

Periodontal Disease

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“Because periodontal disease is the most common problem affecting dogs and cats of all age groups, programs to prevent periodontal disease should be considered among the most important prophylactic services we can offer.”
Gregg A. Dupont

INTRODUCTION

Primary oral diseases can be subdivided into conditions affecting the tooth, the periodontium or other oral tissues (**Table 47-1**). Diseases that affect tooth structure (**Figure 47-1**) may result in lesions of the periodontal apparatus, oral mucosa or both. Diseases affecting the periodontium may result in exfoliation of teeth. Additionally, primary diseases of other organs may cause oral lesions and are important considerations in formulating differential diagnoses. Furthermore, oral disease can contribute to diseases of other organs and body systems.

Periodontal disease is the principal cause of tooth loss in dogs and cats. Food can influence periodontal disease through control of plaque and thus is the primary focus of this chapter. Oral health is achieved through professional care and effective homecare; however, compliance is a significant issue in veterinary dentistry (**Box 47-1**). Traditional methods of plaque control such as toothbrushing may be difficult for clients to accomplish. Therefore use of an effective dental food can be an appro-

priate and effective means of daily plaque control and oral health maintenance for dogs and cats.

The steps in promoting oral health in dogs and cats include: 1) controlling plaque, the cause of periodontal disease, 2) assessing the level of plaque control necessary to prevent gingivitis in each patient, 3) determining each pet owner's ability to control substrate accumulation and selecting methods most likely to ensure compliance, 4) feeding a food with an appropriate texture and nutritional profile and 5) recognizing that oral health may affect systemic health; therefore, a healthy oral cavity may affect longevity and quality of life.

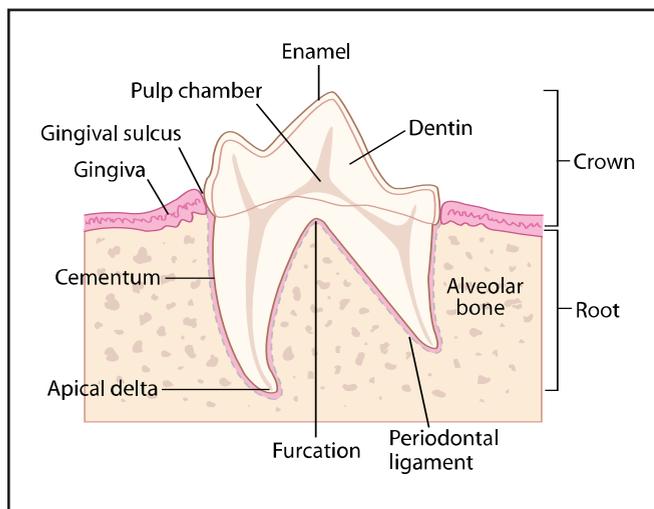
CLINICAL IMPORTANCE

Prevalence of Periodontal Disease

Periodontal disease is the most common disease of adult dogs and cats. As early as 1899, Eugene Talbot described “interstitial gingivitis or so-called pyorrhoea alveolaris” found in dogs at necropsy (1899). In 1939, Wright noted that “the incidence of

Table 47-1. Conditions affecting the oral cavity.

Conditions primarily affecting teeth	Conditions primarily affecting the periodontium/oral mucosa
Abrasion	Chemical or thermal burns
Attrition	Gingival hyperplasia
Erosion	Gingivitis
Fracture	Gingivostomatitis
Intrinsic staining	Neoplasia
Odontoclastic resorption	Periapical abscess
Pulpitis	Periodontitis
	Ulcers

**Figure 47-1.** Normal tooth and periodontal anatomy.

disease of the teeth in the dog is so high that dental surgery occupies a prominent place in the work of the veterinarian engaged in small-animal practice. The most common affection necessitating surgical interference is paradontal disease” (1939).

Periodontal disease has been observed in dogs and cats of varying breed, gender and age. Surveys from several countries report prevalence rates of periodontal disease that range from 60 to more than 80% of dogs and cats examined (Gray, 1923; Bell, 1965; Rosenberg et al, 1966; Saxe et al, 1967; Gad, 1968; Hamp et al, 1975; Hamp and Lindberg, 1971; Sorensen et al, 1980; Page and Schroeder, 1979; Golden et al, 1982; Reichart et al, 1984; Isogai et al, 1989; Harvey, 1992; Hoffman and Gaengler, 1996).

Data from the National Companion Animal Study representing 54 veterinary practices across the United States confirmed that oral disease was the most frequent diagnosis in all age categories of 39,556 dogs and 13,924 cats (Lund et al, 1999).

PATIENT ASSESSMENT

History

A complete history is important to diagnosis and treatment planning and is an integral tool for developing a complete

Box 47-1. Compliance and Dental Homecare.

Oral health is achieved through an effective periodontal management program that includes professional care and client-provided homecare. Appropriate homecare recommendations consider the client and patient preferences and specifically address the degree of oral pathologic change present and client and patient compliance.

Compliance is critical to effective homecare. Clients must be willing and able to perform the recommended hygiene and the patient must accept oral hygiene procedures. Noncompliance may result from lack of an effective recommendation by the veterinary health care team. A comprehensive study of compliance demonstrated that appropriate periodontal therapy was not provided for approximately 15.5 million dogs and cats with recorded periodontal disease scores of 2, 3 or 4. No recommendation for periodontal management was given in 66% of cases with a recorded periodontal disease score of 1. In the same study, 19% of patients lacked any notation of periodontal examination or score in health records.

Even with client education and good pet compliance, some owners are unable to provide routine and effective plaque control. Compliance failure may be due to: 1) lack of skill, 2) lack of perceived benefit, 3) unpleasantness of procedure, 4) lack of noticeable impact and 5) lifestyle constraints. Emphasizing the benefits, including improved oral and systemic health, less breath odor, cost effectiveness and strengthening of the owner-pet bond, may increase compliance.

The most important part of periodontal therapy is how well a patient maintains oral health. Long-term success depends on the degree of plaque control the client is capable of providing between professional visits.

health maintenance program for pets. An adequate health history must include: 1) information about previous medical and surgical procedures, 2) current preventive measures such as vaccination status and heartworm medication administration, 3) the pet’s general environment, including confinement, 4) information about other household pets and 5) who in the household is responsible for primary care.

Inquiries specific to nutrition and oral care should include past and present information about: 1) oral hygiene and level of compliance, 2) presence of any signs that may be related to oral dysfunction, 3) chewing behavior, 4) access to rocks and other materials that may cause occlusal trauma, 5) access to dental treats and toys, 6) eating behavior and 7) foods eaten, with special attention given to texture and other factors.

Physical Examination Initial Oral Examination

Examination of the skull and oral cavity should be a regular part of every physical examination. An extraoral examination should be done before opening the mouth to inspect the skull and facial areas for any abnormalities, such as muscle atrophy, swelling, draining tracts and ocular or nasal discharge. Extraoral examination should also include inspection for facial symmetry,

palpation of the temporomandibular joints, regional lymph nodes and salivary glands and thorough inspection of the skin and lips. Extraoral abnormalities related to oral dysfunction may include mucopurulent discharge from the eyes or nostrils, soft or hard swellings, crepitus, salivation and an inability to open or close the mouth (Marretta, 1987, 1992; Kapatkin et al, 1991; Ramsey et al, 1996).

After the extraoral examination, the lips should be gently parted or retracted to allow inspection of the oral mucosa. Patients experiencing severe oral pain may not tolerate even a cursory oral examination without sedation. The facial surfaces of the teeth and gingivae (**Figure 47-2**) should be examined for substrate accumulation (i.e., plaque, calculus and stain [See Etiopathogenesis.]), inflammation, trauma and capillary refill time. Tooth position and occlusion should be evaluated. The lingual surfaces of the teeth and gingivae should be inspected, as well as the palates, tongue (ventral and dorsal), frenulum, oropharyngeal area and tonsils.

Comprehensive Oral Examination

A definitive oral examination must be done with the patient heavily sedated or anesthetized, and is often done immediately before periodontal therapy. The general examination should be used as a starting point in client communication with the understanding that the definitive oral examination may uncover other lesions that require treatment.

The examination should begin with a thorough inspection of all oral tissues. An overall assessment of oral health should consider the amount and location of substrate accumulation. Substrate location and accumulation provide valuable information about the frequency and effectiveness of oral hygiene (Woodall, 1990). Common substrate and periodontal indices used to measure oral health have been described (Logan et al, 1992; Logan and Boyce, 1994) and were adopted by participants of the 1994 International Symposium on Veterinary Oral Care (Logan and Boyce, 1994; SVOC, 1994). Modifications and refinements to substrate indices have been published (Hennet, 1999; Harvey, 2002; Hennet et al, 2006). Furthermore, a recognized system (Veterinary Oral Health Council [VOHC]) exists for validating product claims.

The remainder of the periodontal indices (e.g., probe depth, attachment loss, furcation exposure and tooth mobility) are usually charted after prophylaxis or periodontal therapy to ensure accurate assessment after removal of subgingival debris that may impede measurement. Each tooth and its associated periodontium should be evaluated using a dental explorer-probe to examine the tooth for defects, lesions or both. The same instrument should be used to evaluate periodontal health by measuring the extent of gingival inflammation, attachment loss and alveolar bone loss. Any abnormalities in tooth or periodontal structures should be noted on the dental chart. Detailed dental charting allows for disease assessment and provides a record for future reference. The results should become part of the patient's permanent medical record.

