

APICAL HEALING, RESORBABILITY, AND DIGITAL RADIODENSITY AFTER APICAL EXTRUSION OF TOTALFILL VERSUS AH-PLUS SEALERS (ONE-YEAR RETROSPECTIVE STUDY)

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ABSTRACT

Objectives: This one-year retrospective study evaluated the effect of unintentionally apically-extruded sealers (bioceramic versus epoxy-resin) on apical healing, sealers' resorbability, and sealers' digital radiodensity.

Materials and Methods Thirty patients with root canal treatment showing unintentional apically-extruded sealer (n= 15 for TotalFill sealer, and n= 15 for AH-plus sealer) were included in the study. One-year recall radiographs were compared with immediate post-obturation ones for presence or absence of apical healing, and extruded sealer's resorption, and digital radiodensity, using digital radiography. Data were statistically analyzed using Mann Whitney U-test and student-t test.

Results: TotalFill recorded higher observations (1.67) of apical healing as compared to AH-Plus (1.2). The difference was statistically significant $P \leq 0.05$. Regarding sealer resorption, TotalFill recorded lower observations (0.06) as compared to AH-Plus (0.4). The difference was statistically significant $P \leq 0.05$. Digital radiodensity of TotalFill (37.46) was higher than that of AH-Plus (-19.73). The difference was statistically significant $P \leq 0.001$.

Conclusions Within the limitations of the present study, TotalFill recorded higher observations of complete apical healing, compared to AH-Plus. TotalFill had a lower dissolution (resorbability) rate when compared to AH-Plus within the 12 months' timeframe. Digital radiodensity of TotalFill increased by time when compared to the declining radiodensity of AH-Plus within the same period of time.

KEYWORDS: Root canal sealers, bioceramic sealers, TotalFill, epoxy-resin sealers, AH-Plus, apical extrusion, apical healing, sealers' resorbability, digital radiodensity.

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INTRODUCTION

The purpose of obturation is to seal all portals of exit and perfectly flow and adapt to all micro-irregularities of the root canal system. This would not be achievable unless the root canal system has been already prepared to aseptically receive the filling material. Successful endodontic treatment depends on the leakage-proof quality of obturation and coronal restoration^[1]. The quality of the endodontic treatment is usually evaluated using radiographic images upon completion of obturation^[2]. The intraradicular space should confine the filling material within 0-2mm short of the root apex^[3].

Wide canals with immature apices, apical over-instrumentation, and use of undue force with piston-like effect during intra-radicular maneuvers; all can be identified as potential factors that facilitate extrusion of the intra-canal contents beyond the root apex. The extruded material might be pathogens, necrotic tissue, irrigants, intra-canal medicaments, or filling materials.^[4,5]

Minimal extrusions are well-tolerated by the periradicular tissues, provided that the material is soluble in tissue fluid, resorbable, biocompatible, and the local environment is infection-free^[6,7]. The apically-extruded filling materials might slow-down or impair the healing process of teeth with apical periodontitis^[8,9].

Being newly introduced to the market, information regarding the solubility of the apically-extruded bioceramic sealer and its effect on healing of the periapical tissue is scarce.

The aim of this one-year retrospective study was to compare the effects of apically-extruded bioceramic sealers versus epoxy-resin sealers on apical healing, sealers' resorbability and radiodensity using digital radiography.

MATERIALS AND METHODS

The teeth included in the present study are part of 400 teeth (from 383 patients) treated by the author in his clinic using a standardized treatment protocol over a period of 12 months (from July 2016 to July 2017). 89 teeth (from 82 patients) exhibited apical sealer extrusion in the immediate post-obturation radiograph. 30 patients (n= 15 for AH-plus sealer, and n= 15 for TotalFill sealer) with root canal treated mandibular first molars with one-year postoperative recall radiographs were included in the study. Apically overextended gutta-percha was not included in the study. All teeth were clinically diagnosed with chronic apical periodontitis at the time of treatment and confirmed radiographically by presence of mild to moderate apical radiolucency. The assigned patients for the study were free from systemic or immunological diseases that might hinder the healing process with an age range of 20 -35 years old.

