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"COMPARISON OF APICAL MICROLEAKAGE OF BIOCERAMIC SEALERS & EPOXY RESIN BASED SEALER USING DYE EXTRACTION LEAKAGE METHOD"

Endodontics

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ABSTRACT

Background: This study aimed to evaluate the apical sealing ability of two Bioceramic Endodontic Sealers, CeraSeal RCS, and BioRoot RCS compared to AH plus resin based sealer using dye extraction leakage method. Thirty human single-rooted teeth were selected and were decoronated at 12 mm length and instrumented using the crown down technique with the Micromega Hero shaper to apical file size 40 with 0.04 taper. The roots were randomly divided into three experimental groups: Group A (n=10) contained roots that were obturated with CeraSeal RCS . Group B (n=10) contained roots that were obturated using BioRoot RCS. Group C (n=10) contained roots that were obturated using AH PLUS sealer. Apical microleakage was assessed with dye extraction method where the absorbance of leaked 1% methylene blue dye was measured using a spectrophotometer. The absorbance values were converted into concentrations using Beer's law. One-way ANOVA test followed by Tukey's HSD Post hoc Analysis was used to compare the mean Dye concentrations between the three groups. **Conclusion:** The test results showed that AH Plus sealer group showed significantly lesser Dye Concentration as compared to Ceraseal & BioRoot RCS groups at p≤0.001. However, no significant was observed in mean Dye Concentration between Ceraseal & BioRoot RCS groups [p≤0.78].

KEYWORDS

Bioceramic sealer, Apical microleakage, Dye extraction method, Spectrophotometer, BioRoot RCS, CeraSeal RCS, AH Plus.

INTRODUCTION

One of the chief tenets in the obturation of endodontically treated tooth is to achieve a fluid tight seal to ensure that no leakage of fluid from the periapical area to the canal space or vice a versa.

Gutta percha remains to be one of the most widely used obturating material while a sealer is used to fill the gaps between the obturating material and the dentinal wall[1]

Among the wide range of available sealers Epoxy resin-based sealers are routinely used, and several studies have considered AH Plus to be the gold-standard sealer. However, it still has limitations, including possible mutagenicity, cytotoxicity, inflammatory response, and hydrophobicity.[2,3,4]

Bioceramics are ceramic materials designed specifically for medical and dental use. There are two major advantages associated with the use of bioceramic materials as root canal sealers.[5] Firstly, their biocompatibility prevents rejection by the surrounding tissue.[6] Secondly, bioceramic materials contain calcium phosphate which enhances the setting properties of bioceramics and results in a chemical composition and crystalline structure similar to tooth.[7]

Drawing upon the advantages of mineral trioxide aggregate, calcium silicate-based sealers were introduced with high levels of biocompatibility and hydrophilicity. Because of the hydrophilic environment in root canals, water resorption and solubility of root canal sealers are important factors contributing to their stability. Sealers displaying lower microleakage and stronger push-out bond strength are also needed to endure the dynamic tooth environment.[5]

Apical leakage continues to be a topic of great interest because in spite of the advances in endodontics, clinical failures still occur. Most failures are probably attributed to the proliferation of bacteria that remain viable after chemical-mechanical preparation and cause periapical tissue irritation.[8]

In the dye extraction or dissolution method, the teeth are dissolved in acids that release all the dyes from the interface and the optical density of the solution is measured by a spectrophotometer. It is fast and can be carried out with equipment available at most universities.[9]

According to Camps and Pashley, the relationship between dye penetration and microleakage was nonexistent. Because both techniques take into account the presence of porosity in the interface between both the filling material and the root, the fluid filtration technique produced results that were comparable to those of dye extraction. Both methods rely on precise measurements of the liquids that travel through these contacts.[10,11]

The aim of this study was to evaluate the apical sealing ability of **two Bioceramic Endodontic Sealers, CeraSeal RCS and BioRoot RCS compared to AH plus resin based sealer using dye extraction leakage method.**

MATERIALS AND METHODS

2.1. Sample Selection and Preparation

For the investigation, thirty permanent single-rooted human teeth were gathered. Using an ultrasonic scaler, all teeth were cleansed of superfluous tissue and calculus. In order to assess the form of the root canal and determine whether any exclusion criteria apply, radiographs of each tooth were taken in the buccolingual (BL) and mesiodistal (MD) projections. It was confirmed that each tooth had one apical canal opening, no root fractures, and no apical cracks. The coronal portion of all teeth was removed using a diamond disk under the cement-enamel junction to standardize the root length of 12 mm from the anatomic apex measured by digital caliper. The determination of the working length was performed at magnification ×8 using a surgical microscope by inserting #10 K-file to the root canal terminus and subtracting 1 mm from this measurement. Biomechanical preparation of the canals was performed by using a crown-down technique with the hero gold shaper files starting with #20 with 0.04 taper upto #40 with 0.04 taper.

