Section of the

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One of the many questions raised at the 1961 annual meeting of the American Association of Endodontists concerned the type and relative incidence of the periapical lesions. Although a number of studies were cited in this discussion, there was no unanimity of opinion on the subject. The incidence of radicular cysts was reported to vary from 7 to 54 per cent and that of dental granuloma from 46 to 84 per cent of all apical lesions.¹⁻⁵ According to the figure most frequently quoted by various members of the audience, however, about 85 to 90 per cent of the lesions are dental granulomas and the remainder represent radicular cysts.⁶ This estimate is based upon the clinical observation that in about 85 to 90 per cent of apically involved teeth, root canal filling leads to disappearance of the lesion or to a marked reduction in its size. From this clinical observation, it is assumed that the lesions which disappear represent dental granulomas while those which do not are radicular cysts.

In addition to the questions concerning the incidence of dental granulomas and radicular cysts, a number of other aspects of periapical pathosis are open

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to discussion and evaluation. The relative value of culturing root canals prior to filling, the mechanism of cyst growth, the effect of conservative endodontic treatment versus apicoectomy, the possibility of other apical lesions besides the dental granuloma and radicular cysts, are but a few of them.

It was to investigate some of the above problems that a study was started in the Department of Oral Pathology at the United States Army Institute of Dental Research. The purpose of this investigation was to study in detail the types, incidence, distribution, pathogenesis, natural history, and results of treatment of the diseases which occur in the periapical tissues. The present report is only the first in a series which will appear in the literature and which will present various aspects of this 4 year investigation.

METHODS AND MATERIALS

The present study is based on 2,308 cases of periapical lesions which were examined in the Department prior to April, 1963. For the purposes of these investigations, "apical tissues" were defined as those areas of the jaws which lie in immediate juxtaposition to and include the root apex. These tissues consist of the following: (a) cementum of the root apex, (b) the connective tissue and other components of the apical periodontal ligament, (c) the trabecular bone which lies across the root apex, and (d) its marrow contents.

In edentulous spaces the "periapical area" represented an arbitrarily delineated region which corresponded to the apex of the lost tooth.

The majority of specimens included in the study were submitted by civilian endodontists, but some were also received from the Army Dental Clinics. In all, the specimens in this study were received from 314 contributors. Each case represented a radiolucency in the apical area of the tooth. The specimens were accompanied by roentgenograms, and an attempt was made to correlate the roentgenologic and histologic findings.

In classifying apical lesions, the diagnosis of radicular cyst was made only when a definite epithelium-lined cavity could be identified. In instances where the apical lesion consisted of granulation tissue with varying degrees of epithelial proliferation but an absence of cavitation, the lesion was classified as a dental granuloma.

All specimens were fixed in 10 per cent formalin, embedded in paraffin, cut at 6 microns, and stained with hematoxylin and eosin. Selected specimens were stained with Brown and Brenn and Gomori's methenamine silver stains.

FINDINGS

Types of apical lesions

All of the 2,308 cases included in this study represented radiolucencies in the apical areas of teeth. Microscopically, these apical radiolucencies represented nine different types of lesions, namely, (1) dental granuloma, (2) radicular cyst, (3) residual cyst, (4) apical scar, (5) cementoma (Stage 1), (6) dental abscess, (7) foreign-body reaction, (8) cholesteatoma, and (9) giant-cell lesion.

The relative incidence of the lesions is given in Table I. In the following

description they will be considered briefly. Some of these, however, will be the subjects of more detailed subsequent reports.

Dental granuloma. Of the total, 1,108 cases (48 per cent) represented dental granulomas. These occurred with the same frequency in both sexes, and the maxilla was involved approximately three times as frequently as the mandible. Patients ranged in age from $4\frac{1}{2}$ to 81 years, and the greatest incidence was in the third decade of life. Table II gives the clinical features of the lesion. An examination of the roentgenograms showed that the lesions ranged in size from a few millimeters to about 2 by 2 cm. and that there was no correlation between the size and shape of the radiolucency and the final diagnosis (Figs. 1 and 2).

