

Fluid flow evaluation of coronal microleakage intraorifice barrier materials in endodontically treated teeth

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ABSTRACT

Objective: The objective of this study was to compare the coronal microleakage intraorifice barrier materials, called CoroSeal (CS), fissur sealant (FS), flowable composite FC, and polycarboksilate cement (PC), by using the computerized fluid filtration method.

Materials and Methods: Fifty freshly extracted, single-canal human maxillary central teeth were used in this study. The teeth were decoronated to a standardized root length of 15 mm. After preparation and irrigation, all the teeth were obturated with gutta-percha and AH-Plus. In all teeth, the coronal 2 mm of root filling was removed and replaced with one of the intraorifice barriers. According to intraorifice barriers, teeth were divided randomly into 4 experimental groups ($n = 10$) and 2 control groups ($n = 5$). Group 1: CS; Group 2: FS; Group 3: FC; and Group 4: PC. **Positive Control Group:** No barrier material was used. **Negative Control Group:** Roots were completely coated with the nail polish, including the orifice. Leakage was evaluated by using a computerized fluid filtration model. Differences in fluid filtration among groups were subjected to statistical analysis using the Kruskal-Wallis Test and multiple comparisons test. **Results:** A value of $P < 0.05$ was statistically significant. Statistical analysis has indicated that the CS leaked significantly less than other groups ($P < 0.05$). There was a significant difference between FS and PC ($P < 0.05$), in contrast there was no significant difference between FS and FC ($P > 0.05$). **Conclusions:** Using the CS material as an intraorifice barrier material reduced amount of microleakage as compared with FS, FC, and PC.

Key words: Barrier materials, CoroSeal, fluid filtration, leakage

INTRODUCTION

Bacterial penetration to root canal treatment can occur coronal microleakage.^[1] A coronal restoration after endodontic therapy could prevent the movement of bacteria and their products.^[2,3] Therefore, long-term prognosis of endodontically treated teeth depends on the quality of the final restoration.^[4] Ray and Trope found that the quality of coronal restoration might be a more important factor than quality of the root canal obturation.^[5]

Reinfection of root canals filled with gutta-percha and

sealer has been seen as a potential cause of endodontic treatment failure, if permanent or temporary seal or tooth structures is missed or fractured^[6,7] and if the patient defers placement of a permanent restoration.^[8] Investigators have determined that gutta-percha and sealer alone cause leakage after a while when exposed to oral microflora.^[8] Swanson and Madison found that, in the absence of coronal seal, this contamination could occur as soon as 3 days.^[1] Torabinejad *et al.* showed that the 50% of the canals are completely contaminated after 19 days of exposure to *Staphylococcus epidermidis*.^[7] To date, several materials, and techniques have been recommended to prevent the coronal microleakage.

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According to Roghanizad and Jones^[6], Carmen and Wallace^[9], after endodontic therapy applied by using the intraorifice barrier materials and sealing pulp chamber with the adhesive systems provides a second line of defense to bacteria. Different materials such as amalgam, Cavit, Glass ionomer Cement, composite, Mineral Trioxide Aggregate (MTA), Intermediate Restorative Material (IRM); etc., have been used as intraorifice barriers to prevent coronal microleakage in the root canal filling.^[2,10-14]

CoroSeal (CS) (Ivoclar Vivadent AG, Liechtenstein) is an adhesive system, which has been specially developed for sealing root canal entrances. CS adhesive system is built up with the CS and tightly bonded to the dentin with the self-etching CS adhesive (Primer and Bond). According to the manufactures, endodontically treated teeth can provide long-lasting protection by creating a barrier against bacteria at the root canal entrances with CS.

Various studies have shown that intraorifice barriers decrease the coronal microleakage.^[4,10-12] Several techniques have been used to evaluate the coronal microleakage of barrier materials, e.g. bacterial and dye leakage, as well as fluid filtration method.^[15] Bacterial and dye leakage techniques cause the destruction of the samples after the measurements of the leakage.^[16] Computerized fluid filtration method exceeds the disadvantages of other methods and also this method is computerized, highly sensitive, fully electronic, safe, and has digital air pressure checking system.^[17-19]

The purpose of this study was to compare the coronal microleakage intraorifice barrier materials, called CS, fissur sealant (FS), flowable composite (FC) and polycarboksilate cement (PC), by using the computerized fluid filtration method.

MATERIALS AND METHODS

Fifty freshly extracted, single- canal human teeth were used in this study. All teeth were examined for fractures or defects, and the teeth with fractures were excluded. Subsequently, the teeth were decoronated to a standardized root length of 15 mm. Standard occlusal access cavities were prepared and working lengths were determined visually by subtracting 1mm from the point at which a size # 10 K- file just exited the apical foramen. The canals were instrumented using a crown-down technique with rotary ProTaper nickel-titanium files to a master apical file size of "finishing file No: 3 (F3)" and during preparation, the canals were irrigated with 5.25%

NaOCl (Sultan Healthcare Inc., Englewood, USA). After the preparation, smear layer was removed using 5 ml 17% EDTA (Aklar Chemistry, Ankara, Turkey). Later on, the root canal was flushed with 5 mL of 5.25% NaOCl, 5 mL distilled water, respectively. Canals were dried using paper points. All teeth were obturated with gutta-percha (Discus Dental, Culver City, USA) and AH-Plus (Dentsply De Trey, Konstanz, Germany) using cold lateral compaction technique.

