Assessment of a new root canal sealer's apical sealing ability

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Objective. The aim of this study was to investigate the apical sealing ability of a newly introduced root canal sealer: iRoot SP Root Canal Sealer.
Study design. Sixty-eight extracted human anterior single-root teeth were used. The coronal part of each tooth was removed and the root canals were prepared with ProTaper files. The specimens were divided into 3 groups of 20 teeth each. Group A specimens were filled with iRoot SP using the continuous wave condensation technique; Group B specimens were obturated with iRoot SP using a single cone technique; Group C specimens were filled with AH plus by means of the continuous wave condensation technique. Evaluation of the apical leakage was performed with a fluid filtration method at 24 hours and 1, 4, and 8 weeks. Scanning electron microscopy (SEM) was used to qualitatively assess what mechanisms might be responsible for leakage of the different groups.
Results. There was no significant difference in fluid leakage among the groups, as well as no time effect on leakage ($P > .05$). SEM revealed both gap-free regions and gap-containing regions in canals filled with both materials.
Conclusion. iRoot SP was equivalent to AH Plus sealer in apical sealing ability. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:e79-e82)**

It is generally accepted that microleakage between the root canal filling and root canal walls might adversely affect root canal treatment results.[1] Therefore, complete sealing of the root canal system after cleaning and shaping is critical to prevent oral pathogens from colonizing and re-infecting the root and periapical tissues.[2] In endodontic therapy, a sealer is basically used to fill the irregularities of the root canal system, bond the core material to the root canal walls, and serve as a lubricant.[3] An ideal root canal sealer should be biocompatible, antibacterial, nontoxic, and radiopaque, and it should also hermetically seal the root canal system, be dimensionally stable, and should have good adhesion to the root canal wall.[4]

A new obturation sealer, iRoot SP root canal sealer (Innovative BioCreamix Inc, Vancouver, Canada), has recently been introduced to the market. According to the manufacturer's description, iRoot SP is a convenient, premixed, ready-to-use injectable white hydraulic cement paste developed for permanent root canal filling and sealing applications. iRoot SP is an insoluble, radiopaque, and aluminum-free material based on a calcium silicate composition, which requires the presence of water to set and harden. To date there appear to be few studies evaluating the apical sealing of this new material. The purpose of the study was to evaluate the sealing ability of iRoot SP using the fluid filtration technique.

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MATERIALS AND METHODS

Preparation of teeth

Sixty-eight extracted human anterior single-root teeth were selected for study. Roots with open apices, cracks, and resorptive defects were excluded. Teeth were cleaned of extraneous tissue and calculus and then rinsed and stored in saline solution before instrumentation. To ensure that all specimens were the same length, they were resected 12 mm from the apex using a water-cooled diamond bur and then stored in deionized water.

Next, the canals were accessed and the working length was determined by inserting a #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until it was just visible at the apical foramen, and then subtracting 1 mm. The canals were instrumented using a crown-down technique with rotary ProTaper nickel-titanium files (Dentsply Maillefer) to F3. All canals were irrigated with 10 mL of a freshly prepared solution of 5.25% sodium hypochlorite (NaOCl) between files. After completion, the smear layer was removed by a wash in 10 mL of 17% EDTA for 60 seconds, followed by a wash of 5.25% NaOCl.[5] The canal was then dried with sterile paper points.

Obturation of canals

The specimens were randomly divided into 3 groups of 20 samples each. Four teeth were set aside as a negative control and another 4 were designated as positive control.

Group A: the continuous wave condensation technique with iRoot SP. Canals were filled using the E & Q Plus system (Meta Dental Corp., Cheongju, Korea) according to the manufacturer's instructions. Briefly, a heating tip in the pen-grip hand piece was selected to fit 4 mm short of the working length without binding. A ProTaper Gutta-percha Point (Dentsply Maillefer) was selected that fitted snugly within 1 mm of the working length. iRoot SP sealer was placed into the root canal with the master gutta-percha cone. The 200°C heating tip was inserted in a slow, steady motion into the canal to a depth 4 mm short of the working length and was held for 3 to 4 seconds. The tip was allowed to cool for 10 seconds and then removed after applying a single burst of heat for about 1 second. The canal was then backfilled using the E & Q gun until the canal was completely filled with gutta-percha.

