Risk Factors for Odontoclastic Resorptive Lesions in Cats

A cross-sectional study evaluating potential risk factors for odontoclastic resorptive lesions (ORL) in feline teeth was conducted. Owners of 32 cats with ORL and 27 cats without ORL were interviewed regarding their respective cat’s demographic characteristics, diet, and medical and dental histories. Four factors were identified as significantly associated with ORL using unconditional logistic regression. A history of dental disease (gingivitis, calculus, or periodontal disease; odds ratio [OR], 4.5); city residence (OR, 4.4); and being an exclusively indoor cat (OR, 4.5) were associated with an increased risk for ORL. Consumption of commercial treats (OR, 0.3) appeared protective for ORL. J Am Anim Hosp Assoc 1999;35:188–92.

Introduction
Tooth destruction from odontoclastic resorptive lesions (ORL) results in a painful dental condition of cats. Odontoclasts attack and begin to resorb teeth, either externally or internally.1,2 Externally they attack at the neck or cervical area of the tooth, often extending into the tooth root and surrounding alveolar area. Internally, they attack the tooth through the apical foramen and can subsequently enter into the root and dentin. In the early stages, cats are asymptomatic; but as the disease progresses and dentinal tubules and/or pulp are exposed, the lesions become increasingly sensitive and painful. Cats may present with a history of poor appetite or anorexia, eating on one side of the mouth, weight loss, and depression.3–5 External lesions may be difficult to identify if they remain hidden beneath the gingiva or calculus. As the lesions progress, they are often associated with gingival inflammation, bleeding or hyperplasia, and increasing loss of tooth substance. Ultimately, part or all of the affected teeth are lost. Characterizing the full extent of root and alveolar bone involvement requires dental radiographs.4,6

Odontoclastic resorptive lesions are common, affecting 20% to 67% of cats receiving dental care,7 and the prevalence varies with the characteristics of the population studied. In a recent study of cats undergoing a wide range of procedures requiring anesthesia in a private veterinary practice in Wisconsin, 48% of cats examined had one or more ORL;8 this compares closely with an estimate of 52% for a similar sample in Australia.9 The frequency is probably higher, since many lesions are subgingival and difficult to identify, and missing teeth may have been lost because of ORL.7 Despite the variability in prevalence estimates, the frequency of ORL appears to have increased over time. A recent reexamination of the teeth in 80 cat skulls examined originally by Cloyer in 1936 found one skull (1.3%) with ORL;7 a pre-1950 skull series had a 0.4% prevalence, while a post-1970 skull series had 26.5% of skulls with lesions.10 This apparent increase in the prevalence, however, may reflect changes in the age distribution of the cat populations examined.10

Despite a high prevalence, the cause(s) of ORL is unknown. The lesions were originally confused with caries11 which result from demineralization of the tooth enamel by toxins produced by carbohydrate-fermenting bacteria. Unlike caries, however, ORL occur when activated odontoclasts resorb tooth and bone tissue. In response, bone and cemen-
tum tissue initiate remodeling, odontoclastic activity con-
tinues, and the process repeats itself until ankylosis (i.e.,
fixation of the root in the alveolus through destruction of
the periodontal ligament and lamina dura) occurs, the
tooth is permanently damaged, and the root is fixed into
the alveolar bone.  

Odontoclasts are normally active only in young ani-
mals in resorption of the roots of deciduous teeth, facilit-
tating loss of these teeth and making room for the
permanent dentition. In cats with ORL, these cells are
inappropriately stimulated to differentiate and become
active for reasons that are not well understood. The
apparent increase in the prevalence suggests some
change(s) in the environment of cats that influences
mechanisms that affect the odontoclasts, and the search
for some environmental risk factor(s) important in the
etiologic of this disease has begun.

Numerous hypotheses regarding the etiology have
been proposed; they include chronic regurgitation due to
hair balls;10,13 a natural progression of periodontal dis-
 ease;8,13 associations with stomatitis potentially caused
by feline calici, feline leukemia, and feline immunodefi-
ciency virus infections;14 nutritional factors such as acidifi-
cation of dry cat foods;13 hypervitaminosis A from
consumption of raw liver;5,16 nutritional hyperparathy-
roidism;13 inadequate dietary calcium (e.g., homemade
diets);15 other dietary factors (e.g., feeding certain brands
of nongrocery cat foods or certain table foods);17 and
more recently, low magnesium diets.8

This cross-sectional study was initiated to examine
risk factors associated with ORL.

