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## INFLAMMATORY ORAL CAVITY DISEASES OF THE CAT

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A discussion of inflammatory oral lesions must start with a definition of terms. The term *stomatitis* means inflammation of the mucous membranes of the mouth. Stomatitis has been unfortunately used in veterinary parlance to describe severe forms of oral inflammation. Without more precise descriptions, however, it is difficult to differentiate conditions that may have specific lesions or causes. Proper terms are also necessary to convey an accurate visual picture of the disease process. For instance, which term in each of the following pairs of terms allows the mind's eye to visualize a lesion the best: stomatitis versus severe chronic ulceroproliferative faucitis, or stomatitis versus severe acute necrotizing ulcerative gingivitis (ANUG)? Stomatitis is a very nonspecific term, whereas chronic ulceroproliferative faucitis and ANUG, as described in subsequent sections, are distinctly different disease entities with specific causes.

The duration of the lesions should be defined using the classic medical terms of acute and chronic. The common medical dictionary definition of acute is "having a short . . . course."<sup>8</sup> Chronic is defined as having a "long continued course." The terms carry no specific time period, and for practical purposes *acute* diseases have a finite or transient lifespan, and *chronic* diseases persist indefinitely.

The physical appearance of the lesion should be described by adjectives such as vesicular, bullous, ulcerative, proliferative, suppurative, diphtheritic (fibrinous), and hemorrhagic or combinations thereof, e.g., ulceroproliferative.

Severity is subjective judgment. Most clinicians agree, however, that the mind can usually differentiate mild, moderate, and severe disease processes. Severe lesions have an immediate and forceful impact on the viewer. Moderate lesions are readily apparent but lack the visual and mental impact of severe lesions, and mild lesions are appreciated only after more careful observation. Diffuse lesions involve a substantial portion of the affected region and are often ill-defined at their margins, whereas focal lesions are less widespread and well

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circumscribed. *Multifocal* pertains to lesions that are well defined in nature but numerous.

The location of the lesion within the oral cavity is extremely important because specific disease processes usually affect specific structures. Inflammatory lesions of the tongue are referred to as *glossitis*, lesions of the lips as *cheilitis*, lesions of the inner cheek as *buccostomatitis*, lesions of the pharynx as *pharyngitis*, lesions of the fauces (glossopalatine folds or angles of the mouth) as *faucitis*, palate lesions as *palatitis* (hard or soft palatitis), lesions of the gingiva as *gingivitis*, tonsillar inflammation as *tonsillitis*, and lesions of the periodontium (periodontal membrane, gingiva, and alveolar bone) as *periodontitis*. The oropharynx is everything from the caudal edge of the hard palate to the epiglottis. Because the soft palate and fauces are parts of the oropharynx, inflammation of these structures is often lumped under the term *pharyngitis*. When specific regions of the pharynx, however, such as the fauces, are involved, it is preferable to use the more specific term, e.g., *faucitis*.

## ORAL IMMUNITY

### Anatomic Considerations

The oral cavity is at the primary interface between the outside environment and the host. Not only are microbes ingested from the outside, but also many microorganisms actually live as commensals on the external surfaces of the oral tissues. A plethora of antigenic substances, both from living and dead organisms, are ingested daily.

The membranes lining various structures of the mouth are designed for specific functions and in such an anatomic manner as to protect underlying tissues from microtrauma and macrotrauma, toxic substances, and infectious agents. The oral membranes are also bathed in saliva from both monostomatic and polystomatic salivary glands. Saliva keeps the tissues of the mouth moist, pliable, and lubricated as well as containing some of the digestive enzymes. Saliva effectively dilutes out or neutralizes many toxic, caustic, and allergenic substances that are taken into the mouth during eating or grooming. Saliva also contains substances that inhibit microbial growth.

The tonsils are the primary organized lymphoid organs in the oral cavity. They are basically lymph nodes covered by a specialized epithelium. The structure of the tonsils allows for the screening of ingesta for antigenic substances, and the tonsils are often the first tissues invaded by microbial pathogens. The regional lymph nodes play a somewhat similar role as the tonsils except that antigenic material and infectious agents usually enter these structures in interstitial fluid (free or in macrophages) via local afferent lymphatics. Diffuse lymphoid structures are widespread under the oral mucous membranes, although they may be difficult to visualize in normal tissues. In the face of antigenic stimulation, however, a substantial lymphocytic/plasmacytic infiltrate may become apparent.

### Local and Systemic Oral Immunity

#### *Active Immunity*

Both systemic and local immune responses are involved in oral cavity infections. Immunoglobulins of several classes are actively secreted or diffused

into the saliva, as are a number of nonspecific antimicrobial substances. The saliva protects the oral mucous membranes and tooth surfaces. An interesting oral microenvironment exists in the gingival crevice. In response to inflammation, the gingival crevice becomes fluid filled. Crevicular fluid is diffused largely from the blood and contains immunoglobulins as well as microphagocytic and macrophagocytic cells. Antibodies within the crevicular fluid are derived both from the serum and from local plasma cells and lymphocytes. Both antibodies and phagocytic cells are thought to play an important role in protecting the critical gingival crevice from microbial attack.<sup>11, 17</sup>

### *Innate Oral Immunity*

The mucous membranes of the mouth differ greatly from area to area. They are designed in such a way as to resist toxic substances, heat and cold, and abrasive materials. Anything that temporarily or permanently disrupts the oral mucous membranes will render the underlying tissues susceptible to microbial attack. The fact that microbes abound in the ingesta and on mucous membrane surfaces makes anatomic defenses of the oral cavity even more important than for other tissue barriers in the body.

The normal bacterial flora of the oral cavity plays an important role in innate resistance. Similar to the lower digestive and urinary tracts, resident bacteria prevent colonization and growth of nonresident microbes. Because resident microbes have evolved with their host, they are nonpathogenic in normal numbers and proportions. Favorable diets can play an important role in maintaining the normal flora in a beneficial balance, whereas unfavorable diets may cause a harmful balance.

Anatomic factors are also important in local oral defenses. Malocclusion of the jaws or malalignment of teeth is often associated with chronic gingival and eventually periodontal disease. The mechanisms behind anatomic abnormalities and chronic gingival and periodontal disease are not fully understood. Malaligned teeth may provide pockets where food material, and secondary microbial colonization, can accumulate. Malaligned occlusal surfaces do not allow for adequate "chewing exercise" or pressures on the periodontium or result in abnormal directional forces on the tooth and resultant stretching, increased tooth mobility, and resorption of periodontal tissues. Teeth that normally have excess mobility, such as the incisors of cats, are also much more prone to develop periodontitis than firmly seated teeth.<sup>19</sup>

### **Local Oral Immunity: Beneficial or Harmful?**

#### *Humoral and Cellular Immunity and Disease*

Although local oral immunity is generally considered to be beneficial, it can also be indifferent or even harmful.<sup>15</sup> The beneficial and harmful effects of host immunity apply both to antibodies and polymorphonuclear leukocytes<sup>30</sup> and to lymphocyte-mediated immunity.<sup>54</sup> Antibodies are beneficial in situations in which they increase the destruction of microbes by direct action or by enhancing opsonization, but they may be harmful in situations in which they cause excessive complement activation, arthus-type reactions, or blockage of microbial surface recognition receptors. Likewise, phagocytes are beneficial when they ingest and destroy microorganisms but may be harmful when they harbor pathogenic microbes, spread pathogens from one area to the other, or

nonspecifically damage surrounding normal tissues with their cytokines. Lymphocyte-mediated immunity plays an important role in destroying cells harboring pathogenic microbes but can also cause "autoimmune" damage to normal fibroblasts and other inappropriate damage.<sup>13, 52, 54</sup>

