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Histopathological profile of surgically removed persistent periapical radiolucent lesions of endodontic origin

R. M. Love & N. Firth

Department of Oral Diagnostic and Surgical Sciences, University of Otago, Dunedin, New Zealand

Abstract

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Aim To determine the types of periapical lesions associated with root filled teeth with persistent periapical pathosis that required surgical treatment based on specific inclusion and exclusion criteria.

Methodology Periapical lesions from a consecutive clinical sample of 100 patients were examined histopathologically to determine a definitive diagnosis.

Results Females were more represented (n = 56), the average age was 46.5 years and there were no age differences between gender or lesion type. A diagnosis of periapical granuloma was the most common finding with a similar number present in females (n = 40) and males (n = 37). A cyst was present in 18% of the cases with a majority of females (n = 12) represented in the sample. Evidence of foreign material, with an appearance consistent with endodontic sealer materials, was seen in 25 periapical granulomas, two cysts and one scar. Two periapical scars were seen, one had a history of apicectomy and amalgam root-end filling while the other was associated with extruded root filling material.

Conclusions By using defined clinical inclusion and exclusion criteria a predictable clinical diagnosis of a persistent periapical lesion due to endodontic origin can be reliably made. Periapical granulomas and cysts were the most common periapical lesions of endodontic origin associated with persistent periapical pathosis with the overall incidence of periapical cysts similar to previous studies. The presence of endodontic material in a high proportion of periapical lesions suggests a cause-effect association with the inference that clinicians should employ canal preparation techniques that limit apical extrusion of material.

Keywords: endodontic material, periapical cyst, periapical granuloma, persistent periapical pathology.

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Introduction

Infection of the root canal system is central to the development of inflammatory periapical pathosis (Kakehashi *et al.* 1965, Möller *et al.* 1981) where microbial invaders and/or their products invoke a complex, primarily protective, inflammatory response in the periradicular tissues (Stashenko *et al.* 1998). However, these host defense systems cannot enter the root canal in teeth with necrotic pulps and eliminate the invading microbes, as a consequence the inflammatory response results in the formation of various types of periapical lesions.

There are a number of classifications for periapical lesions of endodontic origin based on aetiology, symptoms or histopathological features, for example The World Health Organization Classification leans toward a clinical classification (World Health Organization 1995) while Nair (1997) describes a histopathological classification. Although all classifications have their use a clinician is primarily concerned with the histopathological diagnosis of biopsied tissue to confirm the clinical diagnosis or to provide a definitive diagnosis and further information on various factors such as an

Correspondence: R. M. Love, Department of Oral Diagnostic and Surgical Sciences, University of Otago, PO Box 647, Dunedin, New Zealand (e-mail: robert.love@dent.otago.ac.nz).

indication of predicted treatment success and ongoing treatment needs. As such a classification of periapical granuloma, radicular cyst, or some other pathology is of interest to the endodontic clinician.

Studies show that a periapical granuloma is the most common periapical lesion of endodontic origin, the diagnosis is based on the presence of connective tissue, blood vessels and inflammatory cells and may also be called chronic apical periodontitis when chronic inflammatory cells feature or secondary acute apical periodontitis when polymorphonuclear leukocytes are present (Nair 1997). A periapical or radicular cyst is a common lesion and can be classified as either a true cyst when a pathological cavity is completely enclosed in an epithelial lining or a bay/pocket cyst when an epithelial lined cavity is open to and continuous with the root canal (Simon 1980, Nair *et al.* 1996). Accurate differentiation between these types of cyst requires meticulous serial sectioning of whole lesions including the root apex, which is not always possible to provide after apical surgery. There is great variation between studies on the incidence of granulomas and cysts (Nair 2004) and this may be due in part to variation in histopathological diagnosis reporting or the clinical source of the lesions, for example lesions associated with failed endodontic treatment may have a different profile than those presenting from a primary infection of the root canal.

Historically numerous indications for endodontic surgery have been proposed though contemporary practice suggests that endodontic surgery should be performed only if conventional endodontic re-treatment will not eradicate potential areas of canal infection such as in an un-instrumented portion of a canal or will have the potential to irreversibly damage the tooth for example root fracture subsequent to post removal, or if previous re-treatment has not resulted in healing.

The aim of this study was to determine the types of periapical lesions associated with root filled teeth with persistent periapical pathosis that required surgical treatment based on one endodontist's clinical decision making and one pathologist's reporting rational.

