

# The nature of the periapical lesion—a review of 1108 cases

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## ABSTRACT

The lesions most commonly found at the apices of non-vital teeth are the periapical granuloma and radicular cyst. The treatment and prognosis may differ according to the lesion present. Previous studies to determine the diagnostic features and incidence of these lesions have failed to reach a consensus view. A study of over 1000 endodontic surgery procedures was therefore carried out.

Of 1108 lesions assessed, 186 (16.8 per cent) were shown histopathologically to be cystic. Of 163 maxillary cysts, 95 were associated with lateral incisors. The highest incidence of cysts and granulomas was noted in the fourth decade for both male and female patients. The incidence in both cases was not significantly different between the sexes. In addition to radicular cysts, one keratocyst and one globulomaxillary cyst were determined histopathologically. The accuracy of the authors' clinical diagnosis was comparable to that of previous workers.

## INTRODUCTION

Each year in the UK over one million root canal treatments are provided under General Dental Services Regulations (Dental Estimates Board, 1981-1985). As less than fifty thousand apicectomies are performed annually, it is assumed that the majority of treatments have a satisfactory outcome. However, a review of recent literature on the nature of periapical lesions (*Table I*)

suggests that as many as 54 per cent of periapical lesions are cystic. Some of the surveys are small (Morse, 1973) or selective according to the radiographic dimensions of the lesion. Details of age and sex of patients, or of the operative site are often omitted.

The purpose of the present study was to take all the above details into account in a survey of a large number of endodontic surgical procedures.

*Table I.* Incidence of cysts and granulomas: summary of previous published works

Study	Lesions (no.)		Cysts		Granulomas		Other	
	No.	%	No.	%	No.	%	No.	%
Priebe et al. (1954)	101	55	54	46	46	0	0	0
Sommer et al. (1956)	170	11	7	143	84	16	9	9
Baumann and Rossman (1956)	121	32	26	89	74	0	0	0
Wais (1958)	50	13	26	32	64	11	10	10
Linenberg et al. (1964)	110	31	28	68	62	11	10	10
Patterson et al. (1964)	510	70	14	420	84	20	2	2
Bhaskar (1966)	2308	969	42	1108	48	231	10	10
Lalonde and Luebke (1968)	800	350	44	361	45	89	11	11
Mortensen et al. (1970)	396		41		59			
Morse (1973)	43	10	23.2	33	76.8	0	0	0
Block et al. (1976)	230	14	7	216	93	0	0	0
Winstock (1980)	9804	824	8.4	8167	83.3	813	8.3	8.3
Present authors	1108	186	16.8	856	77.3	66	5.9	5.9

## MATERIALS AND METHODS

The study comprised a sequence of 1146 endodontic surgery procedures performed by the principal author or staff under his direction in the Department of Conservative Dentistry, University Dental Hospital of Manchester between 1968 and 1986. The indications for surgery were similar to those listed by Barnes (1984), namely teeth failing to respond to conventional endodontic therapy; teeth unable to be treated because of the presence of post crown restorations; root-filled teeth where subsequent radiographs demonstrated apical areas increasing in size; teeth with unfavourable root curvature; foreign bodies extruded into the periapical tissues; fractured instruments impacted in the apical third of the root canal, and the presence of suspected dental cysts. In other words endodontic surgery was undertaken only when conventional methods of treatment had or would have failed. Histopathological diagnosis was inconclusive, or records incomplete for 38 cases, and thus complete details of 1108 cases were available for computer analysis.

In each case a clinical diagnosis was based on the radiographic appearance and a macroscopic examination of the pathological material at the time of surgery. Tissue was transferred to the Oral Pathology Unit of the University Dental Hospital of Manchester in buffered formalin. All the sections were stained with Harris's haematoxylin.

A cyst was diagnosed where there was evidence of odontogenic epithelium lining a surface, even if it was only fragmentary. If a proliferating epithelium was seen within a fibrous tissue mass the lesion was recorded as a developing cyst. A diagnosis of cyst was also made in the case of a lesion greater than 6 mm in diameter where there was a distinct fibrous capsule with dense inflammatory infiltration giving the appearance of an infected dental cyst where the epithelial lining had been destroyed. If no epithelial tissue was seen, the lesion was diagnosed as a granuloma.