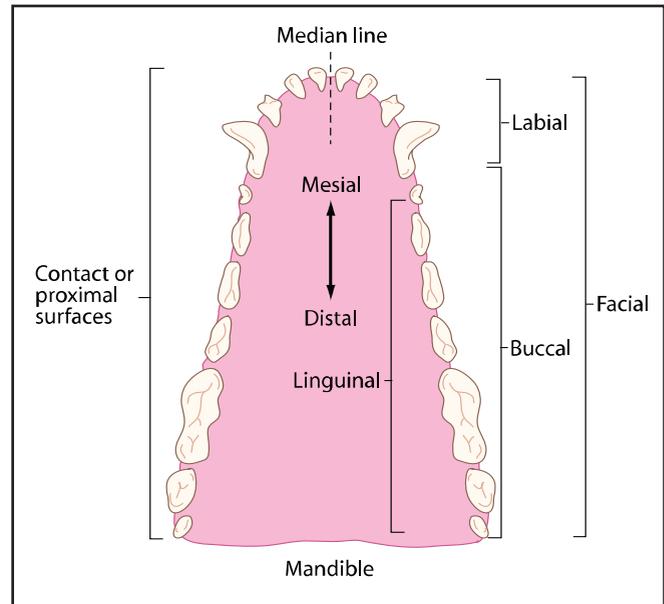


Figure 47-2. Directional nomenclature used to describe anatomic position of tooth surfaces. (Adapted from Wiggs RB. Canine oral anatomy and physiology. *Compendium on Continuing Education for the Practicing Veterinarian* 1989; 11: 1476.)

Radiographic Examination

Oral radiography may be indicated to identify lesions that cannot be detected visually or manually, and to determine the extent of pathology. Root fractures, periapical abscesses, alveolar bone loss, acute resorption lesions and anatomic anomalies are difficult to assess without radiography. Additionally, oral radiographs are useful in selecting a definitive treatment plan and assessing the outcome of a dental procedure. Oral radiographic techniques have been well described elsewhere (Wiggs and Lobprise, 1997; Niemiec, 2005; Niemiec and Furman, 2004, 2004a; Niemiec et al, 2004, 2004a). In addition, digital radiography is becoming more common (DuPont and DeBowes, 2002).

Laboratory Studies

A complete blood count, serum biochemistry profile, bacterial culture, virus isolation, cytologic examination and biopsy may add useful information. Other diagnostic tests such as urinalyses and cardiac examinations may complement a standard panel as part of a preanesthetic profile. Patients with suspected renal or cardiac disease may be compromised by bacteremia associated with dental manipulations.

Risk Factors

All mammals are susceptible to periodontal disease. The primary etiologic agents associated with periodontal disease are bacterial plaque and bacterial by-products (Löe et al, 1965; Theilade et al, 1966; Socransky, 1979; Lindhe et al, 1973; Lindhe and Rylander, 1975). Bacterial plaque is also directly involved in the pathogenesis of enamel caries and may be a contributing factor in the development and progression of

Box 47-2. Digestible Carbohydrates and Their Role in Oral Health of Dogs and Cats.

The role of digestible (soluble) carbohydrates (sugars) in the development of dental caries has been well documented in people and rodents. Dental caries, however, occurs infrequently in dogs and cats. One study demonstrated that dogs do not develop carious lesions even after long periods of consuming carbohydrate-rich foods. Carlsson and Egelberg reported that the addition of sucrose to a soft food resulted in no difference in plaque accumulation and gingival inflammation in a group of 12 mongrel dogs. Human studies have demonstrated that larger amounts of plaque were formed when sucrose was the primary sugar consumed. Commercial and homemade pet foods typically contain large quantities of digestible carbohydrates, usually in the form of starch.

The Bibliography for **Box 47-2** can be found at www.markmorris.org.

tooth resorption and other oral inflammatory lesions. Any factor that enhances bacterial accumulation or affects the resistance of the periodontium may influence the disease process. Specific risk factors that contribute to the severity and progression of periodontal diseases include: 1) breed, 2) age, 3) immunocompetence, 4) nutrition and food characteristics, 5) chewing behavior and 6) systemic health (Wiggs, 1995).

Breed

Breed plays a major role in the development of dental disease. Small, toy and brachycephalic breeds are prone to malocclusive disorders including overcrowding and rotation of teeth, retained deciduous teeth and supernumerary teeth. Occlusal abnormalities provide plaque retentive areas and increase the difficulty of oral hygiene procedures. Brachycephalic breeds are also predisposed to mouth breathing, which tends to dry and irritate oral tissues (West-Hyde and Floyd, 1995). Periodontal disease, tooth resorption and gingivostomatitis have been reported to occur with relatively greater frequency in purebred cats, particularly Asian breeds such as Siamese and Abyssinians (Van Wessum et al, 1992). Ulcerative stomatitis has been documented to occur in family clusters of Maltese dogs (Harvey and Emily, 1993).

Age

Several surveys have reported that older pets have a greater frequency and an increased severity of dental disease. One report of a survey of owners of 1,350 dogs noted that calculus deposition, gingival inflammation, tooth mobility, furcation exposure, attachment loss and missing teeth all increased significantly with increasing age (Harvey et al, 1994). In an evaluation of 4,776 cats aged seven to 25 years and 8,692 dogs aged 10 to 25 years, oral disease was the most frequent diagnosis reported (Lund et al, 1999).

It has long been reported that periodontal disease in people

increases in severity with increasing age. Recent data suggest that the severity may represent a lifetime disease accumulation and not necessarily be an age-specific condition (Page, 1984; Van der Velden, 1984; Johnson et al, 1989). There may be some age-related changes that could negatively affect oral health, such as decreased salivary flow and antioxidant capacity (Dodds et al, 2005; Aejmelaes et al, 1997; Navazesh, 2002). It is not surprising that geriatric pets with little history of oral hygiene or veterinary oral care demonstrate an increased prevalence and severity of periodontal disease.

Immunocompetence

The host immune response protects against systemic infection from periodontal pathogens. An over exaggerated immune response can cause severe local periodontal destruction. An inadequate immune response may predispose pets to opportunistic or overwhelming systemic infection (Genco, 1992).

Nutrition and Food Characteristics

The dramatic difference in food form represented by commercial dog and cat foods as compared with the natural prey of wild canids and felids is often implicated as a significant cause of the degree of periodontal disease diagnosed in domestic dogs and cats (Gray, 1923; Colyer, 1990; Watson, 1994). Colyer examined 1,157 wild canid skulls and reported that periodontal disease as suggested by alveolar bone destruction was present in only 2% of specimens (1990). The subject of how well specific commercial food types promote oral health is discussed below.

Box 47-2 reviews a common concern of pet owners regarding food sugar content and dental caries and **Box 47-3** discusses the role of topical coatings of dry cat foods in feline tooth resorption. Although not associated with periodontal disease, these text boxes are included because the topics relate to food and dental diseases.

Etiopathogenesis Tooth-Accumulated Materials

Several materials accumulate on tooth surfaces and participate in the pathophysiology of dental and periodontal disease. These substances are commonly referred to as tooth-accumulated materials or dental substrates and are categorized as: 1) acquired enamel pellicle, 2) microbial plaque, 3) materia alba/debris, 4) calculus and 5) stain. These substrates accumulate in a dynamic continuum, initiated by the adsorption of salivary constituents onto tooth surfaces (Fedi, 1985; Schwartz et al, 1971).

Saliva is a critical oral fluid primarily recognized for its digestive functions. However, saliva also bathes the oral cavity with a fluid rich in proteins (e.g., enzymes), glycoproteins, electrolytes, lipids, antioxidants, antimicrobial peptides (defensins), immunoglobulins, bicarbonate ions and mucins that provide an initial protective barrier to pathogenic invasion, lubricate and clean the oral cavity and aid in the transportation of solids (Lingström and Moynihan, 2003; Mizukawa et al, 1999). In people, diminished salivary function (xerostomia) is associated with increased prevalence of caries and periodontal disease, mucosal irritation, difficulties in chewing and swallowing and

impaired taste. Saliva initiates film formation on all oral surfaces (Scannapieco and Levine, 1990; Navazesh, 2002).

ENAMEL PELLICLE

Enamel pellicle is a thin film or cuticle. Early enamel pellicle is composed of proteins and glycoproteins deposited from saliva and gingival crevicular fluid. Early enamel pellicle protects and lubricates. However, as pellicle ages, existing constituents are modified and additional salivary, crevicular and bacterial components are incorporated. Enamel pellicle and its components provide a framework for initial bacterial colonization and also function in the maturation of dental plaque (Scannapieco and Levine, 1990; Rolla, 1983).

DENTAL PLAQUE

Pellicle deposition and subsequent bacterial colonization occur almost immediately after a dental prophylaxis. Studies have demonstrated that within minutes after polishing, approximately one million organisms are deposited per mm² of enamel surface (Lindhe, 1989). Aggregates of bacteria combine with salivary glycoproteins, extracellular polysaccharides and occasionally epithelial and inflammatory cells to form a soft adherent plaque that covers tooth surfaces. Dental plaque is not easily removed by normal tongue actions, water drinking or forced water spray, but can be affected by mechanical and chemical means.