Oral immunity is most effective in keeping the normal oral flora in balance and in rapidly eliminating acute infections when they occur. In the case of chronic disease processes, however, oral immunity is apt to be either indifferent to the process or harmful. This is understandable because chronicity is evidence in itself that the infectious process has defied all initial immunologic attempts to contain it. The ineffectiveness or harmful effect of oral immunity in chronic oral infections would also explain why local cellular infiltrates and antibody production increase in direct proportion to the severity and chronicity of local disease activity.<sup>31</sup>

Ebersole et al<sup>11</sup> listed three possible scenarios for the sequence of events in oral infection and immunity in relation to disease activity: (1) infection→ disease activity→ local and systemic immunity; (2) infection→ local immune response→ disease activity→ systemic immune response; and (3) infection→ local and systemic immune response→ disease activity. Evidence indicates that the second scenario is most common; disease activity follows a failure of local immunity, and systemic immunity is evoked only after an infectious process becomes well established. This disease activity scenario is best demonstrated by gingivitis and periodontitis. Although a weakness in local immunity allows gingivitis to occur, the systemic immunity that is evoked will usually contain the infection to the gingiva. Periodontitis requires a weakening of both local and systemic defenses.

### **Oral Cavity as an Initial Site of Immune Defenses**

Many infectious diseases begin in the lymphoid tissues of the oral cavity. Canine parvovirus replicates initially in the lymphoid tissues of the oral cavity and then spreads systemically to target tissues in the gut and bone marrow.<sup>14</sup> The same is true of feline leukemia virus (FeLV).<sup>50</sup> The best known example of these phenomena is the omnipresent "tonsillitis" in young children who are being exposed for the first time to a myriad of upper respiratory infections. Is there any evolutionary significance to the fact that infections often start in the oral tissues? It can be argued that if an infection is going to occur, it is preferable to put that infection in contact with the immune system at the earliest possible time. In this manner, specific and nonspecific host defenses can be initiated before the disease agents reach their specific target cells in other tissues of the body.

### **Immunodeficiency and Oral Disease**

Because the oral cavity is the primary interface between the environment and the host, any abnormality in local or systemic host immunity (either congenital or acquired) will be readily manifested by oral disease. Therefore the oral cavity is an excellent mirror of deficiencies in local and systemic immunity, whether they are congenital or acquired.

#### *Deficiencies in Local Immunity*

Local immunodeficiency is caused by two basic things, derangements in the normal anatomy (acquired or congenital) or physiology (acquired or con-

genital) of the mucous membranes of the oral cavity or periodontium and deficiencies in local humoral or cellular immune functions. The former derangements involve innate immunity, whereas the latter involve active immunity. Defects in innate immunity have already been described. Defects in active local immunity may involve immunoglobulin A (IgA) production or the functioning of phagocytic cells.

### *Deficiencies in Systemic Immunity*

Systemic immunodeficiency is either congenital or acquired. The most flamboyant congenital immunodeficiency is the "boy in the glass bubble" type syndromes (severe combined immunodeficiency disorders [SCID]). Similar syndromes occur in all animal species, but they are relatively rare. Moreover, most individuals with SCID die of fulminating systemic infections and not from oral infections. Therefore chronic oral cavity disease is more apt to be seen in congenital disorders that are not overwhelmingly immunosuppressive. Animals with specific immunoglobulin defects (especially IgA), classic complement component deficiencies, defects in the alternate complement activation or properdin systems, and minor defects in phagocytosis are much more likely to suffer from chronic low-grade infections of the oral cavity, intestinal tract, respiratory tract, and skin than from fulminant systemic disease.

Although we tend to think mainly about the few well-defined heritable immunodeficiencies, such well-characterized disorders are involved in only a minute proportion of chronic oral infections. Most chronic oral cavity infections in animals or people have a congenital predisposition, but the nature of the defect(s) is not readily apparent at this time. Why are certain groups of humans or animals more susceptible to chronic gingivitis and periodontitis than others? Why do certain individuals develop more dental calculus on the same diets than others? Why do many humans and animals maintain normal periodontal health without any special precautions? Why do some have oral disease that can be managed with faithful prophylaxis, and why do a few individuals have progressive periodontal disease that defies prevention? The congenital nature of such susceptibility is even more obvious in veterinary medicine because of the routine practice of inbreeding animals. There is no question that certain breeds of dogs and cats suffer much more from oral disease than others. It is also obvious from both human and veterinary experiences that the genetic defects underlying these common forms of gingival and periodontal disease are complex and frequently interplay with a number of different environmental and dietary factors. The fact that we do not understand all of the subtle abnormalities that can lead to a loss of resistance and periodontal disease should not be disheartening. Every year new discoveries are made. For instance, the discovery of abnormal phagocytic functions of polymorphonuclear neutrophils has only recently offered an explanation for a large proportion of the cases of juvenile periodontitis in humans.<sup>29</sup>

Acquired immunodeficiency is of either infectious or noninfectious etiology. Certain diseases, such as feline immunodeficiency virus (FIV) infection of domestic cats, lead to a slow progressive decline in immune functions.<sup>64</sup> Once these immune functions are diminished to a critical point, secondary infections appear. Given the primary position of the oral cavity in host defenses, it is understandable why many of those secondary infections first appear in the oral cavity.

Acquired immunodeficiency can also be caused by noninfectious diseases that either specifically affect one or more components of the immune system

or lead to a more generalized state of ill health. Diabetics, patients in chronic kidney failure, cancer victims, or malnourished individuals suffering from any number of degenerative diseases often have increased problems with oral infections. Aging itself often leads to a slow decline in systemic immune functions<sup>62</sup> as well as degeneration of local anatomic and physiologic repair and defense mechanisms. Aging is one of the most important risk factors for periodontitis in humans<sup>19</sup> and animals. Immunosenescence is highly variable in clinical manifestation from individual to individual and may occur independent of degenerative changes in other organs. Immunosenescence has more impact on systemic than local immunity,<sup>62</sup> which may explain why periodontitis increases in frequency with age, whereas the frequency of gingivitis remains constant.

### **Oral Inflammatory Cell Infiltrates**

Great emphasis is often placed on the types of inflammatory cells that accumulate in oral lesions. For example, lymphocytic/plasmacytic stomatitis is often referred to in feline medicine as a specific disease entity. Infiltrates composed largely of polymorphonuclear neutrophils are more apt to be associated with acute lesions, whereas the addition of increasing numbers and proportions of lymphocytes and plasma cells indicates chronicity. The presence of eosinophils is suggestive of either parasitic or allergic (type 1 hypersensitivity) reactions. Because secondary microbial infection is so common in mouth lesions, most oral inflammatory lesions are of a mixed nature, i.e., containing elements of active and chronic inflammation. Suppurative inflammation will have a predominance of neutrophils, whereas chronic inflammation will have a predominance of macrophages, lymphocytes, and plasma cells. Pyogranulomatous inflammation, which is frequently seen in chronic oral infections in cats, is a mixture of the two. The nature of the cellular infiltrate also varies with the depth of the lesion. Breaches of the oral membranes by any disease process offer an avenue for microorganisms to invade superficially into the underlying submucosa. These may lead to a more suppurative process (neutrocytophilic/monocytic) near the surface and more immunogenic (lymphocytic/plasmacytic) response deeper. This means that oral biopsy specimens should be large and deep enough to sample the entire disease process.