The histopathological reports fell into eight groups:

1. Granuloma.
2. Cyst.
3. Scar tissue.
4. Bone.

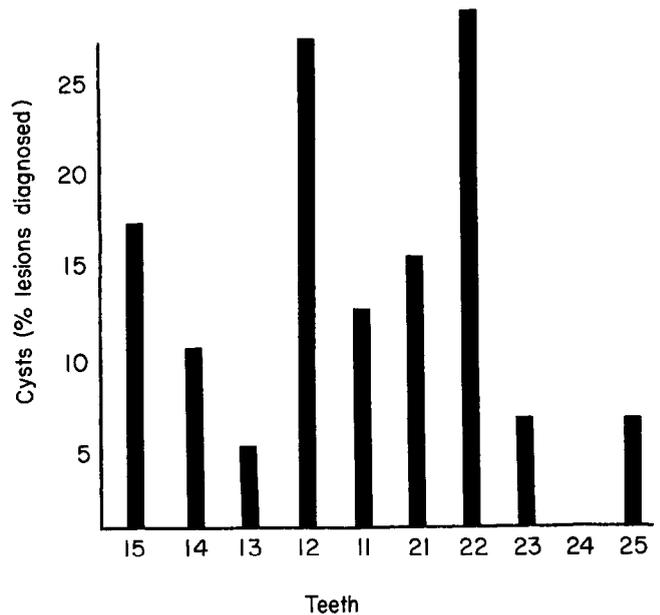


Fig. 1. To show high incidence of cysts on maxillary lateral incisors.

5. Foreign body.
6. Keratocyst.
7. Globulomaxillary cyst.
8. Actinomycotic infection.

For the purposes of this study, 'abscesses' were recorded as granulomas. In the case of several lower incisor lesions it was not possible clinically or radiographically to determine the tooth of origin of the lesion, and such cases were credited to the nearest central incisor tooth.

All data was entered onto computer for analysis using an SPSS statistical package (Nie et al., 1975).

## RESULTS

The nature of the sample is shown in *Tables II* and *III*. Histopathological diagnoses are shown in *Table IV*. The relationship of cysts and granulomas to dental arch and individual teeth is listed in *Table V* and shown graphically in *Fig. 1*.

The relationship between age, sex of patient and the principal lesions is shown in *Table VI*.

Table II. Age distribution of the sample

	Age (yr)									
	10-20		21-30		31-40		41-50		50+	
	No.	%	No.	%	No.	%	No.	%	No.	%
Males*	15	2.9	145	27.8	180	34.5	104	19.9	78	14.9
Females†	32	5.5	162	27.6	180	30.7	117	20.0	95	16.3
Total	47	4.2	307	27.7	360	32.5	221	19.9	173	15.6

n.b. Youngest patient 14 years of age, oldest patient 92 years of age.

\*n = 522.

†n = 586.

Table III. Teeth operated on: males and females

	%															
Males	82.8	2	7	7	7	17	69	108	99	95	6	8	5	2	=	432
Females	87.2	1	1	17	20	21	90	110	112	100	12	16	11	—	=	511
Teeth		17	16	15	14	13	12	11	21	22	23	24	25	26		
Teeth		47	46	45	44	43	42	41	31	32	33	34	35	36		
Males	17.2	—	2	1	3	1	9	26	38	8	—	2	—	—	=	90
Females	12.8	—	—	2	5	1	6	25	23	4	—	6	1	2	=	75

Table IV. Results of histopathological diagnosis

Diagnosis	Males		Females		Total	
	Cases	%	Cases	%	Cases	%
1. Granuloma	398	76.2	458	78.2	856	77.3
2. Cyst	99	19.0	87	14.8	186	16.8
3. Scar	21	4.0	29	4.9	50	4.5
4. Bone	1	0.2	7	1.2	8	0.7
5. Foreign body	2	0.4	3	0.5	5	0.5
6. Keratocyst	0	0	1	0.2	1	0.1
7. Globulomaxillary cyst	0	0	1	0.2	1	0.1
8. Actinomycotic infection	1	0.2	0	0	1	0.1

