

# Radiographic patterns of periodontitis in cats: 147 cases (1998–1999)

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**Objective**—To determine patterns of alveolar bone loss (periodontitis) and other lesions evident on full-mouth survey radiographs of cats.

**Design**—Retrospective study.

**Animals**—147 cats.

**Procedure**—Full-mouth radiographs were evaluated for evidence and severity of alveolar bone loss, odontoclastic resorption lesions (ORL), retained roots, missing teeth, signs of endodontic disease secondary to periodontitis, and apical resorption.

**Results**—106 (72%) cats had some degree of periodontitis, 100 (68%) were missing teeth, 98 (67%) had ORL, 78 (53%) had expansion of the buccal alveolar bone at 1 or more canine teeth, 75 (51%) had retained roots, 48 (33%) had apical resorption, and 12 (8%) had signs of endodontic disease secondary to periodontitis. Cats < 4 years old were not significantly more likely than the general population to have normal alveolar bone height. Prevalence of ORL increased with age, but cats ≥ 13 years old were less likely than the general population to have moderate or severe generalized periodontitis. Purebred cats were not significantly more likely to have periodontitis or ORL than mixed-breed cats.

**Conclusions and Clinical Relevance**—Results suggest that periodontitis is common in cats and that horizontal bone loss is the most common radiographic pattern of alveolar bone loss. Purebred cats were not more likely than mixed-breed cats to have ORL or periodontitis, but when they did have periodontitis, it was more likely to be moderate to severe. Cats with ORL were less likely than cats without ORL to have normal alveolar bone height and more likely to have severe focal vertical bone loss. (*J Am Vet Med Assoc* 2001;218:230–234)

Periodontal disease includes inflammation of the gingiva, periodontal ligament, cementum, and alveolar bone.<sup>1</sup> Loss of alveolar crestal bone is readily apparent on dental radiographs, especially in the advanced stages of periodontal destruction,<sup>2</sup> and height of the alveolar bone, as seen on radiographs, is frequently used to evaluate severity of periodontal disease in humans,<sup>3</sup> even though it is a measure of past destructive events rather than a true representation of the present inflammatory condition.<sup>4</sup> The alveolar crest, the most coronal portion of the alveolar bone, is normally parallel to the plane of occlusion and perpendicular to the tooth surface.<sup>4</sup> A distance of 1 to 2 mm from the cemento-enamel junction to the alveolar

crest is considered normal in humans,<sup>2,3,5</sup> and it is generally accepted that the alveolar crest should be within 1 mm of the cemento-enamel junction in healthy cats.<sup>6</sup>

Bone loss associated with periodontitis may be classified radiographically as horizontal or vertical. Horizontal bone loss involves a reduction in the alveolar crest height, with the bone margin remaining perpendicular to the tooth surface.<sup>4</sup> Vertical or angular bone loss occurs in an oblique direction so that the base of the defect is apical to the surrounding bone.<sup>4</sup> Horizontal bone loss typically involves 2 or more adjacent teeth, whereas vertical bone loss may affect a single tooth or a single root of a tooth.<sup>6</sup> With either type of bone loss, the buccal and lingual plates as well as bone mesial and distal to the tooth may be affected but not necessarily to the same degree around any given tooth,<sup>4</sup> and defects on the buccal and lingual surfaces may not be detected radiographically. In multi-rooted teeth, periodontal bone destruction may affect the furcation areas, leading to partial (furcation involvement) or complete (furcation exposure) bone loss in the interradicular area.<sup>4</sup>

The diagnostic yield of routine full-mouth radiography in cats is high, particularly in older cats.<sup>7</sup> In 1 study,<sup>7</sup> for instance, 25.2% of cats had evidence of periodontitis and bone loss apparent on radiographs that was more severe than what was expected or clinically apparent. A separate survey of 150 teeth in 15 cats revealed radiographic signs of alveolar bone destruction in 77.3% of all premolars and molars examined.<sup>8</sup> In another study involving radiographic evaluation of mandibles obtained from 81 cats at necropsy,<sup>9</sup> 93% of the cats > 4 years old had radiographically visible root or alveolar bone lesions.

Odontoclastic resorption lesions (ORL) are a common problem in cats. There has been much debate about the pathogenesis of ORL in cats, and periodontitis has been suggested as a possible cause.<sup>8</sup> It has also been speculated that purebred cats may be more susceptible to ORL<sup>10</sup> and to periodontal disease.<sup>11</sup>

The purposes of the study reported here were to determine patterns of radiographically apparent alveolar bone loss in cats, whether age or breeding (purebred vs mixed breed) was related to severity or pattern of bone loss, and whether ORL were associated with bone loss.