Although the type, location(s), and intensity of cellular infiltrate may give a clue as to the cause of the disease, as in eosinophilic granulomas or vasculitis lesions, they are often misleading. There are two reasons for being misled: the inflammatory responses of oral tissues are similar regardless of cause, and they occur in response to antigenic stimulation but do not differentiate the origin or etiologic importance of that stimulation. For instance, any condition that breaches the oral defense mechanisms may allow normal oral flora to invade the deeper tissues and to elicit inflammation. The ultimate cause of the inflammation, however, is the breach of oral defenses and not the microbes. To complicate matters, the lesion may actually result from the host's attempt to contain immunologically or eliminate foci of microbial persistence, e.g., chronic diffuse ulceroproliferative faucitis associated with chronic oral carriage of feline calicivirus. A biopsy of the latter lesion would demonstrate a severe and diffuse plasmacytic/lymphocytic infiltrate in deeper tissues and a more ulcerative and suppurative process superficially. Without additional information, the biopsy and histopathologic findings would not help in making the correct diagnosis. Therefore there is not a specific disease process called

lymphocytic/plasmacytic stomatitis just as there is not a specific disease entity called stomatitis.

## **INFLAMMATORY DISEASES OF THE ORAL CAVITY**

Inflammatory lesions of the oral cavity of domestic cats have multiple causes and include (1) neoplastic disease, (2) autoimmune disease, (3) toxic disease, (4) specific infectious diseases, (5) periodontal disease, and (6) miscellaneous diseases.

### **Neoplastic Disease of the Oral Cavity**

Although neoplastic oral lesions are often associated with secondary infections and resultant inflammation, they are not inflammatory in the strictest sense. Therefore neoplastic oral lesions are not covered herein. Instead the reader is directed to several reviews of feline oral tumors.<sup>6, 7, 9, 10</sup> Nevertheless, the more proliferative, ulcerative, or ulceroproliferative forms of squamous cell carcinomas, fibrosarcomas, or melanomas can mimic lesions caused by infectious or miscellaneous agents or vice versa. This is only one reason why lesional biopsies should be a routine part of clinical workups of oral disease.

### **Autoimmune Diseases of the Oral Cavity**

Oral ulcerations have been described in at least four different diseases of an immune or "autoimmune" basis: (1) systemic lupus erythematosus (SLE), (2) pemphigus, (3) idiopathic vasculitis, and (4) toxic epidermal necrolysis (TEN).<sup>25, 58</sup> Although the lesions in these diseases are similar, the pathogenesis of the ulcers differ. Ulcerative lesions of feline SLE, idiopathic vasculitis, and TEN are due to the disruption of local blood supply, whereas the ulcers of pemphigus are due to the formation of fluid-filled clefts or bullae within the epidermal cell layer and subsequent rupture.

#### *Systemic Lupus Erythematosus*

Two cats with SLE had palatine or glossal ulcers as one feature of their illness.<sup>45</sup> Feline SLE is most usually manifested as behavioral changes, variable fever, lymphadenopathy, weight loss, and leukopenia. Almost all of the affected cats will have a nonerosive polyarthritis as based on inflammatory joint fluids, but only one fourth or so actually will outwardly manifest rheumatologic signs of lameness or stiffness. Dermatitis, oral ulcers, and hematologic abnormalities (anemia, thrombocytopenia) are seen in a smaller portion of animals. Many cats with SLE will have a low-grade proteinuria and slowly progressive renal failure owing to an immune complex type of glomerulonephritis. The oral ulcers are probably a complication of the systemic vasculitis that so often accompanies SLE in humans and animals. This vasculitis is associated with deposition of immune complex in the basement membranes of small blood vessels.

#### *Bullous Diseases*

Three forms of bullous diseases (pemphigus) have been recognized in the cat: *pemphigus foliaceus* (PF), *pemphigus erythematosus* (PE), and *pemphigus vulgaris*



(PV).<sup>5, 27</sup> The bullous diseases involve mainly the mucocutaneous junctions. PV is the one bullous disease that is most commonly associated with oral as well as skin lesions.<sup>5</sup> Diffuse or focal ulcerative lesions are most frequently seen on the hard palate but may also be found on the tongue, lips, gums, nasal philtrum, and commissures of the mouth.<sup>5, 27, 70</sup> Cats with PV usually present with hypersalivation, dysphagia, and weight loss; lesions may be grossly visible around mucocutaneous junctions of the mouth. Treatment is usually with immunosuppressive drugs as for feline SLE.

### *Idiopathic Vasculitis*

The author has observed an idiopathic vasculitis of the leukocytoclastic type in two young female sibling cats. The disease syndrome was manifested by recurrent but chronic bouts of multifocal oral (palatine, lingual), corneal, skin, and nasal philtrum ulceration (Color Plate 3,\* Figure 14). The oral ulcers tended to be shallow and slow healing and at times covered a considerable portion of the hard palate and tongue. Biopsy specimens showed large numbers of polymorphonuclear neutrophils marginating inside and around blood vessels. The condition did not respond well to glucocorticoids alone but was successfully kept in remission with a combination of prednisolone and cyclophosphamide. The condition, however, would recur after each attempt to stop treatment.

### *Toxic Epidermal Necrolysis*

TEN of cats is a relatively uncommon condition that tends to involve mainly the skin. Glossal ulcers have been an accompanying feature of one cat with TEN.<sup>53</sup> TEN of cats is almost always a consequence of a drug reaction, usually to substances such as immune sera, antibiotics, or steroid preparations that were injected parenterally several days earlier. The lesions themselves are ultimately caused by vasculitis and thrombosis of blood vessels supplying a distinct region of skin or mucous membrane. Affected skin is initially painful, then rapidly becomes nonpainful and erythematous. Within 1 to 2 days, the well-circumscribed lesion becomes discolored, cold, and devitalized. The affected skin or mucous membrane is either sloughed (mucous membranes) or undergoes dry gangrene (skin). Therefore affected oral lesions usually appear as a large ulcer, whereas affected skin appears like parchment that is slowly sloughed.

### **Toxic Oral Cavity Lesions**

Oral lesions caused by toxic chemicals are surprisingly common in cats. Most of them occur when toxic substances are either knowingly or unknowingly placed on the fur. The toxic material is then groomed into the mouth, with the highest levels (in order of concentration) being at the tip of the tongue, the overlying hard palate, the oropharynx, and the esophagus. The most common offending substances are disinfectants used on cages (which often end up on the fur) or on surgical sites. Many toxic oral lesions are of a nosocomial nature, being seen when cats are taken into the hospital environment. Problems usually arise when the wrong disinfectants are used or when too high of a concentration is employed in the cages or on surgical or nonsurgical wound sites.