Table V. Incidence of cysts by dental arch and individual tooth

	Maxilla	Mandible
Teeth operated on (no.)	943	165
Cysts (no.)	163	23
Percentage of cysts	17	14
Ratio	5.8 : 1	7 : 1

The slightly higher incidence of cysts in the maxilla is statistically insignificant

Cysts as % of lesions on tooth*	Maxilla							Mandible						
	17.4	11.5	5.5	27.8	12.63	15	29	5.5	0	6.25				
Cyst	0	1	4	3	2	41	25	30	54	1	0	1	1	
Granuloma	3	7	19	23	34	106	173	170	132	17	23	15	1	
Teeth	17	16	15	14	13	12	11	21	22	23	24	25	26	
Teeth	47	46	45	44	43	42	41	31	32	33	34	35	36	
Granuloma	0	2	2	4	1	13	44	48	8	0	6	3	2	
Cyst	0	0	1	4	1	1	3	10	3	0	0	0	0	

\*This row of figures is shown graphically in Fig. 1.

Table VI. Relationship between age and sex of patient and principal lesions

Lesions	Age (yr)									
	10-20		21-30		31-40		41-50		50+	
	No.	%	No.	%	No.	%	No.	%	No.	%
Granulomas	9	2.3	113	28.5	132	33.2	82	20.7	61	15.4
Males										
Females	24	5.3	125	27.4	137	30.0	93	20.4	78	17.2
Cysts	6	6.1	26	26.3	32	32.3	21	21.2	14	14.1
Males										
Females	6	6.9	26	29.9	33	37.9	12	13.8	10	11.5

**Table VII.** Cysts related to specific teeth: results of work by Staphne (1945) and Mortensen et al. (1970)

Teeth	Staphne (349 cysts)		Mortensen et al. (164 cysts)	
	Maxilla	Mandible	Maxilla	Mandible
Central incisors	25	42	9	5
Lateral incisors	120	29	24	7
Canines	19	15	8	2
1st premolar	20	19	21	18
2nd premolar	22	7	14	13
1st molar	13	13	11	11
2nd molar	1	0	9	8
3rd molar	1	3	1	3
Total	221		97	

## DISCUSSION

### Frequency of teeth operated on

Winstock (1980) appears to be the only author who has given precise details of teeth operated on in a series of 9804 cases. However, in this study no details are given about the age or sex of the patients involved. Lalonde and Luebke (1968) in their report of 800 cases are somewhat vague regarding the distribution of lesions. They state that the most commonly affected teeth are maxillary lateral and central incisors, followed by mandibular first and second molars. The present survey corresponds to this with regard to the large proportion of maxillary teeth operated on—943 maxillary teeth and 165 mandibular teeth were involved.

### Incidence of cysts

In this study 16.8 per cent of the lesions were shown to be cystic. The results of previous authors (*Table I*) suggest the incidence of cysts varies from 7 per cent to 54 per cent. The two largest studies (Bhaskar, 1966; Winstock, 1980) provide widely different results for the incidence of cysts. It is probable that different histopathological criteria were used in the diagnosis of cysts by several previous workers. Bhaskar (1966) required the presence of an epithelial-lined lumen. By contrast, Mortensen et al. (1970) laid down no specific diagnostic details, but the lesions in this study were in excess of 5 mm in diameter. Hence, it might be said that the results of their study were biased in favour of cystic lesions. All the surveys could be open to unquantifiable complications from the viewing of only one section plane and by the occasional fragmentary nature of specimens. If the incidence of cysts increases with the size of the lesions, then a large number of Bhaskar's sample must have approached 10 mm in diameter. Yet in the report by Winstock, which included details of 9804 cases, only 8.4 per cent were found to be cystic. It must be appreciated that Winstock's criteria for operation was to establish a diagnosis of periapical lesions and to effect a definitive eradication of diseased tissue. It can be assumed that many of his cases would have responded to conventional treatment and therefore the incidence of

cystic lesions will be lower than the operator who apicected only when conventional therapy had failed.

