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COMPARING THE RETREATABILITY OF BIOCERAMIC SEALER TO RESIN SEALER USING ROTATIONAL INSTRUMENTATION SUPPLEMENTED BY IRRIGANT ACTIVATION: A LABORATORY-BASED MICRO-COMPUTED TOMOGRAPHY

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ABSTRACT

Using micro-computed tomography for assessment, this study examined the retreatability of filling materials from canals filled with Total Fill bioceramic sealer (FKG Dentaire, La Chaux de Fonds, Switzerland) and Dia-ProSeal epoxy resin-based sealer (Dia dent, Korea) sealing a gutta-percha core. According to the sealer utilized, 30 mandibular premolars were randomly allocated into two groups. Canals were retreated two weeks following obturation using Fanta retreatment kit (FANTA dental materials, China). The length of time required for retreatment was listed. After obturation, retreatment and irrigant activation (XP endo finisher R), the roots were scanned. The Wilcoxon & Mann-Whitney tests were used to assess the data. In comparison to canals filled with Dia-ProSeal, Total Fill bioceramic sealer canals showed considerably less residual filling material ($P< 0.05$). The remaining material in both groups significantly decreased with irrigant activation ($P< 0.05$). The Dia-ProSeal group was found to have considerably less retreatment time than Total Fill bioceramic sealer group ($P< 0.05$).

INTRODUCTION

It has been demonstrated that non-surgical root canal therapy has a high success rate and is a predictable technique [(1)]. Non-surgical retreatment is typically regarded as the first line of treatment in the event of failure [(2)]. Therefore, being able to be readily removed from the canal when necessary is one of the qualities of an excellent root canal filler material [(3)]. In conjunction with a sealer, gutta-percha is the substance that is most frequently utilized for root canal obturation [(4)].

In endodontics, epoxy resin-based sealers were the gold standard, and modern variations of the original formula are often employed for root canal filling procedures [(5)]. Due to their exceptional physicochemical and antibacterial qualities [(6)], epoxy resin-based sealers are often utilized.

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Calcium silicate-based root canal sealers have lately gained popularity Because of its benefits including bioactivity and biocompatibility [7]. Total Fill BC Sealer (FKG, La Chaux-de-Fonds, Switzerland) is a calcium silicate-based sealer that was developed to combine the physicochemical characteristics of a root canal sealer with the advantages of MTA's bioactivity, or its ability to form an apatite layer when in contact with phosphate-containing physiological fluids In addition, MTA is known to interact with dentine in the presence of phosphate-buffered saline (PBS) to form tag-like structures, intrafibrillar apatite deposition over time, intratubular Ca and Si incorporation, and intrafibrillar apatite deposition [8].

Manual files, Ni-Ti rotary files, solvents, heat, and lasers can all be used to remove root filling material[9]. Studies have shown that, regardless of the procedure, it is impossible to completely remove the filling material [10]. Therefore, using additional techniques to enhance filler material removal may be advantageous [11]. To improve root canal debridement, supplemental irrigant activation techniques such ultrasonic, sonic, and brushes have been employed. In order to speed up cleaning, improve canal disinfection, and get rid of the smear layer, irrigant activation has been employed during root canal therapy [12].

Meanwhile, for instances requiring retreatment, it is crucial to remove any filling components that might serve as a bacterial source and to create a healing environment. The current study's objective was to assess the retreatability of obturation materials from canals filled with gutta-percha and Total Fill BC Sealer and Dia-ProSeal together. When micro-CT is employed for assessment, the null hypothesis states that there is no difference between these sealers in terms of the amount of remaining obturated material.

MATERIALS AND METHODS

Sample selection

30 freshly removed human single-rooted lower premolars with straight roots were chosen. An 80% power analysis indicated that 15 samples per group were needed to show a difference between groups that was significant. After acquiring digital radiographs, roots with curvatures >10 degrees, immature apices, and more than one root canal were discarded. Teeth having root caries or restorations were excluded from this research, to obtain roots with a standard length of 16 mm; the teeth were decoronated using a diamond disc. A size 10 K-file (FKG, La Chaux-de-Fonds, Switzerland) was inserted into the canal until it was visible at the apical foramen, and then the working length was calculated by deducting 1 mm from this measurement.