Materials and Methods

All cats presented for dental prophylaxis to the dental
section of the Community Practice Service of the Com-
panion Animal Hospital at Cornell University between
February and July 1994 were identified. Cats with ORL
were eligible for inclusion in the case group, and those
without lesions were randomly sampled to serve as con-
trols. Cats were evaluated primarily by Dr. Saidla. Cats
were anesthetized for dental prophylaxis. The entire
mouth was thoroughly examined for dental pathology,
and the data was recorded in the medical record by an
experienced examiner. Each tooth was probed with a
color-coded probe, looking for subgingival lesions, gin-
gival recession, extrusion of teeth, very small enamel
lesions or pits, loss of tooth crowns with retained roots,
and hyperplasia of the gingiva into enamel defects. The
degrees of gingivitis and periodontal disease were also
noted. The following data was retrieved from each cat’s
medical record: the date of diagnosis of ORL; history of
dental disease; the number and location of lesions in the
mouth; prior extractions; types of other oral pathology;
prescriptions for antibiotics and other medications; and
disease diagnoses prior to the diagnosis of ORL.

Owners of both case group cats and control cats were
asked to participate in a 15- to 20-minute telephone
interview during which they were asked to describe their
cat’s demographic characteristics (e.g., age, sex), diet
(e.g., type of food, frequency of feeding, table food),
time spent outdoors, previous use of medications, and medical history at and prior to the
date of diagnosis of ORL. All owners were told the study
was an assessment of factors affecting oral health. Inter-
viewers were blind to whether clients owned cats with
ORL or not, until late in the interview.

Associations between proposed risk factors and ORL
were evaluated using the chi-square test of independence
or Fisher’s exact test (where expected cell values were
less than 5) for categorical variables, and Student’s t-test
for continuous data with a Gaussian distribution.18 The
effects of variables significant at a p value of 0.20 or less
were evaluated further to control for potentially con-
founding variables using unconditional logistic regres-
sion where the dependent variable was the presence or
absence of ORL.19 The model parameters were obtained
by maximum likelihood estimation using the computer
program EGRET.8 The models were constructed using a
forward stepwise procedure. The assessment of interac-
tions was attempted, but the small sample size resulted in
failure to converge in most models. The significance of
variables in the models was determined by evaluating
the likelihood ratio chi-square statistic in each step of the
fitting process. In light of the small numbers, variables
significant at a p value of 0.10 or less were retained in
the final model. The regression coefficients were
exponentiated to obtain the adjusted odds ratio (OR) for
each parameter.

Results

Thirty-five cats with ORL and 32 without were identi-
fied, of which 33 cases (94%) and 27 controls (84%) were
interviewed respectively. Reasons for nonparti-
cipation included being too busy, death of a cat, and
travel. There were more females in the case group
(51.5%) than in the control (40.7%) group, but the differ-
ence was not significant. All cats were neutered, and
most were of mixed breed (94%). Cases were, on aver-
age, a year older than controls, but both groups had been
owned an average of 7.5 years and had a mean weight
between 11 and 12 pounds [Table 1].

When individual variables were screened for their
association with ORL, seven were significant (p value of
0.20 or less). A higher proportion of cats with ORL
received two or more brands of canned foods, were fed
liver and other organ meats from the table, and had a
history of dental disease (including calculus, gingivitis,
and periodontal disease). Control cats spent more time
outdoors daily (particularly in the summer), lived in
rural areas more often, were fed commercial treats more
often, and received coat supplements. Control cats were also more likely to have been treated recently for upper respiratory infections (URI), episodes of diarrhea, and to have received antibiotics. When the owners were asked about their respective cat’s medical history, however, there were no differences in the frequency of reported lifetime episodes of URI, diarrhea, or other medical conditions.

The seven factors that were significantly associated with ORL using a liberal p value of 0.20 or less, were examined simultaneously in the multivariate models. Only the four factors that remained significant (p value of 0.10 or less) are discussed. In the multivariate models, four factors (i.e., time spent outdoors, a history of dental disease, urban-rural residence, and consumption of commercial cat treats) remained associated with ORL. Since time spent outdoors was highly correlated with area of residence (i.e., city, village, or rural), both residence and time spent outdoors were not examined in the same multivariate model. Therefore, two models are presented [Table 3]. Living in an urban area (OR, 4.4) and a history of dental disease (OR, 4.5) increased risk more than fourfold compared to cats living on a farm and with no previous dental disease, respectively. Receiving commercial treats reduced risk approximately threefold.

If time spent outdoors was evaluated in lieu of residence, strictly indoor cats had a 4.5 times higher risk of ORL, and cats spending some time (but no more than six hours) outside daily had a 4.3 times higher risk of ORL compared to cats spending seven or more hours outdoors daily in the summer. The risks associated with a history of dental disease and commercial treats were essentially unchanged in this model.