## Criteria for Selection of Cases

Medical records of all cats examined by the Dentistry and Oral Surgery Service of the University of California, Davis, Veterinary Medical Teaching Hospital between January 1998 and August 1999 were reviewed. Cats for which full-mouth radiographs had been obtained were included in the study. Cats were

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not selected for inclusion in the study on the basis of severity of dental disease, and full-mouth radiographs were routinely obtained from all new adult cats undergoing dental treatment during this period. For cats examined more than once during the study period, only the first set of full-mouth radiographs was included in the study.

### Procedures

Because elongation or foreshortening of an image on a radiograph can lead to over- or under-estimation, respectively, of bone loss, consistent radiographic techniques were used for all cats examined during the study period to ensure that images and measurements would be accurate. The parallel technique was used to obtain radiographic views of the mandibular premolars and molars, the bisecting angle technique was used to obtain views of the mandibular and maxillary incisors and canines, and an extraoral near-parallel technique was used to obtain views of the maxillary premolars and molars.<sup>12</sup>

Cats were grouped according to breed (mixed breed vs purebred) and age (< 4 years old, ≥ 4 but < 9 years old, ≥ 9 but < 13 years old, ≥ 13 years old). Full-mouth radiographs were evaluated for evidence and severity of alveolar bone loss and furcation involvement. Alveolar bone loss was categorized as horizontal or vertical and as generalized or focal. Severity of bone loss was graded on a scale from 0 to 3, as follows: grade 0 (normal), no evidence of bone loss; grade 1 (mild), 1 to 15% bone loss; grade 2 (moderate), 16 to 40% bone loss; and grade 3 (severe), > 40% bone loss or complete (through-and-through) furcation exposure. Cats were considered to have normal alveolar bone height if scores for generalized horizontal bone loss, focal horizontal bone loss, generalized vertical bone loss, and focal vertical bone loss were all 0.

Buccal alveolar bone of the maxillary and mandibular canine teeth was examined, and its width was measured and scored on a scale from 0 to 3, as follows: grade 0 (normal), ≤ 1 mm; grade 1 (mild), > 1 but < 2 mm; grade 2 (moderate), ≥ 2 but < 3 mm; and grade 3 (severe), ≥ 3 mm. Radiographs were also evaluated for ORL, retained roots, missing teeth, signs of endodontic disease secondary to periodontitis, and apical resorption. Although retained root fragments, missing teeth, or resorption of the apical portion of a tooth may have been a result of ORL, it was impossible to determine radiographically whether these findings resulted from ORL, trauma, periodontitis, endodontic disease, or another cause. Therefore, these findings were considered independently of ORL.

**Statistical analyses**—The Wilson procedure without correction for continuity was used to compare patterns of bone loss in the population as a whole with patterns for each of the 4 age groups. This same procedure was used to compare results for purebred cats with results for mixed-breed cats, to compare results for cats with ORL with results for cats without, to determine whether pattern of bone loss was associated with buccal bone expansion, and to determine whether pattern of bone loss was associated with signs of

endodontic disease (eg, periapical lesions) secondary to periodontitis. For all analyses, values of  $P < 0.05$  were considered significant.

### Results

One hundred forty-seven cats were included in the study. Of these, 120 were mixed-breed cats, and 27 were purebred cats. Twenty-two were < 4 years old, 55 were ≥ 4 but < 9 years old, 57 were ≥ 9 but < 13 years old, and 13 were ≥ 13 years old.

Forty-one (28%) cats had normal alveolar bone height without any evidence of horizontal or vertical bone loss; all age groups were represented. One hundred (68%) cats were missing teeth, 98 (67%) had ORL, 81 (55%) had generalized horizontal bone loss, 78 (53%) had expansion of the buccal bone at 1 or more canine teeth, 75 (51%) had retained roots, 48 (33%) had focal horizontal bone loss, 48 (33%) had focal vertical bone loss, 48 (33%) had apical resorption, 12 (8%) had signs of endodontic disease secondary to periodontitis, and 8 (5%) had generalized vertical bone loss. Endodontic disease secondary to periodontitis was always observed in association with severe vertical bone loss.

