



**Research Article**

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## Comparison of root canal walls cleanliness obturated with two commercially available; calcium silicate sealers and a resin sealer after retreatment

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### Abstract

**Background:** Despite improvements and advances in materials and methods, root canal treatment is not always satisfactory. After completing the obturation procedures, retreatment might be mandatory in cases of reinfection or inappropriately cleaned root canal. Retreatment strategy involves elimination of the obturating material, and then the whole mechanical and filling procedures are repeated again. Thus, root canal sealers removal shouldn't represent an obstacle. **Objective:** The current study aimed is to investigate and observe the cleanliness of root canal walls that were previously obturated with two types of calcium silicate bioceramic sealers compared to a resin sealer. **Materials and Methods:** 21 single-rooted premolars were utilized. After complete removal of the obturating materials using Protaper retreatment universal system, the roots were cut by the use of a hammer and a chisel, then the middle third of the retreated canals were observed under a scanning electron microscope at magnification 1000x, the amount of clear, opened dentinal tubules was compared. **Results:** Among the three investigated sealers, ADSEAL showed the largest number of clear dentinal tubules while, a fewer open dentinal tubule were observed with Well Root and Ceraseal. **Conclusions:** None of the investigated sealers could be totally removed from root canal walls. However, the quantity of remnants of root filling material with well root and ceraseal were significantly more, compared to ADSEAL.

**Keywords:** calcium silicate bioceramic based root canal sealers, resin-based root canal sealer, root canal retreatment and scanning electron microscope

### INTRODUCTION

Endodontic sealers are used in obturation of root canals in conjunction with gutta-percha for tightly sealing the main canal, in addition to the lateral and accessory canals. Accordingly, sealers help in prevention of microbial leakage by forming a fluid-tight sealed root canal system [1-3].

Different types of root canal sealers have been marketed; bioceramic sealers have recently been an attracting material, because of their physio-chemical properties claimed by their manufacturers combined with their favorable biological characteristics. The main constituents in their composition are; alumina, zirconia, bioactive glass, glass ceramics, hydroxy-apatite and calcium phosphates. They can be classified into bioactive or bioinert materials in reference to their interaction with the surrounding vital tissues. Bioceramic sealers are characterized by their excellent biocompatibility, moreover they contain calcium -phosphate which enhances their setting characteristics, resulting in the formation of a structure that has the chemical and crystalline characteristics similar to that of both the tooth and the bone apatite, and consequently, their bond strength to dentin is enhanced. On the other hand, their main disadvantage is that they represent an obstacle in cases of retreatment or post space preparation due to their difficulty in complete elimination from the canal once complete setting is achieved [1-3].

Despite improvements and advances in materials and methods, root canal treatment is not always satisfactory. After root canal obturation procedures, retreatment might be mandatory in cases of inappropriate cleaning or reinfection. Retreatment strategy involves elimination of the current obturating material, and then the whole mechanical and filling procedures are repeated [4].

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As a result, practitioners are always faced with the challenge of managing endodontic failure in every day clinical practice. Non-surgical retreatment is an option that allows another chance of saving a failing, previously root treated tooth [5]. For successful non-surgical retreatment, it is crucial that the root canal obturating material should be easily and efficiently eliminated, to give the chance to properly correct any deficiencies in the original treatment [5].

Different methods have been postulated for complete elimination of the gutta-percha and sealer such as; hand files, ultrasonics, heat pluggers, lasers, different solvents and NiTi rotary instruments. Lately, specialized rotary instruments for retreatment have been marketed which are specially fabricated to eliminate the root filling materials such as ProTaper Universal retreatment instruments, two retreatment files and R-Endo retreatment files [6].

Accordingly, the current study aimed to examine and observe the cleanliness of root canal walls that were previously obturated with two types of calcium silicate bioceramic sealers compared to a resin sealer by the use of a scanning electron microscopy (SEM).

## MATERIALS AND METHODS

Materials used in the current study were; ADSEAL (META BIOMED, Korea), Well-Root ST (Vericom, Gangwon-Do, Korea) and Ceraseal (Meta Biomed Co., Ltd.)

### Methods

#### Sample selection

Twenty-one recently extracted human upper incisors were selected. Teeth were caries free, without calcifications or internal resorption; detected through periapical radiographs.

#### Sample preparation

Teeth were cleaned by the use of an ultrasonic scaler, they were placed in 2.5%NaOCl for 30 min for disinfection, then stored in distilled water. Before canal instrumentation, crowns were cut at the level of cement-enamel junction by a water cooled precision micro saw (IsoMet 4000 micro saw, Buehler,USA.), leaving averagely 15 mm long root segments.