Table I. Type and incidence of various types of apical lesion

Type	Total number of cases	Incidence (per_cent)
Dental granuloma	1,108	48.0
Radicular cyst	969	42.0
Residual cyst	84	3.7
Apical scar	58	2.5
Cementoma (Stage 1)	28	1.2
Dental abscess	26	1.1
Foreign-body reaction	23	1.0
Cholesteatoma	10	0.4
Giant-cell lesion	2	0.1
	2,308	100.0

Table II. Location, sex, and age distribution of 1,108 cases of dental granuloma

Location	·····	· · · · · · · · · · · · · · · · · · ·
Mavilla	706	
Maxina Maxina	190	
Mandible	237	
Unknown	75	
Scx		
Male	550	
Female	558	
Aac		
Range: 4½ to 8. Distribution:	ı years	
Years		No. of cases
0 to 10		17
11 to 20		182
21 to 30		226
31 to 40		138
41 to 50		118
51 to 60		71
61 to 70		25
71 to 80		19
21 to 80		61
51 to 90		1

*Ages were not recorded in the remaining cases.



Figs. 1 and 2. Roentgenogram and photomicrograph of a dental granuloma. Note root resorption in two areas. (Case 8911.)

Radicular cyst. Of the total, 969 cases (42.0 per cent) represented radicular cysts. This lesion was about twice as common in the male as in the female, and it occurred almost ten times as often in the maxilla as in the mandible. Patients ranged in age from 4 to 80 years, and the greatest incidence was in the third decade of life. Table III gives the clinical data in more detail. Examination of the roentgenograms showed that the lesion ranged in size from a few millimeters to 2.5 by 2.5 cm., and there was no correlation between the final diagnosis and the size or shape of the radiolucency (Figs. 3 and 4). The presence or absence of root resorption also did not have any correlation with the final diagnosis.

Residual cyst. Eighty-four cases (3.7 per cent of the total) represented residual cysts. The maxilla was involved twice as often as the mandible. The patients ranged in age from 10 to 80 years, and the largest number of lesions occurred during the fourth decade. Table IV shows the clinical features of this lesion (Figs. 5 and 6).

Apical scar. This lesion has been briefly described in the literature,⁷ and its features will be reported in detail later. The lesion occurs at the apical areas of

Table	Ш.	Location,	sex,	and	age	distribution	of	969	cases	of	radicula	r cy	/st
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Location			
Maxilla	798		
Mandible	82		
Unknown	89		
Sex			
Male	605		
Female	327		
Age			
Range: 4 to 80 Distribution:	years		
Years		No. of cases	
0 to 1	0	31	
11 to 2	0	213	
21 to 3	0	232	
31 to 4	0	195	
41 to 5	0	145	
51 to 6	0	45	
61 to 7	0	47	
71 to 8	0	19	
		927*	

*Ages were not recorded in the remaining cases.



Figs. 3 and 4. Roentgenogram and photomicrograph of a radicular cyst. (Case 7168.)

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	Location		
	Maxilla	57	
	Mandible	27	
	g		
	Sex		
	Male	46	
	Female	38	
	Age		
	Range: 10 to 80 years Distribution:		
	Years		No. of cases
	0 to 10		1
	11 to 20		$\frac{1}{2}$
	21 to 30		$\frac{1}{4}$
	31 to 40		19
	41 to 50		16
	51 to 60		12
	61 to 70		9
	71 to 80		1
			0.1*
			h4 °

Table IV. Location, sex, and age distribution of 84 cases of residual cysts

*Ages were not recorded in the remaining cases.

Table V. Location, sex, and age distribution of 58 cases of apical scar

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	Location		
	Maxilla	39	
	Mandible	18	
	Unknown	1	
	Sex		
	Male	29	
	Female	26	
	Unknown	3	
	Age		
	Range: 9 to 70 Distribution:	years	
	Years		No. of cases
	0 to 10)	1
	11 to 20)	8
	21 to 30)	5
	31 to 40)	9
	41 to 50)	18
	51 to 60)	7
	61 to 70)	6
	Age not	given	4
			58

teeth which have had root canal fillings or both root canal fillings and apicoectomy. The apical scar is radiolucent, and microscopically it consists of dense collagen (Figs. 7 and 8).

Of the present series, fifty-eight cases (2.5 per cent of the total) represented apical scar. This lesion occurred more often in the maxilla than in the mandible, and the patients were usually in the fifth decade of life. Table V shows the clinical features.



Figs. 5 and 6. Roentgenogram and photomicrograph of a residual cyst. (Case 12262.)

Cementoma. Cementoma in Stage I presents as an apical radiolucency, and twenty-eight of the present series (1.2 per cent of the total) represented these lesions (Figs. 9 and 10). The mandible was involved about four times as frequently as the maxilla, and the lesion occurred predominantly in the female. Table VI gives more detailed data on its clinical features.