**Patterns of bone loss**—Mild (grade 1) generalized horizontal bone loss was the most common pattern of bone loss and was seen in 56 (38%) cats (Fig 1). Moderate (grade 2) or severe (grade 3) focal horizontal bone loss was also common and was seen in 40 (27%) cats. Moderate or severe focal vertical bone loss was evident in 39 (27%) cats (Fig 2). Other patterns of bone loss were observed less frequently. Severe focal vertical bone loss was found in 29 (20%) cats and was seen in combination with mild generalized horizontal bone loss in 15 (10%) cats. Moderate or severe generalized horizontal bone loss affected 25 (17%) cats, moderate or severe generalized vertical bone loss affected 8 (5%), and severe combined generalized horizontal and vertical bone loss affected 3 (2%). Of the 56 cats with vertical bone loss, 47 (84%) had moderate or severe loss.

**Buccal bone expansion**—Mild expansion of the buccal alveolar bone at 1 or more canine teeth was evi-



Figure 1—Radiographic view of the left mandibular premolars and molar in a 4-year-old cat. Notice the mild horizontal bone loss, particularly on the mesial aspects of the third and fourth premolar and the distal aspect of the first molar.



Figure 2—Radiographic view of the right mandibular premolars and molar in a 4-year-old cat. Notice the severe focal vertical bone loss affecting the mesial root of the fourth premolar and both roots of the first molar. Subgingival calculus and inflammatory resorption of the mesial root of the fourth premolar is also evident.



Figure 3—Radiographic view of the maxillary canines and incisors in a 16-year-old cat. Mild expansion of the buccal bone of both canines is evident; however, there is no evidence of horizontal or vertical bone loss.



Figure 4—Radiographic views of the maxillary canines and incisors of 2 cats. Left—Radiographic view of an 11-year-old cat. Moderate expansion of the buccal bone of both canines is evident along with vertical bone loss on the buccal aspect of the left canine. Notice the complicated crown fracture and wide pulp cavity of the right canine. Right—Radiographic view of a 10-year-old cat. Severe expansion of the buccal bone of both canines is evident along with severe vertical bone loss on the left maxillary canine. The right canine likely was lost because of severe attachment loss. Several incisors are missing, and retained fragments of the roots of several incisors are evident.

dent in 67 (46%) cats and was not associated with any specific pattern of bone loss (Fig 3). Twelve of the 41 cats with normal alveolar bone height had grade-1 buccal bone expansion. Eleven (7%) cats had moderate or severe buccal bone expansion at 1 or more canine teeth, and of these, 10 also had severe vertical bone loss (Fig 4).

**Effect of age**—Cats < 4 years old were not significantly more likely than the general population to have normal alveolar bone height but were significantly less likely to have severe generalized vertical bone loss, moderate focal horizontal bone loss, and moderate focal vertical bone loss (Table 1). They were also less likely to be missing teeth and to have ORL, retained roots, and apical resorption.

Prevalence of ORL increased with age: 8 of 22 (36%) cats < 4 years old, 36 of 55 (66%) cats  $\geq$  4 but < 9 years old, 43 of 57 (75%) cats  $\geq$  9 but < 13 years old, and 11 of 13 (85%) cats  $\geq$  13 years old had ORL. Cats  $\geq$  13 years old were significantly more likely than the general population to have apical resorption but were significantly less likely to have moderate or severe generalized horizontal bone loss, severe generalized vertical bone loss, or endodontic disease secondary to periodontitis (Table 2).

**Effect of breed**—Compared with mixed-breed cats, purebred cats were not significantly less likely to have normal alveolar bone height (Table 3). However, they were more likely to have moderate generalized horizontal bone loss, severe focal horizontal bone loss, and severe generalized vertical bone loss. Prevalence of ORL in purebred cats was not significantly different from prevalence in mixed-breed cats.

**Association of periodontitis and ORL**—Compared with cats without ORL, cats with ORL were significantly less likely to have normal alveolar bone height and were significantly more likely to have severe focal vertical bone loss (Table 4). As would be expected, they were also significantly more likely to be missing teeth, have retained roots, and have apical resorption.