Working lengths were recognized for all canals by a # K file (Mani, Tochigi, Japan). Root canals were mechanically treated using ProTaper system (Dentsply Maillefer, Ballaigues, Switzerland) starting by ;Sx, followed by S1, S2 in a brushing motion , followed by F1,F2 F3,F4 and finally F5 in a non-brushing motion, apical patency was checked using the patency file between every file and the other. Irrigation was done during instrumentation with 5ml of 25% NaOCl solution between each file change using end-perforated 27 gauge needle (SUNG SHIM, Seoul, Korea) to ensure complete cleanliness of the root canals.

After complete cleaning and shaping, samples (n= 21) were grouped into three groups according to the type of sealer used as mentioned previously.

#### Obturation

Obturation was performed using Protaper universal gutta-percha points and the type of sealer used according to its group using lateral condensation technique.

Group A: ADSEAL.

Group B: Well-Root.

Group C: Ceraseal.

Roots were then coded according to the type of sealer used and stored for 7 days in a moist environment to ensure hundred percent setting of the sealers before testing.

### Scanning electron microscopic investigation

After complete obturation and radiographic assessment, Protaper retreatment universal system was used for complete elimination of the obturating materials, in a crown-down technique in conjunction with a torque-controlled engine (NSK, Japan) at 500 rpm. Procedure was completed when no obturation remnants was observed on the instruments. 5 mL 5.25% NaOCl and 5 mL of sterile saline was used to irrigate the canals and then dried [7].

Hammer and chisel were utilized for cutting the crowns, the middle third of the root canal walls observed under a scanning electron microscope with magnification 1000x (Quanta 250 FEG (Field Emission Gun) attached with EDX Unit (Energy Dispersive X-ray Analyses), with accelerating voltage 30 K.V(Netherlands). Cleanliness of the canal walls was examined in regard to the number of opened dentinal tubules (Fig 1-3).

### Statistical analysis

Data were presented as mean and standard deviation. Data were tested for normality using Shapiro Wilk test. ANOVA test was used for analyzing normally distributed data followed by Bonferroni post hoc test for pair-wise comparison. Analysis was performed using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.

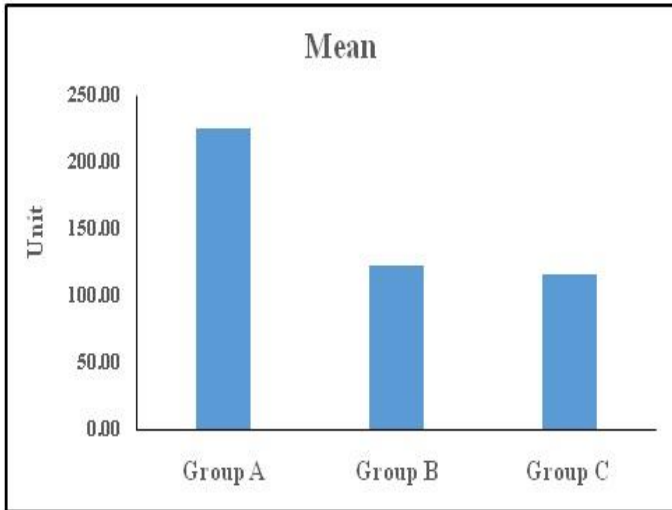
## RESULTS

**Table 1:** presents the mean and standard deviation (SD) of ANOVA test for comparison of cleanliness between the three groups represented by the number of open, clear dentinal tubules. Results showed that there was a statistically significant difference between the three tested groups. ( $p < 0.001$ ).

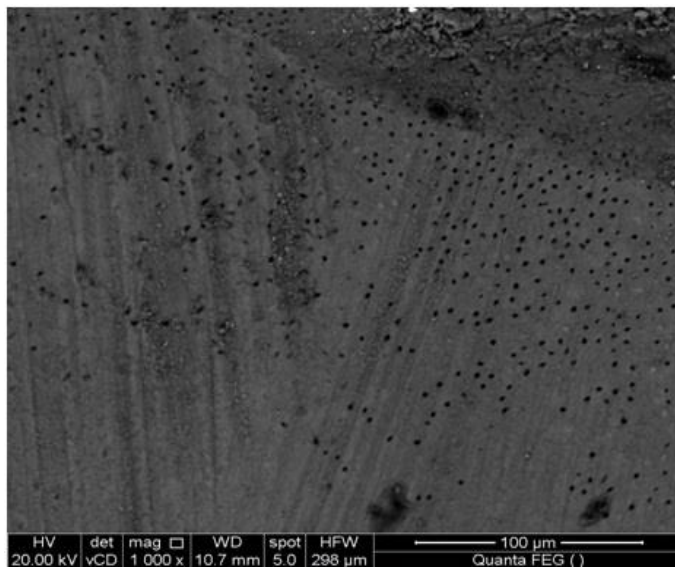
|      | GROUP A | GROUP B | GROUP C | P-Value |
|------|---------|---------|---------|---------|
| Mean | 225.50  | 123.00  | 115.50  | <0.001  |
| SD   | 6.61    | 50.32   | 4.21    |         |