Toxic oral lesions vary in severity depending on the type of toxic substance,

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\*See color section in the beginning of this issue.

its concentration, and the sensitivity of the particular animal. Phenolic compounds are the most toxic, although virtually any substance licked into the mouth can cause mouth lesions if groomed into the mouth at high enough concentration or if ingested by the wrong individual. Lesions are most common on the margin of the tip of the tongue (Color Plate 3, Figure 15). If enough toxin is ingested, lesions may also be seen on the palate (Color Plate 3, Figure 15). High toxin concentrations will also lead to lesions in the oropharynx and even the esophagus. Cats with oropharyngeal/esophageal involvement are often quite ill and may die. The most common clinical sign is dysphagia and hypersalivation occurring within 1 to 2 days or so of exposure. Examination of the mouth at the early stages may demonstrate discoloration, devitalization, and sloughing of affected tissues (Color Plate 3, Figure 15). Ulceration develops rapidly, however, and may be the predominant feature. Most cats will continue to eat, especially if fed soft food. Secondary bacterial infection is uncommon, and the lesions are usually well on their way to healing within 5 to 7 days.

The main differential diagnosis for toxic oral ulcers is nosocomial feline calicivirus (FCV) infection (see following). Cats are often exposed to calicivirus by vaccination with a live-virus vaccine just before entering the hospital, by direct contact with contaminated oral specula and endotracheal tubes, or by being put into contact with the oral secretions of carrier cats. About 20% of randomly tested cats are calicivirus oral shedders, so the odds of handling an infected animal are high. The virus is shed in both saliva and feces and will live for a few days off of a cat. Therefore contamination of caging by a previous resident cat or the use of improperly cleaned and disinfected litter/food/water pans can transmit the virus. Gloved and ungloved hands can also readily transmit the virus from one cat's mouth to another, especially if hands are not washed or gloves changed between patients. The fact that routine surgical procedures are often done on a group of cats during the same period of time and by the same people also adds to the problem. Oral lesions usually appear within 3 to 5 days of exposure.

FCV infection can usually be differentiated from toxic reactions in the following ways: (1) the oral lesions of FCV infections start as a vesicle, whereas toxic lesions start as an area of necrosis; (2) FCV lesions tend to be more randomly distributed on the tongue and palate (Color Plate 3, Figure 16), (3) cats with FCV infection may have other systemic signs of illness, such as fever (which can be seen in more severe toxic reactions), generalized soreness or limping, or mild conjunctivitis or rhinitis.

## **SPECIFIC ORAL INFECTIONS**

A number of infectious agents have been associated directly or indirectly with oral inflammatory lesions of cats. These include viral, fungal, mycoplasmal, and bacterial agents.

### **Viral Agents**

At least three different types of retroviruses are shed chronically into the saliva of symptomatic or asymptomatic infected cats: FeLV, FIV, and feline syncytium-forming virus (FeSFV). FCV is a fourth virus that is persistently shed into the saliva of many asymptomatic cats in nature. Feline herpesvirus, type 1 (FHV-1) can be isolated from oral swabs during the active stage of

primary infections (about 2 to 4 weeks); after recovery many cats become latent carriers and will actively shed virus only for brief periods of time when stressed. All of these viruses except for FeSFV have been described as direct or indirect causes of either acute or chronic oral lesions. One additional virus, feline infectious peritonitis virus (FIPV) has been associated with granulomatous-type oral lesions on rare occasions. This virus is not thought to be an inhabitant of the normal mouth.

### *Feline Leukemia Virus*

FeLV causes a persistent viremia in from 5% to 30% of infected cats, depending on age at the time of infection and severity of exposure.<sup>39</sup> Persistent carriers shed high levels of virus into the saliva; most of this virus originates from infected salivary epithelial cells. The virus is infectious when placed into the mouth, so virus spread is mainly by intimate contact, i.e., mutual grooming and using common litter and food and water dishes. Cat bites, wherein infectious saliva is inoculated into the tissues, are probably of secondary importance in multiple cat households but of greater importance among free-roaming cats.

Oral lesions have not been associated with acute FeLV infection under conditions of experimental infection. The relationship of oral cavity infections and the chronic FeLV carrier state is not precisely known. One report states that 50% of cats with chronic stomatitis and gingivitis are FeLV infected.<sup>16</sup> This seems, however, to be a substantial overestimate. Several studies failed to link FeLV with common<sup>22</sup> or uncommon<sup>24</sup> forms of inflammatory oral diseases. There is no doubt, however, that a small proportion of FeLV infected cats are immunosuppressed because of the effects of the infection on the immune system or on leukocyte numbers and that this immunosuppression may predispose cats to an increased incidence or severity of secondary or opportunistic type oral infections. The author has observed leukopenic FeLV-infected cats with severe gingivitis (Color Plate 4, Figure 17), ANUG (Color Plate 4, Figure 18) (see section on bacteria), and focal tooth root abscesses. FeLV infected cats with chronic ulceroproliferative faucitis<sup>2</sup> or chronic lingual ulcers<sup>16</sup> have also been described.

### *Feline Immunodeficiency Virus*

FIV is also shed into the saliva of chronic carrier cats.<sup>44</sup> The precise origin of this virus shedding is unknown, however. As with FeLV, this oral shedding is important in the transmission of the virus in nature. Because FIV is not highly infectious when placed into the mouth, most transmission occurs via cat bites. The canine tooth acts as a needle to inoculate the infectious saliva directly into the tissues.

Acute gingivitis has been observed in a small proportion of cats during the transient primary stage of FIV-related illness. This gingivitis is usually seen in cats that have the most severe primary signs of illness and that are the most profoundly leukopenic (usually neutropenic). There is also a significant drop in CD4+ T lymphocyte (T helper cells) numbers during this time. Therefore it is possible that the gingivitis is secondary to normal oral microbes that may invade the tissues secondary to transient systemic immunosuppression occurring during primary FIV illness.

Chronic oral disease is one of the most common signs of persistent FIV infection. FIV infection, however, is far from being the sole underlying cause

of severe stomatitides in cats; only about 15% of cats in the United States and in Japan with severe oral cavity infections have underlying FIV or FIV/FeLV infections.<sup>18, 68</sup> Oral cavity infections become more significantly linked to FIV infections as the severity of the lesions increases.<sup>61</sup> Therefore cats with milder forms of oral cavity infections, such as gingivitis, are even less likely to be FIV infected than cats with ulceroproliferative faucitis or periodontitis. The likelihood of FIV being associated with the oral disease also increases with the age of the cats. This is because of two factors: FIV is much more rapidly progressive when acquired by aged animals, and if infected as young adults, it often takes many years between the time of infection and the demise of the immune system.

The stomatitis observed in older FIV-infected cats is of three basic types: severe gingivitis, severe periodontitis (Color Plate 4, Figure 19), or severe chronic diffuse ulceroproliferative faucitis with or without involvement of the periodontium and other oral tissues (Color Plate 4, Figure 20). It is still uncertain whether oral disease is a direct or indirect effect of the virus, although most evidence would support the latter. The ulceroproliferative faucitis appears to be a primary FCV-related illness (see section on FCV),<sup>49</sup> whereas pure gingivitis or periodontitis may be associated with tissue invasion by resident oral bacterial flora.

