Internal apical resorption and its correlation with the type of apical lesion

Vier FV, Figueiredo JPA. Internal apical resorption and its correlation with the type of apical lesion. Int Endod J 2004; 37: 730-7.

PMID: 14689265 [PubMed - indexed for MEDLINE]

http://dx.doi.org/10.1111/j.1365-2591.2004.00830.x

International Endodontic Journal (ISSN: 0143-2885)

Internal apical resorption and its correlation with the type of apical lesion

F. V. Vier

J. A. P. Figueiredo

Post-Graduate Program of Dentistry, ULBRA, Canoas, Brazil

Correspondence:

José Antônio Poli de Figueiredo

E-mail: endofig@zaz.com.br

ABSTRACT:

Aim To determine the presence of various periapical pathologies and their association with the presence and extent of internal apical inflammatory root resorption in human teeth.

Methodology A total of 75 root apices from extracted teeth with periapical lesions were examined. Semi- serial sections of soft tissue lesions were stained with HE. The lesions were classified as non-cystic or cystic, and according to the degree of abscess severity: 0, 1, 2 or 3. The apices were reduced to 3 mm in length and longitudinally cut so that the internal aspect could be analyzed under scanning electron microscopy (SEM). Internal root resorption was also classified as 0, 1, 2 or 3 according to the extent of the resorbed area. Addition- ally, six vital teeth were used as a control.

Results Non-cystic lesions with severe abscesses were the most common finding (70.7%), while 20% of the lesions were cystic (4% little or no abscess; 16% severe abscesses). Non-cystic lesions with little or no abscess comprised 9.3% of the sample. Of the root canals containing periapical lesions, 48% had internal apical resorption in more than half of the area, while 25.3% of the sample had no internal resorption. Resorption degree 1 was identified in 12% of the cases, and 14.7% showed resorption degree 2. The control group displayed significantly less internal resorption than the test groups.

Conclusions Most periapical lesions (86.7%), whether cystic (16.0%) or non-cystic (70.7%), showed large collections of acute inflammatory cells. Apical internal resorption was present in 74.7% of roots and was associated with periapical lesions. There was no correlation between internal apical resorption and the histological diagnosis of the lesions.

Keywords: apical root resorption, diagnosis, periapical pathology, SEM.

Introduction

The presence of microorganisms in a root canal is the main aetiologic factor in the development and continuation of periapical lesions (Kakehashi et al. 1965, Fabricius et al. 1982, Lin et al. 1991).

The periapical region, connected to the pulp through the principal and accessory foramina and the apical delta, responds to the antigenic stimulus present in the root canal and becomes inflamed. Immunological reactions, in this case periapical lesions, are established in the periapex to combat the infectious agent and promote the repair of the affected region (Torabinejad & Bakland 1978). These pathologies cause bone lysis to make room for their organisation and growth.

The differential diagnosis of periapical pathologies is confirmed only by means of histological processing (Linenberg et al. 1964).

Several authors disagree about the prevalence of these pathologies: the prevalence of cystic lesions ranges from 6.0% (Block et al. 1976) to 54% (Priebe et al. 1954), and that of granuloma, from 45% (Lalonde & Luebke 1968) to 94.0% (Block et al. 1976). Numerous studies using scanning electron microscopy (SEM) have reported external apical resorption inteeth with apical periodontitis (Hess et al. 1983, Laurent-Maquin et al. 1986, Delzangles 1989, Bohne 1990, Malue et al.1996, Lomçali et al. 1996, Bonifacio et al. 2000, Vier & Figueiredo 2000, Vier & Figueiredo 2002), but few have reported on the extension of this resorption process into the interior of the root canal.

Paiva & Antoniazzi (1988), Delzangles (1989) and Malueg et al. (1996) showed that external periapical resorption may partially or totally alter the border between the cementum and dentine apical, an anatomic reference for preparation of the root canal, and length of the root filling. These authors, however, did not report on the extent of this process in the apical root canal. Malueg et al. (1996) only reported that, of 25 teeth with necrotic pulp, 18 had root resorption extending to the internal surface of the foramen.

Delzangles et al. (1996) evaluated the surface of root canals of 160 teeth with a histological diagnosis of granuloma and periapical cysts in the cervical, middle and apical thirds. They reported that dentinoclasts were observed in all specimens, more markedly in the apical third and less so towards the cervix. They did not find any correlation between the histological diagnosis of periapical lesion and the resorption process.

