Healing of Apical Periodontitis After Endodontic Treatment With and Without Obturation in Dogs

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Abstract

The principle of obturation of the root canal space is generally accepted. This belief has dominated the field of endodontics despite the absence of credible scientific evidence. Little information is available on the possible relationships between endodontic success and obturation of the root canal system. The present study compares the healing of instrumented and obturated versus instrumented and nonobturated root canal systems with apical periodontitis. Fifty-six root canals in 28 third and fourth bilateral lower premolar teeth with completely formed apices in seven mixed German Shepherd dogs were used. Apical lesions were created by accessing the canals, removing the pulp and leaving them open to the oral environment for 42 days. The teeth in the control group were instrumented, irrigated, and then obturated using a lateral condensation technique with gutta-percha cones and AH26 Plus as the endodontic sealer. The teeth in the experimental group were instrumented and irrigated without obturation. All teeth in both groups were sealed coronally. After 190 days, the animals were euthanized. Vital perfusion with 10% formalin through common carotid artery was performed. Thirty to 40 serial 5-μm thick sections were obtained from each root and stained with hematoxylin and eosin for histological evaluation by observer blinded to the treatment allocation. The control group showed less cementum and dentin resorption in comparison with test group ($p < 0.5$). No statiscally significant difference was found in other parameters between the control and test groups ($p > 0.05$). The noteworthy finding of this study was that there was no difference in healing of apical periodontitis between the instrumented and obturated and instrumented and nonobturated root canal system. The success of endodontic treatment ultimately depends on the elimination of the microorganism, host response and mechanical closure (coronal seal) of treated root canals that may provide a potential for future bacterial contamination. *(J Endod 2006;32:628–633)*

Key Words

Apical periodontitis, histology, inflammation, obturation, resorption

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The success and failure of endodontic therapy was traditionally based on sterilization of the root canal system and the need to achieve a hermatic seal. The basis for this belief came from Hunter's focal infection theory (1), Rosenow's concept of elective localization (2), and the hollow-tube theory by Rickert and Dixon (3). They reported evidence of inflammation around open ends of implanted hollow tubes that led to the conclusion that when canals are poorly filled, the space provokes inflammation. Kalnins et al. (4) reported that organic matter might pool in the unfilled root canal and become infected. Seyle (5) and Torneck (6) questioned this theory by studying glass and polyethylene tube implants, respectively, and found little or no inflammation around the open ends of tubes.

Filling the canal has always been assumed. There have been many studies on filling length (short, flush, and long), over filled as opposed to over extended and leakage studies (from isotopes, dyes, saliva, and viable bacteria); however, no studies have been conducted on whether or not filling is necessary. The only discussion on filling space was the hollow tube theory that was disproved by Torneck (6). There are also many studies on filling materials from sparrow dropping to wires, N2, silver cones, gutta-percha cones to thermaphil and resilon. Even today dentists believe cases fail because they are not filled properly. In theory if we can sterilize the canal and prevent coronal leakage, then a filling should not be necessary. We have all seen very poorly filled canals with no symptoms or periradicular radiolucencies. These are not the majority but the concept of no filling has not been tested.

The purpose of this study is to investigate the importance of obturation in healing of periapical periodontitis.

Materials and Methods

Fifty-six root canals in 28 third and fourth bilateral lower premolar teeth with completely formed apices in seven mixed German Shepherd dogs, aged 1.5 to 2 yr, weighing 51 to 60 pounds were used. The animals were first anesthetized with an intravenous injection of 5% Sodium Thionembutal (10 mg/kg body weight). An access opening was made with spherical carbide burs. After pulp removal and irrigation with saline, the root canals were instrumented with #25-40 K-file (Dentsply Maillfer, Tulsa, OK). The teeth were left exposed to the oral environment for 42 days. After isolation with a rubber dam and disinfection with 0.3% iodoethanol (0.3% iodine in 70% alcohol), the root canals were instrumented by using the crown-down technique and irrigation was performed with abundant 5.25% sodium hypochlorite. The apical foramen was enlarged with sequential K-files (sizes #15-40) in the total length of the root. The apical delta was removed. Working length was established at 1.5 to 2 mm short of the radiographic apex. Instrumentation was performed sequentially with Gates Glidden #2 and 3 and K-files to size 70 to the working length (confirmed radiographically) and irrigated using 3.6 ml of 5.25 % sodium hypochlorite solution at every file change. After preparation, the root canals were irrigated with saline, aspirated and dried. EDTA was placed and agitated for 3 min with K-files. Saline was used for irrigation/aspiration and then dried with absorbent coarse paper points (Dentsply).