The standardized root canal treatment protocol was performed using a strict aseptic technique with rubber dam isolation. The working length was established 1mm short off the root apex as indicated by the electronic apex locator (Raypex-6, VDW GmbH, 81737 Munchen, Germany) and confirmed by working length radiographs.

ProTaper-NEXT niti rotary files (Dentsply, Maillefer, CH- 1338 Ballaigues, Switzerland) were used for canal preparation in all cases. Care was taken to avoid violation of the apical constriction. Irrigation was frequently done using copious amounts of 3% sodium hypochlorite with a #30-gauge Flexi-Glide needle (Inter-Med, Inc. Racine, WI 53404, USA). 2ml of 17% EDTA (SmearClear, SybronEndo, Glendora, CA 91740, USA) were agitated inside the canals for 1 minute before a final flush with the hypochlorite solution followed by distilled water. All teeth were treated in single visits.

Obturation was done with the lateral compaction technique of gutta-percha and the sealer. The used sealers were the bioceramic TotalFill (Brasseler Savannah, GA 31419, USA) or AH-Plus (De-Trey GmbH, Konstanz, Germany). All immediate post-obturation digital periapical radiographs (Kodak Dental Imaging Software 6.14.0, Carestream Health Inc, 2014) were taken using the parallel cone technique. The radiographic parameters were standardized and set at 60kV, DC, 7mA and 0.1 Sec, using HelioDent DS x-ray machine (Sirona Dental Systems, GmbH, Germany). All selected cases had a permanent (amalgam or composite) coronal restoration.

Follow-up Examination

Again, the standardized conventional straight cone-projection technique was used to take one-year follow-up intra-oral digital periapical radiographs. Radiographic assessment (comparing the immediate post-obturation versus the one-year post-obturation radiographs) was done blindly by two separate examiner endodontists. Three main points of comparison were targeted; apical healing, sealer resorption, and extruded sealer radiodensity.

Periradicular tissue was considered healthy when the periodontal ligament space was of normal width

and contour and when the surrounding radiolucency turned into normal bone appearance or started to show signs of bone filling (fig-1). Scores of apical healing were; “0” = no healing, “1” = incomplete healing, and “2” = complete healing.

Assessment of sealer resorption was based on absence or presence of the apically extruded sealer. “0” = non-resorbed sealer and “1” = resorbed sealer. Digital radiodensity of the extruded sealer was quantitatively measured in pexels using the densitometric analysis tool (fig-2) available in Kodak Dental Imaging Software. Change in digital radiodensity was calculated by subtracting the immediate post-obturation record from the one-year post-obturation record. When examiners’ evaluations were contradictory, a third examiner was consulted.

Data Analysis

For statistical analyses, KyPlot statistical software program was used (KyPlot Version 2.0 beta 15 @1997-2001 Koichi Yoshioka). Mann-Whitney U-test for unpaired data was used to compare the sealers’ data of the apical healing and sealers’ resorption. On the other hand, Student t-test was used to compare the sealers’ data related to digital radiodensity.

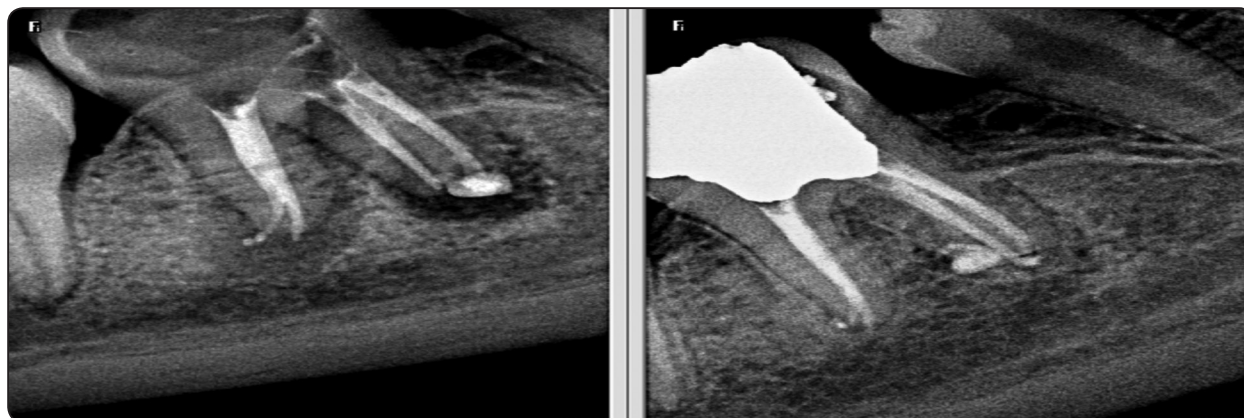


Fig. (1) Radiographic signs of good apical and periradicular healing when combined with clinically asymptomatic tooth denote successful root canal treatment.