Dental abscess. Because of its acute nature and almost unequivocal clinical diagnosis, the acute dentoalveolar abscess was not biopsied. Consequently, such lesions did not comprise a part of this study. The dental abscesses submitted to the Registry usually represented dental granulomas, radicular cysts, or residual cysts which had undergone secondary acute or subacute inflammatory episodes (Figs. 11 and 12). There were twenty-six of these lesions, and they formed only 1.1 per cent of the sample. Table VII gives the clinical features of these cases.



Figs. 7 and 8. Roentgenogram and photomicrograph of an apical scar. (Case 16025.)

Table VI. Location, sex, and age distribution of 28 cases of cementoma in Stage I

*Ages were not recorded in three cases.



Figs. 9 and 10. Roentgenogram and photomicrograph of a cementoma in Stage 1. The tooth was treated as a result of misdiagnosis. (Case 7524.)

Foreign-body reactions. Twenty-three cases (about 1 per cent of the total) represented apical radiolucencies which, when biopsied, revealed tissue reaction to some exogenous foreign material (Figs. 13 and 14). These consisted of guttapercha fragments, silver particles, cotton fibers, and lipoid material. In brief, the foreign-body response was evidenced by histiocytic proliferation, giant-cell formation, and fibrosis. Table VIII gives the clinical features of the lesions.

Cholesteatoma. Ten cases (about 0.4 per cent) in this series represented cholesteatoma (Figs. 15 and 16). This term was applied to those radiolucent lesions which, on surgical excision, revealed a predominance of cholesterol clefts surrounded by numerous giant cells. These lesions had no cystic areas, and they represent dental granulomas with marked evidence of fatty degeneration. Radicular cysts and residual cysts which contained a few or many cholesterol clefts



Figs. 11 and 12. Roentgenogram and photomicrograph of a deutoal veolar abscess. (Case 12119.)

Table VII. Location, sex, and age distribution of 26 cases of dental abscess

Location		
Maxilla	17	
Mandible	9	
Sex		
Male	16	
Female	10	
Age		
Range: 8 to 74 y Distribution:	ears	
Years		No. of cases
0 to 10		2
11 to 20		7
21 to 30		5
31 to 40		1
41 to 50		5
51 to 60		4
61 to 70		1
		1
71 to 80		Ţ



Figs. 13 and 14. Roentgenogram of an apical scar in which an area of gutta-percha had produced a foreign-body reaction (Fig. 17). Fig. 18 shows the photomicrograph of area containing gutta-percha. (Case 10989.)

in the connective tissue wall were not included under this heading. The roentgenogram shows lesions which vary in size from a few millimeters to a few centimeters (Fig. 15). Of the ten lesions, six occurred in males and four in females, and the patients were from 16 to 55 years of age.

Giant-cell lesion. In two cases the periapical radiolucency (Figs. 17 and 18), when excised, revealed small lesions which consisted of multiple circumscribed foci of giant cells, fibroblasts, and hemosiderin in a vascular connective tissue stroma. On a histomorphologic basis, these two lesions were indistinguishable from the much larger central giant-cell reparative granuloma of the jaws.



Figs. 15 and 16. Roentgenogram and photomicrograph of a cholesteatoma. (Case 9399.)

Table VIII. Clinical features in 23 cases of foreign-body reactions

Location		
Mandible Maxilla	4	
Unknown	1	
Sex		
Male	15	
Female	8	
Age		
Range: 11 to 73 Distribution:	years	
Years		No. of cases
0 to 10		0
11 to 20		5
21 to 30		7
31 to 40		2
41 to 50		5
51 to 60		0
61 to 70		1
71 to 80		1
Age unkr	lown	
		23



 $Figs. 17\ and\ 18.$ Roentgenogram and photomicrograph of an apical giant-cell lesion. (Case 458.)

DISCUSSION Types of apical lesions

The present study has shown that, in addition to the dental granuloma and the radicular cyst, there are seven other lesions which involve the apical area of a tooth and therefore must be considered in the differential diagnosis of apical lesions. In some cases the tooth is vital; in others, it has a history of apicoectomy and root canal filling; in still others, there is a history of tooth loss. Therefore, the distinction between many of these lesions on a clinical basis is not impossible. Needless to say, the ultimate success of endodontic therapy depends a great deal on correct diagnosis. Conversely, it is likely that at least some of the failures in the past may be attributed to the giving of technically perfect therapy for the wrong lesion.