In all teeth, the coronal 2 mm of root filling was removed and replaced with one of the intraorifice barriers. According to intraorifice barriers, teeth were divided randomly into 4 experimental groups ($n = 10$) and 2 control groups ($n = 5$). Group 1: CS (Ivoclar Vivadent); Group 2: FS (Ketac Molar Easymix); Group 3: FC (Filtek flow); and Group 4: PC (3M Espe).

Positive control group: No barrier material was used.

Negative control group: Roots were completely coated with the nail polish, including the orifice.

All restorative materials have been prepared in accordance with the manufacturer's recommendations. Radiographs were taken from all teeth after the placement of the restorative materials to verify their uniformity and density, and the sealers were allowed to set for 7 days at 37°C and 100% humidity. Experimental groups and positive controls received two layers of nail polish, except for root canal orifice and apical 2 mm.

Leakage was evaluated using with a computerized fluid filtration model. Roots sections were inserted into the plastic tube from the coronal side and connected to an 18 gauge stainless steel tube. The cyanoacrylate adhesive (Patex, Henkel. Turkey) was applied circumferentially between the root and plastic tube. The computerized fluid filtration meter with a laser system used in this study has a 25 µl micropipette mounted to it horizontally. Oxygen from a pressure tank at 200 kPa was applied to the coronal side. The pressure was kept constant throughout the experiment by means of a digital air pressure regulator (DP-42 Digital pressure and vacuum sensors Red LED display SUNX Sensors, West Des Moines, IA, USA) added to the pressure tank. A 25 µl micropipette was connected to the pressure reservoir by polyethylene tubing (Microcaps, Fisher Scientific). The whole system (all pipettes, syringes, and the plastic tubes) on the coronal side of the sample was filled with the distilled water. The water was soaked up approximately 2 mm with the microsyringe, so we created an air bubble in the micropipette and

the air bubble was regulated to a suitable position in the syringe. The fluid movement was measured automatically for 2 min during the 8 min for each sample using the computerized fluid filtration PC-compatible software (Fluid Filtration = 03, Konya, Turkey). The leakage quantity was expressed as $\mu\text{L}/\text{cm}^2 \times \text{cmH}_2\text{O} \times \text{min}$ at 2 atm and the mean was determined.

Differences in fluid filtration among groups were subjected to statistical analysis using the Kruskal-Wallis Test and multiple comparisons test. A value of $P < 0.05$ was statistically significant.

RESULTS

The results are presented in Table 1. The positive control group had extensive bubble movement and negative control group had no bubble movement. Statistical analysis showed that CS group leaked significantly less than other groups ($P < 0.05$). There was a significant difference between FS group and PC group ($P < 0.05$), in contrast there was no significant difference between FS and FC ($P > 0.05$).

DISCUSSION

The ideal properties of an intraorifice barrier suggested by Wolcott *et al.*^[19] include the following characteristics: Easily placed, bonds to tooth structure, seals against microleakage, distinguishable from the natural tooth structure, and does not interfere with the final restoration.

Composite resin, glass ionomer cement, zinc oxide- eugenol cement, and MTA have all been suggested as potential materials for this type of procedure.^[2,10-12,15] Many of these restorative materials are white or near tooth-colored; this could potentially increase the possibility of perforation during restoration or reentry into the canals.^[12] However, CS barrier material is transparent. If reentry is necessary into the canals, root canal sealing can be easily seen and can be safely and efficiently removed.

Table 1: Microleakage values are means \pm SD		
Materials	N	Mean \pm SD $\mu\text{L}/\text{cm}^2 \times \text{cmH}_2\text{O} \times \text{min}$
CS	10	$37.8 \times 10^{-5} \pm 15.9 \times 10^{-5}$
Fissur sealant	10	$42.9 \times 10^{-5} \pm 27.1 \times 10^{-5}$
Flowable composite	10	$41.2 \times 10^{-5} \pm 28.5 \times 10^{-5}$
Polycarboksilate cement	10	$92.3 \times 10^{-5} \pm 13.6 \times 10^{-5}$
Control	5	$98.9 \times 10^{-5} \pm 31.3 \times 10^{-5}$
CS: CoroSeal		

Under the conditions of this *in vitro* study, CS sealed significantly better than the other groups, no statistically significant difference in fluid flow leakage was found between FS and FC, and PC exhibited the highest leakage. However, the positive controls leaked significantly more than all experimental groups ($P < 0.05$). Therefore, the use of an effective barrier material on top of the root canal filling can reduce short-term microleakage inside the root canal.^[20,21]

Sauáia *et al.*^[22] showed that Cavit sealed significantly better than Vitremer and Flow-It when used as intraorifice filling materials. According to this author it was possible that eugenol content of the root canal sealer used might have had an interaction with composite materials.^[22] And our study results FC showed the same leakage with FS.

Our findings are consistent with those of Sezinando.^[23] He reported that CS resulted in better marginal seal than Fuji IX and Cavit.^[23] We also found that CS had the best sealing ability when compared to other barrier materials. In contrast to our results, Özçopur *et al.*^[24] showed that Clearfill SE Bond and SuperBond C and B sealed better than CS and control groups when used as intraorifice filling materials and CS exhibited the highest leakage rate among the tested materials. The differences may depend on the wrong application of the CS by the authors.

There is a few study about CS material in literature.^[23-25] It should be evaluated after more work for the widespread use of this material.

CONCLUSION

The results obtained in this study demonstrated that CS was the most effective material among the other materials in reducing the coronal leakage when compared to FC, FS, and PC.

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