The teeth in each animal were randomly divided into control and experimental groups. This resulted in 28 roots filled and 28 nonfilled. The teeth in the control group were obturated using the lateral condensation technique with gutta-percha cones and AH26 Plus endodontic sealer (Dentsply De Trey Gmbh, Konstanz, Germany). The experimental group remained unfilled. All teeth in both groups were sealed coronally with a fourth generation adhesive (Scotch bond multi purpose, 3M company) and a high copper nonguma 2 amalgam. First, following the manufacture's instructions, all teeth

TABLE 1. Score of histological parameters in both groups

Parameters Groups	Cementum Dentine Resorption				Bone Resorption			Inflammatory Infiltration			PDL Thickness			Cementum Formation		Radiographic Observation			
	0	1	2	3	0	1	2	0	1	2	0	1	2	0	1	0	1	2	3
Test group (percent)	8	20	52	20	28	32	40	36	32	32	40	20	40	32	68	24	52	12	12
Control group (percent)	0	12	28	60	16	28	56	12	60	28	28	20	52	36	64	16	48	32	4
p-value	0.031				0.336			0.342			0.38			1.00		0.518			

were etched for 15 s, rinsed for 15 s, and air-dried for 2 s. Activator was then applied for 5 s, primer for 5 s, and then the adhesive and catalyst mixed and applied on all surfaces of the teeth. Amalgam was placed, condensed and burnished with a ball burnisher. Amalgam was condensed into the orifice of the experimental group.

After 190 days, the animals were euthanized with an anesthetic overdose. Vital perfusion with 10% formalin through the common carotid artery (using Pedrello pump, made in Italy) was performed. The mandible was removed and from canine to M1 of each mandible was sectioned and fixed in 10% formalin. The teeth were individually separated and fixed in a buffer solution of sodium cacodylate with saccharose and glutaraldehyde. The samples were decalcified in 10% formic acid for 18 to 20 days. The samples were then placed in carbonate lithium for 5 min to neutralize the formic acid. Thirty to 40 serial 5-μm thick sections were obtained from each root and stained with hematoxylin and eosin.

A Zeiss binocular photomicroscope (BX41 made by Olympus, Japan) was used to evaluate the following: (A) inflammatory infiltrate; 2 = absent/slight, (less than 1000 chronic inflammatory cell was seen in 10 high power field (HPF), 1 = moderate (between 1000 and 5000 chronic inflammatory cell was seen in 10 HPF), 0 = severe (more than 5000 chronic inflammatory cell was seen in 10 HPF). (B) cementum and dentin resorption; 3 = absent (cementum-dentin), 2 = less than 1 mm (cementum), 1 = more than 1 mm resorption from normal architecture (cementum), 0 = both cementum and dentin resorption, (C) bone resorption; 2 = absent /slight (less than 0.5 mm), 1 = moderate (0.5-1 mm), 0 = severe (more than 1 mm); (D) periodontal ligament (PDL); 2 = normal or slightly thick (less than 0.5 mm), 1 = moderately thick(1-2 mm), 0 = severely thick (more than 2 mm). (E) formation of new cementum; 1 = present, 0 = absent. (F) radiographic observation; 0 = PDL thickness of greater 2 mm, 1 = PDL thickness of 1 to 2 mm, 2 = PDL less than 1 mm, 3 = normal PDL.

In this study Normal Architecture referred to the normal outline of the root, bone and periodontal ligament and was determined objectively. The pathologist who evaluated the specimens was calibrated and blinded to the groups being evaluated. Values of 0, 1, 2, and 3 (worst to best) were given to each parameter analyzed for statistical analysis.

Statistical analysis of the importance of obturation in the healing of periapical periodontitis was carried out using the Wilcoxon test to evaluate the inflammatory infiltrate, cementum, dentin resorption, bone resorption, and periodontal ligament. The McNemar test was also used to evaluate formation of new cementum.

Results

The overall histological results for the test and the control groups are summarized in Table 1. The major finding of this study was the fact that there was no statistically significant difference in any of the parameters between the control and test group ($p > 0.05$). Instrumented and obturated versus instrumented and nonobturated teeth have the same amount of bone resorption, inflammatory infiltrate, and thickness of periodontal ligament. The test group showed more resorption of both dentin and cementum.