Not surprisingly, an increased incidence and severity of oral infections has also been seen in humans with human immunodeficiency virus (HIV) infection.<sup>69</sup> Oral infections in HIV-infected individuals are associated with an increased number of normal resident type microorganisms and a tendency toward colonization with opportunistic type (nonresident) microbes, especially yeast.<sup>69</sup> Similar studies need to be done in FIV-infected cats with oral disease.

Cats with FIV-associated oral infections will respond to symptomatic treatment for their basic oral diseases. The more immunologically compromised they are, however, the less response will be obtained.

### *Feline Syncytium-Forming Virus*

FeSFV infection is widespread among free-roaming cats. The proportion of persistently infected cats in the United States is less than 1% at birth and rises to levels of 50% or more by 6 to 10 years of age.<sup>35</sup> The FeSFV genome is latent in blood leukocytes but is actively shed into the saliva. Similar to FIV infection, the source of this virus shedding has not been determined. FeSFV is not highly infectious by the oral route, so little transmission occurs from intimate contact. FeSFV infection is not a common infection among cats maintained strictly in the indoor environment. Some in utero transmission occurs, although the majority of cats are horizontally infected, probably by bites. Therefore the epidemiology of FeSFV infection closely parallels that of FIV infection. Fortunately for cats, FeSFV has not been statistically linked to any major disease syndrome. Virtually all chronic carrier cats remain healthy, and there does not appear to be synergism between FeSFV and either FeLV or FIV infections. The single disease that has been linked to FeSFV infection is chronic progressive polyarthritis, a rare illness of young, genetically predisposed, male cats.

### *Feline Calicivirus*

FCV is a small RNA virus in the *Picornaviridae* family. The virus is related to the San Miguel Sea Lion and swine vesicular stomatitis viruses, which cause vesicular disease (ulcerations of mouth and skin) in seals and swine.<sup>38, 57</sup> FCVs

exist in numerous serotypes, a serotype being a variant of the prototypic virus that exhibits a distinctly different set of antigen(s) on its surface.

Calicivirus infections are probably acquired at two stages in life.<sup>38</sup> Many kittens born to carrier mothers are apparently infected at a few weeks of age, even before maternal immunity has waned. Kittens infected in the face of maternal immunity usually show no clinical signs of infection. Kittens not born to infected mothers are probably infected by the oral route when they contact infectious saliva or feces from other cats after weaning. Because of the many serotypes, repeated infections probably occur throughout life. Live virus vaccines may be another source of exposure. About 20% of the random cat population throughout the world will chronically shed FCV from their oral cavities.

FCVs produce a spectrum of disease signs.<sup>38</sup> Although upper respiratory disease (rhinitis, conjunctivitis) was claimed to be one of the most common manifestations of FCV infection, this has not proved to be the case on further experimentation. Rhinitis and conjunctivitis are uncommon and mild manifestations of experimental infection, even when using very pneumotropic strains and aerosol exposure. A transient fever associated with limping and variable oral vesiculation and ulceration, usually of the tongue and palate, is probably a more common manifestation of FCV infection in the field. Some FCV infected cats may develop focal areas of interstitial pneumonia, which may predispose to secondary bacterial bronchial pneumonia.

Several studies have linked FCV oral carriage to *chronic stomatitis*<sup>24</sup> or *plasma cell gingivitis and pharyngitis*<sup>63</sup> in cats. Although there is no doubt that acute FCV infection can cause acute focal to multifocal ulcerative glossitis and palatitis, experimental FCV infection has never been associated with chronic oral lesions like those described from the field.<sup>23</sup> The author and colleagues also recently completed a serosurvey among cattery and household pet cats that tried to link oral carriage of FeLV, FIV, and FCV to chronic inflammatory oral cavity disease.<sup>61</sup> The most common oral cavity lesion observed among cats in this study was a mild to moderately severe gingivitis (affecting about 40% of the cats). This common lesion did not appear to be statistically linked to any of these three virus infections. In contrast, cats with severe oral cavity disease, usually periodontitis with involvement of other tissues (fauces, palate, cheeks, tongue), appeared to have a higher incidence of FIV or FCV/FIV infections than could be accounted for by coincidence or chance. This led to the conclusion that FIV was an important underlying factor in a proportion of cats with more severe oral cavity infections and that FCV may be involved in severe oral cavity inflammations if it occurred with immunosuppressive viruses like FIV. The latter conclusion was supported by studies of Knowles et al.<sup>24</sup>

After closely examining a large number of cats with chronic oral inflammatory lesions, one particular lesion stood out, a moderate to severe chronic ulceroproliferative lesion of the oral fauces (see Color Plate 4, Figure 20).<sup>49</sup> This lesion was similar to a peculiar chronic stomatitis or gingivitis and pharyngitis that has been previously reported.<sup>2, 20, 63</sup> This chronic ulceroproliferative faucitis occurred in a small proportion of younger to middle-aged cats and persisted for life in spite of all attempts to treat it symptomatically. With time, the proliferative lesion in the fauces often spread rostrally along the teeth, leading to severe gingivitis, periodontitis, and tooth loss.

All cats with chronic ulceroproliferative faucitis have been found to be persistently shedding FCV from their mouths, which was significantly higher than FCV isolation from the mouths of normal cats (about 20%).<sup>49</sup> In an attempt to recreate chronic faucitis, adolescent specific pathogen free cats were experi-

mentally infected (by mouth) with four different FCV isolates from field cats with chronic ulceroproliferative faucitis.<sup>49</sup> These strains were efficient at inducing severe oral cavity lesions, including a transient gingivitis and faucitis. Coupling experimental and clinical studies, it can be postulated that (1) FCV-induced feline ulceroproliferative faucitis exists in acute and chronic forms, (2) chronic ulceroproliferative faucitis develops in a small proportion of cats that had acute faucitis and appears to be associated with FCV persistence, (3) chronic faucitis lesions may result from an atypical and persistent immune response on the part of a small proportion of cats toward virus-infected cells in the oral fauces; and (4) the atypical immune response may be enhanced by underlying FIV or FeLV immunodeficiency in a small proportion (10% to 15%) of affected cats.<sup>49</sup>

Chronic ulceroproliferative faucitis, with or without periodontitis, has not been successfully treated. Antibiotic treatment, sometimes coupled with local antiseptics, will lessen pain and swelling, indicating that secondary bacterial infection is occurring. Corticosteroids will also alleviate pain and swelling. About one fifth of affected cats will respond somewhat to gold salt therapy. Surgical curettage of severely proliferative faucial tissues is sometimes indicated, as is removal of badly diseased molars. Therapy is usually palliative, however, and most cats are eventually euthanatized. Only rarely will the disease spontaneously go into remission.

