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Evaluation of Apical Sealing Ability of A Calcium Silicate Based Sealer With A Calcium Hydroxide Based Sealer Using Confocal Laser Scanning Microscope: An In Vitro Study.

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Abstract

Background: A successful root canal treatment requires a thorough debridement of the canal space and a 3-dimensional obturation. This is facilitated by a good filling material and a sealer. The aim of this study was to determine the depth of penetration of each sealer into the radicular dentine using a Confocal Laser Scanning Microscope to compare and evaluate the sealing ability of BioRoot RCS with Sealapex.

Materials and Methods: In this in-vitro study, 52 teeth with single canals were decoronated and instrumented with ProTaper system (Dentsply, Maillefer, Ballaigues, Switzerland) until a F5 (50/05) instrument. 2.5% sodium hypochlorite and 17% EDTA was used for 3 minutes to irrigate the canals and then washed with 3 ml of distilled water. The canals were divived into two groups. GROUP A: Root canals sealed with BioRoot RCS and filled with gutta-percha cone and GROUP B: Root canals sealed with Sealapex and filled with gutta-percha cone. After setting, all samples were sectioned at 3 mm from the apex and assessed by confocal laser scanning microscope.

Results: BioRoot RCS showed the best depth of penetration into the radicular dentine with a mean value of 1352.669 ± 184.821 µm. For Sealapex sealer the depth of penetration was 602.965 ±40.612 µm.

Conclusion: With the limitations of this study, it was proved that BioRoot RCS has superior sealing properties and higher depth of penetration into the dentinal tubules when compared to Sealapex.

Keywords: BioRoot RCS, Sealapex, sealer, Confocal Laser Scanning Microscope, depth of penetration, calcium silicate sealer.

Introduction

A successful root canal treatment aims at thoroughly debriding the root canal system by elimination of pathogenic organisms and sealing the root canal space using gutta percha points. For a hermetic seal to be present, root canal sealers should be placed in between the dentine and gutta percha to prevent ingress of bacteria from the oral environment. It should be able to create an accurate 3-dimensional obturation of all the length of the endodontic space. [1]

Endodontic sealers fill the root canal system; entomb the remaining bacteria; and favor periapical healing by creating a physical blockage inside the canal. They are flowable and hence, fill the spaces that cannot be reached by the gutta-percha. This prevents leakage and avoids the entrance of inflammatory exudates, bacteria, saliva, and chemical fluids to the interior of the canal (Ersahan and Aydin, 2013). [2] Evaluation of sealing ability has been considered an important parameter to assess the introduction of each new sealer. [3] Penetration of sealer into the dentinal tubules has been one of the many methods used to assess this. This increases the interface between material and dentin thus improving the sealing ability and retention of the material by mechanical locking. Hence, it is important to have sealer/dentin interface as great as possible. [4]

The sealers that are now available are classified according to their chemical components as: Zinc oxide eugenol sealers, sealers containing calcium hydroxide, and resin based, glass ionomer based, silicone based, and bioceramic sealers.[5] In this study, BioRoot RCS (Septodont, Saint-Maur-des-Fosses, France) and Sealapex (Sybron Endo) have been used using confocal laser scanning microscopy.

Materials and Methods

Inclusion Criteria

- Human teeth with single canals.

Exclusion Criteria

- Grossly decayed teeth.
- Teeth with root caries.
- Teeth with anomalies.
- Teeth with immature apices.

Procedure

52 teeth with single canals were first decoronated to standardize the root length to 15 mm. Then the root canals were instrumented with ProTaper system (Dentsply, Maillefer, Ballaigues, Switzerland) until a F5 (50/05) instrument. The working length was established with a #10-K file at 1 mm from the apical foramen. A volume of 1ml of 2.5% sodium hypochlorite (NaOCl) was used to irrigate the canal after the use of each instrument. After irrigation, the canals were activated with endo-activator to effectively remove the smear layer. After this, the canals were irrigated with 3 ml of 2.5% NaOCl and 17% EDTA for 3 minutes and washed with 3 ml of distilled water. Finally, the canals were dried with paper points and the specimens were randomly divided into two groups.