Gender, history of treatment with antibiotics, urinary acidifiers or other medications, source of water supply, number of other cats in the household, frequency of daily feeding, prevalence of free-choice feeding, and the proportion of cats fed canned, dry, or semimoist pet foods were not associated with ORL in this study. Also, consumption of various table foods did not differ significantly between cats with ORL and without ORL.

### Discussion

Builder11 first mentioned ORL in 1950, but speculated that the lesions were a form of caries. It wasn’t until 1976 that Schneck first distinguished ORL from dental caries and coined the term "neck lesions." Since that time, the importance of ORL as a leading cause of dental disease in cats has been appreciated. Factors that may predispose cats to the disease are beginning to emerge.

If the apparent increase in ORL prevalence is not just a result of cats living to older ages, then the change suggests the introduction of some environmental factor(s) or the removal of protective ones, or both. The primary objective of this study was to compare exposures to various environmental factors between cats with ORL and without ORL.

Previous dental disease (as recorded in the medical records) was the strongest risk factor identified, with an odds ratio of between four and five (depending on the model), suggesting that cats with previous dental disease had approximately four to five times higher risk for ORL than those without previous dental disease. The prior dental disease was predominantly calculus accumulation, gingivitis, and periodontal disease. One theory of etiopathogenesis suggests that plaque bacteria induce an inflammatory response in the gingival tissue which leads to attraction of circulating stem cells that become odontoclastic cells. These cells then initiate damage and lead to granulation tissue with an enhanced blood supply which facilitates remodeling of bone-cementum tissue, all of which contribute to ORL.21 The inflammation, however, may be secondary to the resorptive lesion.10,20 At least two previous studies have found an association between the occurrence of ORL and periodontitis.7,22

Cats with ORL spent more time indoors, and being indoors most of the time (18 hours or more) increased risk more than fourfold. The converse of this, time outdoors, particularly in the summer, appeared to lower risk. Cats with ORL also spent less time outside during the winter, but the results were not statistically significant, probably reflecting the small number of cats spending prolonged periods outdoors in central New York. The authors speculate that the significance of time spent outdoors may be related to hunting activities and that consuming prey may help to clean teeth and prevent oral disease leading to ORL. Many owners were unsure whether their cat “hunted,” and, therefore, the quality of

### Table 1

**Characteristics of Cats With Feline Odontoclastic Resorptive Lesions (Cases) and Controls**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cases (n=33)</th>
<th>Controls (n=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at diagnosis (yrs)</td>
<td>Mean 7.7</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>Range 2–16</td>
<td>2–18</td>
</tr>
<tr>
<td>Years owned</td>
<td>Mean 7.5</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>Range 2–16</td>
<td>2–13</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>Mean 11.5</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>Range 7–19</td>
<td>9–16.5</td>
</tr>
<tr>
<td>Gender</td>
<td>No. %</td>
<td>No. %</td>
</tr>
<tr>
<td>Male</td>
<td>16 48.5</td>
<td>16 59.3</td>
</tr>
<tr>
<td>Female</td>
<td>17 51.5</td>
<td>11 40.7</td>
</tr>
<tr>
<td>Purebred</td>
<td>No. %</td>
<td>No. %</td>
</tr>
<tr>
<td>Yes</td>
<td>2 6.1</td>
<td>1 3.7</td>
</tr>
<tr>
<td>No</td>
<td>31 93.9</td>
<td>26 96.3</td>
</tr>
</tbody>
</table>

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1. Purebred Yes 2 6.1 1 3.7
2. Gender Male 16 48.5 16 59.3
3. Gender Female 17 51.5 11 40.7
4. Purebred Yes 2 6.1 1 3.7
5. Purebred No 31 93.9 26 96.3
data solicited with questions regarding hunting is suspect. Lund, et al., found no association with access to the outdoors, but no inquiries were made about time spent outdoors. Access or nonaccess to the outdoors was also not significant in this or a previous study. It was only after inquiries were made about time spent outdoors that differences emerged. There are reports of stray and feral cat populations having a lower prevalence of lesions, but more studies are needed. The demonstration of ORL in wild felidae does not necessarily contradict this hypothesis, as the actual prevalence of wild animals with lesions has not been reported. The finding that some breeds may have a higher prevalence of ORL may be a reflection, at least partially, of their lack of access to the outdoors because owners do not want to risk losing valuable animals. There were insufficient purebred cats in this study to evaluate breed as a risk factor.

