Comparison of coronal bacterial leakage between immediate versus delayed post-space preparation in root canals filled with Resilon/Epiphany

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Abstract

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Aim To compare the sealing ability of Resilon/EpiphanyTM after immediate versus delayed post-space preparation using an *ex vivo* bacterial leakage model.

Methodology Eighty extracted, decoronated, singlerooted human maxillary teeth were randomly divided into two experimental groups and two control groups (n = 20). Root canals were prepared in a standard manner with Sequence nickel–titanium rotary files to a final apical size of 50, .06 taper. Root canals in the experimental groups were filled with Resilon/EpiphanyTM using a warm vertical compaction technique. In group 1, the post-space was prepared immediately and in group 2 the post-space was prepared 5 days later. Positive controls were filled with Resilon master cones without sealer. The negative controls were not obturated but the entire root surface including the orifices and foramina were sealed with fingernail polish. Leakage was examined at different time intervals using a dual-chamber bacterial microleakage model. The marker microorganism used was *Streptococcus mutans.*

Results All positive controls leaked within 3 days. All negative controls showed no leakage at each time interval. All experimental specimens leaked within 14 days. Statistical analysis showed that there was no difference in microleakage between the two experimental groups at each time interval.

Conclusion In this *ex vivo* study, there was no significant difference between immediate and delayed post-space preparation using Resilon/EpiphanyTM. Both groups failed to provide an adequate apical seal regardless of the timing of the post-space preparation.

Keywords: endodontics, post-space, Resilon/Epiphany.

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Introduction

After completion of the root canal treatment, post and core restorations are frequently needed when there is inadequate coronal tooth structure to retain a crown. During the creation of the post-space, it is important not to disrupt the integrity of the remaining filling material that is providing the apical seal. Post-space preparation associated with gutta-percha root fillings has been studied extensively (Kwan & Harrington 1981, Madison & Zakariasen 1984, Fan *et al.* 1999, Solano *et al.* 2005). The timing of the postspace preparation in canals filled with gutta-percha continues to be debated. Several articles claim that delayed post-space preparation in root canals filled with gutta-percha results in more apical leakage when compared to immediate post-space preparation (Kwan & Harrington 1981, Madison & Zakariasen 1984, Solano *et al.* 2005). This has been the result regardless of which of the following root canal sealers were used with the gutta-percha: Grossman's sealer (Kwan & Harrington 1981), AH26 (Madison & Zakariasen

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1984), Pulp Canal Sealer (Madison & Zakariasen 1984), or AH Plus (Solano *et al.* 2005).

Resin bonded root canal filling materials have been suggested as alternatives to gutta-percha. Resilon (Resilon Research, LLC, Madison, CT, USA) is a thermoplastic synthetic polymer-based root filling material. It has handling properties similar to guttapercha and may be softened with heat. The sealer used with Resilon is Epiphany Root Canal Sealant (Pentron Clinical Technologies, Wallingford, CT, USA), which is a dual curable dental composite resin sealer (Shipper et al. 2004, Stratton et al. 2006). Biggs et al. (2006) and Onay et al. (2006) reported that Epiphany sealer with a Resilon core, hereafter referred to as Resilon/ Epiphany, did not demonstrate superior sealing properties when compared to gutta-percha used with AH Plus sealer. If Resilon/Epiphany is chosen as the root canal filling material, it will also need to be removed if space needs to be created for a post and core restoration.

The purpose of this study was to compare the ability of Resilon/Epiphany to maintain an apical seal after immediate versus delayed post-space preparation using an *ex vivo* bacterial leakage model. The null hypothesis is that immediate or delayed post-space preparation will not affect the seal provided by the Resilon/EpiphanyTM material remaining in the apical portion of the root canal system.

Materials and methods

Sample preparation

Eighty extracted human maxillary anterior teeth with single straight roots were stored in sterile water. The roots were examined with an operating microscope (Global Surgical Corp., St Louis, MO, USA) at 12× magnification to eliminate teeth with cracks. The selected teeth were decoronated so that a standardized root length of 16 mm was obtained. Using the operating microscope, patency was established using a size-10 K-file (Dentsply Maillefer, Tulsa, OK, USA) and the working length was determined by extruding the size-10 K-file beyond the apical foramen and then retracting it until it was 0.5 mm short of the foramen. The root canal of each tooth was then instrumented to a final apical size of 50, .06 taper using EndoSequence Rotary instruments (Brasseler USA, Savannah, GA, USA) to the established working length. The teeth were irrigated with 5 mL of 3% sodium hypochlorite (The Clorox Company, Oakland, CA, USA) after the use of each file size. Following instrumentation the canals were cleaned with 17% EDTA (Benco Dental, Wilkes-Barre, PA, USA) followed by sterile water per the manufacturer's instructions.