Group A: Root canals sealed with BioRoot RCS and filled with gutta-percha cone.

Group B: Root canals sealed with Sealapex and filled with gutta-percha cone.

The sealers were mixed with Rhodamine-B dye to allow visualization on a confocal laser-scanning microscope (CLSM). Next, the canals were filled using the single cone technique. After setting, all samples were sectioned at 3 mm from the apex and assessed by confocal laser-scanning microscope.

Confocal laser scanning microscopy

Two-millimeter-thick samples were submitted to confocal laser scanning microscopy under ×10 magnification. The

microscope used was LEICA microsystems DMi8, Germany. Argon laser with an intensity of 545-609 nm was used. The greatest depth of penetration the root canal sealer was recorded for each sample in that respective group using a linear measurement. The canal wall served as the starting point and sealer penetration into dentinal tubules was measured to a maximum depth for each tooth section of each group and the values were recorded.

Statistical Analysis

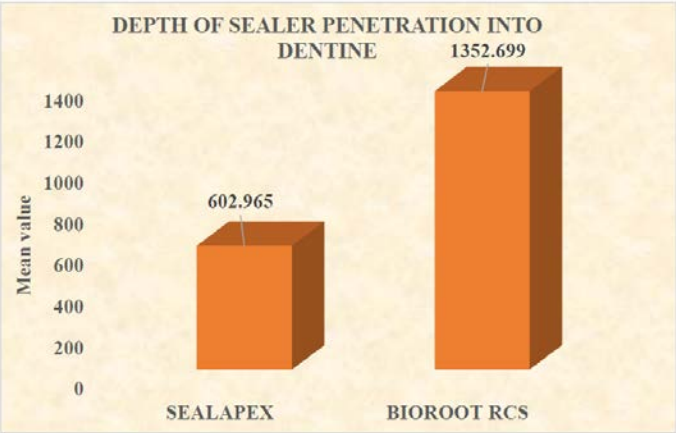
The statistical parameters such as mean and SD of the depth of penetration of each sealer were obtained for each group as shown in Table 1. The mean depth of penetration for BioRoot RCS group was the highest at 1352.699 ± 184.821 µm and for Sealapex, it was 602.965 ±40.612 µm.

Table 1: Depth of Sealer Penetration Into Dentine

CLASS	N	Mean	Std. Deviation	T
SEALAPEX	26	602.965	40.612	18.156
BIOROOT RCS	26	1352.699	184.821	P<0.001 VHS

Result

In the present study, the depth of penetration of sealer into the dentinal tubules was considered as an ideal requirement of a good sealer. Confocal Laser Scanning Microscope revealed that BioRoot RCS showed the best dentinal penetration amongst both sealers.



