



The Effect of Acidic Environment on Ion Release and Interfacial Adaptation of Two Bioceramic Sealers

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Abstract

The aim of the study is to conduct an evaluation and comparison of the ion release and interfacial adaptation of two bioceramic sealers (BS) and those are Dia-Root and NeoSealer Flo sealers in normal conditions (PBS) and in infectious conditions with the help of scanning electron microscopy (SEM) as well as energy dispersive X-ray spectroscopy (EDX). Methods: Slices of dentin which were 80 in number along with spaces of canals that are standardized were segregated into groups of two where the value of n for each was 40, and sealers like Neo Sealer as well as Dia-Root was used to fill them. There were specimens of 40 in each group and they were further divided into subgroups of two where the value of n is 20 with regard to the liquids used in experiment and their subjection to 1mmol per liter of butyric acid which has a pH value of 5.4 as well as subjection to PBS with a pH value of 7.4. Post which, an incubation of specimens for a period of seven days at a temperature of 37°C. With the aid of SEM, the evaluation of release of ions and the gap along the margins of the sealer as well as the interface of the dentin's root was performed. Results: EDX of examined sealers subjugated to PBS showed mean Ca/P ratios that were greater than the natural HAP ratio (1.67). The NeoSEALER Flo sealer had a considerably reduced mean gap width than the DIA-ROOT sealer in an acidic environment where $P \leq 0.05$. Whereas the standard deviation as well as mean for DIA-ROOT and NeoSEALER exposed to PBS were determined, DIA-ROOT BIO Sealer formed the smallest gap, and NeoSEALER Flo formed the largest gap. Conclusion: All examined sealers (Dia-Root and NeoSealer Flo) produce calcium, aluminum, and oxygen ions in all storage media. Acidic environments have an impact on the interfacial adaptation of the tested BS to perform root canalizing on dentins.

Keywords:

Butyric acid, scanning electron microscopy, energy dispersive X-ray spectroscopy, root canal sealers, bioceramic.

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Introduction

A crucial process that is a part of endodontic treatment is the procedure of having the root canal filled and the reason behind this is that it aids in sealing accessory branches of primary root canal and the root canal which is beneficial in stopping the bacteria from entering perpendicular tissues in the root canal and also in areas between root canal (Al-Askary & Al-Jubori, 2023; Duarte et al., 2018). Gutta-percha along with a sealant for root canal is one of the common substances utilized for filling of root canals. The properties that are desirable in sealers of root canals are the ones that have sufficient radiopacity, contraction of a lower setting, particles that are small as well as thin such that they don't get the dental tissues stained, procedures that are antimicrobial, the capacity of fluids of tissues to be insoluble, a time of setting that works, biocompatibility and easy removal from the depths of the system of root canal if required (Dawood et al., 2024; Abu Zeid et al., 2022).

The BS is also called calcium silicate-based endodontic sealers, they have calcium phosphate and silicates, ceramic and bioactive glasses, hydroxyapatite, alumina, zirconia as well as silica (Assiry et al., 2023). When evaluated in vitro, BS sealers for root canal exhibit encouraging outcomes as well as outperform traditional sealers utilized for root canalizing regarding some of their properties (Benezra et al., 2018).

BS sealers for root canal are popular because of certain biological features they possess especially when they are used in situations that are clinical and also in cases where there's more chance of extrusion of material in the periodontium, like in the procedure of resorption of roots, teeth that possess an apex that is open or canals that have been overly instrumented. (Aminoshariae & Kulild, 2020; Badawy & Mohamed, 2022).

In the process of obturation of canal, the contact of sealers with the fluid surrounding apex is prevalent which because of inflammation or because of injection can have a pH that is either acidic or normal (Doğan, 2022). The BS sealer's chemical and physical properties can be negatively impacted if they have an environment around them that is acidic (Deepthi et al., 2018; Chandravanshi & Neetish, 2023) Within a week's time or probably less than that, the pH can be restored back to about 7.4 which is mildly alkaline if the endodontic treatment has a control over the tissues that are adjacent. Hence, while the process of setting takes place, the material's surfaces will be subjugated to levels of pH ranging from mildly alkaline to acidic. (Kang et al., 2021; Yang et al., 2023; Salman et al., 2023).