### *Feline Herpesvirus, Type 1*

FHV-1 infection is common in cats but is of greatest clinical significance in high-stress, multi-cat environments, especially where there is extensive breeding.<sup>37</sup> Up to one third of cats that recover from the primary upper respiratory disease become latent carriers. Transient bouts of active virus shedding (ocular, nasal, and oral) is intermittent and especially follows stressful periods. The stress of lactation may induce virus shedding in queens and infection of their young. Disease is seen mainly in postweanling kittens and is usually manifested by varying degrees of rhinitis and keratoconjunctivitis. Pharyngitis and even pneumonia are occasionally seen. Ulcers are sometimes seen on the tongue, nasal philtrum, and palate, but they are infrequent compared with FCV infection (Color Plate 4, Figure 21), FHV-1 infection can usually be differentiated from FCV on clinical appearances alone; rhinitis and conjunctivitis are prominent lesions in FHV-1 infection and uncommon in FCV infection. Limping and stiffness are common in FCV infection and unusual for FHV-1 infection.

### *Feline Infectious Peritonitis Virus*

FIPV is a coronavirus that causes a highly fatal systemic disease syndrome.<sup>36</sup> Two forms of feline infectious peritonitis (FIP) occur: a serositis with massive inflammatory fluid exudation that involves the peritoneal or pleural cavities or both (effusive FIP, wet FIP, nonparenchymatous FIP) or a disseminated granulomatous disease (non-effusive FIP, dry FIP, parenchymatous FIP) with variable involvement of the mesenteric lymph nodes, kidneys, liver, terminal jejunum/cecum/ileocecocolic nodes, pleura, pericardium, eyes, or central nervous system. The FIP virus coexists with the closely related but not highly pathogenic feline enteric coronavirus. Therefore most cases of FIP in the United States originate from large and crowded multiple cat households that produce kittens. Involvement of the oral cavity with granulomatous or pyogranulomatous lesions has

been reported on several occasions, although admittedly unusual.<sup>36</sup> When seen, lesions tend to involve the lingual frenulum or oropharynx.

### **Specific Bacterial Infections of the Oral Cavity**

#### *Dermatophilosis*

Proliferative masses on the dorsum of the tongue and extending into the tonsillar crypts have been described in two cats, and *dermatophilus* spp was isolated from both lesions.<sup>1, 32</sup> The mode of entry appeared to be a foreign body (a feather) in one of the animals.

#### *Mycobacteriosis*

Systemic *Mycobacteria bovis* infection, once very common in cats, may affect the oral cavity, in particular the tonsils and pharynx.<sup>42</sup> Small ulceroproliferative lesions on the tongue and lip have been seen in a small proportion of cats with feline leprosy (*Mycobacterium lepraemurium*).<sup>28</sup>

#### *Acute Necrotizing Ulcerative Gingivitis*

ANUG is a rare disorder of cats. It is similar to a disease of humans known as Vincent's infection. ANUG of humans is associated with spirochetal and fusiform bacteria and is often a sequelae of poor oral hygiene and suboptimal nutrition.<sup>55</sup> Affected cats are often older and obese and suffering from some degree of chronic periodontitis. A significant proportion are very leukopenic, usually owing to an underlying FeLV infection. The condition is characterized by acute necrosis of the gingiva, often exposing underlying bone, and ulcerations of the buccal mucosa, tongue, and palate (Color Plate 4, Figure 18). Lesions are often coated with a fetid purulent exudate. The overwhelming oral stench is due to volatile fatty acids produced by causative anaerobic bacteria. Treatment is dependent on whether there are serious underlying reasons for the disease, such as FeLV-related leukopenia or diabetes. Penicillins and metronidazole used in combination, oral antiseptic solutions, and surgical removal of badly infected teeth and surrounding bone are used in animals that do not have terminal underlying health problems.

#### *Tooth Root Abscesses*

Tooth root abscessation is a common sequelae of periodontitis. Focal tooth root abscessation, in the absence of obvious periodontitis, is less common and often associated with underlying immunosuppression. The author observed a leukopenic FeLV-infected cat with severe root abscessation of an upper premolar.

### **Mycoplasma Infections of the Oral Cavity**

*Mycoplasma* and mycoplasma-like organisms belong to three groups: *Mycoplasma*, *Ureaplasma*, and *Acholeplasma*.<sup>41</sup> *Ureaplasma* are differentiated from *Mycoplasma* by their ability to metabolize urea in culture. These various types of mycoplasma can be isolated frequently from the conjunctival sacs, oral cavities, and genital tract of healthy cats. The only mycoplasma that has been commonly linked to disease in cats is *M. felis*, a cause of conjunctivitis and

occasionally pneumonia in young cats. *M. gatae* has been isolated from the inflamed joints of severely immunocompromised cats. The author has isolated cytopathogenic *Mycoplasma* species in cell culture from the mouths of several cats with chronic oral infections. These oral isolates did not grow on conventional mycoplasmal growth media and did not cause disease when inoculated orally into specific pathogen free cats. Therefore mycoplasma-like organisms are probably much the same as normal oral bacteria in regards to disease potential.

## Fungal Infections of the Oral Cavity

### *Cryptococcosis*

A systemic fungal disease caused by *Cryptococcus neoformans* is relatively common in domestic cats.<sup>43</sup> Infection is by inhalation of the yeast form of the organism, which is ubiquitous to dried pigeon or dove feces (*C. neoformans*, var. *neoformans*) or in vegetative matter from the river red gum (*C. neoformans*, var. *gattii*). Therefore cryptococcosis usually occurs in cats living near concentrations of doves and pigeons, i.e., cities or pigeon lofts, or in warmer regions where the river red gum grows in abundance.

Following inhalation of the yeast form, dissemination occurs from the lungs to the nasal cavity and central nervous system, including the eyes. Fleshy, proliferative lesions that consist predominantly of organisms infiltrate the nasal passages and may break into the oral cavity. About 5% of cats with cryptococcosis may have lesions on the palate, gingiva, lips, or tongue.<sup>43</sup> Diagnosis is simple because aspirates, impression smears, or biopsies of the lesions will easily demonstrate the organism.

### **Mycetomas**

Proliferative lesions associated with unusual types of soil fungi have been rarely seen in the oral cavity of cats. A granulomatous lesion under the tongue caused by *Cephalosporium potranii* has been reported in a cat.<sup>65</sup>

## PERIODONTAL DISEASE

### **General Considerations**

Periodontal disease is a collective term for gingivitis and periodontitis. Gingivitis of humans refers to gingival inflammation without the formation of significant gingival pockets (sulci), whereas periodontitis is present whenever there is destruction of the periodontal ligament and associated alveolar bone. Normal oral bacterial flora play an important role in periodontal disease of humans and animals. The pathogenesis of periodontal disease involves the concept of *specificity*. Specificity implies that periodontal disease is a group of diseases, each of which is associated with different but specific groups of microorganisms.<sup>30</sup> According to this concept, some groups of bacteria are potentially pathogenic, whereas others may be beneficial to periodontal health. *Bacterial succession* is also important in the pathogenesis of periodontal disease.<sup>30</sup> This term applies to the successive stages in the development of bacterial



plaques; early plaques are made up mainly of beneficial bacteria, whereas more advanced plaques contain mainly pathogenic types of flora. Gingivitis is associated with bacterial plaques at the level of the gingiva, whereas periodontitis is associated with subgingival plaque formation. Bacterial plaques elicit inflammation in adjacent soft tissues.