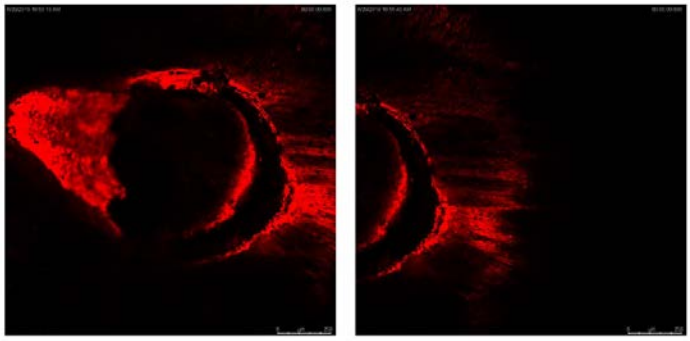


Figure 1 : Confocal laser scanning images of BioRoot RCS sealer

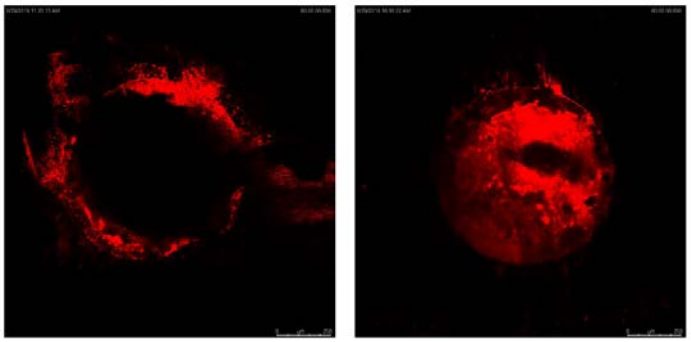


Figure 2: Confocal laser scanning images of Sealapex sealer

Discussion

The major goal of a successful root canal filling is to prevent any exchange between the oral cavity, the root canal system, and the peri radicular tissues, providing a barrier to the existing canal infection and possible anticipated reinfection by using gutta-percha and root canal sealers.[4]

The most common failure of the root canal obturation is the presence of gaps and porosities at the sealer-dentin interface. This can lead to re-colonization of microorganisms leading to failure of the root canal treatment. Gutta percha has been used commonly as the material of choice for obturation. It possesses many properties such as biocompatibility, chemical stability, radiopacity, non-porosity & the ability to be manipulated. However, the main drawback of Gutta percha is its hydrophobic nature. Hence, the Gutta percha does not bond to the internal tooth structure, resulting in an

incomplete seal with the root canal. Therefore, a good sealer with an excellent sealing ability is important to combat the drawbacks of Gutta Percha. [6]

Sealapex (Sealapex® SybronEndo, Glendora, CA) is a calcium hydroxide-based sealer. It forms calcium hydroxide after being hydrated on contact with the tissue fluid. This material has good biocompatibility and an osteo-inductive ability to stimulate mineralization. This factor can induce apical sealing after endodontic treatment. Moreover, the calcium reduces the presence of carbon dioxide, which bacteria use for anaerobic respiration and the high pH favors antimicrobial properties.[7]

A study by Milton Carlos Kuga et al (2013) to compare the antibacterial activity of MTA Fillapex sealer when compared to Sealapex and AH Plus sealers, concluded that Sealapex presented better antibacterial effectiveness than the MTA Fillapex and AH Plus. [8] However, it presents with more microleakage than AH Plus. [9] Another older study conducted by Jayalatha et al. (1998) to compare the sealing ability of Sealapex, AH-26 and ZnOE employing bacterial leakage and dye penetration methods, showed that AH-26 has maximum sealing ability followed by Sealapex and ZnOE. Pommel et al. (2003) also evaluated the sealing ability of various sealers including sealapex and AH26 and found that AH26 sealed better than Sealapex. [10]

Recently a new class of bio-ceramic material has been introduced in the market, BioRoot RCS. This tricalcium based sealer has a property of reacting with the tissue fluids when in contact with it and reduces the chance of micro leakage by the formation of calcium hydroxide at the sealer and dentin interface. In a study conducted by Hemalatha Paranthaman and Priyadharshini Theetharappan (2019), it was seen that Bioroot RCS group possessed greater sealing ability compared with the Guttaflow II and AH Plus. [11] The findings of this study are consistent with the study by Viapiana et al where he compared the sealing ability of Bioroot RCS and AH Plus and concluded that Bioroot RCS showed a better sealing ability. BioRoot RCS is said to release calcium hydroxide after setting (Camilleri 2015).[3]

Confocal Laser Scanning Microscope offers several advantages like the use of non-decalcified or hard tissue samples that do not require a specific section technique (sputter coating). It also provides detailed information about the presence and distribution of sealers at relative low magnification through the use of fluorescent Rhodamine-marked sealers and allows the exclusion of artifacts from the sample.[4] It does not require special specimen processing, and observations can be made under near normal conditions.[12] The CLSM used in the present study was the LEICA Microsystems DMi8, Germany. The scanning speed was 200Hz. All the images were analysed using the LEICA Application Suite X (LAS X) software.

Conclusion

Within the limitations of the present study, the sealing ability of both sealers was determined using Confocal Laser Scanning Microscope which was visualized using a Rhodamine B dye by checking the extent of sealer penetration into the dentine. BioRoot RCS showed highest dentinal penetration.

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