The increased risk associated with urban residence or, conversely, the protective effect of rural residence (which appeared to decrease risk more than four times compared to city residence) may also be associated with hunting activities. Time spent outdoors and rural residence were significantly associated. It is also possible that some other factor(s) associated with rural residence (such as water source) may be of etiological significance. Lending support to this hypothesis is Lund, et al.’s observation that a higher proportion of cats with ORL drank well water (according to their univariate analysis). Similarly, strictly indoor, city-dwelling cats may be exposed to unknown factor(s) that increase their risk.

### Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Cases</th>
<th>Controls</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Rural/farm</td>
<td>10</td>
<td>12</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>City of &lt;2,500 people</td>
<td>4</td>
<td>9</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>City of &gt;2,500 people</td>
<td>19</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Hours outdoors daily</td>
<td>Not out</td>
<td>16</td>
<td>10</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>1 to 6</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 or more</td>
<td>7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Previous dental disease</td>
<td>Yes</td>
<td>12</td>
<td>5</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>21</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Fed organ meats from table</td>
<td>Yes</td>
<td>5</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>28</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Fed commercial cat treats</td>
<td>Yes</td>
<td>7</td>
<td>11</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>26</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Fed coat supplement</td>
<td>Yes</td>
<td>1</td>
<td>4</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>32</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Number of canned brands fed</td>
<td>None</td>
<td>11</td>
<td>7</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;1</td>
<td>15</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

* P value comparing variable distribution between cases and controls

### Table 3

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Odds Ratio</th>
<th>90% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>Village (&lt;2,500 people)</td>
<td>0.5</td>
<td>0.1–1.8</td>
</tr>
<tr>
<td>City (≥2,500 people)</td>
<td>4.4</td>
<td>1.4–13.6</td>
</tr>
<tr>
<td>History of dental disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>Yes</td>
<td>4.5</td>
<td>1.4–15.2</td>
</tr>
<tr>
<td>Commercial treat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>Yes</td>
<td>0.3</td>
<td>0.1–0.9</td>
</tr>
<tr>
<td><strong>Model II</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time outdoors (summer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥7 hours</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>1 to 6 hours</td>
<td>4.3</td>
<td>1.1–15.9</td>
</tr>
<tr>
<td>Not out</td>
<td>4.5</td>
<td>1.3–15.2</td>
</tr>
<tr>
<td>History of dental disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>Yes</td>
<td>5.3</td>
<td>1.5–18.0</td>
</tr>
<tr>
<td>Commercial treat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td>Yes</td>
<td>0.3</td>
<td>0.1–0.9</td>
</tr>
</tbody>
</table>
The significance of the apparent protective effect of commercial treats is unknown. Approximately 41% of cats with no lesions and 21% of those with lesions received treats at least once weekly. Closer examination of this data revealed that most of the cats with and without ORL which were fed treats received one brand, but the significance of this observation is unclear. It may be that some other aspect of the care or management of cats fed treats is related to risk for ORL, or the finding occurred by chance.

The observation that cats without ORL were more likely to have been treated recently for URI and diarrhea most likely reflects a bias in control selection; that is, when these cats were presented for treatment of URI or another presenting health concern, dental cleanings were recommended. When owners were asked about their respective cat’s history of respiratory, intestinal, and other illnesses, there were no differences between cases and controls. No associations were found with gender, number of cats owned, a history of hair regurgitation, prior URI or other diseases, types of diet (e.g., dry or canned), or consumption of various table foods.

While the authors attempted to collect information about potential causes preceding the diagnosis of ORL, the critical period during which the lesions may be induced is unknown. Therefore, data regarding diet, residence, time spent outdoors, etc., was collected primarily from the time of diagnosis of ORL or the time of recommended dental procedures in controls. Since much of the exposure data was cross-sectional in nature (i.e., collected at the time of diagnosis), the design is considered cross-sectional despite sampling cases and controls.

This design enabled the study of multiple possible risk factors but was limited by its cross-sectional nature. The study was also limited by incomplete records, where specific information was either incomplete or entirely missing. Identification of the nature and extent of previous dental disease, for example, was not always complete. Similarly, although every effort was made to remove cats with previous ORL from the control series, a few may have had lesions themselves as not all cats were radiographed. The relatively small sample size also hampered efforts to examine multiple variables simultaneously.

**Conclusion**

Data from previous studies suggests that the prevalence of feline ORL has increased, possibly due to a change(s) in the environment of cats. Numerous hypotheses have been advanced, but the etiology of these lesions remains elusive. Results from this study suggest that cats spending more time outdoors or living in a rural residence, or both, may have reduced risk, perhaps because of access to supplementation of their diet with natural prey. A decreasing number of cats with outdoor access may explain the increase in frequency of this disease. The etiology is undoubtedly complex, resulting from the interaction of multiple factors. In light of its high frequency and serious consequences, further research is warranted.

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**References**


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**Figures and tables**