Table 1—Prevalence of various radiographic dental abnormalities in cats &lt; 4 years old (n = 22) versus cats in general (147)

Abnormality	Percentage affected		Difference*	95% CI†
	Cats < 4 years old	All cats		
None (normal alveolar bone height)	31.8	27.9	3.9	-13.4 to 25.8
Moderate focal horizontal bone loss	0	4.8	-4.8	-19.8 to -0.02
Moderate focal vertical bone loss	0	6.8	-6.8	-22 to -1.5
Severe generalized vertical bone loss	0	4.8	-4.8	-19.8 to -0.02
Missing teeth	40.9	68.0	-27.1	-49 to -8.1
ORL	36.4	66.7	-30.3	-52.5 to -12.2
Retained roots	27.3	51.0	-23.7	-46.1 to -7.5
Apical resorption	13.6	32.7	-19.1	-39.9 to -7.1

\*Prevalence in cats < 4 years old minus prevalence in all cats. †95% confidence interval (CI) for the difference in prevalence in cats < 4 years old versus prevalence in all cats; intervals that do not contain 0 indicate a significant difference.  
ORL = Odontoclastic resorption lesions.

Table 2—Prevalence of various radiographic dental abnormalities in cats ≥ 13 years old (n = 13) versus cats in general (147)

Abnormality	Percentage affected		Difference*	95% CI†
	Cats ≥ 13 years old	All cats		
None (normal alveolar bone height)	23.1	27.9	-4.8	-32.8 to 12
Moderate generalized horizontal bone loss	0	7.5	-7.5	-30.5 to -2.1
Severe generalized horizontal bone loss	0	9.5	-9.5	-32.6 to -3.7
Severe generalized vertical bone loss	0	4.8	-4.8	-27.7 to -0.02
Endodontic disease secondary to periodontitis	0	8.2	-8.2	-31.2 to -2.6
Apical resorption	61.5	32.7	28.8	1.7 to 50.8

\*Prevalence in cats ≥ 13 years old minus prevalence in all cats. †95% confidence interval (CI) for the difference in prevalence in cats ≥ 13 years old versus prevalence in all cats; intervals that do not contain 0 indicate a significant difference.

Table 3—Prevalence of various radiographic dental abnormalities in purebred (n = 27) versus mixed-breed (120) cats

Abnormality	Percentage affected		Difference*	95% CI†
	Purebred cats	Mixed-breed cats		
None (normal alveolar bone height)	18.5	30.0	-11.5	-31.1 to 2
Moderate generalized horizontal bone loss	18.5	5.0	13.5	1.8 to 31.9
Severe focal horizontal bone loss	37.0	19.2	17.8	0.4 to 37.6
Severe generalized vertical bone loss	14.8	2.5	12.3	2.3 to 30.1
ORL	77.8	64.2	13.6	-6.6 to 28.2

\*Prevalence in purebred cats minus prevalence in mixed-breed cats. †95% confidence interval (CI) for the difference in prevalence in purebred cats versus prevalence in mixed-breed cats; intervals that do not contain 0 indicate a significant difference.  
See Table 1 for remainder of key.

Table 4—Prevalence of various radiographic dental findings in cats with (n = 98) and without (49) ORL

Finding	Percentage affected		Difference*	95% CI†
	Cats with ORL	Cats without ORL		
No abnormality (normal alveolar bone height)	20.4	42.9	-22.5	-38.1 to -7
No focal horizontal bone loss	62.2	77.6	-15.4	-31.5 to -1.7
No focal vertical bone loss	60.2	81.6	-21.4	-37.3 to -8.5
No buccal bone expansion	40.8	59.2	-18.4	-35.5 to -2.8
Severe focal vertical bone loss	25.5	8.2	17.3	4 to 28
Missing teeth	83.7	36.7	47.0	30.5 to 60.4
Retained roots	66.3	20.4	45.9	29.5 to 58.3
Apical resorption	45.9	6.1	39.8	25.7 to 50.4

\*Prevalence in cats with ORL minus prevalence in cats without. †95% confidence interval (CI) for the difference in prevalence in cats with ORL versus prevalence in cats without; intervals that do not contain 0 indicate a significant difference.  
See Table 1 for remainder of key.

## Discussion

Results of the present study suggest that as in humans,<sup>4</sup> horizontal bone loss is the most common radiographic pattern of periodontal bone loss in cats. Generalized horizontal bone loss was diagnosed in 81 of 147 (55%) cats in the present study. In most instances, cats with generalized horizontal bone loss had only mild bone loss. By contrast, of the 56 cats with vertical bone loss, 47 had moderate or severe bone loss.