Ferlini Filho (1999) conducted a microscopic study of teeth with radiographically visible periapical lesions, and reported that 100% of the foraminal resorptions were found in the cementum, and 66.66% in the dentine of the canal. His findings confirmed the results of others, which demonstrate that the external apical resorption moves towards the interior of the root canal. Ferlini Filho (1999) also pointed out that 5.88% of the samples showed partial destruction of the root apex, which made the cementum and the border between the cementum and dentine within canals disappear.

Vier & Figueiredo (2002) evaluated 104 root apices with periapical lesions adhering to the root after extraction, and reported that there was no correlation between the histological diagnosis of the periapical lesion and the presence and extent of the periforaminal and foraminal apical resorption revealed by SEM. Several specimens showed external apical resorption in the foraminal area, which raised the question of how extensive the clastic process was in the apical third of the root canal.

The purpose of this study is to evaluate, by using SEM, the presence and extent of internal resorption in the apical third in a sample of roots of human teeth with periapical lesions, and to correlate the presence and extent of this process with the histological diagnosis of periapical lesion.

Materials and methods

The samples were those used by Vier & Figueiredo (2002). The sample comprised 113 extracted human teeth with visible periapical lesions. The extracted teeth were obtained from the Public Dental Services in the state of Rio Grande do Sul, Brazil, where endodontic or restorative treatment is not provided. Some of the teeth were symptomatic; others were extracted because the crown was completely compromised by dental caries. Only teeth with whole and intact periapical lesions were included. The size of the lesion was measured. The dental group was determined according to the operators' information.

A control group was added to the previous samples, comprising of six teeth with vital healthy pulps extracted for orthodontic reasons.

The specimens were stored in a solution of formaldehyde (10%, w/v), and radiographed to exclude previous root canal treatment or incomplete root formation. For this reason, 15 teeth were discarded; of the remaining 98 teeth, six presented two lesions on separate roots. A total of 104 apical lesions and 104 root apices were longitudinally cleaved for the analysis of internal apical resorption.

The periapical lesions were gently removed from the root apices and labeled before processing.

Semi-serial sections (0.5 lm at 0.5 mm intervals) of soft periapical lesions were stained with HE.

The periapical lesions were classified as:

• Non-cystic lesions:

– Periapical granuloma: lesions predominantly infiltrated by lymphocytes, plasma cells and macrophages, with or without epithelial remnants (Nair et al. 1996), and covered by a capsule of collagen fibres. In these lesions, neutrophils were sparse, and did not form any abscess microcavities or concentrated infiltrates.

– Periapical abscess: Lesions with a distinct collection of neutrophils in the interior of a previously existing granuloma (Nair et al. 1996). These were further classified according to the total area of the visualised legion in the histological sections that the abscess cavity occupied: 1: 1/3 of the area; 2: 1/3-2/3; 3: > ou =2/3.

• Cystic lesions

– Periapical cyst: lesions with a layer of stratified squamous epithelium along a surface of an amount of conjunctive tissue enough to indicate a delineated cavity, and surrounded by a slight fibrous capsule (Patterson et al. 1964, Lalonde & Luebke 1968, Lalonde 1970, Nobuhara & Del Rio 1993, White et al. 1994).

– Abscessed periapical cyst: Cysts containing pus-filled cavities classified as 1, 2 or 3, as mentioned above. Two blinded and previously calibrated observers analyzed the histological sections using 32, 100 and 400X magnifications (Zeiss microscope, Noord-Brabant Thornwood, USA).

All histological sections were considered for the diagnosis of each pathology. The presence of epithelium delineating a pathological cavity in one or more sections of a lesion characterised it as a periapical cyst. Abscess severity was classified according to the section showing the largest dimension. Thereafter, the periapical lesions were grouped into two sub- groups:

– non-cystic lesions: A1 – with no or small abscess (periapical granuloma and abscess degree 1); A2 – with advanced abscess (periapical abscesses degrees 2 and 3). – cystic lesions: B1 – with no or small abscess (periapical cyst and abscessed cyst degree 1); B2 – with advanced abscess (abscessed cysts degrees 2 and 3).

The root apices, previously sectioned from the tooth remnant, were longitudinally cleaved with a carborundum disc to expose the root canal. They were then bathed in acetone for 7 min. SEM was conducted with a Philips XL 20 (Eindhoven, The Netherlands) microscope, operating at 15 kV. Electromicrographs were obtained at 50X magnification. Two previously calibrated observers later independently analyzed the apical 0.5 mm sections.