A disposable side vented needle with a 30 G tip was used to inject 1 ml of 5.25% sodium hypochlorite into each canal after every rotary file, and the solution was forced through the apical foramen to ensure patency. Finally, the root canal was irrigated with 3 ml of solution for one minute followed by 3 ml of 5.25% sodium hypochlorite for one minute, and then flushed with 5 ml of distilled water. Paper point size 40 with a 0.04 taper was used to dry every canal until a dry paper point was obtained. The roots were covered with two layers of nail polish once the biomechanical preparation was finished, and a size 10-K file was inserted through the apical foramen to prevent nail varnish from getting on it. Before adding the next layer to the root's surface, each coat was given time to dry. Based on the sealer material utilized, the prepared roots were randomly divided into two experimental groups, each with 10 roots, and one control group, containing 10 roots.

A. CeraSeal RCS
B. BioRoot RCS
C. AH plus resin based sealer

To evaluate the apical seal, 2 ml of methylene blue dye at 1% concentration was put into a glass vial. Each vial containing a root was sealed with silicon glue before being turned upside down for access to the apical foramen. This made sure that the entire apical region was covered in the dye, and gravity would improve dye penetration when stored for seven days at room temperature in a dark cabinet. After samples had dried, nail polish was scraped off using a scalpel blade. Following that, the teeth were placed for 72 hours in a glass test tube containing 4.0 ml of a 65% nitric acid solution. The solutions were centrifuged for seven minutes at a speed of 4,000 rpm.

The absorbance was converted to concentration (µg/ml) using **Beer–Lambert law** as follows:

Cu / Cs = Au / As

Where

Cs: The prepared Known concentration of methylene blue dye.

As: The absorbance of the prepared known concentration of methylene blue dye measured by spectrophotometer.

Au: The absorbance of the unknown sample determined by spectrophotometer.

Cu: Concentration of the unknown sample.

All the samples absorption were applied to the equation to obtain the amount of methylene blue dye concentration in it.

Statistical Analysis:

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics:

Descriptive analysis includes expression of dye concentration in terms of Mean & SD for each group.

Inferential Statistics: One-way ANOVA test followed by Tukey's Post hoc test was used to compare the mean dye concentration between 3 groups.

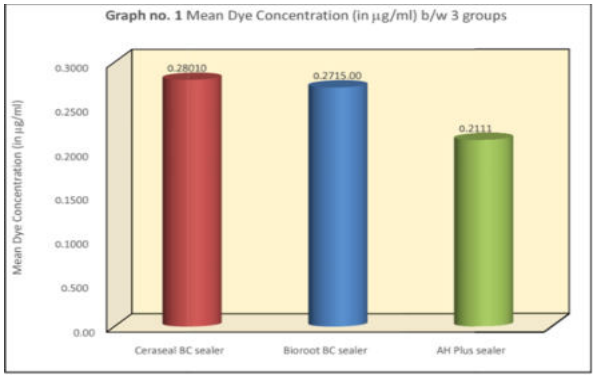
The level of significance [P-Value] was set at P<0.05. between different study groups. The level of significance [P-Value] will be set at P<0.05

RESULTS

The test results demonstrate that the mean Dye Concentration for CeraSeal BC sealer group was 0.2801.00 ± 0.031036, BioRoot RCS group was 0.2715.00 ± 0.028191 and AH Plus Sealer group was 0.21190 ± 0.0026493. This mean difference in the Dye Concentration between 3 groups was statistically significant at P<0.001 [Graph no.1].

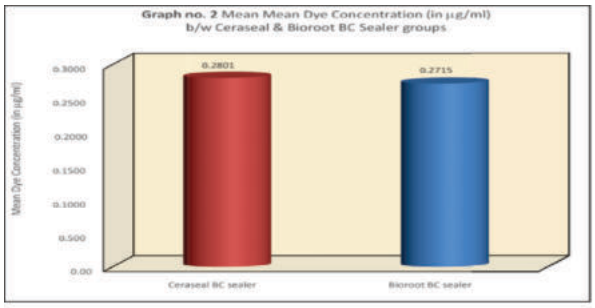
Comparison of mean Dye Concentration (in µg/ml) b/w 3 groups using One-way ANOVA Test

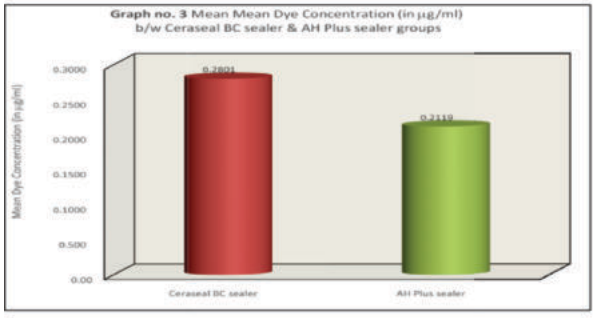
Groups	N	Mean	SD	Min	Max	p-value
Ceraseal BC sealer	10	0.2801	0.31036	0.2280	0.3230	<0.001*
Bioroot BC sealer	10	0.2715	0.28191	0.2210	0.3130	
AH Plus sealer	10	0.2119	0.26493	0.1720	0.2490	