Dental plaque has a specific composition and structure that changes with time (DuPont, 1997). Supragingival dental plaque forms above and along the free gingival margin; subgingival dental plaque is formed entirely within the gingival sulcus. Growth and maturation of supragingival plaque are necessary for subsequent colonization of subgingival surfaces by dental plaque (Kornman, 1986). Supragingival and subgingival plaque are distinct compositional masses that influence the inflammatory reaction of gingival tissues. Studies in people have demonstrated an organized progression of microbial colonization and growth that leads to the development of mature pathogenic dental plaque (Lindhe, 1989).

Canine and feline studies characterizing the microbial composition of supragingival and subgingival plaque have been reported. Supragingival plaque in dogs with clinically healthy gingivae is primarily composed of gram-positive aerobic organisms. As plaque matures, the bacterial composition shifts to a predominately gram-negative anaerobic flora (Courant et al, 1968; Soames and Davis, 1974; Wunder et al, 1976; Syed et al, 1980, 1981; Svanberg et al, 1982; Isogai et al, 1988; Mallonee et al, 1988; Hennet and Harvey, 1991, 1991a, 1991b; Boyce et al, 1995; Harvey et al, 1995). Several sources have detailed lists of specific bacteria associated with periodontal diseases of dogs (Hardham et al, 2005; Syed et al, 1980; Wunder et al, 1976; Hennet and Harvey, 1991, 1991a, 1991b; Allaker et al, 1997; Isogai et al, 1989; Svanbert et al, 1982) and cats (Mallonee et al, 1988). The inflammation and destruction that accompanies periodontal disease results from the direct action of bacteria and their by-products on periodontal tissues and the indirect activation of the host immune response (Genco, 1990). Thus, bacte-

Box 47-3. Do Commercial Cat Foods Cause Tooth Resorption?

Although the etiology of tooth resorption in cats is unknown, examination of skulls that pre-date the 1960s revealed a lower prevalence of tooth resorption than current estimates, which suggests a relatively recent increase. Commercial foods have been implicated as a causative factor in the increased detection of tooth resorption in cats based on several physical and chemical properties of these foods.

Questions have been raised that relate to the common practice of applying an acidic coating to dry cat foods (i.e., feline digest) to enhance palatability. Human studies have demonstrated that consumption of a food or beverage with an acidic pH contributes to erosive lesions. Additionally, chronic vomiting/regurgitation have been associated with these lesions because vomitus is acidic. To address this issue, Zetner and Steurer investigated the tooth surface pH of cats with 1) tooth resorption, 2) chronic oral inflammatory disease and 3) cats with no oral lesions. These researchers also measured tooth surface pH after cats consumed either a commercial moist food or a commercial acid-coated dry food. Results from this study demonstrated that cats with tooth resorption had lower tooth-surface pH values than healthy cats, but that consumption of the dry food was not associated with the pathogenesis of odontoclastic resorptive lesions.

It has also been suggested that hard dry cat foods cause microfractures that predispose teeth to infection and initiate the inflammatory cascade leading to odontoclastic activation. However, it must also be noted that teeth that are not normally associated with mechanical forces related to consuming dry foods are also susceptible to tooth resorption.

Finally, recent work has implicated dietary vitamin D in the etiology of tooth resorption. Evidence in support of this theory includes the correlation between cats with tooth resorption and increased blood levels of 25-hydroxyvitamin D, and histologic comparisons of the effects of excessive intake of vitamin D to the effects of tooth resorption. Because cats cannot synthesize vitamin D, they must rely on their diet to supply the nutritional requirement.

Definitive studies that document a cause-and-effect relationship implicating a single etiologic factor have not yet been done, and care must be taken to maintain distinctions between casual and causal relationships when evaluating current information. In addition, it is possible that tooth resorption has a multifactorial etiology, highlighting the complexity of the problem and emphasizing the need for additional research.

The Bibliography for **Box 47-3** can be found at www.markmorris.org.

rial plaque is the most important substrate in the development of periodontal disease.

MATERIA ALBA AND OTHER ORAL DEBRIS

Materia alba is a soft mixture of salivary proteins, bacteria, desquamated epithelial cells and leukocyte fragments. Materia alba and dental plaque are two distinct materials. Materia alba

does not have the organized bacterial structure or the adherence properties of dental plaque (Schwartz et al, 1971); it can generally be washed off with a forced water spray. The role of *Materia alba* in the etiopathogenesis of plaque accumulation and periodontal disease remains unclear.

Other debris commonly observed in the oral cavity of dogs and to some extent in cats includes food, impacted hair and miscellaneous foreign materials acquired through chewing behaviors. Food debris retained in the mouth after eating can usually be removed by the action of the tongue and saliva.

Dogs and cats fed soft, sticky foods, particularly those breeds compromised by occlusal abnormalities, may retain more food debris. No reports directly correlate retention of food debris with increased plaque accumulation and periodontal disease in dogs and cats. Egelberg reported that neither the frequency of feeding nor bypassing the oral cavity by tube feeding affected the accumulation of plaque and the development of gingivitis in a group of six mixed-breed dogs with medium to large body size (1965). The effect of food retention in small and brachycephalic breeds is unknown. Retained or impacted debris may act as a nidus for plaque accumulation and exacerbate gingival inflammation. The role of food type and texture in oral health and disease is discussed below.

DENTAL CALCULUS

Dental calculus is mineralized plaque. Calculus is a hard substrate formed by the interactions of salivary and crevicular calcium and phosphate salts with existing plaque. Dental calculus is observed frequently in dogs and cats (Harvey, 1992; Harvey et al, 1994; Richardson, 1965; Coignoul and Chevillie, 1984) but differs in its composition. Feline calculus is comprised mostly of carbonate-containing hydroxyapatite, whereas canine calculus is comprised mostly of calcium carbonate (calcite) (Clarke, 1999; Legeros and Shannon, 1979). Calculus accumulates supragingivally and subgingivally; calculus deposits thicken with time. Undisturbed calculus is always covered by vital dental plaque. Aged calculus may chip or break off with mastication; however, a film of plaque remains that is rapidly mineralized. Calculus provides a roughened surface to enhance plaque attachment and accumulation and chronically irritates gingival tissues (Lindhe, 1989a; Mandel, 1990; Schroeder, 1969). A study in dogs demonstrated that calculus control in the absence of plaque control is cosmetic only; thus, preventive or therapeutic protocols to control periodontal disease should always include anti-plaque measures (Warrick et al, 2003).

DENTAL STAIN

Acquired dental stain (extrinsic stain) is initially stained pellicle that becomes part of the mineralized, layered laminate of pellicle, plaque and calculus. Dental stain occurs frequently in dogs (Schemehorn et al, 1982). Various nutritional, chemical and bacterial factors affect the presence and intensity of stain. Although nonpathogenic, dental stain is of aesthetic concern to pet owners and may signal teeth abnormalities.

Enamel staining (intrinsic stain) occurs due to trauma or

antibiotic administration during development or before tooth eruption. Erupted teeth may also be injured with resulting discoloration due to hemorrhage into the dentinal tubules.

Enamel staining varies in intensity and distribution of discoloration and is distinguished from acquired stain by its irreversible nature (Robinson et al, 1983).

Pathophysiologic Basis of Clinical Signs PERIODONTAL DISEASE

In susceptible patients, plaque accumulation along the gingival margin induces inflammation in adjacent gingival tissues. Without plaque removal or control, gingivitis progresses in severity to include local changes that allow subsequent bacterial colonization of subgingival sites. Inflammatory mediators damage the integrity of the gingival margin and sulcular epithelium, allowing further infiltration of bacteria. The immune response of the host attempts to localize the invasion of periodontal tissues; the result may be further destruction of local tissues due to cytokines released from inflammatory cells (Grove, 1982; Genco, 1984, 1990; DeBowes, 2000; Harvey, 2005).

Periodontal disease is episodic with periods of active tissue destruction followed by periods of inactivity and healing (Figure 47-3). Additionally, not all teeth are affected at the same rate or to the same degree. Periodontal disease begins with gingivitis and progresses through increased destruction of the periodontal apparatus, resulting in tooth mobility and eventual tooth loss. Generally, a stage classification system is used, beginning with a healthy periodontium and ending with tooth exfoliation (Table 47-2 and Figure 47-4) (Wiggs and Lobprise, 1997a).

Periodontal disease is often a silent process that progresses without detection. Even in severe cases, dogs and cats may not demonstrate obvious discomfort. One signal often noticed by pet owners is oral malodor (Hennet et al, 1995), but even then, pet owners may not link bad breath to periodontal disease. Oral disease is a primary cause of offensive breath odor, but other metabolic processes may be involved (Tonzetich, 1977, 1978; Preti et al, 1992; Chen et al, 1970). A positive correlation between periodontal disease and malodor has been found in beagles (Simone et al, 1997).

Other signs of periodontal disease include: 1) accumulation of dental substrates on tooth surfaces, 2) gingival redness, 3) swelling and bleeding of the gingival margin, 4) gingival recession, 5) periodontal pocket formation, 6) accumulation of purulent material in the gingival sulcus or periodontal pocket and 7) tissue destruction with loss of attachment, furcation exposure and tooth mobility (Table 47-3).