The prepared roots were randomly divided into four groups (n = 20 per group). In groups 1 and 2, a size-50, .06 taper Resilon master cone was fitted into the canal with tug-back to within 0.5 mm of the working length. According to the manufacturer's instructions, a paper point was placed to length, primer was applied. and then the point wicked the primer to the apex. The excess primer was removed with paper points and the Resilon master cone, coated with Epiphany sealer, was seated into the root canal. A System B (SybronEndo, Orange, CA, USA) heat source at 150 °C and a power setting of 10 was used to downpack the Resilon and an Obtura II (Obtura Spartan, Fenton, MO, USA) unit with thermoplasticized Resilon was used to backfill the canal. The Obtura II was set to 160 °C per manufacturer's instructions and the thermoplasticized Resilon was delivered into the root canal through a 23-gauge needle.

For group 1, the post-space was created immediately after canal filling. A System B unit with a .06 tapered tip was used to remove the coronal 6 mm and Gates Glidden drills (Roydent, Johnson City, TN, USA) at 9000 rpm were used to remove the remaining Resilon/ Epiphany to a depth that left 4 mm of the material in the apical portion of the root canal (Solano *et al.* 2005). For group 2, the teeth were placed in 100% humidity at 37 °C for 5 days to assure final set of the sealer. At the end of the 5 days, the post-space was created as described for group 1. For group 3 (positive control) the 20 root canals were filled with a size-50, .06 taper Resilon master cone fitted to tug-back, but with no Epiphany sealer. The cone was not down-packed. The 20 teeth in group 4 (negative control) were instrumented and no filler material was placed. The teeth were completely sealed with fingernail polish (Pink Diamond Shine, Sally Hansen, Uniondale, NY, USA).

Bacterial leakage model

Two coats of fingernail polish were applied to each root, leaving the apical 2 mm and coronal canal orifice clear. A hole was created in the screw cap of a 20 mL scintillation vial (Sigma-Aldrich Co., St. Louis, MO, USA). Each root was then placed through the hole in the cap so that the root end extended about 14 mm into the glass vial. Rapid-setting cyanoacrylate (Krazy Glue, Columbus, OH, USA) as well as quick setting

Orthodontic Resin powder and liquid (Dentsply Caulk, Milford, DE, USA) were used to seal any gaps that existed between the root and the screw cap opening. The caps with the attached roots were then screwed onto the vials. Each apparatus was then autoclaved using standard steam sterilization. After autoclaving the glass vials were filled with Brain Heart Infusion broth (Sigma-Aldrich Co.). The caps, with the roots fixed in place, were seated into the glass vials so that the root end was completely immersed in the broth. Ten microlitres of Streptococcus mutans culture (ATCC, Manassas, VA, USA) was then introduced into the prepared post-space. To ensure viability of the bacteria, each root canal was flushed with sterile water twice a week to remove the contents and then the space was re-inoculated with 10 µL of fresh S. mutans. Bacterial leakage was considered to be complete when the Brain Heart Infusion broth exhibited turbidity. The samples were inspected for turbidity 3, 7, 10, 14 and up to a maximum of 28 days after the start of the experiment.

A Fisher's exact test was used to compare the experimental groups at each time interval. The alpha level for significance was set at P = 0.05.

Results

All positive controls showed leakage within 3 days in contrast to the negative controls, which showed no leakage at any time period. All of the experimental samples demonstrated bacterial leakage within 14 days (Table 1). The result of the Fisher's exact test revealed that there was no significant difference between the two experimental groups at any time period examined (P > 0.05). As a result, the null hypothesis is not rejected at $\alpha = 0.05$ level.

Discussion

In this study, *S. mutans*, a facultative anaerobic bacterium, was used to test leakage. This model was successfully used in a Resilon leakage study reported by Shipper *et al.* (2004). In their study there was mini-

Table 1 Results of two experimental groups

Post-space preparation	Number (percentage) of leaking speci- mens			
	Day 3	Day 7	Day 10	Day 14
Immediate $(n = 20)$	0 (0)	5 (25)	14 (70)	20 (100)
Delayed $(n = 20)$	1 (5)	10 (50)	18 (90)	20 (100)
<i>P</i> -value	0.5	0.095	0.118	1.0

mum leakage over a 31-day period in roots obturated with Resilon/Epiphany using either lateral compaction or the continuous wave technique and *S. mutans* as the bacterial marker. The major difference from the present study was that post-space was not created in any of their samples and therefore the length of the root fillings tested in their study was at least twice that in the present study.

