Coronal Sealing Ability of a New Root Canal Filling Material

Emre Bodrumlu, *DDS, PhD;* ***Umut Tunga,*** *DDS, PhD*

Contact Author

Dr. Bodrumlu
Email: bodrumlu@omu.edu.tr

ABSTRACT

Background and Objective: To date, many different materials have been proposed for root canal fillings, but gutta-percha (used with various types of sealers) has remained the material of choice for over a century. A new root canal obturation system, the Epiphany endodontic obturation system, has been developed to replace gutta-percha and traditional sealers for root canal obturation. The purpose of this study was to evaluate the coronal sealing ability of the new endodontic obturation system.

Materials and Methods: Seventy-two maxillary and mandibular single-rooted human teeth extracted for periodontal reasons were used. The root canals were instrumented using the step-back technique and were irrigated with 5.25% sodium hypochlorite. The smear layer was removed by washing in 10 mL of 17% ethylenediamine tetra-acetic acid (EDTA). The specimens were randomly divided into 3 groups (group 1 to be filled with gutta-percha and AH 26 sealer, group 2 with gutta-percha and AH plus sealer, and group 3 with Epiphany self-etch sealer and Resilon obturating material) and obturated by lateral condensation. Teeth were centrifuged at 30*g* for 5 minutes in 2% methylene blue dye solution to allow evaluation of any coronal leakage. The tooth roots were longitudinally grooved with a diamond disk and split with a chisel. Dye penetration was measured from the coronal to the apical part of the root canal using a stereomicroscope with ocular micrometer, and the mean leakage value for each group was calculated and recorded.

Results: The 6 positive control specimens had total dye penetration of the root canal system, whereas the 6 negative control teeth had no dye penetration into the roots. All of the experimental groups demonstrated some degree of coronal leakage. Coronal leakage was greatest in the teeth filled with gutta-percha and AH 26 sealer and least in teeth treated with Epiphany sealer and Resilon core material. These differences in coronal leakage were statistically significant ($p < 0.05$).

Conclusion: All of the root canal filling materials tested in this evaluation yielded a satisfactory seal; however, the Epiphany root canal filling system exhibited the least coronal leakage.

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Obturation of the root canal is an essential part of endodontic treatment and must be performed to the highest clinical standards.[1] The material chosen for root fillings is one of the critical determinants for the success or failure of endodontic treatment. The sealing properties of root canal filling materials constitute another important factor that can influence the success of treatment. Several in vitro experiments have demonstrated that some microorganisms can penetrate the coronal portion of root canal

fillings and eventually reach the apical region in some cases.[2,3] Hence, preventing coronal leakage is essential to the success of root canal treatment.[1]

To date, many different materials have been proposed for root canal fillings, but gutta-percha (used with various types of sealers) has remained the material of choice for over a century.[4,5] Many studies[6–8] have shown that this material cannot prevent leakage, even when used in conjunction with a sealer.

Various methods[9–13] have been used to evaluate the coronal sealing properties of root canal filling materials. The assessment of linear dye penetration apically or coronally is the most common in vitro method of examining the adaptation of a root filling to the canal walls, because of its sensitivity and ease of use.[14] The method is based on the supposition that the depth of dye penetration represents the gap between the root filling and the canal walls.

A new root canal obturation system, the Epiphany endodontic obturation system (Pentron Clinical Technologies, Wallingford, Conn.), has been developed to replace gutta-percha and traditional sealers for root canal obturation. The system uses Epiphany self-etch sealer in combination with Resilon, a thermoplastic synthetic polymer-based root-canal filling material. The Epiphany sealer is a dual-curable dental resin composite sealer.

The aim of this study was the in vitro evaluation of coronal leakage associated with the Epiphany endodontic obturation system.

Materials and Methods

Seventy-two maxillary and mandibular anterior human teeth with single, straight root canals were selected for this study. Roots with open apices, cracks and resorptive defects were excluded. The teeth were carefully cleaned with curettes to remove soft-tissue remnants and were stored in saline solution before instrumentation.