As Table 1 shows root resorption (both in cementum and dentin) was found in 8% of teeth in the test group and none of the teeth in the control group (Table 1, Fig. 1). The difference between these two groups was statistically significant ($p = 0.031$). Cementum resorption less than 1 mm was also noted in 52% teeth in the test group and in 28% of teeth in the control group (Table 1, Fig. 1). Five cases in the test group and three cases in the control group showed cementum resorption more than 1 mm from normal architecture (Figs. 1 and 2). Also cementum formation occurred in 68% of the test group versus 64% of control group (Table 1).

Forty percent of the test group and 56% of the control group did not show resorption of bone (Table 1, Fig. 3). Severe apical bone resorption noted in 28% of the test group and 16% of the control group (Fig. 4). The difference between these two groups was not statistically significant ($p = 0.336$). Moderate inflammation also occurred in 60% of the control group versus 32% of the test group (Fig. 5).

Radiographic observation reveals that 24% of the cases of the test group and 16% of the cases of the control group had periodontal ligament thickness of greater than 2 mm (table 1). Meanwhile 12% of the test group and 4% of the control group had a physiological PDL thickness. The difference between the two groups was also not statistically significant ($p = 0.518$, Table 1).

Discussion

To evaluate the role of obturation in periapical repair, it was necessary to create apical pathosis by leaving the tooth open for a period of 6 weeks, then clean and shape the infected canals. The cleaned canals were randomly divided into control and test groups. The control groups were not obturated to assess the role of obturation in the healing of periapical pathosis.

The major finding of this study was the fact that there was no statistically significant difference in any of parameters between the control and test group ($p > 0.05$). Obturated and nonobturated teeth had the same amount of bone resorption, inflammatory infiltrate, and thickness of periodontal ligament, except cementum and dentin resorption. In other words, there was not any difference between the healing of unfilled and filled teeth.

The test group showed more resorption of both dentin and cementum; however, cementum resorption of more than 1 mm noted in 20% of test group compare to 12% of the control group and only 8% of the test group showed both dentin and cementum resorption. Interestingly enough is the fact that new cementum formed more in the test group (68%) versus 64% of the control group, however this was not statistically significant. Moderate inflammatory infiltrate also was present in 60% of the control compare to 32% of test group.

Our findings are in agreement with Madison (7) and Troabinejad et al. (8) in the importance of coronal seals. The integrity of the coronal seal and three dimensional cleaning, shaping, and

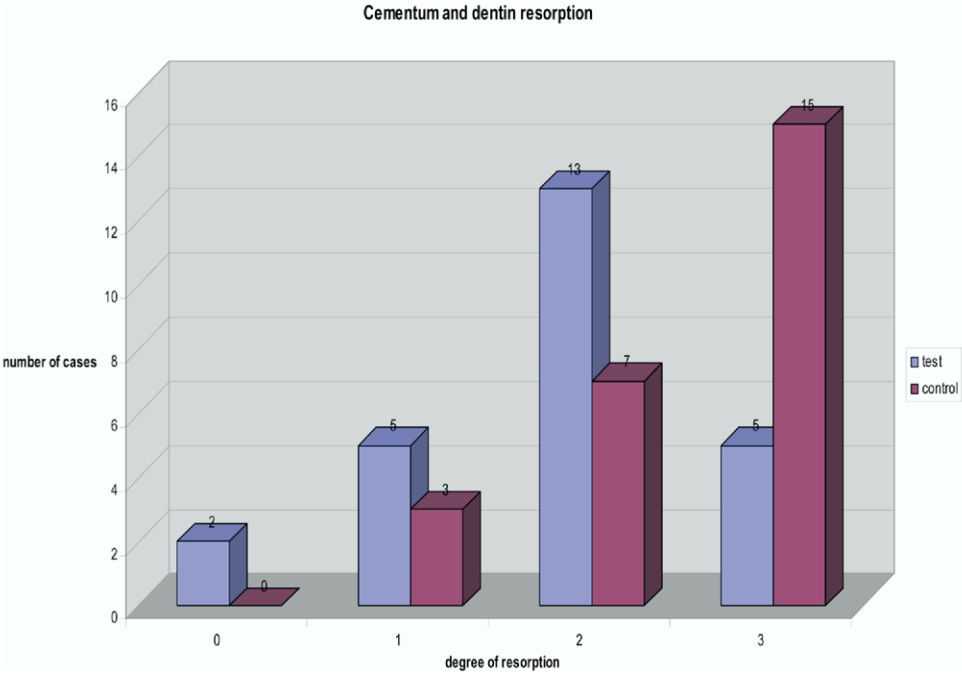

Figure 1. Degree of cementum and dentin resorption.

chemical irrigation seems to be the vital elements in endodontics success. In agreement with their findings, all teeth in both groups were sealed coronally with a fourth generation adhesive (Scotch bond multi purpose, 3M company) and a high copper nonguma 2 amalgam. Our findings also strongly support the findings of Barthel et al. (9) who found a strong tendency for teeth with radiographically insufficient coronal restorations or no coronal restorations to have a histologically inflamed periapex. These findings also support the findings of Ray and Trope (10) who found the quality of the coronal restoration was more important than that of the root filling for periapical health.