Fig. (2) Measurement of the digital radiodensity of the apically extruded sealer (in pexils) using the densitometric analysis tool available in Kodak (CareStream) Dental Imaging Software.

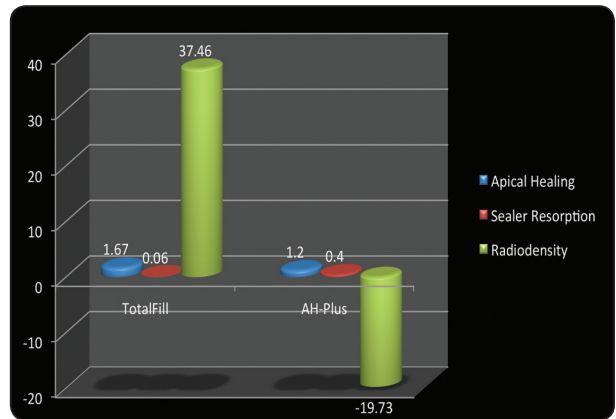


Fig. (3) Mean records of apical healing, sealer resorption and radiodensity of TotalFill bioceramic sealer as compared to AH-Plus epoxy-resin sealer. Digital radiodensity of AH-plus is erected in the negative direction of the Y-axis, indicating a decrease in density of the sealer by time.

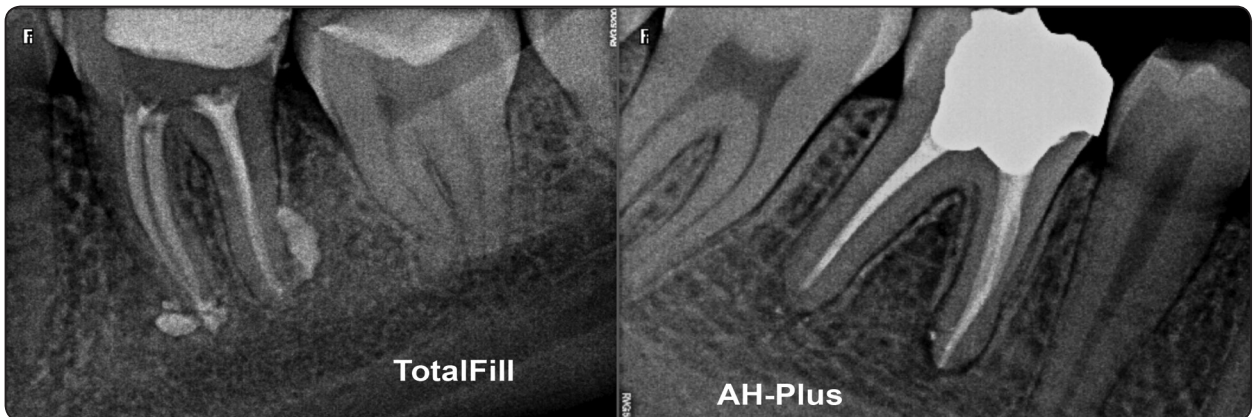


Fig. (4) One-year post-obturation recall radiographs for cases with extruded TotalFill (Lt.) and AH-Plus (Rt.) sealers. Notice the high resorption rate of the extruded AH-plus with incomplete healing compared to TotalFill.