In the present study, radiographic assessments of bone loss were used to classify severity of periodontitis. However, because radiographs are 2-dimensional, radiographic evidence of loss of the bony support along half the length of a tooth root should not be assumed to be indicative of loss of half the total area of attachment of the root surface to alveolar bone.<sup>3</sup> The buccal and lingual alveolar bone plates are not readily seen radiographically, and estimates of attachment loss made solely on the basis of radiographic findings are likely to underestimate the actual attachment loss,<sup>3</sup> particularly because attachment loss associated with periodontitis includes loss of soft tissue as well as bony support. However, a strong correlation between radiographic assessment of alveolar bone loss and clinical assessment of attachment loss has been demonstrated,<sup>13,14</sup> and radiographs are routinely used in human dentistry to assess severity and monitor progression of periodontal disease.<sup>15</sup>

Approximately a fifth of the cats in this study had severe bone loss, either horizontal or vertical, affecting 1 or more teeth. Without dental radiography, these lesions may have gone undetected.<sup>7</sup> Because periodontal disease is an important cause of tooth loss in cats,<sup>11</sup> early detection of periodontal bone loss is vital to the adequate treatment of affected areas.

In addition to causing tooth loss, severe alveolar bone loss can progress to the apex of the root or to the level of the lateral canal, inducing pulpitis and pulp necrosis.<sup>16</sup> In the present study, signs of endodontic disease secondary to periodontitis were evident in 12 (8%) cats and were always associated with severe vertical bone loss. Detection and treatment of areas of vertical bone loss during the early stages will help prevent development of endodontic disease secondary to periodontitis.

Although horizontal and vertical

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bone loss have been well-described in the veterinary dental literature,<sup>6,8,17</sup> expansion of the buccal alveolar bone at 1 or more canine teeth has not, to our knowledge, been described previously. The alveolar buccal bone was > 1 but < 2 mm wide in 67 (46%) cats in the present study, and 12 of the 41 (29%) cats with normal alveolar bone height had mild buccal bone expansion. This suggests that a buccal bone width up to 2 mm may be considered normal. On the other hand, a buccal bone width > 2 mm may reflect a pathologic process, as 10 of 11 cats in the present study with moderate or severe buccal bone expansion at 1 or more canine teeth also had severe vertical bone loss. The underlying processes resulting in increased width of the buccal alveolar bone have not been elucidated, and further investigation is warranted.

It has been stated that 85% of dogs and cats > 6 years old have clinically important periodontal disease.<sup>18</sup> Periodontal disease includes gingivitis as well as alveolar bone loss (periodontitis). In the present study, only 41 of 147 (28%) cats ranging from 1 to 16.5 years old had normal alveolar bone height. Young cats were not more likely to have normal alveolar bone height than were cats in the general population, which suggests that periodontitis affects more than 70% of cats > 1 year old in this population. However, the study population consisted of cats brought to the veterinary teaching hospital for dental treatment, and, therefore, prevalence of periodontitis in this population may not reflect the prevalence in the general population of cats.

Age has long been considered a risk factor for periodontal disease.<sup>19</sup> In the present study, however, young cats did not have a lower prevalence of periodontitis than did cats in the general population, and cats ≥ 13 years old were significantly less likely than the general population to have moderate or severe generalized periodontitis. They were also less likely to have endodontic disease secondary to periodontitis. Studies have documented the systemic effects of periodontitis.<sup>20</sup> Although it is premature to conclude from these data that cats with moderate or severe generalized periodontitis are less likely to live to 13 years of age, it is possible that moderate to severe periodontitis may have an effect on longevity.

Odontoclastic resorption lesions were observed in 98 of the 147 (67%) cats in the present study, and the prevalence of ORL clearly increased with increasing age, as 36% of cats < 4 years old were affected, compared with 66% of cats ≥ 4 but < 9 years old, 75% of cats ≥ 9 but < 13 years old, and 85% of cats ≥ 13 years old. The higher prevalence of apical resorption in cats ≥ 13 years old is likely a reflection of this increase in prevalence of ORL.

It has been suggested that periodontal disease plays a role in the pathogenesis of ORL in cats.<sup>8</sup> In the present study, an apparent association between ORL and periodontitis was demonstrated. Cats with ORL were less likely than cats without ORL to have normal alveolar bone height and more likely to have severe focal vertical bone loss. Further investigation into the pathogenesis of ORL may clarify the relationship between these lesions and periodontal disease.

One author has suggested that periodontal disease

is more common in purebred than in mixed-breed cats.<sup>11</sup> Results of the present study, however, suggest that purebred cats are not more likely than mixed-breed cats to have ORL or periodontitis. However, when periodontitis was present, it was more likely to be moderate or severe in purebred cats. The reasons for this are unclear. Genetic influences on the development and severity of periodontitis in human adults have been demonstrated,<sup>21</sup> and it is possible that a similar predisposition exists in cats.

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