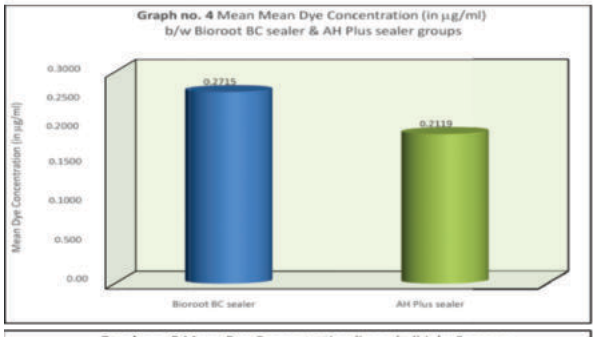


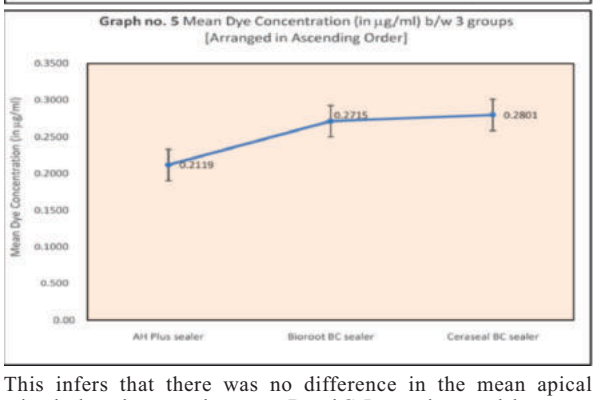
This infers that although all groups showed apical leakage, least was seen in group C (AH Plus Sealer), followed by group B (BioRoot RCS) and the maximum was seen in group A (CeraSeal BC).

The test results showed that AH Plus sealer group showed significantly lesser Dye Concentration as compared to CeraSeal RCS & BioRoot RCS sealer groups at p<0.001. However, no significant was observed in mean Dye Concentration between CeraSeal RCS & BioRoot RCS sealer groups[p=0.72]. This infers that the mean Dye Concentration was significantly lesser in AH Plus sealer group. & higher in CeraSeal RCS & BioRoot RCS sealer groups. [Refer graph no. 2,3,4,5]









This infers that there was no difference in the mean apical microleakage between the groups B and C. It was also noted that group B showed slightly lesser apical microleakage than group C but this was not statistically significant.

DISCUSSION

Among the three steps of root canal therapy, that is microbial control, cleaning and shaping, and efficient sealing of the root canal system . The execution of the last phase determines whether the treatment is successful or not. One of the major objectives of endodontic treatment is to seal the root canal in three dimensionally in order to avoid reinfection of the canal and to maintain the health of the periapical tissues. The most popular core material is gutta-percha, which covers the majority of the canal space. The root canal sealer, on the other hand, fills the accessory

canals, voids within the core material, and the contact between the core material and the dentin wall.[10]

Leakage is still one of the main causes of root canal therapy failure. A root canal filling material should ideally act as a barrier to stop bacteria from entering from the oral cavity. [11]According to Weller et al., the recently introduced Pro Root Endo Sealer, which is based on calcium silicate, seals as well as epoxy resin-based sealers and performs better than ZOE-based sealers while submerged in phosphate-containing fluid. [12]

The group of biomaterials that include ceramics as one of its ingredients may be referred to as "bioceramic materials." These were created to be biocompatible with human tissue and to be utilized frequently in the musculoskeletal system's organ repair and replacement. [13] Only in the past thirty years have bioceramic-based sealers become widely used in endodontics; this development coincides with the growth of bioceramic technology in the disciplines of medicine and dentistry.[14]

The benefits of bioceramic sealer make them a valuable asset when compared to other sealers. When applied into the root canal, a bioceramic nanocomposite network of gel-like calcium silicate hydrate and HAP forms a hermetic seal. Its high alkalinity speeds up mineralization and improves its antibacterial effects. Due to their low contact angle, they can easily spread over the dentin walls of the root canal and enter and fill the lateral micro canals. Moreover, they are also osseoconductive in nature. Because the setting time is 3–4 hours, there is enough of time to insert the root canal. Bioceramics do not contract when they are set. In fact, after the setting procedure is complete, they actually expand a little.[16,17,18,19]