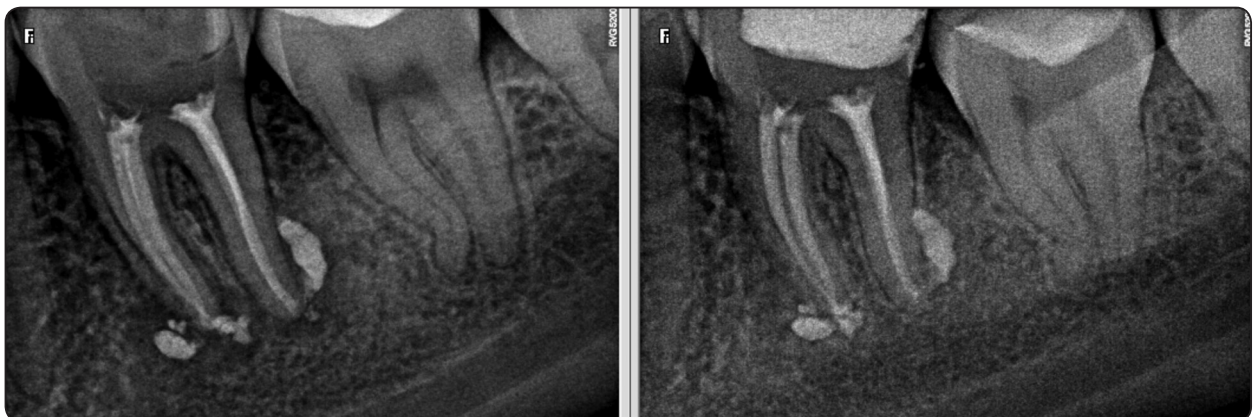


Fig. (5) Immediate post-obturation (Lt.) and one-year recall radiograph (Rt.) for cases with extruded TotalFill. Notice the slow rate of extruded sealer resorption and the excellent periradicular healing despite the presence of huge amount of extruded sealer.

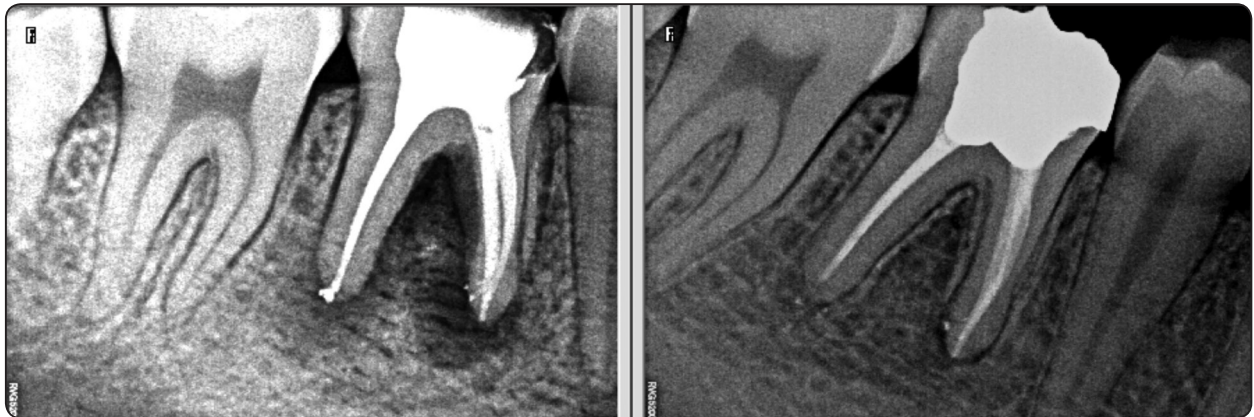


Fig. (6) Immediate post-obturation (Lt.) and one-year recall radiograph (Rt.) for cases with extruded AH-Plus. Notice the high rate of extruded sealer resorption and the incomplete apical healing.

RESULTS

In general, the calculated means of different test variables can be summarized as follows; TotalFill recorded higher observations (1.67) of apical healing as compared to AH-Plus (1.2). The difference was statistically significant $P \leq 0.05$ (table-1, figs-3, 4, 5, 6). Regarding sealer resorption, TotalFill recorded lower observations (0.06) as compared to AH-Plus (0.4). The difference was statistically significant $P \leq 0.05$ (table-2, figs-3, 4, 5, 6). Digital radiodensity of TotalFill (37.46) was significantly higher than that of AH-Plus (-19.73). The difference was statistically significant $P \leq 0.001$. (table-3). The negative value of the mean radiodensity record of AH-Plus sealer indicates a declining digital radiodensity by time. It worth noting, that none of the examined cases in the follow-up visit was clinically symptomatic.