### Incidence of cysts in maxilla and mandible

Bhaskar (1966) in his study of 2308 lesions found the incidence of cysts to be 42 per cent, with cysts approximately 10 times more common in the maxilla than the mandible. This was explained by stating that the maxilla contains far more epithelial debris than the mandible. Soames and Southam (1985) claim that 60 per cent of cysts are found in the maxilla, where there is a particularly high incidence related to the anterior teeth. This is confirmed by Shear (1983) who, in a study of 789 cysts found in African and British patients, noted 60 per cent of cysts to be in the maxilla. Staphne (1945) and Mortensen et al. (1970) found the ratio of cysts in the maxilla to those in the mandible to be approximately 3 : 2 (*Table VII*). Lalonde and Luebke (1968) had previously found cysts to be one and a half times more common in the maxilla.

In the present survey, of the maxillary teeth, 163 (17 per cent) were diagnosed as having cystic periapical lesions. Twenty-three (14 per cent) of the mandibular teeth were similarly affected. The maxillary value, although slightly higher, is of no statistical significance. This is in direct contrast to the results presented by all previous workers.

### The upper lateral incisor enigma

Previous workers have commented on the increased frequency of cysts in the anterior maxilla, but only Staphne (1945) and Mortensen et al. (1970) gave details regarding individual teeth (*Table VII*).

In the author's survey of 163 cysts in the maxilla, 95 were related to upper lateral incisors. Some 354 lateral incisors were operated on, and 26.8 per cent found to have cystic lesions, compared with 429 central incisors with only a 12.8 per cent cyst incidence. This high lateral incisor incidence confirms the findings of Staphne, who in his survey of 221 maxillary cysts found 54.3 per cent associated with this tooth. Mortensen and co-workers' review of 97 cysts of the maxilla found only 24.8 per cent

related to this tooth—but again these teeth were most commonly involved.

Periapical cysts arise from proliferation of the epithelial rest cells of Malassez within a granuloma, but not all granulomas become cysts. The mechanism which brings about the cystic change is uncertain, but chronic inflammation from some products of the non-vital pulp appears to be involved. The reasons for such changes occurring more frequently in the lateral incisor site is unknown. The authors speculate that an increased amount of epithelial debris may be related to the root surfaces of these teeth.

### **Incidence of cysts related to age**

Shear (1983) in an age distribution analysis of a group of British patients with radicular cysts found the greatest incidence in the fifth decade. In a group of South African patients the highest incidence was noted in the third decade.

In contrast to the work of Shear the present authors noted the highest cyst incidence in the fourth decade, 32.3 per cent of male cysts and 37.9 per cent of female cysts occurring in this period.

### **Incidence of cysts related to sex of patient**

Lalonde and Luebke (1968) found a slightly higher incidence of cysts—52.7 per cent—among female patients. Some 52 per cent of the cysts in the sample examined by Mortensen et al. (1970) occurred in females. In contrast to these strikingly similar findings, Shear (1983) reported a significantly higher incidence of cysts in male patients (58 per cent). In the present survey, 53.3 per cent of the cysts were found in males and 46.7 per cent in females, this difference being without statistical significance. Some 19 per cent of the male lesions and 15 per cent of the female lesions were shown to be cystic.

### **Lesion dimensions and accuracy of clinical diagnosis**

Studies carried out by Mortensen et al. (1970), Lalonde (1970) and Morse et al. (1973) have indicated a considerable correlation between increase in size of periapical lesions and cysts. Grossman (1950) was of the opinion that although larger radicular cysts could be diagnosed on periapical radiographs in most cases, difficulty was encountered in differentiating between cysts and granulomas when assessing small lesions. McCall and Wald (1952) stated that cysts could be differentiated from granulomas by size (more than 5 mm in diameter) and the presence of a radiopaque cortex to the lesion. Lalonde (1970) indicates that with lesions having a surface area in excess of 200 mm<sup>2</sup> the incidence of cysts approaches 100 per cent. Bhaskar (1966) on the other hand found a lack of correlation between size and cystic changes.

Mortensen et al. (1970) compared their clinical diagnosis with histological diagnosis in lesions of 5 mm or over in diameter. If one holds the view that such lesions are more likely to be cystic then their accuracy of clinical diagnosis should be particularly high. However, results showed their clinical diagnosis to be only 48 per cent correct in the case of cysts and 81 per cent correct in the case of granulomas.