**Table 2:** Presents the results of Bonferroni post-hoc test for pair-wise comparison of cleanliness between the three groups. Results showed statistically significant difference between all pair groups:

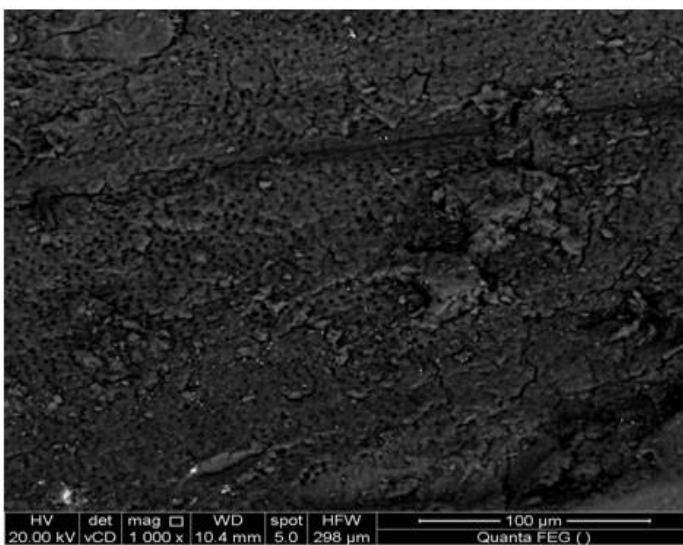
|                   | P-Value |
|-------------------|---------|
| GROUP A – GROUP B | <0.001* |
| GROUP A – GROUP C | <0.001* |
| GROUP B – GROUP C | <0.03*  |



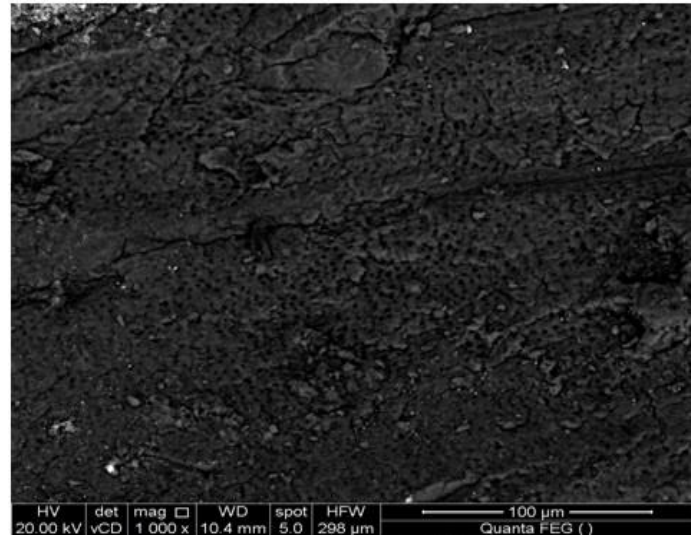
**Graph 1:** Bar chart representing the mean cleanliness in the three groups



**Figure 1:** SEM Micrograph 1000x for canal walls of Adseal



**Figure 2:** SEM Micrograph 1000x for canal walls of Root



**Figure 3:** SEM Micrograph 1000x for canal walls of Ceraseal

## DISCUSSION

Nowadays, nothing could alternate the patient's natural teeth. Root canal treatment is a practical substitute to tooth extraction; however, none of any of the recent materials is fulfilling all the ideal requirements of root obturating materials.

Recently, new types of sealers containing calcium silicate have been marketed. Their major advantage is their potential bioactive characteristics; once reacted with water  $\text{Ca}(\text{OH})_2$  is produced, resulting in an alkaline environment, which in return triggers the expression of alkaline phosphatase, consequently production of highly mineralized tissue and having an ant-microbial effect. Moreover, the alkaline pH of these materials has the ability for neutralization of the acidic environment resulting from the lactic acid extruded from osteoclasts and thus the dissolution process of the highly mineralized tissues of the teeth is completely inhibited <sup>[8]</sup>.