Shemesh *et al.* (2006) compared two different experimental models when measuring leakage along root fillings with or without a smear layer; fluid transport and glucose penetration. In one of the experimental groups, Resilon and Epiphany were used as root filling materials. The coronal portion of the filling was removed leaving only 4 mm of it in the canal as per the present study. The results of their experiment showed that glucose penetrated 90% of Resilon fillings within 14 days. (Shemesh *et al.* 2006).

As its inception Resilon has been studied using several different leakage models and the results have been contradictory (Biggs et al. 2006, Onay et al. 2006, Pitout et al. 2006, Raina et al. 2007, Tunga & Bodrumlu 2006, Verissimo et al. 2007). To date there is only one article available that reported that the timing of post-space preparation affected the root canal seal in canals filled with Resilon/Epiphany (Bodrumlu et al. 2007). Bodrumlu et al. (2007) reported that there was significantly more leakage when the post-space was created immediately versus when post-space was created 1 week later. The present study, which found no significant difference in leakage with regard to the timing of the post-space preparation in root canals filled with Resilon/Epiphany, differs in several ways from that study. The root canals in the present study were prepared to a size-50, .06 taper rotary Sequence file size and filled using the warm vertical compaction, thermoplasticized backfill method versus a final hand file size-40, 0.02 taper and lateral compaction filler method in the other study. Bacterial leakage was measured over a 28-day period in the current study as opposed to measurement of leakage with a fluid-transport system over one 3-h period in the previous study. There is no mention in the study of Bodrumlu et al. (2007) of the actual number of samples in each group, which leaked, only the mean quantitative leakage for each group is reported. Any one or combination of these factors could explain the difference in results between the two studies.

The bacterial penetration model used in this study has its own inherent limitations. It provides qualitative rather than quantitative results. This model only assessed whether there was turbidity created. From this result, it was concluded that there was bacterial leakage. But, even if only one bacterium leaked through the filled canal, it has the ability to multiply in the broth and hence cause turbidity (Chailertvanitkul *et al.* 1997). The number of bacteria penetrating through the filled canals was not measured; thus the measurements were not quantified by numbers of bacteria penetrating the filled canals.

In cases filled with gutta-percha where the post-space preparation has been delayed, it has been reported that the use of Gates-Glidden burs may result in the loss of the seal between the root canal sealer and root canal wall (Goodacre & Spolnik 1995, Schwartz & Robbins 2004). Theoretically the same could occur when the post-space preparation is delayed in cases filled with Resilon/ Epiphany material. Again, in theory, if the post-space is created prior to the complete setting of the sealer, the result should be less leakage because the sealer would less likely be disturbed during the removal of the excess Resilon core with heat and rotary instruments.

In the present study, there was no significant difference in the number of specimens that exhibited leakage whether the post-space was created immediately or if the space was created 5 days later. In this ex vivo model the results show that a true monoblock was not achieved in either situation. Skidmore et al. (2006) reported that, even though it is weak, bonding does occur between Resilon/Epiphany and dentine. Other studies have concluded that the interfacial strength and adaptation achieved with Resilon/Epiphany to intraradicular dentine was not superior to that existing with other filling materials (Gesi et al. 2005, Perdigão et al. 2007). Tay et al. (2005) provided an explanation as to why Resilon monoblocks may leak. During polymerization, shrinkage stresses are relieved by the 'move and flow' of the unbonded surface. 'As the unbonded surface area becomes small, as in long narrow root canals, there is insufficient stress relief by flow and a high probability that one or more bonded areas will pull off or debond (Tay et al. 2005)'. It has been shown by others (Fisher et al. 2007, Sly et al. 2007) that the push-out bond strength of gutta-percha with AH 26 or AH Plus to intraradicular dentine was greater than that achieved with the Resilon/Epiphany filling system.

Conclusions

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The results of this *ex vivo* study demonstrated that there was no significant difference in leakage between the roots with immediate post-space preparation compared to those where post-space preparation was delayed

when Resilon/Epiphany was used as the root canal filing material. Regardless of the timing of the postspace preparation, all experimental specimens leaked within 14 days. These results suggest that in this model there was a failure of the Resilon/Epiphany to create or maintain a true 'monoblock' during the post-space preparation procedure.