The root canal of each half of each specimen was classified according to the presence and extent of internal apical resorption into three different degrees: degree 0 (no resorption), degrees 1, 2 or 3 (resorption in up to 1/4, from 1/4 to 1/2, or in over 1/2 of the area observed, respectively).

Only one half was analyzed in some samples because the other half was lost when the root canal was cleaved. When the two halves were analyzed, the final degree of resorption was determined according to the half where the clastic process was more severe.

The Kappa coefficient was used to measure agreement between observers in diagnosing both periapical lesions and presence and extent of internal apical root resorption.

The one-way anova and Duncan Post Hoc tests were used to evaluate the correlation between the histological diagnosis of periapical lesions and the presence and extent of internal apical root resorption.

Results

Twenty-nine samples were lost during the cleavage of root apices. Table 1 shows the dental groups analysed, and Table 2 indicates the size of the periapical lesions, which varied from 2.0 to 9.9 mm.

Histological analysis was completed for a total of 102 specimens, as two were lost during preparation (Vier & Figueiredo 2002).

Table 3 shows the association of internal apical resorption and histological diagnoses of periapical lesion.

The Kappa coefficient for the diagnosis of periapical lesions was 0.96 (95% CI: 0.82–1.0).

Periapical granulomas were not a common finding. A1 lesions (granuloma and degree 1 periapical abscess) comprised only 9.3% of the sample (Table 1). The most prevalent histological diagnosis was A2 lesion (non- cystic periapical abscess, degrees 2 and 3), which comprised 70.7% of the sample (Table 1). Periapical cysts represented 20.0% of the sample. Only three (4.0%) periapical cysts had no or only small abscess cavities. Of the 15 cysts analyzed, 12 (80.0%) had large abscess cavities.

When the cystic characteristic of the lesions was ignored and only the presence of an abscess was analysed, it was observed that 65 lesions (87.6%) had abscess cavities that occupied a large area. Only 10 lesions (13.3%) were free from microcavities or con- tained only microcavities of acute inflammatory cells (Table 1).

Only 25.3% of the samples were free from internal apical resorption: calcospherites were seen in some of these samples (Fig. 1). A total of 74.7% of the samples had internal apical root resorption. Of these, 12% had internal apical resorption in at least 1/4 of the area examined (Fig. 2). In 48.0% of these cases, resorption14.7% of the samples, internal apical resorption was seen in 1/4 to 1/2 of the area examined (Fig. 3).

The lacunae of resorption were similar to the Howship type, with a circular shape of different sizes. The combination of various lacunae resembled the characteristic aspect of honeycomb (Fig. 4). The resorbed areas resulted in some isolated lacunae, surrounded by an intact dentine surface (Figs 2 and 3). In some cases, the apical canal had fused areas of resorption, and was totally devoid of intact cementum (Figs 4 and 5). Figure 5 shows that internal apical resorption was so severe that it changed the morphology of the apical third of the root canal.

In some cases, the internal opening of a lateral canal on the bed of the main root canal was observed (Fig. 6).

The surroundings of this opening were largely resorbed, while the bed of the root canal was apically free of resorption.

In the control group (vital teeth), the internal apical resorption was absent in five specimens (83.3%), and only one specimen (16.7%) displayed resorption, being classified as degree 1.

There was no statistically significant difference between the type of periapical lesion and the presence and degree of internal apical resorption ($P > 0.05$). The control group displayed significantly less internal resorption than the test groups ($P = 0.01$).

Discussion

The correlation between apical periodontitis and external inflammatory apical resorption has been extensively reported in literature (Hess et al. 1983, Laurent-Maquin et al. 1986, Delzangles 1989, Bohne 1990, Malueg et al. 1996, Lomçali et al. 1996, Ferlini Filho 1999, Vier & Figueiredo 2000, Laux et al. 2000, Vier & Figueiredo 2002). Some authors (Delzangles 1989, Malueg et al. 1996, Vier & Figueiredo 2002) reported that external apical resorption often extends to the interior of the root canal.