“Well-Root” is a previously mixed, ready-to-use, hydrophilic, bioceramic sealer. It is marketed as permanent obturating material for the root canal system, which is used with gutta-percha points. Zirconium oxide, calcium silicate, fillers, and thickening agents are incorporated in its composition. As a result of its hydrophilicity, once it contacts the dentin moisture its setting is initiated and completed. Manufacturers claim that Well-Root exhibit a setting time of 25 min <sup>[8]</sup>.

Another calcium silicate containing sealer “Ceraseal” has been marketed; it is a previously mixed, ready to use sealer. It is formed of calcium silicate which absorbs the moisture present in the root canal resulting in the formation of calcium aluminate hydrate gel (CAH) and calcium silicate hydrate gel (CSH). Manufacturers claim that Ceraseal has a pH of 12.73 and a short setting time which in return prevents the wash-out phenomena, which occurs if MTA root canal sealer is inadequately cured or if exudates is secreted. In return, physical forces wash away the root canal sealer. Moreover Ceraseal exhibit an excellent sealing ability resulting in a perfectly and fully sealed hermetic root canal thus, preventing any bacterial progression. They also claim that Ceraseal shows a unique dimensional stability since it doesn't shrink or expand thus odontoclasia is completely prevented <sup>[9]</sup>.

An epoxy resin based sealer was chosen in this study, as resin sealers are the mostly used sealers nowadays resulting from their stability, biocompatibility, good handling properties and adequate adhesion to dentin <sup>[10]</sup>.

Endodontic treatment has reported around 92% success rate, variety of reasons have been advocated for the failure of root canal treatment

such as inadequately cleaned and obturated root canals, errors of instrumentation, untreated left canals, over extensions of root filling materials and complicated canal anatomy [6].

For an effective endodontic therapy, it is crucial to effectively eliminate all the previously used root filling materials. Consequently, easy removal of sealers is one of its idealistic requirements if retreatment is mandatory to permit full accessibility for an antibacterial agent and medications to root canal ramifications [11].

Efficient elimination of the obturating material and sealer can be accomplished by more than one method; such as hand files, heat pluggers, ultrasounds, lasers, solvents and nickel-titanium rotary instruments. Rotary instruments specialized for retreatment cases have been acquainted which are designed and produced in order to specifically eliminate obturating material from the canals such as ProTaper Universal retreatment instruments, Two retreatment files and R-Endo retreatment files [6].

Therefore, The current study aimed is to examine and observe the cleanliness of root canal walls that were previously obturated with two types of calcium silicate bioceramic sealers compared to a resin sealer.

In the current study, ProTaper NiTi universal system was used to clean the root canals from the obturating materials, as it completely removes the root canal filling materials more efficient compared to other traditionally used techniques [12,13].

Numerous methods have been postulated to assess the materials remnants on root canal surfaces. Scanning electron microscope is the only method that allows detailed investigation of the cleaned and filled dentinal tubules [14, 15].

Results of the current study concealed that none of the tested sealers achieved an effective and complete elimination of obturating materials. The evidence that till now there is no contemporary technique able to completely and efficiently eliminate the root obturating has been verified [16]. Oltra *et al.* in 2017 [17], stated that after two months of storage retreat ability of BioRoot RCS showed significantly better results compared to an epoxy resin sealer, however there was no complete cleanliness of the root canals walls where, all specimens showed remnants of obturating materials.

The descriptive characteristics of the dentinal tubules revealed by the scanning electron microscopic study as shown in figures (1, 2 & 3), indicated that ADSEAL showed the large number of clear dentinal tubules, While, Well Root and Ceraseal, dentinal tubules orifices were filled by the sealer.

Materials as well root and ceraseal are calcium silicate based, consequently they have the ability to form chemical bond with dentin as they undergo biomineralization when they contact any biological tissue. This might be an explanation to the easier elimination of ADSEAL when contrasted to well root and Ceraseal may [8].

Also, Obeid *et al* in 2015 [16], stated that the interaction of Calcium silicate based sealers with a phosphate-containing fluid produces a structure that has the chemical and crystalline characteristics similar to that of both the tooth and the bone apatite. These apatites formed by deposits on the collagen fibrils, forming an interfacial layer with tag-like structures at the sealer-dentin interface. This phenomenon is claimed to enhance their bond strength to dentin. This might also explain the results of the current study.

## CONCLUSION

None of the tested sealers could be entirely removed from root canal walls. However, the remnants of root filling material with well root and ceraseal were significantly more, compared with ADSEAL.

## Conflict of Interest

The author reports no conflicts of interest.

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