References

- Biggs SG, Knowles KI, Ibarrola JL, Pashley DH (2006) An in vitro assessment of the sealing ability of Resilon/Epiphany using fluid filtration. *Journal of Endodontics* **32**, 759–61.
- Bodrumlu E, Tunga U, Alacam T (2007) Influence of immediate and delayed post space preparation on the sealing ability of Resilon. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **103**, e61–4.
- Chailertvanitkul P, Saunders WP, Saunders EM, MacKenzie D (1997) An evaluation of microbial coronal leakage in the restored pulp chamber of root-canal treated multirooted teeth. *International Endodontic Journal* **30**, 318–22.
- Fan B, Wu MK, Wesselink PR (1999) Coronal leakage along apical root fillings after immediate and delayed post space preparation. *Endodontics and Dental Traumatology* 15, 124–6.
- Fisher MA, Berzins DW, Bahcall JK (2007) An in vitro comparison of bond strength of various obturation materials to root canal dentin using a push-out test design. *Journal of Endodontics* **33**, 856–8.
- Gesi A, Raffaelli O, Goracci C, Pashley DH, Tay FR, Ferrari M (2005) Interfacial strength of Resilon and gutta-percha to intraradicular dentin. *Journal of Endodontics* **31**, 809–13.
- Goodacre CJ, Spolnik KJ (1995) The prosthodontic management of endodontically treated teeth: a literature review. Part III. Tooth preparation considerations: review. *Journal of Prosthodontics* 4, 122–8.
- Kwan EH, Harrington GW (1981) The effect of immediate post preparation on apical seal. *Journal of Endodontics* 7, 325–9.
- Madison S, Zakariasen KL (1984) Linear and volumetric analysis of apical leakage in teeth prepared for posts. *Journal* of Endodontics 10, 422–7.
- Onay EO, Ungor M, Orucoglu H (2006) An in vitro evaluation of the apical sealing ability of a new resin-based root canal obturation system. *Journal of Endodontics* **3**, 976–8.
- Perdigão J, Lopes MM, Gomes G (2007) Interfacial adaptation of adhesive materials to root canal dentin. *Journal of Endodontics* **33**, 259–63.
- Pitout E, Oberholzer TG, Blignaut E, Molepo J (2006) Coronal leakage of teeth root-filled with gutta-percha or Resilon root canal filling material. *Journal of Endodontics* **32**, 879–81.
- Raina R, Loushine RJ, Weller N, Tay FR, Pashley DH (2007) Evaluation of the quality of the apical seal in Resilon/ Epiphany and gutta-percha/AH Plus-filled root canals by using a fluid filtration approach. *Journal of Endodontics* 33, 944–7.

- Schwartz RS, Robbins JW (2004) Post placement and restoration of endodontically treated teeth: a literature review. *Journal of Endodontics* **30**, 289–301.
- Shemesh H, Wu MK, Wesselink PR (2006) Leakage along apical root fillings with and without smear layer using two different leakage models: a two-month longitudinal *ex vivo* study. *International Endodontic Journal* **39**, 968– 76.
- Shipper G, Orstavik D, Teixeira FB, Trope M (2004) An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). *Journal of Endodontics* **30**, 342– 7.
- Skidmore LJ, Berzins DW, Bahcall JK (2006) An in vitro comparison of the intraradicular dentin bond strength of Resilon and gutta-percha. *Journal of Endodontics* **32**, 963– 6.
- Sly MM, Moore BK, Platt JA, Brown CE (2007) Push-out bond strength of a new endodontic obturation system (Resilon/ Epiphany). *Journal of Endodontics* **33**, 160–2.

- Solano F, Hartwell G, Appelstein C (2005) Comparison of apical leakage between immediate versus delayed post space preparation using AH Plus sealer. *Journal of Endodontics* 31, 752–4.
- Stratton RK, Apicella MJ, Mines P (2006) A fluid filtration comparison of gutta-percha versus Resilon, a new soft resin endodontics obturation system. *Journal of Endodontics* 32, 642–5.
- Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH (2005) Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. *Journal of Endodontics* **31**, 584–9.
- Tunga U, Bodrumlu E (2006) Assessment of the sealing ability of a new root canal obturation material. *Journal of Endodontics* **32**, 876–8.
- Verissimo DM, Sampaio do Vale M, Monteiro AJ (2007) Comparison of apical leakage between canals filled with gutta-percha/AH-Plus and the Resilon/Epiphany system, when submitted to two filling techniques. *Journal of Endodontics* **33**, 291–4.

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