Systemic Complications of Periodontal Disease

Periodontal disease may predispose affected pets to systemic complications. In people, periodontal disease has been linked to arthritis, low birth weight and pre-term birth, cardiovascular disease, stress and anxiety, diabetes, obesity and stroke (Hamilton, 2005; Mandel, 2004; Newman, 1996; O'Reilly and Claffey, 2000; Rutkauskas, 2000; Gaffar and Volpe, 2004; Klages et al, 2005; Roman, 2003; Dorfer et al, 2004).

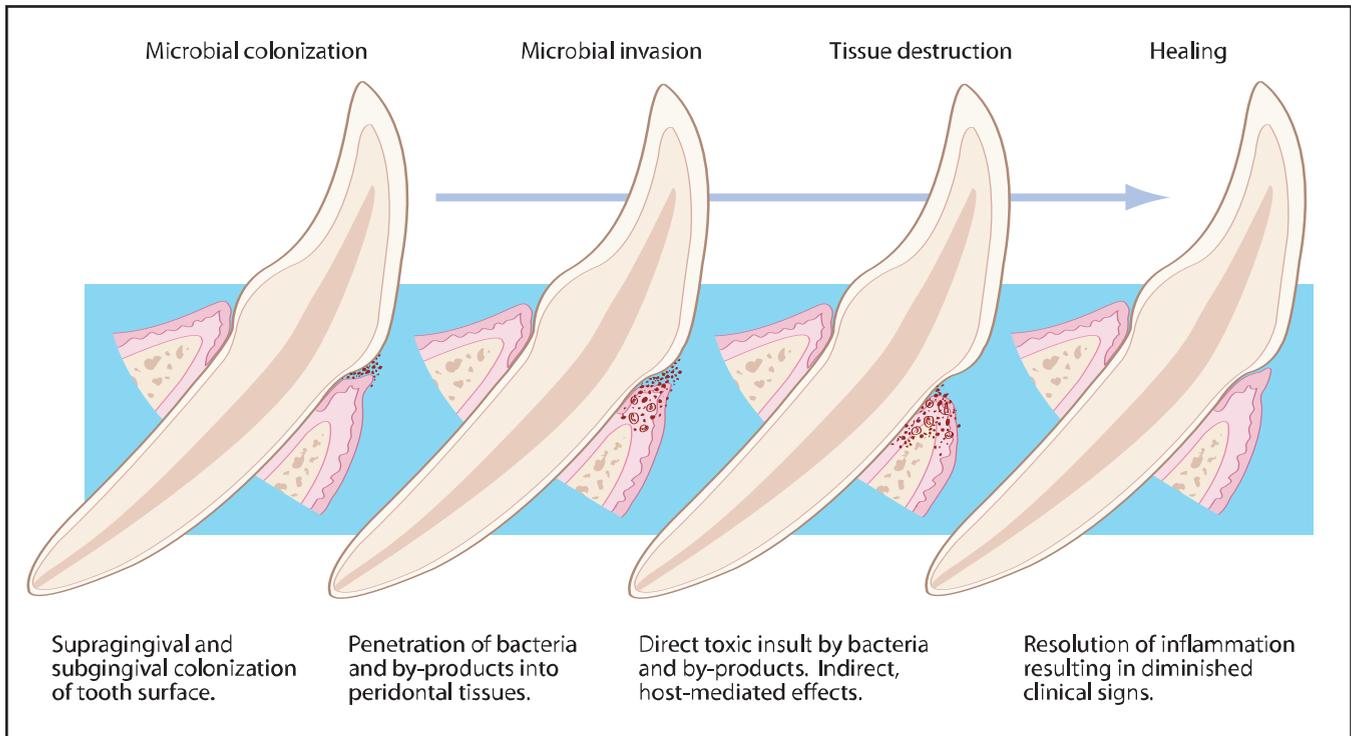


Figure 47-3. Host-bacterial interactions in the pathogenesis of periodontal disease. Periodontal disease is cyclic with bursts of tissue destruction followed by periods of healing and relative quiescence. Four stages in the pathogenesis of periodontal disease have been proposed: 1) Microbial colonization. Salivary pellicle is deposited on the enamel surface and is soon colonized by oral bacteria that multiply forming plaque. 2) Microbial invasion. Plaque bacteria and their by-products invade the gingival tissues and initiate a host inflammatory response. 3) Tissue destruction. Direct toxic effects of bacteria and their by-products and indirect host-mediated toxic responses lead to destruction of periodontal tissue. 4) Healing. Periods of disease remission are characterized by a reduction in the inflammatory response and gingival healing. (Adapted from Genco RJ, Goldman HM, Cohen WD, eds. *Contemporary Periodontics*. St Louis, MO: CV Mosby Co, 1990; 189.)

Although much of the evidence is based on documentation of correlations between oral and systemic health, and the effect of systemic diseases on the health of the oral cavity (particularly in the case of diabetes) (Mealey, 1998; Levin et al, 1996), data are emerging that suggest a more causal and two-way relationship that makes a case for periodontal therapy as an adjunctive treatment to classic disease therapies (D'Aiuto et al, 2004; Montebugnoli et al, 2005; Montebugnoli, 2004; Farooqi et al, 2004; Kiran et al, 2005; Mealey, 2000; Miller et al, 1992; Pucher and Stewart, 2004; Taylor et al, 2004; Rahman et al, 2005; Mercanoglu et al, 2004).

In dogs, numerous reports speculate on the association between chronic periodontal disease and conditions affecting the heart valves and pulmonary airways (Hamlin, 1990; Prueter and Sherding, 1985; Calvert and Dow, 1990; Bonagura, 1981). Furthermore, a positive correlation has been found between the severity of periodontal disease and histopathologic changes in the kidneys, myocardium and liver (DeBowes et al, 1996). Periodontal infections allow bacterial migration into lymphatic and blood vessels, resulting in bacteremia and are associated with increased levels of many of the systemic markers associated with the diseases described above, including C-reactive protein, proinflammatory cytokines, serum cholesterol, plasma fibrinogen, white blood cells and blood glucose (Harari et al, 1993, 1991; Slade et al, 2000;

Table 47-2. Stages of periodontal disease.*

Stage 0	Clinically normal No gingival inflammation or periodontitis clinically evident.
Stage 1	Gingivitis only No attachment loss. Height and architecture of the alveolar margin are normal.
Stage 2	Early periodontitis Less than 25% attachment loss or Stage 1 furcation involvement in multirooted teeth.
Stage 3	Moderate periodontitis 25 to 50% attachment loss or Stage 2 furcation involvement in multirooted teeth.
Stage 4	Advanced periodontitis Greater than 50% attachment loss or Stage 3 furcation involvement in multirooted teeth.

*Adapted from AVDC.org. Wolf HF, Rateitschak EM, Rateitschak KH, et al. *Color atlas of dental medicine: Periodontology*, 3rd ed. Stuttgart, Germany: Georg Thieme Verlag, 2005.

Ide et al, 2004; D'Aiuto et al, 2004, 2005; Joshipura et al, 2004; Lowe, 2004; Holzhausen et al, 2004). The host defenses of normal healthy pets can effectively clear transient bacteremia; however, blood-borne bacteria may colonize distant sites in patients impairing immune function and/or compromising organ function, including development of atherosclerotic lesions (Calvert and Green, 1986; Glurich et al, 2002).