In this experimental study, the simulation of conditions of vivo that were both normal and infectious was carried out by PBS (phosphate-buffered saline) as well as butyric acid. Butyric acid is derived from the metabolic process of a bacteria that is anaerobic which is a microorganism that is dominant in infections that are endodontic (Nazari & Attaran Fariman, 2022). Hence, to mimic situations that are infectious in the experiments performed in labs, the suggestion of utilizing butyric acid has been made (Gunasekaran et al., 2023; Mombeini, 2018). PBS is a fluid of the tissue which consists of phosphate and so it is useful in imitating vivo conditions that are normal during experiments in labs (Bolhari et al., 2014; Paunekar et al., 2023)

Hence, this approach of a study was for the evaluation of release of ions as well as adaptation of interfaces of two BS sealers (DIA-ROOT and NeoSealer Flo) in normal conditions (PBS) and in infectious conditions (butyric acid) by making use of SEM as well as EDX. Null hypothesis of this study is that exposure to acid will not affect the composition of chemicals in BS and their adaptive ability to dentins of root canal (Fakhrian et al., 2022).

Materials and Methods

Specimen Preparation: The depiction in Table 1 shows the composition of chemicals in BS sealers. Eighty premolars that were mandibular of humans with root canals that stood single were acquired from patients between ages 18 and 25 who underwent orthodontic treatment were utilized in this study with permission from the ethical committee. Each tooth was examined with a stereomicroscope at 10X magnification to detect any root crack. To ensure a type I root canal system and the absence of calcification or internal or external resorptions, pre-operative radiographs were taken from both the mesial-distal and facial-lingual directions. If these findings were not met, the tooth would be excluded.

Before the preparation of sample, the procedures that were carried out were teeth cleansing and disinfecting them by having them immersed in a solution of 2.5% NaOCL which is sodium hypochlorite for about 2 hours, post which they were thoroughly rinsed and, in the end, they were kept inside saline solution till the upcoming procedure.

Next, the decoronation of teeth took place in the junction of cemento-enamel with the help of diamond disk placed on a handpiece with a slow speed and a coolant along with it, which helps in acquiring a root that is 14 ± 1 mm in length. The apical portion of each root (Eid et al., 2021) (2 mm from the apex) was cut horizontally and discarded with the help of diamond disk placed on a handpiece with a slow speed and a coolant along with it; after that, root disc of a thickness of 2 mm from the apical part was determined and sectioned horizontally as previously mentioned (Figure 1 A, B). A caliper that is digitalized and has a 0.01 mm precision was utilized for the measurement of the thickness in the final step (Figure 1C). In the end, the slices were held by a tweezer, and the lumens of each had their size increased with the aid of burs that is of the Gates-Glidden type of size 2 to 4 to obtain a diameter which is standardized and about 1.3 mm as shown in Figure 1D.

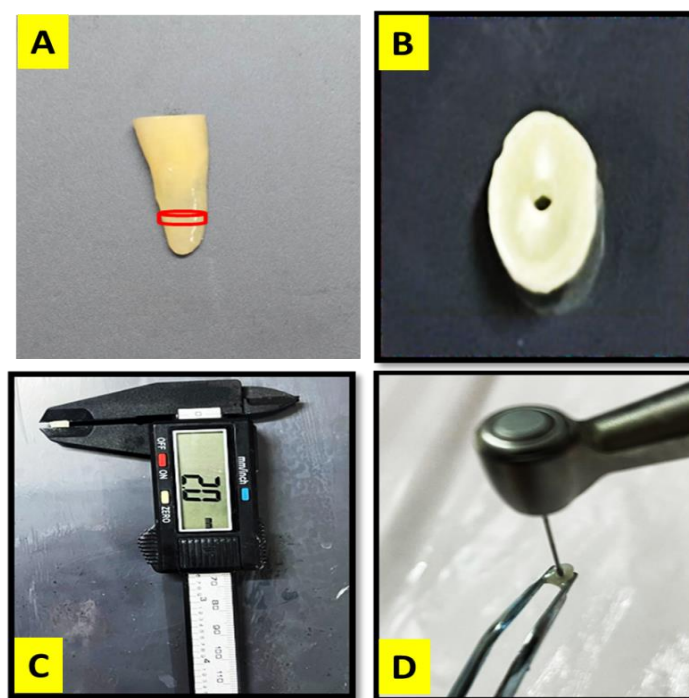


Figure 1. (A) Photograph that depicts apical slices' sites that were planned (2 mm thickness) utilized for assessment of SEM and EDX. (B) Root disc. (C) Measuring the final thickness of root slices by digital caliper (D) Preparation by Gates-Glidden burs