Materials and methods

The study design was an evaluation of a consecutive clinical sample of patients with persistent periapical pathosis who were seen by an endodontist (RML) at the University of Otago School of Dentistry, New Zealand. Persistent periapical pathosis was defined as a radiolucent lesion associated with an root filled tooth with either (i) an enlarging periapical lesion as seen on a radiograph, (ii) an unhealed periapical lesion of 4 or more years duration post-endodontic treatment (Ørstavik 1996), or (iii) a tooth with a periapical radiolucent lesion with clinical signs and symptoms of periapical pathosis of endodontic origin such as pain, swelling, or draining sinus. The inclusion criteria for treatment planning for endodontic surgery were (i) an evaluation that any root canal obstacles could not be bypassed or removed to allow full conventional instrumentation of the root canal system, or (ii) if conventional or surgical re-treatment had not resulted in healing. Additionally, endodontic surgery was only completed if there were no medical complicating factors, it was unlikely that damage to associated structures would occur for example the mental nerve, and it was deemed that it was the most appropriate treatment with a prognosis acceptable to clinician and patient. The consecutive clinical sample and subsequent treatment continued until 100 cases had been recruited for the study.

Endodontic surgery was carried out under local anaesthesia with or without supplementary conscious sedation as required for an individual patient. Surgical approach was gained using a full mucoperiosteal flap and sufficient bone was removed using surgical burs with irrigation to allow curettage of the periapical lesion. The lesion was then placed in formalin (10%). All other necessary clinical procedures were performed, such as root-end resection and root-end filling, and the flap sutured. Patients were given standard postoperative instructions and review appointments.

The periapical specimen was fixed in Formalin (10%) and then prepared for histopathological diagnosis. Briefly the specimens were processed (Citadel 2000 Shandon processor; Thermo Scientific, Cheshire, UK) and embedded in wax (Histology Embedder, Leica, Germany) and 3 μm sections cut (Microtome 340E; Mikronet, Waldorf, Germany). The sections were then stained with haematoxylin and eosin and a cover slip placed. Normally up to four sections were viewed at various magnifications by an oral pathologist (NF) and a histopathological diagnosis made. A diagnosis of periapical granuloma was made based on the histological findings of granulation tissue with inflammatory cells, no distinction was made between the presence of chronic inflammatory cells (chronic apical periodontitis) or acute inflammatory cells (secondary acute periodontitis); a cyst was diagnosed when epithelium was seen to line a lumen, no distinction was made between a true cyst or bay (pocket) cyst; a scar was defined as dense relatively acellular fibrous connective

tissue; and an abscess was defined as a collection of pus (dead and dying neutrophils).

Results

Of the 100 samples, 56 came from females and 44 from males, the average age was 46.5 years with a range of 16–84 years, the mean age between a periapical granuloma (47.9 years, range 15–78 years) and radicular cyst (44.8 years, range 16–84 years) were similar. Table 1 shows the tooth distribution indicating that the maxillary incisors were the teeth most frequently operated on. A histopathologic diagnosis of periapical granuloma was the most common finding (Table 2) and this was found in approximately the same number of females (n = 40) and males (n = 37). A cyst was present in 18% of the cases with a majority of females (n = 12) represented in the sample. Table 3 shows the distribution of cystic lesions with the maxillary lateral incisors representing approximately half of all teeth involved. Epithelial proliferation was seen in six periapical granuloma lesions. Evidence of foreign material, with an appearance consistent with endodontic materials, was seen within 28 lesions. The majority was seen in periapical granulomas (n = 25), while two cysts and one scar showed evidence of foreign material. A periapical scar was seen with two lesions, one case (a maxillary left second premolar) had a history of rooted resection and amalgam root-end filling while the other case (a mandibular left central incisor) was associated with extruded root filling material into the periapical area.

Table 1 Distribution of teeth with persistent periapical pathology treated by periapical surgery (n = 100)

Tooth	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Number	0	0	6	4	3	1	15	14	14	13	3	4	4	6	0	0
Number	0	0	1	0	0	1	0	3	3	1	0	0	0	4	0	0
Tooth	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Table 2 Histopathologic features of periapical lesions (n = 100)

Diagnosis	Number	Female : male ratio
Periapical granuloma	77	1.1 : 1
Periapical cyst	18	2 : 1
Periapical abscess	3	2 : 1
Periapical scar	2	1 : 1

Table 3 Distribution of periapical cysts (n = 18) associated with teeth that had undergone periapical surgery

Tooth	16	15	14	13	12	11	21	22	23	24	25	26
Number	0	0	0	1	5	2	2	3	1	1	0	1
Number	0			0		1	0	1				0
Tooth	46			43		41	31	32				36

Discussion

The study confirmed that apical granuloma and cyst are the most prevalent lesions of endodontic origin accounting for 95% of all lesions. Studies have reported variable incidence of granulomas and cysts ranging from 6% to 55% of inflammatory periapical lesions being cysts (Nair 2004). This variability may be due to the source of the biopsy material and or variations in histological interpretation of a cyst based on the presence of epithelium within a lesion, i.e. proliferating epithelium being diagnosed as a cyst without evidence of a lumen. Studies that have controlled the source of material and histological interpretation show that the percentage of cystic lesions lies around 15–17% (Simon 1980, Stockdale & Chandler 1988, Nair *et al.* 1996), a value confirmed in this study. These studies also suggest that the incidence of cyst development is not related to the clinical condition of the tooth. The studies by Simon (1980) and Nair *et al.* (1996) examined extracted teeth with attached periapical lesions that presented with a nonvital pulp and no endodontic treatment, while the samples examined by Stockdale & Chandler (1988) and the present study were obtained during endodontic surgery by the first authors using strict clinical inclusion and exclusion parameters from teeth with persistent apical pathology. All these studies reported a similar incidence of cysts suggesting that cyst formation is not related to a primary or secondary infected root canal.