Interestingly enough is the fact that low-grade inflammation was present in most of the specimen at the time of histology. This is in agreement with the findings of Brynolf (11), Rowe (12), and Seltzer (13). Green et al. (14), question the findings of Brynolf and state that her findings are not applicable to current clinical practice

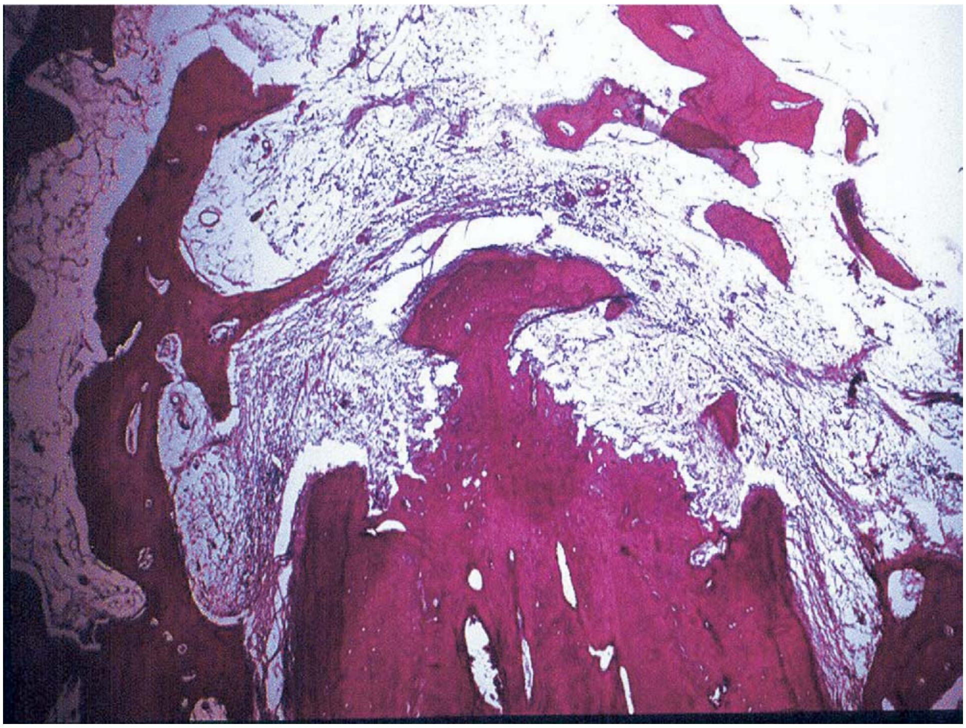

Figure 2. Histological section of a root that received score 1 for cementum resorption of more than 1 mm.