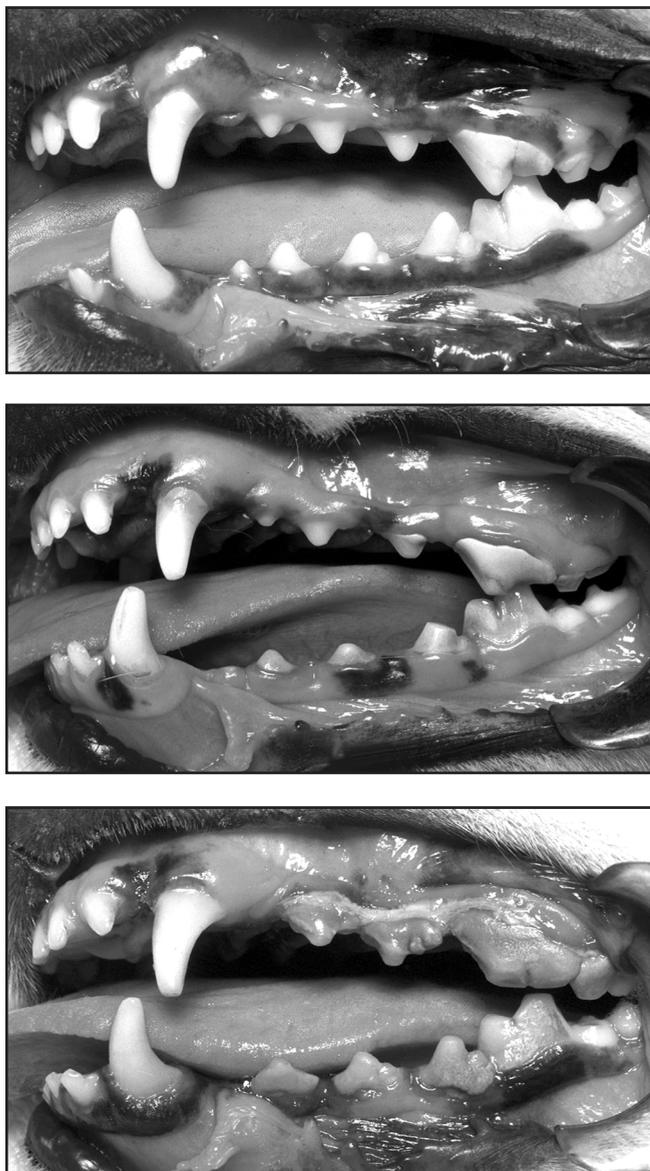


Figure 47-4. Photographic representations of mild, moderate and severe periodontal disease in dogs. (Top) Mild periodontal disease. Some accumulation of plaque and calculus is evident on tooth crowns. There is slight gingival recession around the maxillary canine tooth and the gingival margins are slightly rounded, particularly around the caudal premolar teeth. (Middle) Heavy plaque and calculus accumulation is evident on most teeth. Accumulations are abundant on the maxillary fourth premolar and first molar. A distinct margin of gingival inflammation is present around the maxillary fourth premolar. Inflammatory changes including swelling, reddening and recession are evident around most teeth. (Bottom) Gross plaque and calculus accumulation is present on premolar and molar teeth. Distinct marginal gingivitis with severe gingival recession and periodontal tissue loss is present. Impaction of hair and foreign material occurs commonly at sites of severe tissue destruction.

Key Nutritional Factors

The key nutritional factors for oral health should provide a sufficient level of plaque control to prevent periodontal disease and gingivitis. Proper food texture and composition can directly affect the oral environment through: 1) maintenance of tissue

integrity, 2) alteration of bacterial plaque metabolism, 3) stimulation of salivary flow, 4) cleansing of tooth and oral surfaces by appropriate physical contact and/or 5) chelation of calcu-logic constituents (Box 47-4). However, control of calculus is a secondary consideration because calculus control by itself has not been shown to decrease gingivitis and periodontal disease. Calculus along with stain and malodor are more of a cosmetic concern.

Assessing the relative efficacy of an oral health related key nutritional factor is complex. It is more practical to determine the overall benefit of these constituents in a finished product. However, it can be very confusing for veterinarians, and particularly for pet owners, to discern which products provide significant dental benefits and thus warrant use as oral hygiene agents. The Center for Veterinary Medicine of the Food and Drug Administration (CVM-FDA) monitors and regulates dental health claims in the United States. Cosmetic claims are not objectionable and structure-function claims are not stringently regulated; thus, the wide availability of products that make some type of plaque or calculus claim with little or no research to document their effectiveness. Phrases such as “cleans teeth, freshens breath” are commonplace on commercial food and treats packages. Because “crunchy” texture provides little dental benefit, the purported ability of these types of products to provide any significant level of oral hygiene is a misrepresentation to pet owners.

However, standardized scientific methods by which plaque (and calculus) accumulation are measured in dogs and cats for evaluating product efficacy have been established by the international veterinary dental community (Boyce, 1992; Logan and Boyce, 1994; SVOC, 1994; Harvey, 1995; Logan et al, 1995; Logan, 1996, 1996a; Hennet, 1999; Harvey, 2002; Hennet et al, 2006). Box 47-5 discusses these methods and the VOHC Seal of Acceptance. The presence of a VOHC Seal of Acceptance for plaque or plaque and calculus and/or published evidence-based studies helps determine which products are effective.

Because foods that provide dental health benefits replace regular maintenance foods, several key nutritional factors are included because of their relationship to general health rather than specific benefits for periodontal disease. The key nutritional factors for dental foods for dogs and cats are summarized in Table 47-4 and discussed in more detail below.

Food Texture

The physical consistency, or texture, of foods and treats has long been thought to affect the oral health of dogs and cats. Many of the recommendations made about the effect of food texture on oral health are unsubstantiated and several have turned out to be untrue when exposed to rigorous study, including “natural foods” (Box 47-6). However, food texture can be a very effective means of controlling dental plaque and ultimately periodontal disease.

Numerous studies have reported that dogs and cats fed soft foods have increased accumulation of plaque and calculus and a higher prevalence or severity of periodontal disease when com-

Table 47-3. Clinical signs associated with periodontal disease.

Anorexia	Red, swollen or bleeding gingivae
Behavioral changes	Substrate accumulation (plaque, calculus, stain)
Difficulty eating	Tooth mobility
Halitosis	Ulcerations on gingivae or oral mucosa
Head shaking	
Ptyalism	

Box 47-4. Hexametaphosphate and Tartar Control.

Calcium chelators such as hexametaphosphate (HMP) are sequestrants that bind salivary calcium, making it unavailable for incorporation into the plaque biofilm to form calculus. HMP is delivered as a coating on various treats, dental chews and foods. The purported benefits of these compounds are that they are released during chewing and remain for prolonged periods of time in the oral cavity. It has been demonstrated that the addition of HMP to the surface of baked biscuit treats, rawhide chews and dry foods results in reduced calculus accumulation. However, there is also evidence that shows no significant differences in plaque or calculus accumulation in dogs fed dry foods plus HMP-coated biscuits. Polyphosphates like HMP have no known direct effect on oral microflora populations or plaque accumulation. An effective plaque control regimen should always be the primary recommendation for prevention or post-therapeutic care of periodontal disease.

The Bibliography for **Box 47-4** can be found at www.markmorris.org.

pared with the same parameters in pets fed hard foods. These studies are difficult to compare because different methods were used to assess substrate accumulation and gingival health, and different populations of patients were studied.

Feeding recommendations for oral health commonly include feeding a dry pet food. Hard food purportedly increases mastication, which aids oral health by exercising the gums, increasing keratinization of the gingivae and reducing accumulation of plaque and calculus (O'Rourke, 1947). But many of the studies traditionally cited to substantiate claims that dry foods reduce accumulation of plaque and calculus are old reports that used small numbers of subjects, had varying evaluation methods and did not report data analysis (Burwasser and Hill, 1939; Egelberg, 1965a; Krasse and Brill, 1960; Studer and Stapley, 1973).

Consumption of soft foods may promote plaque accumulation. However, the general belief that dry foods provide significant oral cleansing should be regarded with skepticism. A moist food may perform similarly to a typical dry food in affecting plaque, stain and calculus accumulation (**Figure 47-5**) (Boyce and Logan, 1994). In a large epidemiologic survey, dogs consuming dry food alone did not consistently demonstrate improved periodontal health when compared with dogs eating moist foods (Harvey et al, 1996). Also, periodontal disease is

Table 47-4. Key nutritional factors for foods for dogs and cats for prevention of periodontal disease and maintenance of overall health.*

Factors	Dogs	Cats
Food texture	VOHC Seal for plaque control	VOHC Seal for plaque control
Antioxidants		
Vitamin E (IU/kg)	≥400	≥500
Vitamin C (mg/kg)	≥100	100-200
Selenium (mg/kg)	0.5-1.3	0.5-1.3
Phosphorus (%)	0.4-0.8	0.5-0.8
Sodium (%)	0.2-0.4	0.2-0.5
Magnesium (%)	-	0.04-0.1
Average urinary pH	-	6.2-6.4

Key: VOHC = Veterinary Oral Health Council Seal of Acceptance for plaque control.

*All values are amounts in food on a dry matter basis unless otherwise stated.

Box 47-5. Veterinary Oral Health Council: A System for Recognizing Effective Veterinary Dental Products.

The Veterinary Oral Health Council (VOHC) was established in 1997 after 10 years of open meetings, which included representatives from the American Veterinary Dental College, Academy of Veterinary Dentistry, American Veterinary Dental Society, American Veterinary Medical Association, American Animal Hospital Association, United States Food and Drug Administration, private practice and industry. The purpose of the VOHC is to provide an independent, objective and credible means of recognizing veterinary dental products that effectively control accumulation of plaque and/or calculus (tartar). The VOHC system is similar to the American Dental Association (ADA) Seal of Acceptance system and is recognized worldwide.

The VOHC does not conduct efficacy testing; the council reviews results of tests performed in accordance with approved protocols set by the VOHC. The VOHC awards the Seal in two claim categories: 1) Helps control plaque and 2) Helps control tartar. It is important to recognize the difference between the two claims; plaque is the primary cause of periodontal disease and tartar control in the absence of plaque control is primarily cosmetic. If a product with the "helps control tartar" claim is recommended it is critical to recommend a proven plaque control method. In addition to noting the type of Seal awarded, it is important to be aware of the study design and application (feeding) recommendations associated with meeting the claim requirements. A product that is awarded the Seal based on a specific application (daily) may not perform similarly when applied less frequently.

The first canine and feline dental products to receive the VOHC Seal of Acceptance were Hill's Prescription Diet t/d Canine and t/d Feline, respectively. A complete list of products that have been awarded the VOHC Seal of Acceptance is available at vhc.org.

the most common disease in dogs and cats (Lund et al, 1999); however, most dogs and cats eat dry foods.

Thus, typical commercial dry dog and cat foods contribute

Box 47-6. Natural Food Sources and Periodontal Disease.