Few studies have correlated external (Delzangles 1989, Bohne 1990, Vier & Figueiredo 2000, Vier & Figueiredo 2002) and internal apical resorption (Delzangles et al. 1996) with the nature of periapical lesions. Therefore, the purpose of this study was to correlate the type of periapical lesion with the presence and extent of internal apical resorption, to supplement the findings reported by Vier & Figueiredo (2002).

Delzangles et al. (1996) used SEM to evaluate resorption in the root canal of teeth with granulomas and periapical cysts. Although those authors did not quantify the clastic process in their study, they provided important data, including the fact that resorption seems to be more severe in the apical third than in the middle and cervical thirds of the root canal. For this reason, only the apical third of the root canal, and particularly the apical 0.5 mm, were the object of analysis in this study.

The presence and extent of internal apical resorption in teeth with periapical lesions cannot easily becompared with other results reported in the literature because only Delzangles et al. (1996) studied internal apical resorption in teeth with apical lesions, but without quantifying the clastic process.

The internal apical resorption observed in the present study does not differ from the various periapical pathological conditions, since all of them exhibited a common feature, the presence of inflammation. This is an important aspect to consider in the histological description of these cystic and non-cystic lesions, independent of the degree of abscess. Both constitute a continuous and variable aspect of the same phenomenon, inflammation. The physical presence of a periapical lesion may promote external root resorption and bone lysis, as the lesion makes room for its organisation and growth, independent of its histological classification, and internal apical resorption may be the result of the advance of external apical resorption into the interior of the root canal. It is important to emphasise the importance of infection in the process, since it is always involved in the cases with these types of lesions.

The control group displayed significantly less internal resorption than the test groups, and only one specimen, out of six, displayed resorption, being classified as degree 1. It could be speculated that this resorption could be due to occlusal trauma leading to a light transitional resorption. The absence of any resorption in most cases of vital pulps highlights the influence of infection and bacteria on the presence and extent of root resorption.

During this study, correlating the presence and extent of external periforaminal and foraminal resorption was considered (Vier & Figueiredo 2002) with internal apical resorption. However, this was not possible since in most cases more than one electromi- crograph was obtained for the classification of external resorption because the apical region under study had more than one principal foramen. During longitudinal cleavage of the root for the apical inspection of the root canal, only one canal was found in most cases. This may be explained by the methodology adopted and the small size of the sample. Therefore, it is not clearly determined whether the internal apical resorption pattern observed corresponds to the external apical resorption of the apical foramen and surrounding tissue that has been previously reported by Vier & Figueiredo (2002) because the external resorption pattern used in that study was the pattern seen in the electromicrograph with the most severe form.

The presence of resorptions on the apical surface of the root canal in teeth with periapical lesions may be associated with failure of root canal treatment because bacteria, particularly anaerobic bacteria, remain in the spaces created by dentine resorption and cannot be completely eliminated. Sjögren et al. (1997) and Sundqvist et al. (1998) reported that failure of root canal treatment was associated with infection that remains in the root canal system.

As these resorption spaces are located short of the limit of apical instrumentation, according to the geometric shape of the root canal and the length or lateral limit of the biomechanical preparation, there remains the risk that these voids are neither eliminated nor disinfected.

If the resorption spaces are beyond the limit of apical instrumentation, which should be 1 mm from the radiographic apex, they may not be reached by endodontic instruments, even when foraminal debridement or patency failure is carried out. Moreover, because of the site of resorption, intracanal chemicals and medicaments, as well as systemic antibiotic therapy, may be ineffective or act inappropriately (Lomçali et al. 1996).

According to Bhaskar & Rappaport (1971), root resorption leads to a defective canal preparation and to the escape of filling material into periapical tissues. This is caused by extensive resorption of the apical surface of the root canal and the subsequent morphological alteration of the canal (Fig. 5), which has, in most cases, a circular shape in this region. De Deus (1992) pointed out that, in these cases, there is also infiltration of periapical exudate into the interior of the root canal.

Another relevant aspect is the fact that the cementum in the canal may be absent because of the severity of the resorptive process. Therefore, the point of greatest natural constriction in the canal, where the apical post should be placed, is lost. Therefore, when carrying out a root filling, special care is needed in teeth with periapical lesions because cement and dentine resorption, both external and internal, may be present even when they are not radiographically visible.