Group B: a single-cone technique with iRoot SP. Canals were obturated using a single ProTaper Gutta-percha Point (Dentsply Maillefer) prefitted to the working length. Next, iRoot SP was injected to fill the apical third of the roots. The prefitted master-cone was then coated with sealer and introduced apically into the canal. The cone was subsequently seared off with a hot plugger.

Group C: the continuous wave condensation technique with AH Plus. The canals of group 3 were filled with AH Plus sealer (Dentsply DeTrey, Knstanz, Germany) in the same manner as in Group A.

After obturation of the root canals, all specimens were stored in a humid atmosphere for 24 hours before testing for microleakage.

Measurement of microleakage

Nail varnish was used to limit the passage of fluid across the dentinal tubules. By design, the coronal end was not sealed so to allow detection of any leakage at the root ends. The external surface of the roots was double coated with nail varnish except at the tip of the root (1 mm apical surface free of varnish). Canals filled with gutta-percha (without sealer) and uncoated with varnish were used as positive controls (n = 4); the same roots were then entirely covered with nail varnish for negative controls (n = 4).

Using the fluid-filtration method described by Wu and Wesselink,[6] the roots were connected to a fluid-filled pressure system that measured water movement through obturated roots under a pressure of 3 psi (0.2 atm) by monitoring the movement of an in-line bubble. Measurements of fluid movement were made at 2-minute intervals for 8 minutes, which were then averaged. The specimens were evaluated longitudinally after 24 hours, and 1, 4, and 8 weeks. Between the readings, the specimens were stored at 37°C in isotonic saline solution containing 0.2% sodium azide.

Table I. Leakage of root canal fillings after various intervals ($\mu Lmin^{-1}$)

Time	*Group A*	*Group B*	*Group C*
24 h	0.045 ± 0.023	0.052 ± 0.016	0.048 ± 0.015
1 wk	0.036 ± 0.022	0.043 ± 0.026	0.041 ± 0.012
4 wk	0.024 ± 0.035	0.037 ± 0.034	0.030 ± 0.018
8 wk	0.021 ± 0.014	0.035 ± 0.021	0.029 ± 0.020

Scanning electron microscopy

Scanning electron microscopy (SEM) was used to qualitatively assess what mechanisms might be responsible for the leakage in the different groups. For each group, a specimen that exhibited the greatest leakage was selected. These specimens were split, mounted on aluminum stubs, desiccated, sputter-coated with gold, and examined in a Hitachi S-570 scanning electron microscope (Hitachi Ltd., Tokyo, Japan).

Statistical analysis

The results were analyzed by 2-way analysis of variance (ANOVA), with the groups serving as one factor and time as the other. Multiple comparisons of microleakage values were performed using Student-Newman-Keuls test at $\alpha = 0.05$. Statistical significance was defined in advance as P less than .05 by using the SPSS 13.0 for windows (SPSS Inc, Chicago, IL) statistical package.

RESULTS

The leakage of the negative control, measured by the fluid filtration model, was uniformly 0, and the leakage of the positive controls was immeasurably high. A 2-way ANOVA test showed no significant difference among the experimental groups ($P > .05$) as well as for time ($P > .05$). Group B had higher leakage at all time periods, although it was not significant (Table I).

SEM was used to observe specimens that had the highest leakage after 24 hours. Gap-free and/or gap-containing regions along the sealer-dentin and the cone-sealer interface were observed in all 3 groups (Fig. 1). AH-Plus had little adaptation between the sealer and the gutta-percha point, whereas iRoot SP had good adaptation to the gutta-percha.