Early literature reported that the typical foods of wild canids and felids had a plaque-retardant effect and that wild canids and felids were not afflicted with the generalized form of periodontal disease seen in domesticated pets. Pet food commercialization is often implicated as a contributing factor to the increased prevalence and severity of periodontal disease in domestic dogs and cats (**Box 47-3**). The constituents of natural foods for wild canids and felids probably depend on geographic location, environmental season and individual hunting capabilities. However, historically a natural food refers to small rodents/mammals that would typically fall prey to wolves, coyotes, etc. Colyer specifically refers to “flesh that the animals must rend with their teeth.” Wild canids in particular probably eat fruits and vegetables and an array of tissues including blood, intestines plus contents, muscle, cartilage, bone marrow and bones.

Despite these assertions, there are no published data that compare controlled populations of domestic dogs or cats consuming natural food sources with those consuming a commercial food. In addition, even if it were possible to make such comparisons, confounding variables might include dramatic changes in food form (moist, semi-moist, dry and evolving pet owner preferences) through development of commercial pet foods, specific nutrient variation and selective breeding, which has resulted in dramatic differences in body size and head types of dogs and cats.

Reports exist about the oral condition of small populations of dogs and cats consuming natural foods. One study involved 67 English foxhounds, one to nine years of age that were routinely fed raw carcasses consisting of the bony skeleton, muscle and associated tissues. Oral examinations revealed that all dogs had varying signs of periodontal disease as well as a high prevalence of tooth fractures. Another study examined 45 small feral cats from an Australian national park and reported conditions including calculus deposits, periodontal disease, fractured teeth, attrition and tooth resorption. Examination of gastrointestinal contents of these cats revealed the presence of natural food sources including small mammals, birds, lizards and insects. These findings cast skepticism on the long-held view that a natural food source prevents development of oral disease, particularly periodontal disease, in dogs and cats. **Box 47-8** describes the role of chew toys in periodontal health.

The Bibliography for **Box 47-6** can be found at www.markmorris.org.

little dental cleansing. As a tooth penetrates a kibble or treat the initial contact causes the food to shatter and crumble with contact only at the coronal tip of the tooth surface (**Figure 47-6**). To provide effective mechanical cleansing, a food should promote chewing and maximize contact with the tooth surface (**Figure 47-6**).

Foods with enhanced textural characteristics promote oral health. Several maintenance pet foods are available that provide clinically significant oral cleansing compared with regular commercial dry or moist foods and/or snacks. Numerous studies

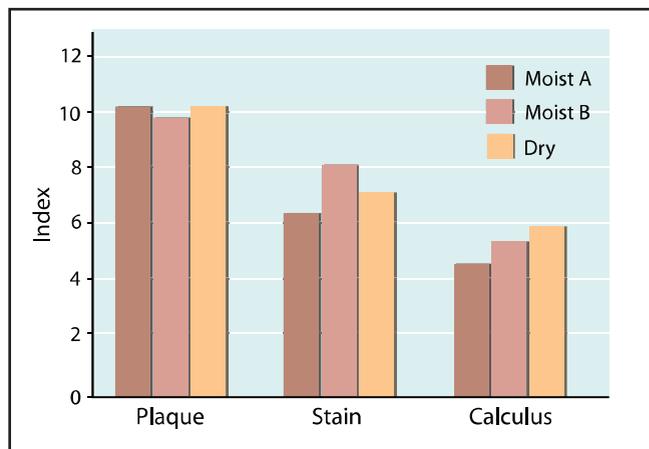


Figure 47-5. Comparison of plaque, stain and calculus accumulation in dogs fed a specialty brand moist food (Moist A), a grocery brand moist food (Moist B) and a grocery brand dry food. There is no significant difference in substrate accumulation among dogs fed the three foods. Moist foods do not always promote increased plaque and calculus formation in comparison to dry foods.

have demonstrated that foods possessing an appropriate combination of shape, size and mechanical structure provide significant plaque, calculus and stain control in dogs and cats (Logan, 1996, 1996a; Boyce, 1992; Jensen et al, 1995; Logan et al, 1995; Finney, 1996). A six-month study investigating the effects of food on plaque accumulation and gingival inflammation in 40 adult mongrel dogs reported that dogs fed the test food had 39% less plaque accumulation and 36% less gingival inflammation than dogs fed the control food (**Figure 47-7**). These studies used a clean-tooth model in which plaque, calculus and stain were evaluated at a specified time following a dental prophylaxis.

One study reported that feeding a food with appropriate physical characteristics to beagles with existing plaque, calculus and gingivitis resulted in a significant decrease in mean plaque and calculus indices after two weeks and in the gingival index after six weeks (**Figure 47-8**). Beagles eating the control food had a significant increase in plaque and calculus accumulation and no change in gingival inflammation over the 16-week test period (Finney et al, 1996).

Fiber-containing foods have long been viewed as “nature’s toothbrush.” Investigators have theorized that fibrous foods: 1) exercise the gums, 2) promote gingival keratinization and 3) clean the teeth. Fiber in foods, especially as it relates to texture, has been shown to affect plaque and calculus accumulation and gingival health in dogs and cats (Watson, 1994; Boyce and Logan, 1994; Logan, 1996). Certain types of fiber combined with specific manufacturing processes can affect a food’s texture. Fiber characteristics that maximize tooth contact time (e.g., orientation within the kibble matrix), combined with a size and shape that promote chewing, are critical to obtaining a dental benefit. A typical dry food does not possess the mechanical characteristics for adequate dental cleansing. Simply enlarging the kibble or varying the shape of the product is likewise inadequate. In the absence of effective plaque control

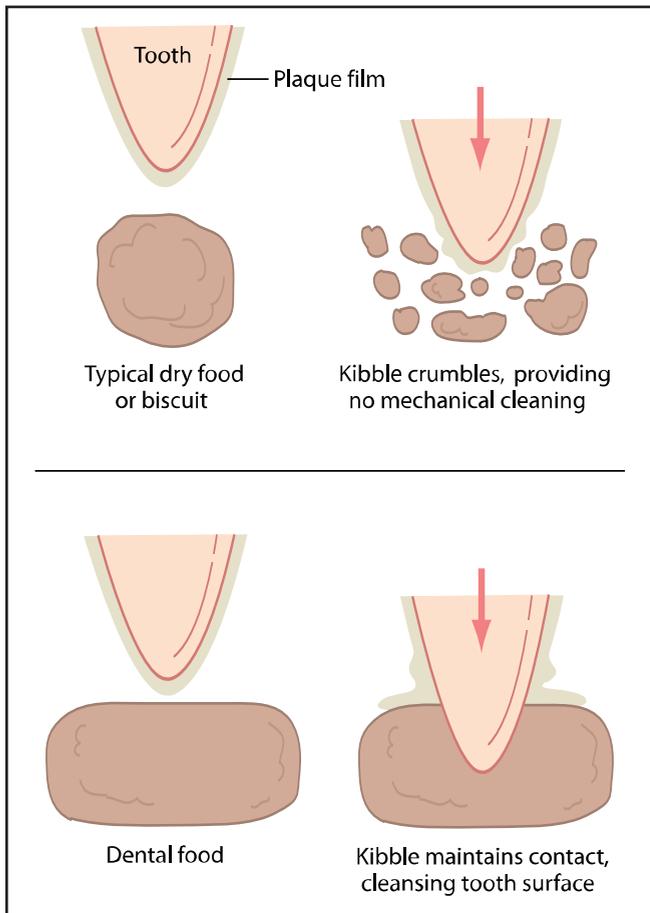


Figure 47-6. This illustration depicts the mechanical cleansing properties of commercial dog and cat foods. The top illustration demonstrates what occurs when a dog or cat chews a typical dry food. The kibble crumbles providing little to no mechanical cleansing. The bottom illustration demonstrates what happens when a dog or cat chews a dental food. The kibble stays together, maintaining contact with the tooth surface and providing mechanical cleansing.

through other measures, or in cases demanding adjunctive plaque control, mechanical attenuation of plaque and calculus accumulation daily with a maintenance dental food is a reasonable alternative. Given the prevalence of periodontal disease in dogs and cats, effective homecare products that improve owner compliance can be a valuable addition to an oral health maintenance regimen.

One way to assess whether the texture of a specific dog or cat food is effective in preventing accumulation of dental plaque (or calculus) is whether or not the product's label carries the VOHC Seal of Acceptance, specifically stating that the product is effective in controlling plaque. Published Grade 1 or 2 evidence-based studies are also reliable indicators of product efficacy.