TABLE (1) Mann-Whitney U-test applied to the mean records of apical healing observations.

	TotalFill	AH-Plus	Total
N	15.00	15.00	30.00
Mean	1.67	1.20	1.43
Median	2.00	1.00	1.00
t0	2.22		
P-Value	* ($P \leq 0.05$)		

TABLE (2) Mann-Whitney U-test applied to the mean records of sealer resorption observations.

	TotalFill	AH-Plus	Total
N	15.00	15.00	30.00
Mean	0.06	0.40	0.23
Median	0.00	0.00	0.00
t0	2.09		
P-Value	* ($P \leq 0.05$)		

TABLE (3) Student t-test applied to the mean records of digital radiodensity readings.

	TotalFill	AH-Plus
N	15.00	15.00
Mean	37.46	19.73
S.D.	13.40	31.79
t0	6.42	
P-Value	*** ($P \leq 0.001$)	

DISCUSSION

This retrospective study evaluated cases of unintentional post-obturation apical extrusion of sealers for the effect on apical healing, resorbability and digital radiodensity of the extruded sealer. The European Society of Endodontology (ESE) released guidelines in 2006 stressing the importance of assessment of the outcome of root canal treatment at least after 1 year and later on as required. Hence, one-year postoperative follow-up or assessment is a cornerstone in determination of the outcome (success or failure) of root canal treatment. ESE also listed some findings to indicate success of treatment e.g., absence of pain, swelling, no sinus tract, no loss of function, and radiographically normal width and continuity of the periodontal ligament space ^[10].

Apical root resorption, immature apices, apical over-instrumentation, and use of undue force with piston-like effect during canal obturation are among the most common causes of filling overextension ^[11, 12].

TotalFill represented the category of bioceramic sealers, while AH-Plus represented the widely used epoxy-resin based sealers. Overall, results revealed that apical healing was not affected negatively in presence of the extruded TotalFill, even if the extruded amount was huge (fig-5). Moreover, complete apical healing was more evident in case of TotalFill as compared to AH-Plus. Incomplete apical healing was more evident in follow-up radiographs of AH-Plus sealer (fig-6). Resorbability of both sealers increased with time. However, TotalFill had an extremely slower rate of resorption than AH-Plus (fig-4). An increase in digital radiodensity in relation to time was evident in the readings of most extruded TotalFill cases. Increased radiodensity and the low solubility rate of the extruded TotalFill might indicate that bioceramic sealer might act as an osteoinductive and osteoconductive material that accelerates healing and adsorbs more minerals from the surrounding tissue, a suggestion that requires further investigations.

The present results showed a higher solubility and resorbability rate of the extruded AH-Plus sealer compared to TotalFill sealer by the end of the 12 months' time-frame. This finding corroborates with Augsburger et al 1990 ^[8] and contradictory to Recucci et al 2016 ^[13] who revealed that only 15% of the AH Plus cases showed complete removal of the extruded material in periods longer than 4 years.

Despite the differences in resorbability rate of either of the test sealers, none of them invited recrudescence or failure. Most of the contemporary sealers have a short-term inflammatory response that resolves by time ^[14-17]. Several studies ^[13, 18] showed that most sealers lose their irritating potential and become inert by time. Moreover, concomitant infection rather than overfilling's cytotoxicity was blamed for failure of most cases with delayed apical healing or no-healing. In another study ^[19], it was revealed that extruded biodegradable sealers minimize the risk of infection and accelerate apical healing, a characteristic that was recommended by Grossmann ^[20].

The present retrospective study has its own limitations. First, the bi-dimensional radiographic description of the presence or absence of the extruded sealer and apical healing should have been augmented by histologic and histochemical analyses studies to quantify the amount of the extruded material. Second, being retrospective in nature, the study did not permit proper randomization of cases.

CONCLUSIONS

Within the limitations of the present study, TotalFill recorded higher observations of complete apical healing, compared to AH-Plus. TotalFill had a lower dissolution (resorbability) rate when compared to AH-Plus within the 12 months' timeframe. Digital radiodensity of TotalFill increased by time when compared to the declining radiodensity of AH-Plus within the same period of time.

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