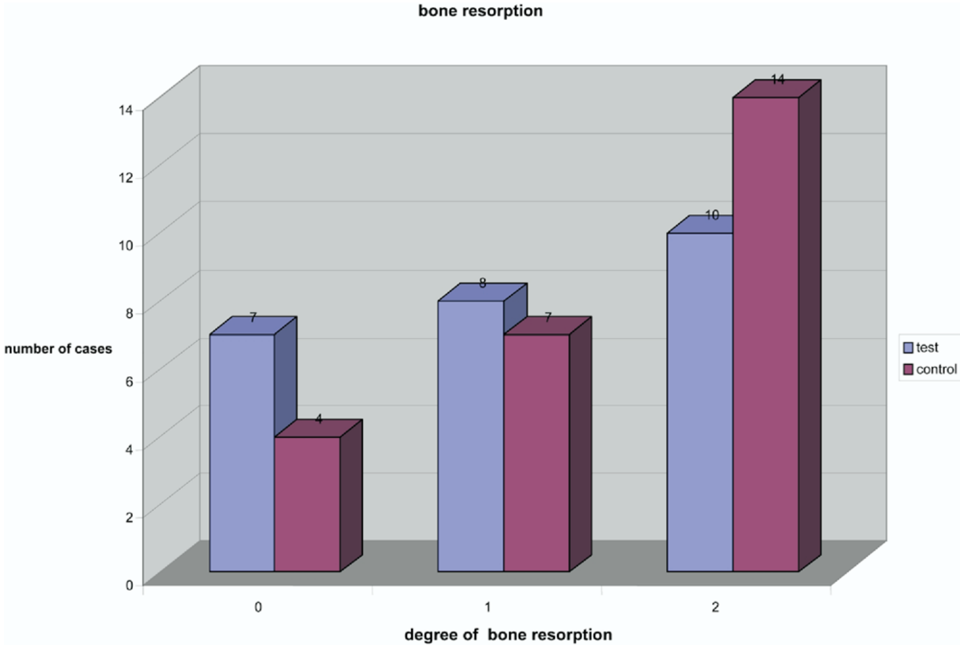

Figure 3. Degree of bone resorption.

because of differences both in treatment technique and methods of radiographic and histological analysis; However, even Green et al. demonstrated that the 19 specimens without periapical radiolucencies displayed a variety of histological findings varying from none to slight to moderate inflammation. There were 26% of these specimens that appeared radiographically normal had histological signs of inflammation. Barthel et al., in her study, also found that the positive predictive value was 0.81, whereas the negative predictive value was 0.67. This means that if an apical lucency was detected, it was inflamed in 81% of the cases, and if an intact PDL was radiographically diagnosed, only 67% of the cases were histologically not inflamed. This may not be clinically relevant in success and failure, however, it can affect the patient's future treatment by formation of a softer bone in the apical region if the tooth was lost.

Healing and no healing are histological terms and support our findings that chronic inflammation may be present even after treatment. Therefore, these terms may not be a good indicator to evaluate the clinical success or failure of a treatment. Furthermore, the phe-

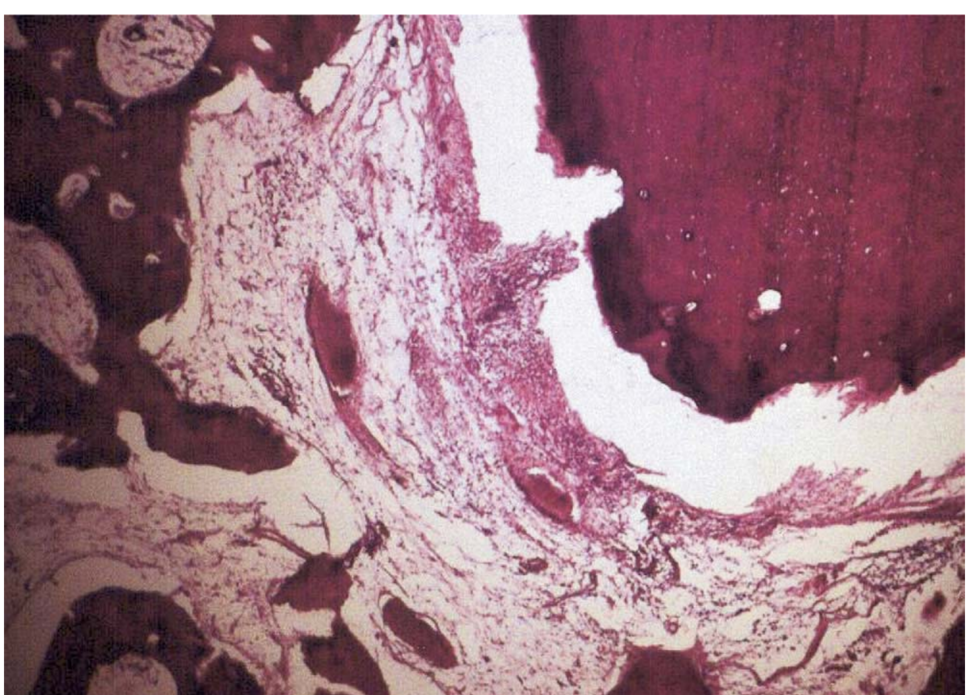

Figure 4. Histological section of a root that received score 0 for severe destruction of apical and cortical bone.