Table 1. The chemical composition of two bioceramic sealers

Root Canal Sealer	Manufacturer	Contents as per the Manufacturer
DIA-ROOT BIO Sealer	DiaDent, Chungcheongbuk-do, (Korea)	calcium aluminate, polyethylene glycol 400, zirconium dioxide, Calcium silicate, 1,1,1-trimethyl-n-(trimethylsilyl)-, sorbitan monooleic acid, hydrolysis products with silica, hydroxypropyl methylcellulose, silanamine, polyethylene glycol 200, ytterbium trifluoride polyoxyethylene (20), light mineral oil
NeoSEALER Flo	Avalon Biomed, Texas, (USA)	calcium sulfate, dicalcium silicate, tricalcium aluminate, calcium aluminum oxide, Tricalcium silicate, tantalite, calcium aluminate

Experimental Groups: The entire set of samples which has the value of n as 80 was segregated into groups of two in a random manner where for each sealer 40 teeth are allotted so the value of n is 40, (40 teeth) for Dia-Root, and (40 teeth) for NeoSealer Flo. The specimens which were 40 in number were further segregated into subgroups of two (so, here the value of n is 20) which were done with respect to the liquids in experimentation that is its subjection to PBS (pH 7.4) and its subjection to butyric acid of about 1 mol per liter which has a value of pH of 5.4.

The mixture of sealers was done as per the instructions of the manufacturer after which they were applied onto lumens of slices (Khan et al., 2021).

Group1 (n=40): The mixture of Dia-Root Bio sealers was done as per the instructions of the manufacturer after which they were applied onto lumens of slices.

Group2 (n=40): The mixture of NeoSealer Flo sealers was done as per the instructions of the manufacturer after which they were applied onto lumens of slices.

Twenty samples from each subgroup wrapped in gauze were immersed in butyric acid which had values of PH of about 5.4 and 20 samples wrapped in gauze immersed in PBS and were kept at 37°C inside incubators for about a week in a relative humidity of 100%. The gauze pieces that were immersed in solution will undergo replacement on an everyday basis so that a pH that is constant is maintained (Paunikar et al., 2023; Özel & Erişen, 2022) (Figure 2).

To make PBS 9.88 g of PBS powder were added to one litter of distilled water under a continuous magnetic stirrer until complete dissolution, then the pH was corrected to 7.4 either by the addition of HCl or KCl, then autoclaved for 20 min at 15 psi (manufacturer's instructions).

In preparation of butyric acid, acid of about 8.8ml was poured with distilled water of about a 100ml and was brought to a level of pH that was bout 5.4.

After letting it set for about a week, the entire set of specimens in the incubator will be taken out (Mahmmud & Al-Sabawi, 2022). Surfaces of specimen's that were subjugated to acid as well as PBS had undergone wet polishing with the aid of grinding papers of silicon carbide which were 1200-grit, also 1000-grit as well as 600-grit, they were done for about 30s for each specimen with the help of consistent irrigation of water and underwent rinsing with distilled water for about 60 sec to take out the debris of surface and were finally dried in air. (Yang et al., 2023; Patri et al., 2020).