Conclusion

On the basis of the present study of extracted human teeth, it can be concluded that in this sample

– Cystic lesions accounted for 20.0% of periapical lesions;

– Most chronic periapical lesions (86.7%), whether cystic (16.0%) or non-cystic (70.7%), had large collections of acute inflammatory cells;

– Apical internal resorption was found in 74.7% of roots associated with periapical lesions, and in 48.0 % of the cases it extended over more than half of the area analyzed; the control group displayed significantly less internal resorption than the test groups.

– There was no correlation between histological diagnoses of periapical lesion and the presence and extent of internal apical resorption and the control group displayed significantly less internal resorption than the test groups.

References

Bhaskar S, Rappaport H (1971) Histologic evaluation of endodontic procedures in dogs. Oral Surgery, Oral Medicine and Oral Pathology 31, 526–35.

Block R, Brushell A, Rodrigues H et al. (1976) Ahistopathologic, histobacteriologic, and radiographic study of periapical endodontic surgical specimens. Oral Surgery, Oral Medicine and Oral Pathology 42, 656–78.

Bohne W (1990) Light and ultrastructural studies of human chronic periapical lesions. Journal of Oral Pathology and Medicine 19, 215–20.

Bonifacio K, Leonardo M, Rossi M, Lilva L, Ito I (2000) MEV – avaliação do ápice radicular de dentes de humanos com e sem vitalidade pulpar. (Abstract A217). Pesquisa OdontológicaBrasileira, 14 (Suppl.), 87.

De Deus Q (1992) Endodontia, 5th ed. Rio de Janeiro, RJ, Brazil: Medsi, pp. 155–87.

Delzangles B (1989) Scanning electron microscopic study of apical and intracanalresorption. Journal of Endodontic 15, 281–5.

Delzangles B, Lamendin H, Forest N (1996) Etats de surfaces endocanalaires en présence de pathologic apicale chronique. Incidences cliniques. Revue Franceise d'Endodontie 15, 5–16.

Fabricius L, Dahlen G, Holm S, Mo ̈ller A (1982) Influence of combinations of oral bacteria on periapical tissues of monkeys. Scandinavia Journal Dental Research 90, 200–6.

Ferlini Filho J (1999) Estudo radiográfico e microscópico das reabsorções radiculares na presença de periodontites apicais crônicas (microscopia ótica e eletrônica de varredura). Thesis. São Paulo, Brazil: Universidade de São Paulo.

Hess J, Culieras M, Lamiable N (1983) A scanning electron microscopic investigation of principal and accessory foramina on the root surfaces of human teeth: thoughts about endodontic pathology and therapeutics. Journal of Endodontic 9, 275–81.

Kakehashi S, Stanley H, Fitzgerald R (1965) The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surgery, Oral Medicine and

Oral Pathology 20, 340–9.

Lalonde E (1970) A new rationale for the management of periapical granulomas and cysts: an evaluation of histopathological and radiographic findings. Journal of the American Dental Association 80, 1056–9.

Lalonde E, Luebke R (1968) The frequency and distribution of periapical cysts and

granulomas. Oral Surgery, Oral Medicine and Oral Pathology, 25, 861–8.
Laurent-Maquin D, BlocquauxVerchere M, Bouthors S (1986) Modifications morphologiques radiculaires de dents atteintes d’une lesion périapicale. Étude au microscope électronique à balayage.Revue d’Odonto-stomatologie 15, 379–84.
Lin L, Pascan EA, Skribner J et al. (1991) Clinical, radiographic, and histologic study of endodontic treatment failures. Oral Surgery, Oral Medicine and Oral Pathology 71, 603–11.
Linenberg W, Waldron C, Delaune Jr G (1964) A clinical roentgenographic and histopathologic evaluation of periapical lesions. Oral Surgery, Oral Medicine and Oral Pathology 17, 467–72.
Malueg L, Wilcox L, Johnson W (1996) Examination of external apical root resorption with scanning electron microscopy. Oral Surgery, Oral Medicine and Oral Pathology and Oral Radiology, Endodontics 82, 89–93.
Nair P, Pajarola G, Schroeder H (1996) Types and incidence of human periapical lesions obtained with extracted teeth. Oral Surgery, Oral Medicine and Oral Pathology 81, 93–102.
Nobuhara W, Del Rio C (1993) Incidence of periradicular pathoses in endodontic treatment failures. Journal of Endodontics 19, 315–8.
Paiva J, Antoniazzi J (1988) Endodontia: bases para a prática clínica, 2nd ed. São Paulo, SP, Brazil: Artes Médicas, pp. 439–52.
Patterson S, Shafer W, Healey H (1964) Periapical lesions associated with endodontically treated teeth. Journal of the American Dental Association 68, 191–4.
Priebe W, Lazansky J, Wuehrmann A (1954) The value of the roentgenographic film in the differential diagnosis of periapical lesions. Oral Surgery, Oral Medicine and Oral Pathology 7, 979–83.
Sjögren U, Figdor D, Persson S, Sundqvist G (1997) Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. International Endodontic Journal 30, 297–306.
Sundqvist G, Figdor D, Persson S, Sjögren U (1998) Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative retreatment. Oral