Antioxidants

Oxidative stress may be important in the etiology of periodontal disease. In one study, dogs with severe periodontitis had gingival crevicular fluid and serum with lower total anti-

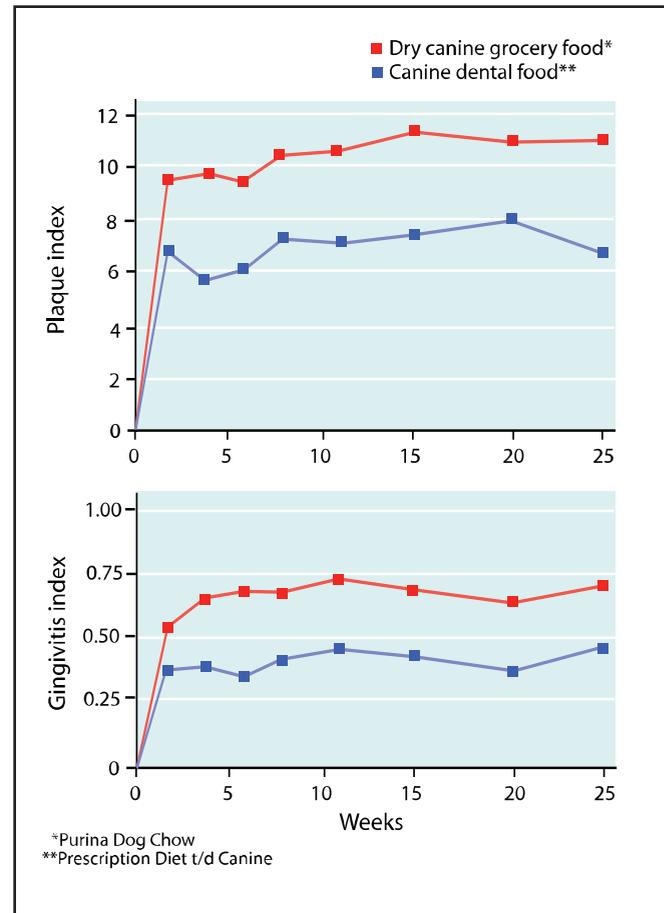


Figure 47-7. The effects of commercial dog foods on plaque accumulation and gingival health in dogs. These graphs compare plaque accumulation and gingival inflammation in dogs fed two different foods for six months. Each group of dogs began the study with a plaque index of zero and clinically healthy gingivae. At all time points, the dogs consuming the test food (Prescription Diet t/d Canine) had significantly lower scores for plaque accumulation and gingival inflammation than the dogs consuming the control food (Purina Dog Chow).

oxidant capacity than dogs with gingivitis or mild periodontitis (Pavlica et al, 2004). The body synthesizes many antioxidants but relies on food for others. Vitamins E and C and selenium are proposed as antioxidant key nutritional factors for foods for periodontal disease because: 1) they are biologically important, 2) they act synergistically (e.g., vitamin C and selenium-containing glutathione peroxidase regenerate vitamin E after it has reacted with a free radical) and 3) much is known about their safety.

VITAMIN E

Vitamin E (α -tocopherol) is the main lipid-soluble antioxidant in plasma, erythrocytes and tissues (NRC, 2006). It is one of the most effective antioxidants for protecting cell membrane constituent polyunsaturated fatty acids from oxidation. Vitamin E inhibits lipid oxidation by scavenging lipid peroxyl radicals faster than these radicals can react with adjacent fatty acids or membrane proteins (Gutteridge and Halliwell, 1994).

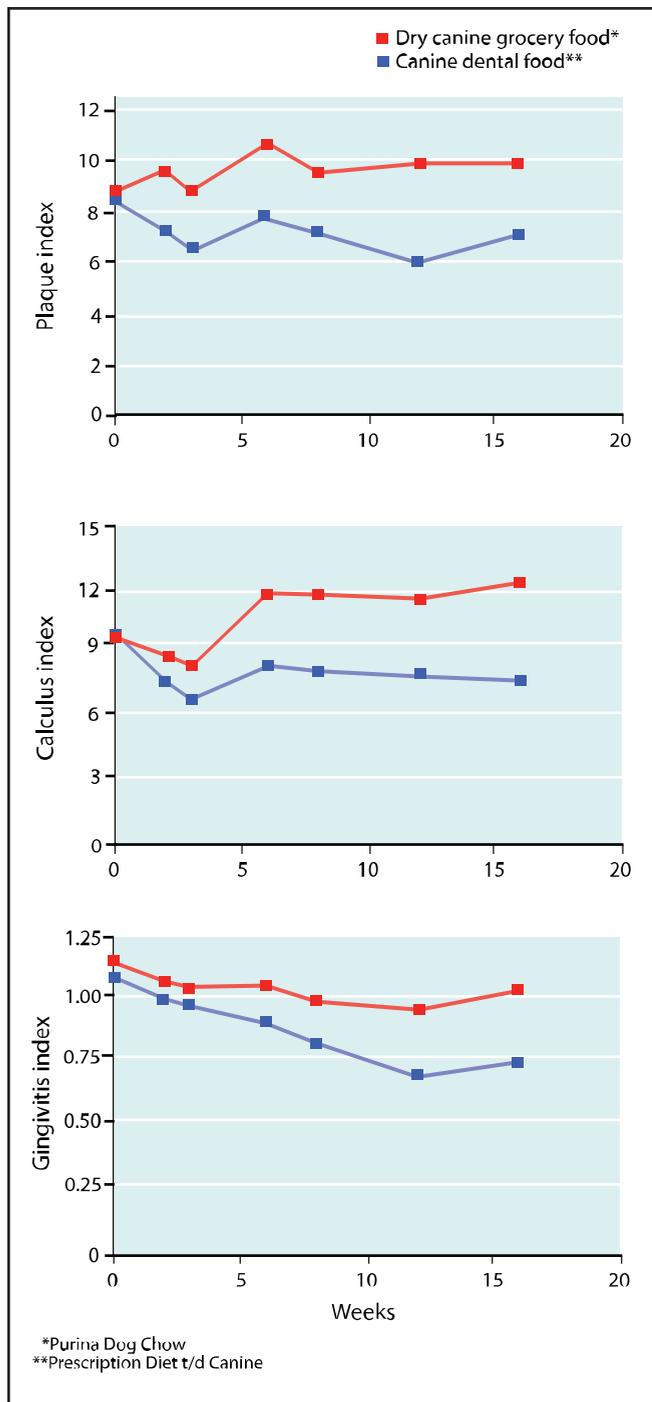


Figure 47-8. The effects of commercial dog foods on existing plaque, calculus and gingivitis in dogs. Each group of dogs entered the study with similar amounts of plaque, calculus and gingivitis. Dogs were fed either a control food (Purina Dog Chow) or a test food (Prescription Diet t/d Canine). Plaque, calculus and gingivitis were evaluated over a four-month period. Dogs eating the test food demonstrated a highly significant reduction in plaque, calculus and gingival inflammation whereas dogs eating the control food had a significant increase in plaque, a highly significant increase in calculus and no significant change in gingivitis.

Research indicates that a level of vitamin E higher than the requirement confers specific biologic benefits (Hayes et al, 1969; Hall et al, 2003; Meydani et al, 1998; Jewell et al, 2002). Based on antioxidant biomarker studies in dogs and cats, for improved antioxidant performance, foods for oral health should contain at least 400 IU/kg dry matter (DM) (dog foods) and at least 500 IU/kg DM (cat foods) (Jewell et al, 2000).

VITAMIN C

Vitamin C (ascorbic acid), is the most powerful reducing agent available to cells. Ascorbic acid: 1) regenerates oxidized vitamin E, glutathione and flavonoids, 2) quenches free radicals intra- and extracellularly, 3) protects against free radical-mediated protein inactivation associated with oxidative bursts of neutrophils, 4) keeps transition metals in reduced form and 5) may quench free radical intermediates of carcinogen metabolism.

Although dogs and cats can synthesize enough vitamin C to fulfill minimum requirements (Naismith, 1958), in vitro studies indicated that dogs and cats have from one-quarter to one-tenth the ability to synthesize vitamin C as other mammals (Chatterjee et al, 1975). Whether or not this translates to a reduced ability in vivo is unknown. For improved antioxidant performance, and in conjunction with recommended levels of vitamin E, foods for adult dogs and cats should contain at least 100 and 100 to 200 mg vitamin C/kg DM, respectively.

SELENIUM

Glutathione-peroxidase is a selenium-containing antioxidant enzyme that defends tissues against oxidative stress by catalyzing the reduction of H_2O_2 and organic hydroperoxides and by regenerating vitamin E. The minimum requirement for selenium in foods for dogs and cats is 0.13 mg/kg DM (Wedekind et al, 2003, 2003a). Animal studies and clinical intervention trials in people have shown selenium to be anticarcinogenic at levels much higher (five to 10 times) than the recommended allowances for people or the minimal requirements for dogs and cats (Combs, 2001; Neve, 2002). Therefore, for increased antioxidant benefits, the recommended range of selenium for dog and cat foods is 0.5 to 1.3 mg/kg DM.

Phosphorus, Sodium, Magnesium and Urinary pH

Phosphorus and sodium are considered key nutritional factors for apparently healthy adult dogs and cats for purposes of ameliorating or slowing the progression of subclinical kidney disease and/or hypertension. The recommended allowances for phosphorus and sodium in foods for adult dogs are 0.4 to 0.8% and 0.2 to 0.4% DM, respectively. For foods for adult cats, the recommended allowances for phosphorus and sodium are 0.5 to 0.8% and 0.2 to 0.5% DM, respectively. In addition, for adult cats, magnesium and urinary pH are also key nutritional factors, based on their role in feline lower urinary tract disease. The recommended allowance for magnesium in foods for adult cats is 0.04 to 0.1% DM. Foods for adult cats should produce a urinary pH in the range of 6.2 to 6.4. For more information see Chapters 13 and 20.