The crowns of the teeth were sectioned at the cementoenamel junction using water-cooled diamond disks. Canal length was visually established by placing a size 15 K-type file (Kerr, Romulus, Mich.) into each root canal until the tip of the file was visible at the tip of the apical foramen. The working length was established 1 mm short of the apex. The canal systems were instrumented to the working length with a size 40 K-type file using the step-back technique. The coronal third of each root was flared up to a 2-4 Gates Glidden bur (Dentsply, Maillefer, Switzerland) (ISO size 70-150) with a low-speed handpiece. The root canals were irrigated with 10 mL of 5.25% sodium hypochlorite (NaOCl) after each filing. The smear layer was removed by washing in 10 mL of 17% ethylenediamine tetra-acetic acid (EDTA) (Canal +, Septodont, Saint-Maur-des-Fossés, France) for 10 minutes, followed by 10 mL of 5.25% NaOCl. Finally, the root canals were flushed with 3 mL saline solution and dried with paper points.

The specimens were randomly divided into 3 equal groups of 20 samples each, with 6 teeth set aside as negative controls (filled with gutta-percha and sealer) and 6 set aside as positive controls (3 roots filled with gutta-percha without any sealer and 3 roots filled with Resilon core material without Epiphany sealer).

The roots in group 1 were filled by a lateral condensation technique with gutta-percha and AH 26 root canal sealer (Dentsply DeTrey GmbH, Konstanz, Germany); those in group 2 were filled by the same method with gutta-percha and AH plus sealer (Dentsply DeTrey GmbH). The roots in group 3 were prepared as follows. First, Epiphany bonding material was applied to the root canal, and excess bonding material was removed with paper points. Next, the Resilon master cone, coated with Epiphany sealer, was placed in the root canal according to the lateral condensation technique. The excess cone was cut off at the orifice level with a heated ball burnisher. Light-curing was applied for 40 seconds with a standard light-curing unit (Hilux, Ledmax-550, Benlioglu, Turkey), according to the manufacturer's instructions.

The root surfaces of teeth in these 3 groups were covered with 2 layers of nail varnish, except for the coronal 2 mm. The negative controls were entirely coated with 2 layers of nail varnish, and the positive controls were coated with 2 layers of nail varnish except for the coronal 2 mm.

After the filling process all samples were stored in saline solution at 37°C for 72 hours.

All specimens were centrifuged at 30*g* for 5 minutes in 2% methylene blue dye solution to allow evaluation of any coronal leakage. The specimens were washed under running tap water for 5 minutes. The tooth roots were longitudinally grooved with a diamond disk and split with a chisel, to verify that the root canal filling had not been penetrated, and were then split into halves by levering with a plaster knife. Dye penetration was measured from the coronal to the apical part of the root canal using a stereomicroscope with ocular micrometer, and the mean leakage value for each group was calculated and recorded. The data were then subjected to analysis of variance (ANOVA). Differences between materials were identified by Mann–Whitney *U* test.

Results

The 6 positive control specimens had total dye penetration of the root canal system, whereas the negative control teeth had no dye penetration into the roots. All of the experimental groups demonstrated some degree of coronal leakage (**Table 1**). The teeth for which Epiphany sealer was used (group 3) exhibited less coronal leakage (mean 1.4 mm; standard deviation [SD] 0.43) than the teeth filled with gutta-percha with the AH plus sealer

Table 1 Mean leakage and standard deviation (SD) for tested materials[a]

Material	Mean extent of leakage (mm)	SD
Group 1: Gutta-percha with AH 26 sealer	2.5	0.52
Group 2: Gutta-percha with AH plus sealer	1.9	0.50
Group 3: Resilon core and Epiphany sealer	1.4	0.43

[a]*The extent of leakage in the teeth filled with Resilon core and Epiphany sealer was significantly different from that in the other 2 groups of teeth (analysis of variance, $p < 0.05$).*

(group 2; mean 1.9 mm, SD 0.5) or the AH 26 sealer (group 1; mean 2.5 mm, SD 0.52). The mean leakage in group 3 teeth was significantly different from that in groups 1 and 2 ($p < 0.05$); in addition, the results for group 2 were significantly different from those for group 1 ($p < 0.05$).

Discussion

Achieving an adequate coronal seal is one of the most important goals in endodontics, but there is wide variation in the sealing ability of different endodontic materials.[9,13,14] Van der Sluis and others[15] showed differences in leakage between oval and round canals. Hence, for consistency in the evaluations, teeth with single, straight, round root canals were used in this study.

In vitro evaluation of leakage may not correlate directly with clinical outcome,[16] but such evaluations are justified for the purpose of simple comparisons and in screening techniques. None of the leakage-evaluation methods in current use[17,18] has been validated, and hence the best method has not been established; however, in simple dye penetration studies, penetration of the dye may be the most reliable method of visualizing the extent of leakage.[14,19] In addition, Pitt Ford,[20] who compared dye leakage associated with several sealers in vitro, found that the observed differences did not correspond to noticeably different tissue responses in vivo.