Surgery, Oral Medicine and Oral Pathology 85, 86–93.

Torabinejad M, Bakland L (1978) Immunopathogenesis of chronic periapical lesion. A review. Oral Surgery, Oral Medicine and Oral Pathology 46, 685–99.

Vier F, Figueiredo J (2000) Morphologic analysis of apical resorption on human teeth with periapical lesions. Endodontics Clinical Practice, Education and Research 2 (3). Online publication of the University of São Paulo: http://www.fo.usp.br/revistas

Vier F, Figueiredo J (2002) Prevalence of different periapical lesions associated with human teeth and their correlation with the presence and extent of apical external root resorption. International Endodontic Journal 35, 710–9.

White S, Sapp P, Seto B, Mankovich N (1994) Absence of radiometric differentiation between periapical cysts and granulomas. Oral Surgery, Oral Medicine and Oral Pathology 78, 650–4.

Table 1 Dental groups examined

Tooth	Upper	Lower	Total
Known			
Incisors	02 (2.8%)	01 (1.4%)	03 (4.2%)
Canines	01 (1.4%)	01 (1.4%)	02 (2.8%)
Premolars	04 (5.6%)	03 (4.2%)	07 (19.9%)
Molars	11 (15.5%)	21 (29.6%)	32 (45.1%)
Unknown			27 (38%)
Total			71* (100.0%)

*Four multirooted teeth displayed more than one periapical lesion in different roots.

Table 2 Size of the lesions examined

Diameter of the lesions	f (%)
2.0 x 3.9 mm	33 (44%)
4.0 x 5.9 mm	30 (40%)
6.0 x 7.9 mm	9 (12%)
8.0 x 9.9 mm	3 (4%)
Total	75 (100%)

Table 3 Presence and extend of internal apical resorption and histological diagnosis of periapical lesion

Type of lesion	Internal apical resorption				
	Degree 0	Degree 1	Degree 2	Degree 3	Total
A1	2 (2.7%)		1 (1.3%)	4 (5.3%)	7 (9.3%)
A2	14 (18.7%)	9 (12%)	8 (10.7%)	22 (29.3%)	53 (70.7%)
B1				3 (4.0%)	3 (4.0%)
B2	3 (4.0%)		2 (2.7%)	7 (9.3%)	12 (16.0%)
Total	19 (25.3%)	9 (12.0%)	11 (14.7%)	36 (48.0%)	75 (100.0%)

A1, Non-cyst lesions with no or minimum degree of abscess; A2, Non-cyst lesions with high degree of abscess; B1, Cyst lesions with no or minimum degree of abscess; B2, Cyst lesions with high degree of abscess.

Legend of figures

Figure 1 Apical portion of root canal free of resorption; presence of calcospherites (50X).

Figure 2 Apical portion of root canal with internal apical resorption – degree 1. (50X).

Figure 3 Apical portion of root canal with internal apical resorption – degree 2. (50X).

Figure 4 Apical portion of root canal with internal apical resorption – degree 3. Note honeycomb aspect of resorption gaps (50X).

Figure 5 Apical portion of root canal with internal apical resorption – degree 3. Note morphological alteration of canal (50X).

Figure 6 Apical portion of root canal with opening of a lateral canal and extensive internal apical resorption surrounding it (50X).