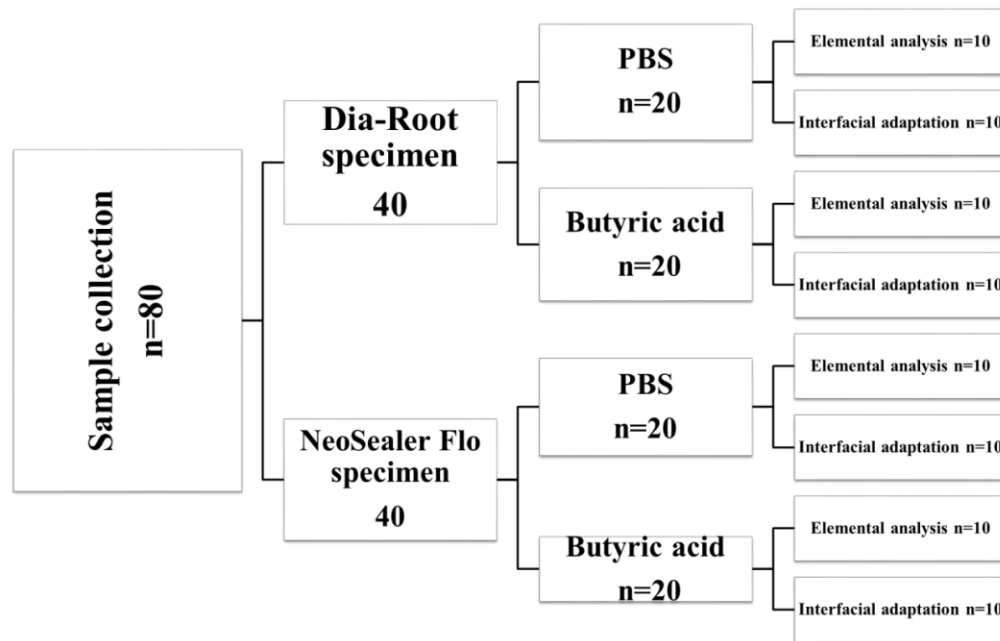


Figure 2. Study flow chart

Elemental Analysis of Bioceramic Sealers Using Energy Dispersive Spectroscopy (EDS): An analysis of the surface microstructure of specimens at the periphery of the set sealers was performed with the aid of EDX as well as SEM. The number of samples used from every subgroup were about 10. Specimens were mounted on a SEM holder, and then a coating of a layer of gold for every specimen was given for about a thickness of 10 nanometers and for a time duration of 60 seconds with the help of argon gas in a vacuum condition and also with a pressure value ranging from 10-2 bar with the help of an equipment called sputtering coater as depicted in figure 3. (Quorum, Q300T T, USA)

The main purpose of doing this is the conversion of specimen that is non-conductive to a specimen that can conduct electricity which will help in the prevention of artifacts of images (Assiry et al., 2023) after the plating of gold, adjustments are made to the SEM in an accelerating voltage of 15kV as well as 10mA. And, the composition of chemicals was evaluated by the data of EDX for the calculation of percentages of weight belonging to chemical elements in sample surfaces of sealers. (Mombeini, 2018; Yang et al., 2018).

The size of particle was evaluated with the aid of a software called ImageJ (ImageJ 1.54g, Wayne Rasband, National Institutes of Health, USA). The calibration of measurements of scale for each image was done, having the particle size's area marked by differentiating the area surrounding it (Badawy & Mohamed, 2022).

Evaluation of Interfacial Adaptation of Sealer to Root Canal Dentin: The other ten specimens from each subgroup were used in this test. The samples were prepared for SEM examination as in the previous test for elemental analysis and examined using Scanning Electron Microscope (ZEISS, version 7.01, Germany). under 5000x magnification with 15 kV voltage and 10 mA. Sealer-dentin interfacial gaps were evaluated and measured using ImageJ software.



Figure 3. (A): Sputter coater device (Quorum, Q300T T, USA), (B): Specimen fixation on aluminum stubs

The width of gap, which is evaluated in terms of micrometers, is the separation at the interface of root detin and sealer. The highest width of gaps in the interface was evaluated with the aid of photomicrographs for every sample and the submission of value for analyzing the statistics (Özel & Erişen, 2022; Yang et al., 2018).

Statistical Analysis: Analysis of the obtained data was performed using SPSS version 19.0. Shapiro-Wik test which is a normality test was implemented on the test data of this study at levels up to a value of 0.05. Independent T-tests were used to assess normal distribution of data and performance of an analysis that is non-parametric was implemented with the use of test called Mann-Whiteny U.

Results

Tables 2 demonstrate standard deviation and values of mean for bioactive element concentrations of sealers for root canals that are subjugated to butyric acid and PBS. According to the results of EDX analysis of tested sealers exposed to butyric acid, NeoSEALER® Flo released calcium ions higher than Dia-Root Bio Sealer, but there was no statistically significant difference between sealers (Table 3). When these sealers were exposed to PBS, Dia-Root BIO Sealer released the highest calcium ions, whereas NeoSEALER® released the fewest, although there wasn't any crucial difference amongst sealers in the aspect of statistics (Table 4).

Results obtained from EDX proved the existence of phosphorus in all tested specimens of sealer which were subjugated to PBS, on the other hand detection of the element was not feasible amongst those that were subjugated to butyric acid where $P < 0.05$.

Important differences were seen in silicon concentration amongst sealers in all storage media, as Dia-Root BIO Sealer did not release this element. In addition, the EDX of all tested sealers exposed to PBS represented the mean Ca/P ratios, which were above that ratio of the natural HAP (1.67); it was about 2.44 for the Dia-Root BIO sealer and about 1.94 for the NeoSealer® flo, which confirmed the formation of HAP precipitation on sealer surfaces.

