control group; zinc-phosphate does not adhere to the tooth structure (Mount & Bryant 1998).

Specimens with glass–ionomer Fuji PLUS cement showed the highest coefficient of variation (CV%) within the group, whilst Fuji PLUS and Harvard cement groups had the largest differences between minimal and maximal microleakage values. Standard deviation values were relative large compared with the mean values because of relatively small number of specimens.

Several factors could affect microleakage of posts systems including some variables that could be only controlled partly by the operator: morphology of canal system, the volume of prepared root canals, presence and character of the smear layer, the distribution of sealer, the condensation of gutta-percha cones (Wu *et al.* 1993), incomplete removal of sealer from intracanal post space (Macchi *et al.* 1992), luting process, distribution of cement in post space and operator error (Wu *et al.* 1993, Fogel 1995). Furthermore, the patency of dentinal tubules (Wu *et al.* 1993), dentine surface area of the canal walls and the remaining dentine thickness (Fogel *et al.* 1987) could affect microleakage.

Bachicha *et al.* (1998) compared fluid filtration microleakage along stainless-steel posts and carbon-fibre posts cemented with different materials and reported statistically different values for microleakage between the cements. Zinc-phosphate cement had the most microleakage, whereas C & B Metabond cement had the least. There was no significant difference in microleakage between the stainless-steel and carbon-fibre posts. In the present study, zinc-phosphate (Harvard) cement exhibited the highest mean value of leaking supporting previous findings (Bachicha *et al.* 1998).

Fogel (1995) intended to evaluate the microleakage of various post systems using a fluid filtration procedure. The post systems tested were stainless-steel posts cemented with zinc-phosphate cement, polycarboxylate cement, a composite resin, a composite resin after use of dentine-bonding agent and composite resin after the use of a dentine conditioner and dentine-bonding agent. None of the post core systems tested was capable of consistently achieving a fluid-tight seal.

Reid *et al.* (2003) evaluated the effect of fatigue testing on microleakage of metallic posts cemented with zinc-phosphate cement and four types of nonmetallic posts cemented with a resin cement. The metallic post group had significantly more leakage when compared with the nonmetallic post groups. The trial was performed using a new nondestructive test system, which could test concurrently fatigue and microleakage.

In the present study, a fluid transport method was used to determine microleakage along the Glassix post systems. In several studies, microleakage along filled root canals has been determinated by penetration of tracers (dyes or radioisotopes), microorganisms or by ion passage using an electrochemical technique (Wu & Wesselink 1993). Capillary action and diffusion of tracer as well as ion transport and movement of nonmotile bacteria are affected negatively by entrapped air (Goldman *et al.* 1989, Spångberg *et al.* 1989, Wu *et al.* 1993). The fluid transport system for measuring root filling leakage is a modified version of Pashley's model system for determining leakage around coronal restorations and fluid transport through dentinal tubules (Pashley *et al.* 1987). It is a technique that could eliminate problems with entrapped air (Wu *et al.* 1994). One of advantages of this system is a possibility of repeated measuring of the same samples through different time periods (Wu *et al.* 1995).

Conclusion

None of the luting cements achieved a seal. Variolink II and Fuji PLUS cement exhibited significantly less fluid movement compared with the zinc-phosphate Harvard cement.

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