Chemomechanical preparation

E-flex blue rotary files (Eighteeth company, China) were used to instrument canals, spinning at 350 (rpm) up to the file 40 #4. Canals were irrigated with 3 mL of 3% sodium hypochlorite (NaOCl) using a Fanta irrigation needle (FANTA dental materials, China) at each instrument change. 5 mL of 17% EDTA was used as the last irrigation for one minute, followed by 5 mL of 3% NaOCl and 5 mL of sterile saline. Using paper points (Diadent, Korea), the prepared canals were dried. Then, roots were scanned using a CT machine (Bruker SkyScan 1173 Micro-CT, Kontich, Belgium).

Obturation

Depending on the substance used to fill the root canals, the specimens (n = 30) were randomly allocated into two groups: group 1, Total fill bioceramic sealer and group 2, Dia-proseal sealer. To keep the groups uniform, a single-cone approach with matching taper was used to fill each canal. A size 40 #04 taper gutta-percha cone with tug-back was trial fitted into each canal at the working length. Since only samples with comparable apical

diameters were selected for this investigation and all specimens were pre-scanned, all specimens had tug-back. In accordance with the manufacturer's instructions, the sealers were blended. Standardised amounts of sealer placed into the root canals using a lentulo spiral, the gutta-percha cone was coated with sealer and inserted to the working length. The extra gutta-percha was cut using a heat carrier (System B, Kerr) and the orifices were filled with a glass ionomer temporary filling (GC Fuji II LC, Japan). The samples were subsequently radiographed to ensure a uniform root canal filling, and if voids were found, the specimens were discarded. At the conclusion of this process, one Total fill group specimen and one Diaproseal group specimen had voids and were discarded. Two fresh samples were chosen and added to the samples to maintain the sample size.

Retrieval strategy

FANTA Retreatment instruments were used in a crown-down manner using a brushing action with lateral pressing movements according to the manufacturer's instructions. When WL was reached and no gutta-percha could be seen on the final instrument or inside the root canal, the retreatment was said to be complete. The root canal was irrigated with 3mL of 3% NaOCl following each filing. Specimens underwent a post-retreatment scan using the micro -CT device.

Retrieval time

Stopwatch was used to measure the amount of time needed to remove the root filling. When a file was put into the canal, the stopwatch began to run, and it stopped when it was taken out. The time spent irrigating and replacing the rotary instruments in the hand piece was not timed. Also noted were procedural flaws and patency re-establishment.

Irrigant activation

The canal received 3 millilitres of 3% NaOCl. XP endo finisher R was put 2 mm short of the working length and moved vertically (2-4 mm) for 30 seconds using an endo motor (FKG, La Chaux-de-Fonds, Switzerland). The canal was then irrigated with 3 mL of 3% NaOCl, followed by 30 more seconds of reactivation. Specimens underwent a post-activation scan using the μ -CT device.

Every E-flex blue instrument, FANTA Retreatment instrument, and XP endo finisher R file were used for three specimens each before being discarded. One endodontist used a dental operating microscope to do all of the primary and retreatment operations.

Evaluation and CT scanning

To limit interoperator variability, all retreatment operations were performed blindly by the same operator. A single observer who was unaware of the group assignment evaluated the remaining filling material using CBCT imaging, measuring the remaining amount in cubic millimetres using the same settings and parameters as the initial scan. By dividing the volume of filling material covered after retreatment by the total filling material and multiplying by 100, the mean volume percentage values of the residual filling material were computed. The scan parameters for the samples were 95 kV, 86 A, 18 m pixel size, 0.25 brass filter, and 360° rotation along the vertical axis with a 0.5° rotation step. Each specimen was operated for an average of 40 minutes. After scanning, the collected images were reconstructed (N-Recon® v.1.6.1.3; Bruker Skyscan) to provide 750-800 cross sections per specimen with a 25% beam hardening correction and a 5 ring artefact reduction. From the coronal opening to the root's apex, the area of interest was present. To confirm that samples were distributed properly, post-instrumentation scans were performed.