Figure 1

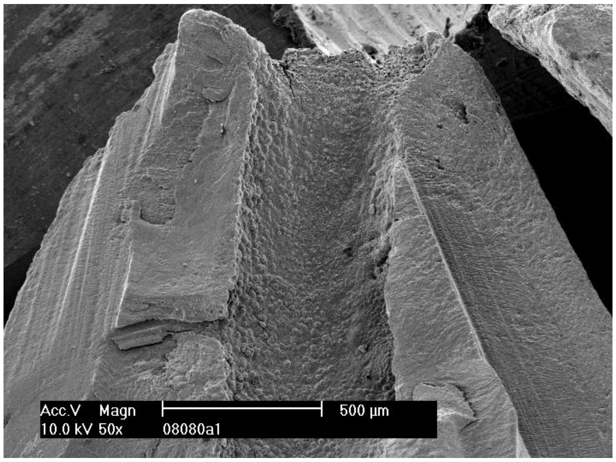

Figure 2

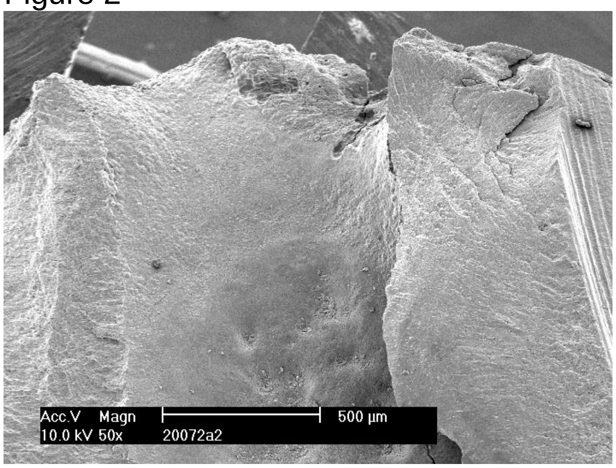

Figure 3

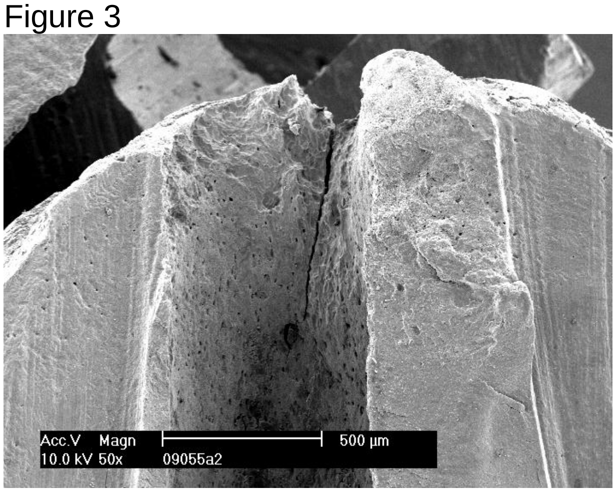

Figure 4

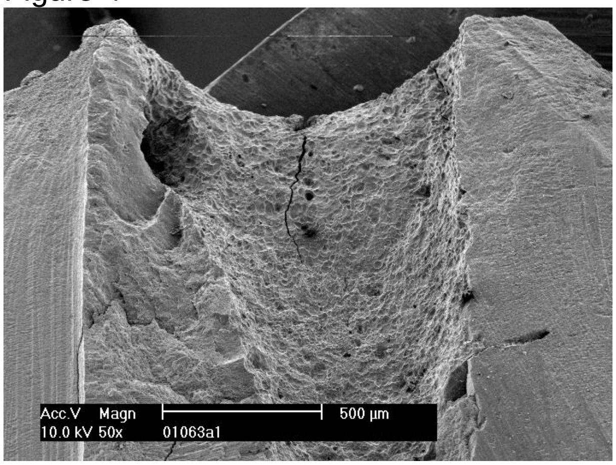

Figure 5

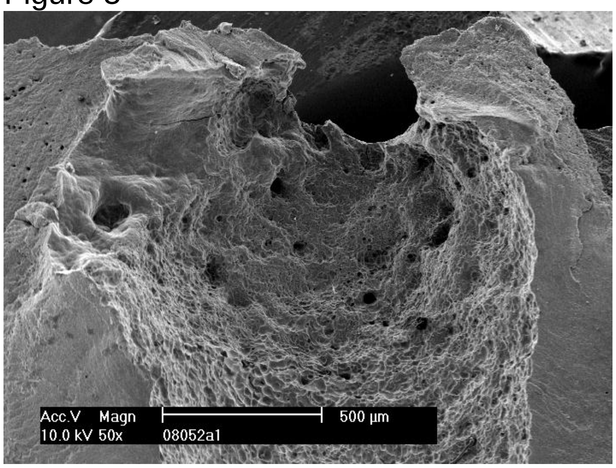

Figure 6