The study did not examine the cystic lesions to determine whether they were a true cyst or a bay/periapical pocket cyst because in the majority of cases root apices were not included in the biopsy material and the material often was not able to be removed in total, as such a true representation of the type of cyst could not be reliably made. It is regarded that a true cyst will not heal after conventional root canal treatment due to the self-sustaining nature of the cyst's growth while a bay/periapical pocket cyst may heal when the intra-canal bacteria are removed (Nair 2004) as the bacterial products directly stimulate the inflammatory growth response of the epithelium. This concept is of relevance to the predicted outcome of conventional orthograde root canal treatment,

however, for this study, and treatment philosophy, a differentiation of cyst types was not required or relevant as the cases had to be treated by surgery. It is possible, however, that the relative proportion of true/Bay cyst in treated root canals may be different from untreated canals in that the true cyst may be more represented in treated canals as conventional treatment would not influence healing of the true cyst.

The incidence of periapical cysts is reported to be highest around the third decade of life (Bhaskar 1966), although the number of cysts in this study is small the average age was higher than this (44.8 years). The age-range (16–84 years), and the similar distribution of patients in the 3rd, 4th and 5th decades of life (four in each decade) suggest that age is not a dominant factor in the development of a cyst. Indeed it is more a reflection of treatment success and longevity of teeth after contemporary endodontic treatment in that the high success rate of contemporary endodontic treatment (Sjögren *et al.* 1990, Ørstavik 1996) makes it a viable treatment for all age groups and is contributing positively to people retaining teeth longer, as a consequence persistent periapical pathosis including cyst development will naturally now be seen in an older patient pool. Cyst development is reported to be more frequent in males than females. Bhasker (1966) reported that 65% of a sample of 932 cysts were from males, in contrast this study showed that 67% were from females. It is likely that the differences in study design and patient numbers may account for these differences, however, there is no clear evidence that there is any difference in cyst development between males or females.

The incidence of periapical granulomas that had epithelial proliferation was approximately 8% (six lesions out of 78) and lower than expected. Simon (1980) reported an incidence of 22.6% while Nair *et al.* (1996) reported that 45% of the periapical granulomas in their study were epithelialized. These studies used step or serial sectioning of a whole lesion, which would have revealed more areas of epithelium than the present study, and more truly reflects the incidence of epithelium proliferation in periapical granulomas.

The periapical lesions identified in this study were all attributable to inflammatory endodontic disease with no lesions such as an odontogenic keratocyst being found. This was likely to be due to the low incidence of these types of lesions developing at the apex of a tooth and probably more importantly related to the diagnostic sieve used by the endodontist who was able to differentiate lesions of non-endodontic origin and refer for treatment.

Healing by scar tissue subject to surgical endodontic treatment is well recognized (Molven *et al.* 1987), one case in the present study that had had previous endodontic surgery and amalgam root-end filling was shown to have incompletely healed by scar tissue. Periapical healing by scar after conventional endodontic treatment has been reported (Nair *et al.* 1999) though the incidence is low. In this study, one case of a conventional treatment showed incomplete healing with scar tissue, however, this was associated with the presence of endodontic sealer that had extruded from the root canal. No histological evidence of a foreign body reaction was seen though it is possible that the sealer influenced the repair process resulting in incomplete healing. The presence of foreign material consistent with endodontic material e.g. sealer within periapical lesions was a feature of the study (28% of all lesions) with it being detected in 32% of periapical granulomas. This is similar to a finding by Koppang *et al.* (1992) who found foreign material in 31% of a sample of periapical granulomas and cysts. Endodontic materials are generally well tolerated by the periapical tissues (Hauman & Love 2003), however, the presence of the sealer material in the periradicular tissue gives an indication that control of the apical extent of the apical preparation and filling was not ideal and suggests that infection may also have been seeded into the periradicular tissues. If bacteria were able to colonize or become associated with the extruded sealer it is possible that the body's defenses may not be able to eradicate them and hence the infected material would act as a continuous source of infection resulting in persistent pathology. This reinforces the notion that clinicians should control the apical extent of the canal preparation, prepare minimal apical sizes, and keep all endodontic files within the root canal.

Conclusion

The study confirms that periapical granulomas and cysts are the most common periapical lesions of endodontic origin associated with persistent periapical pathosis. The overall incidence of periapical cysts was similar to previous studies on teeth with necrotic pulps and no root filling indicating that cyst development is not influenced by endodontic treatment. The presence of endodontic sealer material in a high proportion of periapical lesions suggests a cause-effect association and that clinicians should employ canal preparation techniques that limit apical extrusion of material.

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