Relative incidence of the granuloma and radicular cyst

One of the most unexpected findings in this investigation was the relative incidence of the granuloma and the radicular cyst. Since the diagnosis of radicular cyst was made only in the presence of cavitation and an epithelial lining, there is no doubt that in the present series 42 per cent of the lesions were true cysts. This number is unusually high as compared with the usually quoted figures concerning the relative incidence of these lesions. Since conservative root canal filling leads to regression of 85 to 90 per cent of apical radiolucencies, it is generally assumed that 85 to 90 per cent of apical lesions are dental granulomas and that the remainder are radicular cysts. However, it will be shown in a subsequent report that the epithelial lining of the radicular cysts can be destroyed during some endodontic procedures. It is therefore apparent that although 42 per cent of the apical lesions are indeed radicular cysts, in many of these lesions the epithelial lining is destroyed during endodontic therapy and the lesions regress with conservative management.

It may be argued that this study was based on a biased sample, that the material submitted represented lesions in which the apical radiolucencies did not respond to conservative endodontic treatment, and that this bias is the reason for the high percentage of radicular cysts in the present sample. For two reasons, however, such an objection is not valid. First, the sample was collected from civilian as well as military dentists, and the contributors were requested to remove and submit *all* apical lesions. Although it is possible that some contributors submitted only the refractory cases, the majority of the sample does represent an unselected series. Second, if one were to assume that in the present sample the contributing dentists sent only those cases which did not respond to root canal therapy, this would imply that of the lesions which do not respond to root canal filling 48 per cent are granulomas and 42 per cent are radicular cysts. In other words, it would imply that conservative therapy fails more often if the lesion is a dental granuloma than if it is a radicular cyst. This, of course, is highly improbable.

For these reasons, it may be assumed that the present sample is not biased, that radicular cysts are far more common than was previously assumed, and that many of them respond to conservative endodontic procedures.

Jaw distribution of apical lesions

In the present series it was shown that the dental granuloma occurs almost three times as frequently in the maxilla as in the mandible. This preponderance of the dental granuloma in the maxilla is probably due to the greater frequency of carious lesions in that bone. However, the presence of ten radicular cysts in the maxilla for one cyst in the mandible cannot be explained on that basis alone. Since the maxilla contains far more epithelial debris (epithelial rests of Malassez as well as epithelium left in the wake of fusion of the facial processes that form the maxilla) than the mandible, it is conceivable that a dental granuloma has a much greater potential for becoming a radicular cyst in the maxilla than it has in the mandible.

Cementoma, cholesteatoma, foreign-body reactions, and the giant-cell lesion

The present series contained twenty-eight lesions which represented cementomas in Stage 1. Since the teeth associated with this lesion are vital, it should be possible to distinguish it from the other apical lesions. This clinical distinction is important, particularly in view of the fact that the cementoma is selflimiting and requires no endodontic or surgical therapy.

The cholesteatoma, which comprised a very small portion of the present series, is a radiolucent lesion which can be diagnosed only on histologic analysis. In the roentgenograms it is not possible to segregate it from the dental granuloma or the radicular cyst.

The foreign-body reactions seen in the apical tissues were radiolucent lesions which persisted after endodontic therapy. These lesions resulted when foreign bodies, such as gutta-percha, oils, silver points, paper points, or cotton fibers, were left in the apical tissues. The foreign-body reactions do not disappear spontaneously but require surgical removal; great care should be exercised to avoid leaving these materials in the apical areas.

The two cases seen in the present study, in which apical radiolucencies proved on histologic examination to be very small giant-cell reparative granulomas, are perhaps fortuitous. The teeth associated with these lesions were vital, and their occurrence emphasizes once again the importance of the pulp-vitality test in a differential diagnosis of apical radiolucencies.

SUMMARY

This report is the first in a series from the Department of Oral Pathology, United States Army Institute of Dental Research, and is based on 2,308 cases.

The present report deals only with the incidence and distribution of apical lesions. It has shown that an apical radiolucency may represent any one of nine distinct elinicopathologic lesions. The radicular cyst was found to comprise 42 per cent of all apical diseases. Other lesions seen in the apical area were dental granulomas, residual cysts, apical scars, cementomas, dental abscesses, foreignbody reactions, cholesteatomas, and giant-cell lesions.

The author is grateful to all endodontists who contributed to this study and without whose cooperation and consultation this and other reports to follow would have been impossible.

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