Many bacterial species that normally inhabit the mouth have been implicated in periodontal disease of cats. In contrast to humans, no particular organism or group of organism has been yet implicated in the feline disease more frequently than others.<sup>26, 60</sup> Preliminary studies suggest, however, that the situation in periodontal disease in cats may resemble that of humans; *Fusobacterium nucleatum* was more frequently isolated from plaque of cats with gingivitis than from normal cats.<sup>60</sup> The more diseased the mouth, the higher numbers of bacteria, and bacterial species, that can be isolated or visualized. Anaerobic bacteria from the genera *Bacteroides*, *Fusobacterium*, *Peptostreptococcus*, *Propionibacterium*, and *Clostridium* and aerobic bacteria such as *Pasteurella multocida*, *Corynebacterium pyogenes*, *Actinomyces* species, *Streptococcus* species, *Lactobacillus*, and *Escherichia coli* are generally isolated on culture.<sup>26, 40</sup> A number of unculturable spirochetes and borrelia can also be observed in normal and abnormal mouths. Although no single bacteria or group of bacteria has yet been implicated as the primary cause of periodontal disease in cats, there is little doubt that bacteria play an important role in the overall cause of the lesions.

Cats with chronic periodontitis and hypergammaglobulinemia have higher levels of serum antibodies to common mouth bacteria, suggesting that the organisms were invading into the tissues and causing a systemic immune response.<sup>56</sup> Higher serum levels of IgG, IgM, and IgA have also been demonstrated in cats with chronic oral cavity disease.<sup>70</sup> Almost all such gingival or periodontal infections will respond favorably to a course of antibiotic therapy, but cures are very unusual.

## Gingivitis

Gingivitis occurs in up to 40% of cats from 1 to 4 years of age.<sup>61</sup> This is similar to humans, where 50% of people over 19 years of age have gingivitis.<sup>4</sup> The incidence of gingivitis remains more or less static throughout life. About 54% of people between 19 and 45 years of age have gingivitis, whereas 44% of people from 45 to 64 years of age are affected.<sup>4</sup> The situation is probably similar in cats, with one exception. Gingivitis is relatively common in kittens from 3½ to 7 months of age, probably owing to local tissue trauma caused by eruption of teeth.<sup>22</sup> This form of gingivitis usually disappears with permanent dentition. Although some cases of feline gingivitis can be associated with immunosuppressive diseases, such as FeLV or FIV infections (see Color Plate 4, Figure 17), the greatest majority of cases occur in otherwise healthy animals. Many cats that are destined to develop gingivitis usually manifest disease early in life, from 8 to 16 months of age. This is especially true of gingivitis that is not associated with dental calculus.

Gingivitis of humans is intimately associated with the formation of bacterial plaques on the teeth. In fact, there is a linear relationship in humans between plaque levels and the severity of gingivitis.<sup>3</sup> Many different dietary and prophylactic hygienic factors can enhance or inhibit bacterial plaque formation in humans, and it is likely that many similar factors are involved in the feline equivalent.

The accumulation of dental calculus along the gum line with extension

under the gingiva may also play a role in some types of gingivitis. Dental calculus in cats tends to accumulate on the facial surfaces of the molars and premolars.<sup>46</sup> The average age of cats seen for dental calculus is 6.8 years.<sup>46</sup> Dental calculus accumulation can be greatly influenced both by diet and by genetics. Soft food favors dental calculus formation, whereas hard foods are prophylactic or even curative.<sup>59</sup> Cats are like both dogs and people in that some individuals appear to be genetically predisposed to the buildup of dental calculus, whereas others remain surprisingly calculus free. Purebred cats are said to develop dental calculus more commonly than domestics.<sup>66</sup> The genetic basis of calculus accumulation is not understood. Dental calculus buildup often accelerates for unknown reason with age. Many cats will remain relatively calculus free for the first 4 to 5 years of life and then have increasing problems with calculus accumulation after that time. Dental calculus is least likely to be seen on the incisor teeth and most likely to develop on the premolars and molars.

Although veterinarians tend to link gingivitis with dental calculus, many cats manifest gingivitis by 8 to 18 months of age without identifiable dental calculus accumulation (see Color Plate 4, Figure 17). Moreover, the severity of gingivitis or periodontitis is not always proportional to the amount of dental calculus (Color Plate 4, Figures 22 and 23). There may also be a genetic influence on gingivitis that is independent of dental calculus formation; gingivitis is frequent in purebred cats, especially among certain breeds of cats (such as Persians, Siamese, Abyssinian or related breeds) than others.

The treatment of gingivitis in cats is directed largely at removing dental calculus and bacterial plaques and preventing or delaying their recurrence and subsequent growth.<sup>46</sup> This includes careful hand and machine scaling of the teeth to remove material above and below the gum line, regular brushing of the teeth, and the use of substances such as dilute chlorhexidine as a mouth wash. The importance of removing teeth with substantial periodontitis and resorptive neck lesions has also been stressed.<sup>46</sup> Unfortunately prophylaxis in the form of routine tooth brushing and antiseptic application is not as easily done in cats as in humans. Systemic antibiotic treatment has been advocated for 2 weeks following thorough teeth cleaning. Some veterinary clinicians will also inject corticosteroids into multiple sites along the gums, presumably to accelerate resolution of the plaque-induced soft tissue reactions.<sup>46</sup> Dry food will also encourage gum exercise and help prevent the recurrence of calculus and plaque.<sup>59</sup> Although 90% to 100% 2-year cures have been claimed for vigorous therapy combining many of the above-mentioned features,<sup>46</sup> such claims appear overly optimistic.

## Periodontitis

Periodontitis refers to inflammation of the tissues around the tooth or the periodontium. The periodontium is composed of the gingiva, the periodontal membrane or ligament, and the alveolar bone. The pathogenesis of periodontitis in humans was first reported by Page and Schroeder.<sup>34</sup> More recent concepts of the disease have been presented by Newman.<sup>30</sup> The initial lesion is at the marginal gingiva. Tissue inflammation evoked by local bacterial proliferation, usually in the form of subgingival plaques, leads to slow destruction of the ligamentous attachments of the epithelium to the teeth and atrophy of adjacent alveolar bone, thus creating a gingival sulcus. This sulcus traps food and inflammatory exudate and is slowly enlarged by downward extension along

the periodontal ligament. Antigenic stimulation leads to increasing accumulations of plasma cells and lymphocytes in adjacent mucosal tissues. With increasing depth of the gingival sulcus, more and more alveolar bone and periodontal ligament is destroyed. This causes the tooth to become less securely anchored and increases its mobility when wiggled. Increased mobility leads to an acceleration of the disease process. Eventually the tooth is lost from lack of support. In some cases, the infection rapidly reaches the tooth root and causes a root abscess.

Although it is generally assumed that most cats with gingivitis will eventually develop periodontitis, such a progression is not inevitable. The incidence of gingivitis in humans is relatively stable throughout the life of a person from 19 years of age to old age, whereas the incidence of periodontal disease steadily increases. A similar pattern is seen in cats. Therefore additional factors are probably required to allow gingival inflammation to extend downward into the periodontal ligament.