In the present survey lesions of all sizes were considered. In each case a clinical diagnosis based on radiographic evidence and clinical appearance was made. Computer analysis showed that when the clinical diagnosis was compared with the histopathological diagnosis the authors were 41 per cent correct in their diagnosis of cysts and 81.4 per cent correct in their diagnosis of granulomas. These results are comparable to those of Mortensen et al. (1970).

It is the view of the authors that the relatively poor clinical diagnosis of cysts indicates that neither size nor radiographic appearance should be regarded as definitive diagnostic signs of these lesions. The relatively high successful diagnosis of granulomas is to be expected as these are the most common lesion (77.3 per cent), and one therefore tends to favour this diagnosis.

### **Other pathology**

#### *Odontogenic keratocyst*

No previous workers have noted the findings of an odontogenic keratocyst in their surveys. One case was diagnosed histopathologically in the present survey. It involved the lower right central incisor of a 33-year-old female and a clinical diagnosis of apical granuloma had been recorded.

#### *Globulomaxillary cyst*

One case was recorded following a clinical diagnosis of periapical cysts. The lesion was from the maxillary canine of a female patient aged 28 years.

#### *Actinomycosis*

In the present survey one case was diagnosed histologically as an actinomycotic lesion. This occurred in a male patient aged 35 years and involved an upper right central incisor. A clinical diagnosis of granuloma was recorded.

Periapical actinomycosis has seldom been reported. Martin and Harrison (1984) described a case and referred to Weir and Buck (1982) whose literature review had revealed only 20 cases. Radiographically the lesions are said to be present as an irregular radiolucent area at the tooth apex which resembles a granuloma.

### **Treatment implications**

Oehlers (1970) is of the belief that once the causative agent is removed, periapical lesions, including cysts are eliminated by the body. This view was supported by

Bhaskar (1972) who suggested that the majority of apical cysts undergo resolution after conventional endodontic therapy. This hypothesis was based on endodontists' claims that 85–90 per cent of apical lesions either disappear or become markedly reduced in size following conventional endodontics. Even if, as this study suggests, about 17 per cent of cases are cysts, and with the difficulty of distinguishing between cysts and granulomas on radiographic evidence alone, it must be assumed that the majority of cysts undergo resolution following endodontic therapy. Bhaskar (1972) suggested that during endodontic therapy instrumentation should be done slightly beyond the apical foramen. This produces a transitory acute inflammation which may destroy the epithelial lining of the cyst and convert it into a granuloma, thus leading to its resolution.

Nicholls (1984) states that instruments should not be passed beyond the apical foramen, unless they are to be used to drain an acute periapical abscess. Root canal instruments and filling materials should be confined within the root canal (British Endodontic Society, 1983) and this is the current teaching in UK dental schools.

According to statistics published by the Dental Estimates Board, 1 331 420 teeth underwent endodontic treatment under the General Dental Services regulations in 1985. Some 486 220 of these teeth were incisors or canines, where cysts appear to be most frequent. With various authors reporting cyst incidence to be from 7 per cent to 54 per cent, it might be assumed that amongst these cases between one hundred thousand and seven hundred thousand cysts were present. In the same year 39 940 apicectomies were carried out on incisors and canines. It is probable that this number of apicectomies is artificially low due to the fact that many cases were referred by practitioners to specialist services in teaching hospitals or peripheral oral surgery units.

Regrettably few cases (2540) had material removed for pathological and bacteriological examination, and many of these biopsies will be for other forms of oral diagnosis. This is of particular concern in view of the (albeit rare) occurrence of squamous carcinoma in dental cysts as reported by Lavery et al. (1987). As pathology reports are not made available centrally from the cases investigated, we are left to assume that the majority of cysts actually present resolve following orthograde endodontic treatment.

## SUMMARY OF FINDINGS

1. In the author's study of 1 108 cases, 196 (16.8 per cent) lesions were cystic.

2. The most common candidates for endodontic surgery were the maxillary teeth—943 maxillary teeth as against 165 mandibular teeth.