EDX evaluation of Dia-Root released zirconium, fluoride, ytterbium, and aluminum in all storage media. EDX evaluation of the NeoSEALER® Flo specimen showed the presence of aluminum (Al) and tantalum (Ta) in all storage media (Figure 4).

SEM images revealed that all specimens that were subjugated to butyric acid which has a pH value of 5.4 had relatively a higher number of structures that were porous as compared to those that were subjugated to PBS (Cardinali & Camilleri, 2023). Specimens subjugated to PBS displayed more crystalline structures than those exposed to butyric acid (Donnermeyer et al., 2019). The average particle size of each sealer exposed to acid was smaller than those exposed to PBS. For Dia-Root Bio Sealer, the average size of particles was

(0.1 ± 0.8) μm at pH (5.4) and (0.3 ± 2.6) μm at pH (7.4), while for Neosealer Flo, the average size of particles was (0.2 ± 1.6) μm at pH (5.4) and (1 ± 6.7) μm at pH (7.4).

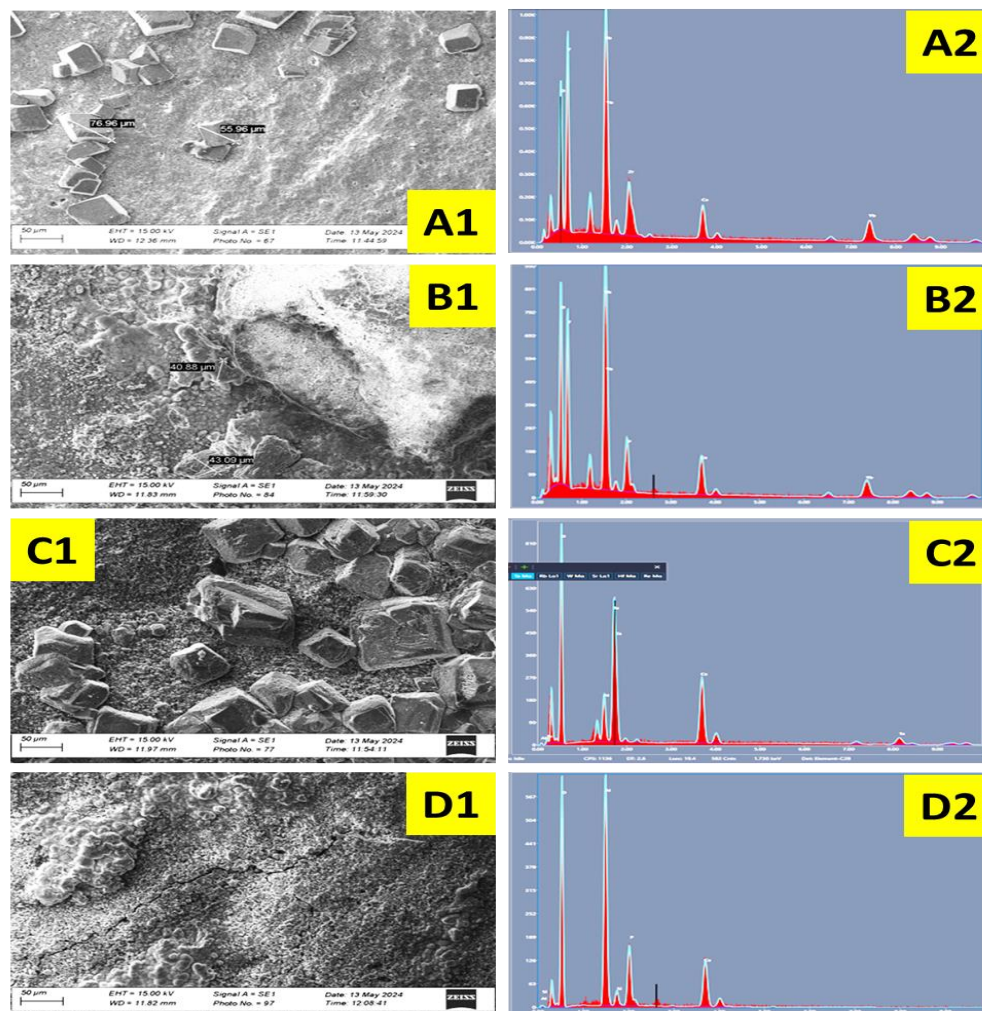


Figure 4. A SEM representative images for Dia-Root BIO Sealer and NeoSealer Flo. (A and B) Dia-Root BIO Sealer exposed to (A) butyric acid at x2.000 magnification (A1) EDX microanalysis (A2). (B) PBS at x2.000 magnification (B1) EDX microanalysis (B2). (C and D) NeoSealer Flo exposed to (C) butyric acid at x2.000 magnification (C1). EDX microanalysis (C2). (D) PBS at x2.000 magnification (D1) EDX microanalysis (D2).