Calcium silicate hydrate gel and calcium hydroxide is formed when the calcium silicates in the powder hydrate with the liquid. A non-toxic material for bone healing and reconstruction known as hydroxyapatite and water precipitate from the reaction of the calcium hydroxide with the phosphate ions. Additional gel-like calcium silicate hydrate is precipitated as a result of the water's ongoing reaction with the calcium silicates which plays a significant role in regulating the pace of hydration and the setting time.[15]

Epoxy resin-based sealants currently available have excellent apical sealing, good physical qualities, and guarantee acceptable biological performance. The most desired "Three dimensional obturation" appears to be difficult to achieve because the polyisoprene component of the gutta-percha cone and the endodontic sealer generally do not chemically combine.[20]

The most major risk factor for apical periodontitis is thought to be microleakage. In the past, many approaches have been employed to evaluate the microleakage of various endodontic materials. Different approaches are used to evaluate dental leakage, including dye penetration, dye diffusion, bacterial and endotoxin infiltration, fluid filtration, glucose, caffeine, and protein infiltration, radioisotope penetration, animal research, and electrochemical or 3D evaluation.[21]

The degree of dye penetration is influenced by particle molecular size, pH, and chemical reactivity.[22] Methylene blue has been utilized as a dye in a considerable number of studies. [23,24] because it is affordable, manageable has a high degree of staining[25] and has a molecular weight lower than that of bacterial toxins .[26]

Dye extraction or dissolution method is a method where the teeth are dissolved in acids, releasing all the dyes from the interfacial areas and a spectrophotometer determines the optical density (OD) of the solution[27] Because both methods take into account the permeability of the interface between the obturation material and the root, the fluid filtering technique produced results that were comparable to those of dye extraction. Both methods rely on precise liquid measurements moving via these interfaces. Because the fluid filtration method's filtration values tend to stagnate as water eventually penetrates all the irregularities, the dye extraction technique is preferable to it.[28]

Some of the bioceramic sealers available are composed of liquid and powder, which must be manually combined while adhering to the manufacturer's recommendations. [29]

BioRoot ™ RCS is a mineral- based root canal. When compared to MTA, it does not discolour the teeth because it is purely comprised of minerals. The formulation, which is composed entirely of calcium silicate and is free of resin and monomer, guarantees nearly no shrinking. It is available in a powder and liquid form which is manually mixed.

CeraSeal RCS is a bioceramic root canal sealant made of calcium that is manufactured from Portland cement is. The advantage of having a uniform mixture without having to be concerned about the powder/liquid ratio altering is provided by this pre-mixed calcium-silicate root canal sealant.[30,31]

This study aimed at evaluating these two ceramic with the gold standard AH plus sealer. Every single experimental group displayed apical leakage. In comparison to CeraSeal RCS & BioRoot RCS groups, the test findings showed that the AH Plus sealer group had a lower dye concentration. However, there was no discernible difference between the CeraSeal RCS and BioRoot RCS groups in terms of mean Dye Concentration. [32]

Results reveal that although AH plus demonstrated less dye penetration, both the bioceramic sealer and AH plus sealer had sealing abilities that were comparable to AH plus sealer. This was in line with research conducted by R. Viapiana et al. that evaluated the porosity and sealing capacity of root fills made of gutta-percha and sealed with either BioRoot RCS or AH Plus.[33]

Hegde and Arora found that the apical sealing ability of single-cone GP point sealed with a bioceramic sealer was better than that of laterally condensed gutta-percha sealed with an epoxy resin sealer.[34]

El-Sayed et al also came to the conclusion that single cone sealed with bioceramic sealer had superior coronoapical sealing ability compared to single cone ProPoint sealed with epoxy resin sealer.[35]It's possible that the variances in the leakage evaluation framework are what's causing this discrepancy. At 4 weeks after setting, calcium silicate-based sealers, however, demonstrated improved sealing. The authors came at the conclusion that after full setting, the calcium silicate sealer displayed a better seal. [36] At the calcium silicate/dentin interface, calcium silicate forms a tag-like structure called the "mineral infiltration zone", a hybrid zone in which hydroxyapatite recrystallizes when calcium silicate is applied to dentin.[37] It may have a positive effect because calcium ions in the tissue react with carbon dioxide to form calcite crystals. [38] These crystals can reduce marginal gaps and porosity while increasing cement retention. [39,40]

Although CeraSeal RCS and BioRoot RCS groups had different mode of manipulation, BioRoot RCS needing manual mixing of the powder and liquid and CeraSeal RCS being available as a premixed sealer, there was no statistically significant difference between the two study groups.

CONCLUSION

Within the limitations of this study, it could be concluded that both CeraSeal RCS and BioRoot RCS showed greater apical microleakage when compared to AH Plus sealer.

It could also be concluded that there was no statistically significant difference between the premixed CeraSeal group and manually mixed BioRoot RCS group.

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