DISCUSSION

A wide variety of root-canal sealers are available commercially. iRoot SP Root Canal Sealer, an alumi-

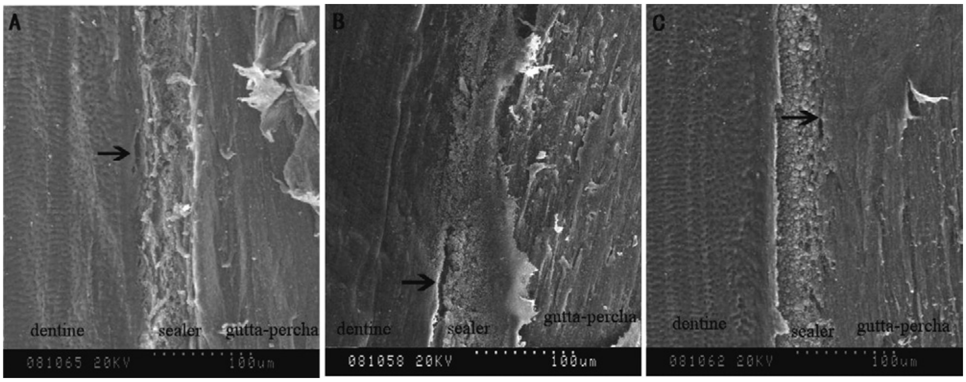

Fig. 1. Scanning electron micrograph (×300) of sealer-dentine and the cone-sealer interfaces for specimens that leaked the most, showing a gap presence (*arrow*). **A,** A specimen was filled with iRoot SP using the continuous wave condensation technique. **B,** A specimen was obturated with iRoot SP using a single-cone technique. **C,** A specimen was filled with AH plus using the continuous wave condensation technique.

num-free sealer based on a calcium silicate composition, was recently introduced to the market. According to the manufacturer, iRoot SP is composed of biocompatible and nontoxic materials that include calcium phosphate, calcium silicates, zirconium oxide, and calcium hydroxide. iRoot SP includes a similar composition to white mineral trioxide aggregate (MTA) material and has both excellent physical properties and biocompatibility. iRoot SP can form a hermetic seal inside the root canal and be used for filling root canals with or without gutta-percha points. Superior qualities and handling abilities make iRoot SP an innovative novel root canal sealer. To date only scant knowledge is available with regard to its sealing ability. The aim of this study was to compare apical leakage between iRoot SP and AH Plus sealer.

The fluid transport method has been demonstrated to be the method of choice in the determination of leakage.[7-10] The major advantage of the fluid transport model is the ability to measure microleakage without destroying the root specimens.[11,12] In addition, the sensitivity of the fluid transport method system can be adjusted by altering the pressure used and altering the diameter of the micropipette.[13] To avoid anatomical variations, and to obtain standardization for the leakage measurements, the length of specimens was kept identical in this study. The canal diameter and anatomy were controlled to reduce study variability.[14]

Previous studies have shown that thin layers of sealer are preferred in modern endodontics, because the sealer might shrink during setting and dissolve over time, producing leakage.[15] In the single-cone technique, the volume of sealer is high relative to the volume of the cone and this ratio promotes void formation and reduces seal quality.[16] However, the concept of the single-cone technique has been recently revisited.[17] The volume of the sealer used in the single-cone technique was minimized because gutta-percha cones were calibrated to the preparation. With the development of the sealer, the single-cone technique allowed a comparison of performance under relatively standardized conditions.[18] The present study found there is no difference in the ability of sealing root canals between iRoot SP using the single-cone technique and AH plus using the continuous wave condensation technique. Possible reasons for the results could be that iRoot SP is based on a calcium silicate composition, which does not shrink during setting and hardens in the presence of water. The result was also confirmed by SEM. iRoot SP and AH plus exhibited architectures that seemed to correlate with their sealing performance. Gap-free and gap-containing regions were observed along the sealer-dentin and the cone-sealer interface with two sealers.

It can be concluded that iRoot SP was equivalent to AH Plus sealer in apical sealing ability. In addition, iRoot SP was a suitable cement paste for use in the single-cone filling technique. However, further studies are needed to clarify the long-term sealing ability of this new material as well as evaluate its clinical performance.

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