The CTAn® v.1.17.7.2 program (Bruker Skyscan) was used to calculate the quantity of residual filling material (in mm3) inside the canal space based on the post-obturation and post-retreatment -XP activation scans. CTVol® v.2.3.2.0 (Bruker Skyscan) was employed to create color-coded pictures of the samples and visualise them in 3D.

Statistic evaluation

The data were not normally distributed, as revealed by the Kolmogorov-Smirnov test (P 0.05). In order to compare groups, Mann-Whitney and Wilcoxon tests were performed. At 0.05, the significance level was established. The analytical tool was SPSS software (version 21.0, SPSS IBM, Armonk, NY).

RESULTS

Figure 1: Images of a representative specimen from each group. All specimens had residual filling material after retreatment and after using the XP activation technique. However, in the Total fill and Dia proseal groups, the percentages of remaining filling material significantly decreased with the addition of XP endo finisher R activation (P 0.001 and P = 0.001, respectively).

Following retreatment with FANTA files and XP endo finisher R activation, the canals that had been filled with Total fill showed considerably less filling material than the canals that had been filled with Dia proseal (P = 0.048 and P = 0.006, respectively). The time needed for retreatment in canals filled with Total fill BC, however, took a lot longer (134.28 18.22 s) than it did in canals filled with Dia proseal (112.29 20.73 s) (P =.001).

TABLE (1) Shows the volume of filling material that is still present (in percent) following retreatment using the rotational system and with the subsequent of XP endo finisher R activation.

		Mean ± SD	Median	IQR interquartile range	*P* Value
Total fill	After retreatment	6.96 ± 7.17	4.59	9.43	<0.001
	After XP activation	2.88 ± 3.8	2.25	3.95	
Dia proseal	After retreatment	13.47 ± 10.91	10.64	14.42	0.001
	After XP activation	9.77 ± 9.17	6.33	13.6	
P Value*		0.048			
P Value**		0.006			

Following retreatment with rotary tools, a P* value was obtained between Total fill and Dia proseal. After using XP endofinisher R , the P** value between Total fill and Dia proseal was computed.

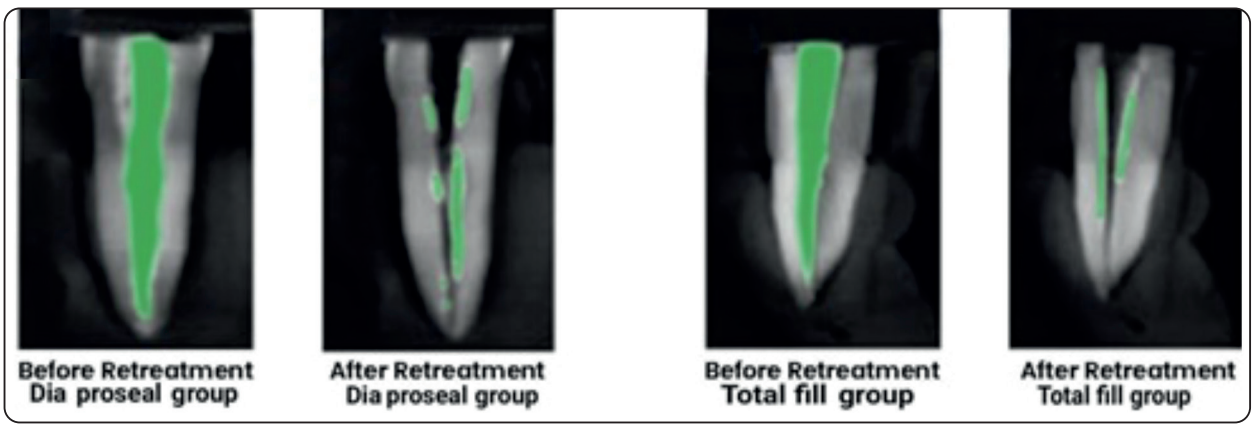

Fig. (1) Images of a representative specimen from each group. All specimens had residual filling material after retreatment and after using the XP activation technique. However, in the Total fill and Dia proseal groups, the percentages of remaining filling material significantly decreased with the addition of XP endo finisher R activation (P 0.001 and P = 0.001, respectively).