Table 2. Elemental composition of Dia-Root BIO Sealer in PBS and butyric acid

Element	Groups	Dia-Root BIO Sealer	NeoSEALER Flo
Ca	Acid	16.77 ± 16.13	24.52 ± 15.38
	PBS	24.94 ± 15.01	13.9 ± 6.35
Si	Acid	0 ± 0	2.16 ± 3.31
	PBS	0 ± 0	4.84 ± 3.92
P	Acid	0 ± 0	0 ± 0
	PBS	$10.05 \pm 4.73^{**}$	$5.79 \pm 4.16^{*}$
Ca\P	Acid	0 ± 0	0 ± 0
	PBS	$2.44 \pm 0.75^{**}$	$1.94 \pm 1.25^{*}$
O	Acid	33.17 ± 27.58	45.49 ± 17.45
	PBS	37.43 ± 11.39	54.44 ± 9.16

Data expressed as mean \pm SD, ** Highly statistically significant differences at $P \leq 0.05$. * Significant differences in statistics with the help of Mann-Whitney test

Table 3. Mann-whitney test for elements concentration of root canal sealers exposed to butyric acid expressed as weight (wt%)

Element	Sealers	Mean \pm Std. Dev.	Test value	p value
Ca	Dia-root	16.77 \pm 16.13	16.5	0.112
	NeoSealor	24.52 \pm 15.38		
Si	Dia-root	0.15 \pm 0.29	27.5	0.648
	NeoSealor	2.16 \pm 3.31		
O	Dia-root	33.17 \pm 27.58	26.00	0.56
	NeoSealor	45.49 \pm 17.45		

Table 4. Mann-whitney test for elements concentration of root canal sealers exposed to PBS expressed as weight (wt%)

Element	Sealers	Mean \pm Std. Dev.	Test value	p value
Ca	Dia-root	24.94 \pm 15.01	1.915	0.076
	NeoSealor	13.9 \pm 6.35		
Si	Dia-root	0 \pm 0	3.488	0.01 *
	NeoSealor	4.84 \pm 3.92		
P	Dia-root	10.05 \pm 4.73	1.913	0.076
	NeoSealor	5.79 \pm 4.16		
Ca\ P	Dia-root	2.44 \pm 0.75	0.956	0.356
	NeoSealor	1.94 \pm 1.25		
O	Dia-root	37.43 \pm 11.39	7	0.009 *
	NeoSealor	54.44 \pm 9.16		

Tested Sealers' Interfacial Adaptation to Root Canal Dentin: The average standard deviation of the sealer-dentin interfacial gap for Dia-Root and NeoSealer subjugated to butyric acid were (5.3 \pm 0.52, 4.49 \pm 0.09) μ m. The NeoSEALER Flo had a highly statistically significant reduced mean gap width compared to the DIA-ROOT sealer where $P \leq 0.001$ as depicted in Table 5.

Standard deviation and mean for Dia-Root and NeoSealer exposed to PBS were 1.48 \pm 0.4 and 3.1 \pm 0.27 μ m, respectively (Table 5). A significant difference was discovered between sealers subjugated to PBS ($P \leq 0.05$), with Dia-Root Bio Sealer exhibiting a low gap and NeoSealer Flo showing the greatest gap generation (Figure 5).

Table 5. Independent sample t - test of dentin-sealer gap width

Groups	Bioceramic Sealer	Mean± Std. Dev.	Test value	p value
Acid	Dia-Root	5.3±0.52	4.827	0.001 **
	NeoSealer	4.49±0.09		
BPS	Dia-Root	1.48±0.4	10.565	0.001**
	NeoSealer	3.1±0.27		
** High Significant differences in statistics where P ≤ 0.05				