Two basic types of periodontitis are observed in humans, juvenile and adult onset. Juvenile type periodontitis is uncommon in cats, whereas adult-onset periodontitis is common. More than one half of a group of 200 apparently healthy adult cats in Europe were found to have mild to severe gingivitis or periodontitis.<sup>63</sup> A surprisingly high incidence of periodontitis was also observed among apparently healthy adult cats in the United States.<sup>61</sup>

Juvenile periodontitis of humans has been related to two basic types of underlying abnormalities: (1) an abnormality in phagocytic activity of polymorphonuclear neutrophils<sup>29</sup> and (2) defects in root cementum.<sup>33</sup> Whether similar defects may be involved in juvenile periodontitis of cats remains to be determined.

The cause of adult type periodontitis in humans and animals is unknown. Only 15% of people over 19 years of age are totally free of some type of periodontal disease, i.e., gingivitis or periodontitis.<sup>4</sup> Among people over 19 years of age, 36% had mild to moderate periodontitis, and 6% had advanced periodontitis. The three most significant risk factors for periodontal disease in humans are (1) age, (2) smoking, and (3) tooth mobility.<sup>19</sup> Gingivitis and dental calculus were important, but not nearly as significant, risk factors. It has also been estimated that from 5% to 30% of the human population are at genetic high risk for periodontal disease.<sup>21</sup> There is good clinical evidence that most of these factors apply to the cat. Age is a readily apparent risk factor for periodontal disease in cats (see discussion of oral immunity), as is tooth mobility (especially in the case of incisor teeth). There is also ample clinical evidence to support the role of genetics; periodontal disease of cats is more prevalent in purebred cats than in domestic and tends to be much more frequent in some breeds than others.

The role of congenital or acquired systemic immunodeficiency in oral infection of humans has only recently been appreciated. People with abnormally functioning polymorphonuclear phagocytes are more likely to develop periodontitis. In addition to the defect in phagocytes observed in juvenile periodontitis, phagocytic abnormalities have been recognized in people with diabetes mellitus, Down's syndrome, lazy-leukocyte syndrome, and Chédiak-Higashi syndrome.<sup>29</sup> Aging brings about a decline in systemic but not local, immunity.<sup>62</sup> Therefore aging is more likely to affect the incidence of periodontitis than gingivitis. HIV infection of humans and AIDS leads to a great increase in oral infections.<sup>69</sup> Cats suffer from some of these same or closely related disorders.

Periodontitis, including osteoclastic resorptive lesions (neck lesions), is a

major cause of tooth loss in cats. Among 200 healthy appearing cats in Europe, 125 of them had lost a total of 811 teeth.<sup>66</sup> Overall tooth loss in cats appeared to be greater in the upper than the lower arcade. Periodontitis has been implicated as the cause of 20% of tooth loss in humans.<sup>4</sup>

Periodontal disease of cats is difficult to treat; a temporary response is usually seen to careful cleaning and antibiotic treatment. Without eliminating gingival pockets and badly affected teeth, however, and correcting any defects in local or systemic immune defects, symptomatic therapy is doomed to failure. The most common treatment therefore is to radiograph and remove those teeth that have extensive atrophy of the alveolus or tooth root infections, regardless of how solid they appear. Care must be taken to remove all remnants of tooth root and surrounding infected bone. Tooth root retention and bone cyst formation are somewhat unique sequelae of feline periodontitis.<sup>48</sup> Good dental hygiene, which normally includes teeth brushing and the use of oral antiseptics, may delay recurrence, but such procedures are not easily sustained by cat owners.

### **Odontoclastic Resorptive Neck Lesions**

About 25% of odontoclastic resorptive lesions along the gum line (so-called neck lesions or neck caries) occur in cats with significant periodontitis.<sup>12, 51</sup> The significant relationship between cervical periodontitis and odontoclastic resorptive lesions may be unique to cats, as has also been alluded to by Reichert et al.<sup>48</sup> It is thought therefore that neck lesions occur secondary to cervical periodontitis. The possibility, however, that the cervical periodontitis is secondary to defects in the root cementum, such as described for juvenile periodontitis of humans,<sup>33</sup> should not be discounted. The author has observed several young cats with generalized enamel hypoplasia and severe periodontitis surrounding and overgrowing most of the teeth.

## **MISCELLANEOUS INFLAMMATORY ORAL DISEASES**

### **Foreign Body Lesions**

#### *String Lesions*

Granulomatous proliferative lesions under the tongue and along the lingual frenulum can be caused by having a string looped under the tongue with the ends extending down the digestive tract. The string will slowly cut into the sublingual tissues and become buried in a mass of granulation tissue. Clinical signs vary from hypersalivation and dysphagia to anorexia, intermittent vomiting, chronic weight loss, and even death, depending on whether or not the string obstruction also affects the intestines. This disorder is virtually specific for cats.

#### *Miscellaneous Foreign Material*

Foreign body granulomas associated with plant material or feathers can occur in the mouth. They are often found under the tongue, where they involve one side or the other of the lingual frenulum. They can extend into the underlying muscles. Foreign body granulomas can be manifested by dysphagia

and hypersalivation, although many are low grade and are picked up only on routine physical examination. The owners may not notice them until they are large enough to peer out from under the tongue when the mouth is opened. Treatment usually involves surgical excision. The foreign material may be visualized grossly or may be apparent only on histologic examination. Therefore all excised tissue should be submitted for microscopic studies. Lesions may recur if some foreign material remains deeper in the glossal musculature.

### **Eosinophilic Granulomas**

Eosinophilic granulomas of unknown cause are surprisingly common in cats. They appear histologically as a hypersensitivity type response involving an eosinophilic cell infiltrate that is centered around focal areas of collagen necrosis. Disease activity is often cyclical in nature; flareups and remissions of lesions occur without seeming reason. Lesions are of an ulcerative (usually the upper lip), linear (usually the skin over the back limbs or pads), or plaque-like nature. Two types of lesions occur in the mouth, a mild to severe ulcerative cheilitis (Color Plate 4, Figure 24) and a proliferative (nodular), ulceroproliferative, or plaque-like lesion involving virtually any structure within the oral cavity but in particular the hard palate.<sup>12</sup> Proliferative or ulceroproliferative eosinophilic granulomas in the mouth may be mistaken for cancers, foreign body granulomas, or infectious granulomas. The diagnosis is easily made from a deep biopsy of the lesion, which will show the characteristic pathology of histiocytic proliferation, eosinophilic infiltrate and collagen necrosis. Eosinophilic granulomas are best treated with systemic long-acting corticosteroids. Large oral lesions may have to be resected along with drug therapy.

### **SUMMARY**

There is a great deal of frustration among veterinarians about the diagnosis and treatment of inflammatory diseases of the oral cavity of the cat. This frustration is due to both the high frequency of feline oral inflammatory lesions and our poor understanding of their causes. This poor understanding can be blamed on several things: (1) a rapidly emerging, but still relatively poor, understanding of feline diseases in general and nutrition in particular; (2) a tendency to lump rather than separate specific oral inflammations; (3) a tendency not to use a thorough and systematic approach to diagnosing oral cavity disease; and (4) the reluctance of veterinarians to apply what is already known about human oral cavity diseases to cats. When problems 2 through 4 are adequately addressed, it becomes apparent that we really know more about oral cavity disease in the cat than we thought we knew and that great progress has been made. The task ahead is to define, in precise medical terms, those remaining disease entities of the oral cavity that pose the greatest health risk to cats, to apply what has been already been discovered from human disease counterparts, and to study them systematically.

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