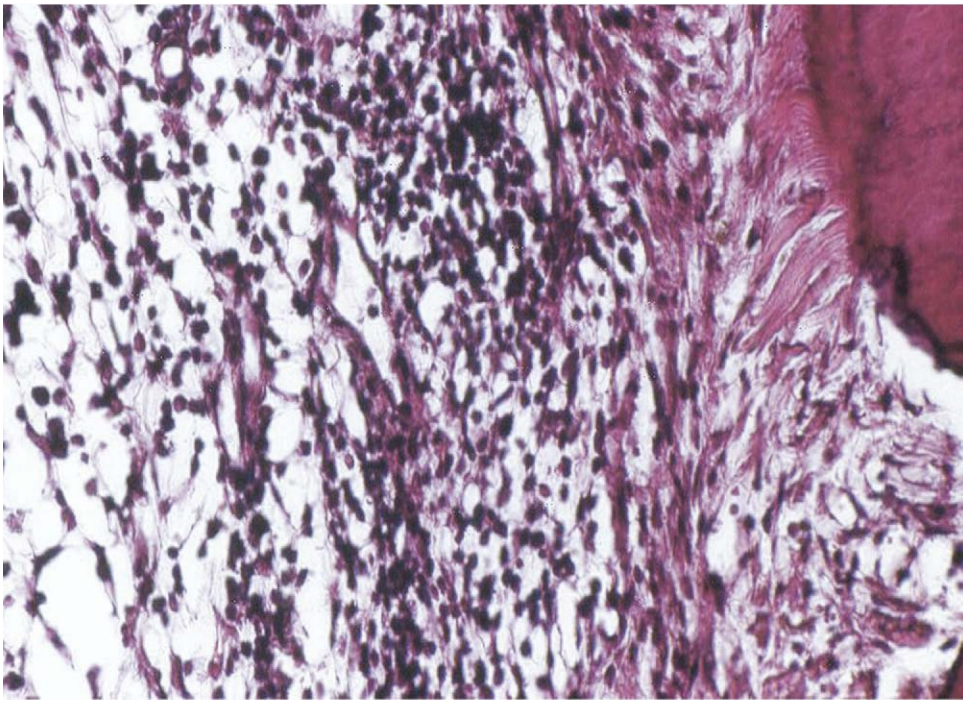

Figure 5. Histological section of a root that receive score 1 for moderate inflammation.

nomenon of a so-called sealer puff and any violation of the apical region with sealer or any irritant may help the inflammation persist.

Our findings also are in agreement with Gutman et al. (15) in the importance of elimination of infection of the root canal system and prevention of reinfection. He indicates that ultimately success can be achieved only through the proper access and thorough debridment of the inflamed, infected, degenerated, or necrotic pulp tissue. Therefore, it would seem that debridment of the canal system through proper cleaning and shaping would be of paramount importance in successful treatment. This means that the elimination of microorganism from the root canals is the ultimate aim of endodontic treatment. He then adds that this does not necessarily negate the role of obturation to minimize the potential role of apical percolation and coronal leakage, although he does not provide any evidence that apical percolation can cause failure.

Farzaneh et al. (16) in the Toronto study identified two factors that have statistically significant association with the higher healed rate for treatment without preoperative AP than with AP, and treatment using vertical compaction of warm gutta-percha (FPVC) rather than step back preparation and lateral condensation (SBLC). She also indicates that the healing rate is higher for single rooted than multirooted teeth. Our study supports these findings since all failing endodontic treatments are because of intraradicular or extraradicular infections. The causes of infection may be microbial contamination at the time of endodontic therapy, insufficient removal of microorganisms from infected root canals, or inadequate mechanical closure of treated root canals that may provide a potential for future bacterial contamination. Thus, multirooted teeth probably are harder to be cleaned than single rooted ones. Treatment technique can make the difference in cleaning and shaping of the canals and as a consequence better elimination of microorganism from the root canal systems. Although this study does not provide the nature of chemical irrigation during the cleaning of the system, FPVC technique may provide more flare for better shaping and better penetration of the irrigated solutions to the root canal system that results in cleaner canals. Thus, one of the main objectives of endodontic treatment is to eliminate infection of the root canal system and to prevent reinfection.

In summary, this study has demonstrated that there is no difference in healing of apical periodontitis between obturated and nonobturated root canal systems providing that thorough cleaning and shaping have been accomplished and a coronal seal has been placed. Because we are not sure that the canal is sterilized and that we are able to eliminate microorganisms in the infected root canal system, the filling is still recommended. This may reduce the space and nutrition for the multiplication of remaining microorganisms. In conclusion, teeth do not fail because of poor filling but because of poor cleaning and shaping. The success of endodontic treatment will ultimately depend on the elimination of microorganisms, host response, and mechanical closure (coronal seal) of treated root canals that may provide a potential for future bacterial contamination.

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