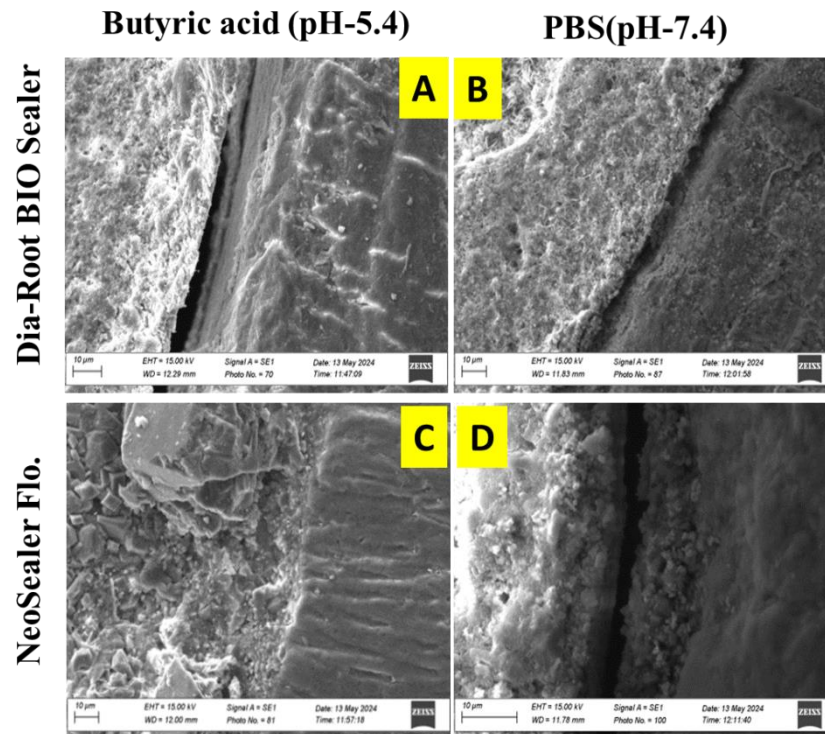


Figure 5. SEM observation of interfacial adaptation at x5.000 magnification for DIA-ROOT, NeoSealer after getting subjugated to a pH of 5.4 and 7.4 using butyric acid and PBS, respectively

Discussion

The impact that the PBS as well as acidic pH has on release of ions as well as NeoSealer Flo bioceramic sealers and Dia-Root Bio Sealer's interfacial adaptation were investigated using EDX and SEM. They were utilized to provide qualitative as well as semi quantitative measurements in bioactive elements (oxygen, silicon, calcium as well as phosphorus) and to evaluate the superficial Ca/P i.e., ratio of calcium to ratio of phosphorous, the presumption was that it would to cross 1.67 when there is an appetite formation (López-García et al., 2020; Williams, 1976).

Enhancement of angiogenesis as well as osteoinduction can be made possible with ions of calcium and silica, these are significant features in biology that help in periapical healing.

Oxygen for hydroxyl ions (OH^-), stimulates an increase in mineralization as well as proliferation of cementoblasts as well as osteoblasts (Belal et al., 2022; Jo et al., 2020). Results of this study rejected the null hypothesis because acidic environments affected the ions release and interfacial adaptation of Dia-Root and NeoSealer Flo bioceramic sealers.

The EDX analysis of this study revealed that both DIA-ROOT and NeoSEALER Flo contained calcium and oxygen ions in all storage medium, implying that calcium ions were released in all studied materials and conditions. The biological impacts of sealers in root canals that are bioceramic is that calcium hydroxide is formed while and after the hydraulic cements are set. Although, for the execution of effects that are microbiological as well as biological, there has to be a release of ions of hydroxide as well as calcium. Because of the initiation of differentiation and migration at a cellular level, ions of calcium have a crucial role in the process of mineralization (Fakhrian et al., 2022; Rajasekharan et al., 2018).

According to the result of this study, NeoSEALER contained silicon ions, while this element was not detected in DIA-ROOT BIO Sealer regardless of storage media, as confirmed by other studies.^{19, 27} The existence of oxygen, calcium as well as silicon in sealer's composition at root canals show that bioactivity would be favoured by sealers and may also have an interaction with dentin (Reszka et al., 2019; Lin et al., 2023).

The EDX for all tested sealers exposed to butyric acid did not detect any phosphorous (P) element in their components. While this element was detected in all tested sealers exposed to PBS, the source of ions of phosphate are plasma, blood, dentinal fluid as well as exudate which are biological fluids, as confirmed by other studies (Zamparini et al., 2022; Khalil et al., 2016).

In all the sealers that were tested, the composition of a sealer in the initial period did not have any trace of phosphorus but later in the solution used for immersing called PBS, phosphorus was present. Hence, because of the participation of phosphorus in apatite generation, there was phosphorous' presence seen on the surface of the material, as evident from Timis study 2023 (Timis et al., 2023).