Many in vitro methods[9–13] have been used to evaluate the sealing qualities of endodontic filling materials, but most studies[21,22] have used methylene blue dye. This dye was also used in the current study because it has a low molecular weight and penetrates more deeply than other dyes along the root canal filling.[19,23] In addition, its molecular size is similar to that of bacterial by-products such as butyric acid, which can leak out of infected root canals and irritate the periapical tissues.[24] In contrast, the fluid transport method is ineffective for showing leakage in coronal or apical sections of the root canal. However, the fluid filtration technique gives results similar to those of the active dye-penetration technique because, like the active penetration method, it takes into account all of the porosities of the interfaces between the filling material and the root.[14]

Air entrapped within the root canal filling material or inside the root canal system may inhibit penetration of dye into the pores and gaps.[25] Oliver and Abbott[25] stated that after centrifugation at 3,000 rpm for 5 minutes, dye penetration was 91.7%; dye penetration by passive immersion was 20.7%. For this reason, active dye-penetration tests, whereby entrapped air is removed under a vacuum or the dye penetration test is performed under high pressure, have been recommended;[25] centrifugation was used in the current study.

Removal of the smear layer can be considered an essential step in successful root canal treatment.[26] For this reason, the smear layer was removed in this study before evaluation of the penetration and adaptation of root canal filling materials.

More emphasis should be placed on prompt completion of the coronal restoration as a way of ensuring success in root canal therapy. A number of studies[27,28] have demonstrated that coronal contamination by microorganisms leads to their penetration of the whole root canal system. Protection of the root canals and the floor of the pulp chamber from leakage can be achieved by placing glass ionomer and zinc oxide-eugenol cements over the area, as a lining.[29] The failure of various sealers may be due to their chemical composition and physical properties (such as adhesiveness, dimensional stability, flow, solubility). Also, obturation techniques, possible presence of a smear layer, irregularity of canals and the presence of accessory canals may be responsible for sealing failure.[30,31]

The results of this study indicate that all 3 sealers tested (Epiphany, AH 26 and AH plus) allow some coronal leakage. The significantly lower mean leakage of the Epiphany sealer, relative to that of AH plus sealer, may be related to inferior adaptation and penetration ability of gutta-percha with AH 26 and AH plus across the root canal. It may also be due to shrinkage and expansion of the AH 26 and AH plus sealer. In the Epiphany endodontic obturation system, the sealer's attachment to the root canal walls and to the Resilon core material seems to be better than is the case for the other sealers.

A good coronal seal for a root canal obturation should be possible with sealers that adhere well to both dentin and the core filling material. The sealing capability of the Epiphany sealer may be attributed to its integrity, which is provided by adhesion of the Resilon filling material to the Epiphany sealer and, in turn, the sealer's adhesion to the dentin walls in the root canal system.[13]

In the present study, the Epiphany endodontic obturation system provided an adequate seal. Similar results have been reported by Shipper and others.[13] In contrast, Tay and others[32] concluded that the quality of apical sealing achieved with the Resilon core material and Epiphany sealer was no better than that achieved with gutta-percha and a conventional epoxy-resin sealer. Discrepancies between the 2 studies are probably due to differences in methodology and the leakage region evaluated. However, the coronal leakage associated with the Resilon core material and Epiphany sealer had not yet been reported at the time of these earlier studies.

Many would agree that gutta-percha should be replaced by a material that better seals the canal. The results of the current study indicate that the Epiphany root canal filling system exhibits less coronal leakage than systems using gutta-percha. Although the Epiphany sealer may have created a better seal in this in vitro study, in vivo results may differ because of factors such as the smear layer on the dentin, which is known to modify the sealing properties of endodontic cements. This study did not address the clinical performance of the new sealing material. In addition to in vitro studies, clinical studies using the Epiphany endodontic obturation system should be carried out.

THE AUTHORS

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Dr. Bodrumlu *is an assistant professor in the operative dentistry and endodontics department, faculty of dentistry, Ondokuz Mayis University, Samsun, Turkey.*

Dr. Tunga *is an assistant professor in the operative dentistry and endodontics department, faculty of dentistry, Ondokuz Mayis University, Samsun, Turkey.*

Correspondence to: *Dr. Emre Bodrumlu, Ondokuz Mayis University Faculty of Dentistry, Operative Dentistry and Endodontics Department, 55139 Kurupelit-Samsun /Turkey.*

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