DISCUSSION

Bioceramic sealers are being used more often in endodontics for a number of purposes, including root canal closure, apexification, and pulp capping. However, a detailed investigation on the retreatability of Bioceramic sealers has not been conducted [7].

In this work, rotational instrumentation and irrigant activation procedures were used to assess the retreatability of bioceramic sealer and resin sealer. Removal of root fillings up to this point have employed after 2-week storage period in order to rule out the potential of sealer that was not fully set at the time of retreatment however patients may come back for a retreatment after several months or even years after receiving primary root canal therapy

The capacity to control undesirable factors is one benefit of in vitro investigations. In order to ensure normalcy between the two groups, the specimens were scanned following canal preparation, and the initial canal volume was statistically assessed. Gutta-percha was employed as the core component to implement the clinical situation. No solvent was employed in the current investigation to rule out a potential confounding factor as the softened gutta-percha can be forced into the abnormalities of the canal, making it more difficult to be removed [12,13].

FANTA Retreatment kit was used for this investigation, because it was specifically created for retreatment.

To make the data more reliable, care was made to standardize every conceivable variable. Standardizing irrigation amounts and/or times is a crucial issue in investigations requiring irrigant activation. While standardizing both may be absolutely hard, this study uniformed the amounts of irrigant used and the time (1 minute) among the two groups.

Numerous studies have employed micro-CT because it is nondestructive, reproducible, and capable of quantitatively measuring the remains with little operator control. However, high-resolution CBCT imaging has been described as a clinical substitute for micro-CT since it is inappropriate for usage in clinical settings [14, 15].

The results of this investigation showed that Dia proseal had more leftover filling material than Total fill did. The null hypothesis under examination was therefore disproved. The root canal sealers' and the root dentine's strong connection may be responsible for this outcome. The chemical interaction between the exposed amino groups of dentine and the epoxide rings of Dia proseal [16] may be the reason for Dia proseal stronger bond strength than Total fill[17]. Hydroxyapatite can be created by Total fill[18]. The'mineral infiltration zone' is created when minerals from calcium silicate materials permeate the intertubular dentine [19].

The physical variations between the root canal sealers— Total fill has a lesser flow than Dia proseal, for example—could be another explanation for the observed findings [20]. Due to improved and deeper penetration into canal abnormalities and dentinal tubules, the flowability of a root canal sealer helps to improve the mechanical interlocking between the sealer and root dentine [21].

This investigation demonstrated that the rotary retreatment technique could not entirely remove the filler material. This is consistent with other investigations[22]. To enhance the removal of filler remains, it has thus been advised to utilize supplemental procedures.

This study also sought to determine whether adding a finisher tool phase would enhance cleaning. For this, independent of the pretreatment group, the specimens that still contained filling remains underwent a finishing procedure using the XP-endo finisher R file. The XP-endo Finisher file was shown to be efficient in increasing elimination of filling material leftovers in a prior study [23]. For retreatment, the XP-endo Finisher R was developed. The results of the current investigation showed that the filling material removal was also enhanced by the use of the XP-endo Finisher R files.

The results of the current study demonstrated that XP-endo Finisher R-irrigant activation improved filling removal in the Dia proseal group. Different methodology, such as sample selection, retreatment procedures, and assessment methods, may account for the contradictory results reported in the literature.

The favourable impact of XP endo finisher activation can be attributed to its vibration, which causes the canal irrigant to move continuously and improve filling removal. However, none of the retreatment procedures could entirely clear the canal space of the filler materials. This is consistent with other research [24].

The type of sealer has an impact on the retreatment time, per the current findings. This concurs with other research [25]. The Dia proseal group in this investigation reported a much quicker retreatment time than the Total fill group. This discovery conflicts with a previous investigation [25].

Regarding clinical safety, there were no instrument separations or other procedural blunders during the retreatment process. This might be connected to sample choice. Straight channel premolars were chosen for the investigation. Therefore, more research must be done on specimens with more complex anatomical configurations.

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