Materials that were heavy like chromium, zinc, cobalt, manganese, lead, copper or bismuth was not a part of the materials of sealer that were tested in any setting conditions and these information obtained from the findings in the study. This is similar to Assiry et al., 2023 study, which also proved that there wasn't any existence of materials in the sealers that were tested, which were heavy like chromium, zinc, cobalt, manganese, lead, copper or bismuth.

In addition to that, Dia-Root contained ytterbium, and Neosealer contained tantalum. Dia-Root and NeoSealer Flo consisted of various radio facifiers like tantalum oxide, ytterbium trifluoride as well as zirconium oxide, respectively. There was no inclusion of bismuth oxide as it could result in tooth discoloration or there could be an impact of bismuth's toxicity when it is kept near periapical tissues (Mombeini, 2018; Zamparini et al., 2022; Lee et al., 2024; Demirci et al., 2021).

Theoretically, the Ca:P ratio in dentin was about 1.67, which is the value for pure HAP. The EDX of all tested sealers exposed to PBS represented the mean Ca/P ratios, which were above that ratio of the natural HAP (1.67); it was about 2.44 for Dia-Root BIO sealer and about 1.94 for NeoSEALER®Flo, which confirmed the formation of HAP precipitation on sealer surfaces (Jo et al., 2020).

Nowadays, the sealer as well as core material's combination is a protocol which is standardly utilized in endodontic treatment. Sealer was introduced to overcome guttapercha's lack of adhesive property. For materials that fill roots, the ability to seal well is an important requirement. After a treatment for leakage of bacteria, a seal that is tight has to be maintained and this can be achieved when the sealers bond with dentins through chemical adhesion or mechanical retention or else through both the ways. Additionally, bearing with stresses which comes while function or because of continuous treatment as coronal restoration or post-preparation, is an important factor. (Jain & Adhikari, 2018; Fattah RA et al., 2020; Al-Anazi et al., 2020).

The outcome of this particular study regarding interfacial gap in dentins and sealer showed that the mean gap width of tested sealers was increased in a significant manner after it was subjugated to a pH value of 5.4. These outcomes may be responsible for the variations in the sealer's physical as well as chemical properties in an environment where the pH is very low. Crystallization of hydroxyapatite occurs because of the material's hydration that are based on calcium and silicate while their fluids in tissues are still present and it also results in creating a layer which is hybrid in nature between materials that are calcium and silicate based as well as dentins. The two surfaces have a gap formed between them and this is because of the distribution of

crystals of hydroxyapatite as well as the hybrid layer at the interface of sealer-dentin into the environment which is acidic in nature. (Paunikar et al., 2023; Özel & Erişen, 2022; Shokouhinejad, et al., 2010; Elnaghy, 2014).

According to the result of this experimental study regarding intercomparing sealers exposed to butyric acid, Neosealer Flo had a significant difference when compared to Dia-root Biosealer. Neosealer flo showed minimum gap formation. Neosealer Flo might be less sensitive to an acidic pH environment than Dia-Root bioceramic sealers; this might be because of the difference in sealer's composition: Dia-Root is tricalcium aluminate, and NeoSealer is a combination of tricalcium silicate and tricalcium aluminate. Setting at faster rate and a resistance to acid can be achieved by having the calcium aluminate cements as well as calcium silicate combined together which can be used in the sites that are infected. (Primus et al., 2020).

For sealers exposed to PBS, Dia-Root showed minimum gap formation and Neosealer showed a higher mean gap width. This study of experiments shows, investigation of root canal's apical third section for interfacial adaptation due to the importance of this area as it is the most critical part of the root. Studies reported that the dentinal tubules were of a lower density as well as a lower diameter in apical level, which resulted in lower penetration through the sealer. Above all, it is difficult to remove layer of smear at apical third as it can physically behave as a barrier which caused interference in adaptation of sealer for the dentin's root canal.

Conclusion

All tested sealers (Dia-Root and NeoSealer Flo) release calcium, aluminum, and oxygen ions in all storage media. Ca/P ratios for all sealers exposed to PBS were above that ratio of the natural HAP (1.67), which confirmed the formation of HAP precipitation on sealer surfaces. Acidic environments affect the interfacial adaptation of the tested bioceramic sealers for the dentin's root canal, as statistically, mean gap width for all sealers that were tested subjugated to the butyric acid was higher than that for the same sealers exposed to PBS. From the study, it can be interpreted that NeoSealer Flo is a better option that can be utilized when subjugated to an environment that is acidic.

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