3. Of the 943 maxillary teeth, 163 (17 per cent) had cystic lesions. Of the 165 mandibular teeth, 23 (14 per cent) had cystic lesions.

4. Of the 163 cysts found in the maxillary teeth, 95 (58.3 per cent) were associated with the maxillary second incisors.

5. Mandibular central incisors exhibited a high incidence of cystic lesions, 56 per cent of mandibular cysts being associated with these teeth.

6. In the maxilla the most common teeth operated on were the central incisors. Similar findings occurred in mandibular teeth.

7. The most common age-group in which endodontic surgery was performed fell in the range 31–40 years. This applied to both sexes.

8. The highest incidence of cysts occurred in the 31–40 age-range in both sexes.

9. In addition to the 186 periapical cysts, one keratocyst and one globulomaxillary cyst were found.

10. One periapical lesion, diagnosed clinically as a granuloma, was found on histopathological examination to be an actinomycotic lesion.

11. The ratio of cysts to granulomas was found to be: 1 : 5.8 in the maxilla, and 1 : 7.2 in the mandible.

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## Book Review

### **Dental Care for the Elderly.**

Edited by Bertram Cohen and Hamish Thomson. Pp. 213. 1986. London, William Heinemann Medical. Softback, £14.95.

This book was written following a symposium held at the Royal College of Surgeons, London, in 1983. It is well set out, although the black and white illustrations are sparse. The theory of ageing and the clinical problems of dealing with the aged are dealt with as two parts, and within each part chapters have been written by experts in their fields.

The first chapter, "Understanding Older Patients", was, I suspect, written by a psychiatrist, and is sprinkled with clinical anecdotes of encounters between dentists and elderly patients. Whether factual, and whether those seeking psychiatric help were dentists or patients, is unclear; although in the case reported in relation to the "exertion of sexuality", involving a 63-year-old woman, it would be surprising if it were not the dentist. As one who finds that it works well to try to deal with an old patient as with an elderly relative, it is difficult to understand how anyone who requires a warning about prejudice against homosexuals, coloured people, those with accents and, worse, foreigners could readily be converted from their aberrations by a few pages of text. Nevertheless this chapter does give food for thought and should be well considered.

The chapter on the ageing of dental tissues is low-key and the information on such matters as tooth wear is no more than should be known by a final-year student from a study of conventional texts. Some statements, such as the old tooth being more brittle than the young, are without substantiation, while potentially interesting subjects such as the ageing pulp are dealt with rather superficially. Oral mucosal disease is summarized in terms of those lesions more frequently found in the old patient; the section on the causes of dry mouth is useful. Nutrition and metabolism in the elderly is most excellently covered, and the book is worth buying for this

section alone which contains information that could otherwise be gleaned only with some effort.

As to the clinical sections. Professor Johns has written a helpful chapter on the delivery of care, which includes useful checklists for domiciliary visits and many snippets of practical information. Herein lies the most delightful line in the book which entreats us to defer to the patient's wig! On the other hand the expert on restorative dentistry offers little more than can be gained from a basic text and the practising dentist will look in vain for adequate advice on the vexed problem of treatment of the worn dentition or for practical tips on the treatment of the carious bifurcation.

The same applies to his prosthodontic colleague who is at a particular disadvantage, since increasingly his discipline is, in the main, involved with the treatment of the aged, a topic well-covered in the standard books. He has thus been forced into making a brief summary of a vast subject, choosing a few facets for special comment, some of which seem to have been chosen at random and to be inappropriate, for example: Every, two-part, locking, and spoon dentures, while other more germane matters, such as the duplication of existing dentures, have been omitted.

All in all, the book is a little like the Archbishop's egg. Although good in parts, it is insufficiently focused and I suspect that, apart from the excellent chapter on nutrition, the experienced practitioner will find little practical advice over and above that which he has already gained as a result of commonsense and experience. Nevertheless, it makes pleasant, easy reading, and the exercise would be well worth undertaking not merely to upgrade knowledge but also to reassess one's own perspective in the light of the thoughtful concern that is emphasized throughout. The book should be essential reading for both undergraduate and postgraduate students, to whom it will give an instructive and, more important, sympathetic introduction to the subject.

I. E. Barnes