Other Nutritional Factors

Calcium

Foods deficient in calcium and excessive in phosphorus may lead to secondary nutritional hyperparathyroidism and significant loss of alveolar bone (Bawden et al, 1995; Becks and Weber, 1931). Experiments in dogs have demonstrated resorption of alveolar bone following consumption of a food with a low ratio of calcium to phosphorus (Henrikson, 1968). Krook and colleagues proposed that periodontal disease results from a nutritional deficiency of calcium, an excess of phosphorus or both (1972, 1972a). Svanberg and colleagues reported that nutritional secondary hyperparathyroidism occurred in a group of beagles fed a food deficient in calcium. The food did not have any effect on the initiation or rate of progression of periodontal disease when compared with findings in a control group fed a nutritionally adequate food (1973). It is unlikely that dietary deficiencies in calcium and phosphorus are primary causes of periodontal disease; however, they may contribute to the progression of the disease process and exacerbate bone loss. Calcium deficiency occurs rarely in dogs and cats that consume commercial pet foods that contain calcium levels that meet Association of American Feed Control Officials' (AAFCO) allowances (2007). Improperly formulated homemade foods are more likely to be deficient in calcium.

Vitamin Deficiencies

Adequate vitamin content can be a problem in improperly formulated homemade foods. Vitamins that have been studied in relation to periodontal disease include A, B, C, D and E. Vitamin A deficiencies have been reported to cause marginal gingivitis, gingival hypoplasia and resorption of alveolar bone (King, 1940; Reifen, 2002). Deficiencies of B-complex vitamins (including folic acid, niacin, pantothenic acid and riboflavin) have been associated with gingival inflammation, epithelial necrosis and resorption of alveolar bone (Becks et al, 1943). Vitamin C, besides functioning as an antioxidant (discussed above), also plays a key role in collagen synthesis. Ascorbic acid deficiencies reportedly affect periodontal tissues adversely in people, including gingival inflammation (Ismail, 1983; Leggott et al, 1986). Vitamin D helps regulate serum calcium concentrations. Vitamin D deficiencies affect calcium homeostasis and reportedly affect the gingivae, periodontal ligament and alveolar bone (Becks and Weber, 1931). Deficiencies of these vitamins are highly unlikely to occur in dogs and cats fed commercial foods that contain levels that meet AAFCO allowances.

Vitamin E is an antioxidant and in one study, dogs with more severe periodontitis also had lower total antioxidant capacity of their gingival crevicular fluid and serum than dogs with gingivitis or mild periodontitis (Pavlica et al, 2004).

FEEDING PLAN

How to Feed Dogs and Cats for Optimal Oral Health

If properly fed as puppies and kittens (Box 47-7), most dogs and cats enter adulthood with healthy mouths. In most cases,

periodontal disease can be prevented with appropriate plaque control. The level of plaque control necessary to maintain oral health must be assessed for each individual patient. Frequent plaque removal (daily, if possible) is widely recommended. Brushing, when done correctly and conscientiously, is a very effective method for achieving the level of plaque control necessary to control gingivitis.

After oral disease is present, it should be treated with appropriate professional therapy. However, aftercare, or continued dental hygiene provided by the pet owner, will determine the overall success of professional therapy. A regimen of soft food may be recommended after invasive or advanced procedures during the initial healing phase. Chemical plaque control should be provided in these instances until mechanical plaque control can be resumed. However, many pets can resume their normal food regimen immediately after receiving professional care, provided the client has been instructed in appropriate plaque control procedures (Box 47-1).

If the pet owner is able to provide effective plaque control through toothbrushing, then an oral benefit from foods and/or treats may be of less concern (Lindhe and Rylander, 1975; Tromp et al, 1986, 1986a). Realistically, however, compliance with toothbrushing is a problem for many pet owners. In addition, certain patients may require aggressive plaque control combined with frequent professional care to maintain optimal oral health. Thus, in many cases, a food/treat approach to plaque control is necessary. The feeding plan includes assessing and selecting the best food and feeding methods for the individual patient.

Assess and Select the Food

After the oral and general health status of the patient has been assessed and the key nutritional factors and their target levels have been determined, the adequacy of the food can be assessed. The steps to assessing foods include: 1) assuring the nutritional adequacy of the food by a credible regulatory agency such as AAFCO and 2) comparing the food's key nutritional factors with the recommended levels. Because dental foods are used in place of regular maintenance foods, the key nutritional

Box 47-7. Feeding Puppies and Kittens for Optimal Dentition.

Puppies and kittens are born edentulous. However, the nutrition they receive from the bitch or queen can affect oral development. The bitch or queen should receive an appropriate growth/lactation food during lactation to ensure adequate milk production and to meet ongoing needs. Deciduous teeth begin to erupt at about three weeks of age. Most puppies and kittens can be given access to soft food at this age. Full deciduous dentition should be present in puppies by 12 weeks of age and in kittens by six weeks of age. The permanent tooth bud will already be formed, so it is essential to dental health that puppies and kittens receive appropriate nutrition during the early weeks of development. This is also the ideal time to train a pet to accept oral hygiene.

Table 47-5. Key nutritional factor content of selected dry commercial dog foods marketed for dental health compared to recommended levels.*

Factors	VOHC Seal for plaque control (Yes/No)	Vitamin E (IU/kg)	Vitamin C (mg/kg)	Selenium (mg/kg)	Phosphorus (%)	Sodium (%)
Recommended levels	Yes	≥400	≥100	0.5-1.3	0.4-0.8	0.2-0.4
Hill's Prescription Diet t/d Canine	Yes	652	79	0.50	0.40	0.22
Hill's Prescription Diet t/d Small Bites Canine	Yes	652	79	0.50	0.40	0.22
Hill's Science Diet Adult Oral Care	Yes	564	175	0.62	0.65	0.24
Medi-Cal Dental Formula	No	na	na	na	0.90	0.40
Purina Veterinary Diet DH Dental Health	No	1,171	na	na	1.25	0.57
Purina Veterinary Diet DH Dental Health Small Bites	No	1,169	na	na	1.24	0.61
Royal Canin Veterinary Diet Dental DD 20	No	604	na	0.44	0.66	0.38
Royal Canin Veterinary Diet Dental DS 23 Small Breed	No	725	na	0.44	0.66	0.77

Key: VOHC = Veterinary Oral Health Council Seal of Acceptance for plaque control, na = information not available from manufacturer.
*All values are amounts in food on a dry matter basis unless otherwise stated.

Table 47-6. Key nutritional factor content of selected dry commercial cat foods marketed for dental health compared to recommended levels.*

Factors	VOHC Seal for plaque control (Yes/No)	Vitamin E (IU/kg)	Vitamin C (mg/kg)	Selenium (mg/kg)	Phosphorus (%)	Sodium (%)	Magnesium (%)	Urinary pH
Recommended levels	Yes	≥500	100-200	0.5-1.3	0.5-0.8	0.2-0.5	0.04-0.1	6.2-6.4
Hill's Prescription Diet t/d Feline	Yes	811	83	0.59	0.80	0.33	0.065	6.34
Hill's Science Diet Adult Oral Care	Yes	670	171	0.55	0.75	0.37	0.058	6.30
Medi-Cal Dental Formula	No	na	na	na	0.70	0.60	na	na
Purina Veterinary Diets DH Dental Health	Yes	722	na	na	1.50	0.63	0.10	na
Royal Canin Veterinary Diet Dental DD 27	No	710	na	0.34	0.81	0.65	0.097	na

Key: VOHC = Veterinary Oral Health Council Seal of Acceptance for plaque control, na = information not available from manufacturer.
*All values are amounts in food on a dry matter basis unless otherwise stated.

factors include those for promoting long-term general health by managing certain other important disease risk factors.

Besides providing the recommended levels of key nutritional factors, **Tables 47-5** and **47-6** provide key nutritional factor profiles for selected commercial foods marketed to provide a dental benefit for dogs and cats, respectively. Special emphasis should be given to the presence of the VOHC Seal of Acceptance for plaque control. If the food in question cannot be found in this table, contact the manufacturer. Manufacturers' addresses, websites and toll-free customer service numbers are listed on pet food labels. If the manufacturer cannot provide the necessary information, consider switching to a food for which this information is available. Optimal nutrient balance is critical to overall health and should not be overlooked when assessing whether a food or treat is appropriate for periodontal health. Thus, it is important that a dental food or treat provide optimal nutritional balance for dogs and cats for their lifestage. Comparing a food's key nutritional factor content with the recommended levels is fundamental to food selection.

Another criterion for selecting a food that may become increasingly important in the future is evidence-based clinical

nutrition. Practitioners should know how to determine risks and benefits of nutritional regimens and counsel pet owners accordingly. Currently, veterinary medical education and continuing education are not always based on rigorous assessment of evidence for or against particular management options. Still, studies have been published to establish the nutritional benefits of certain pet foods. Chapter 2 describes evidence-based clinical nutrition in detail and applies its concepts to various veterinary therapeutic foods. Evidence Grade 1 (the highest level) and Grade 2 exist for foods that confer dental benefits for cats and dogs, respectively.^{a,b}

Treats are often considered for their purported dental benefits, as well as a reward. From a strictly nutritional standpoint, small amounts of treats (less than 10% of the total food intake) will not importantly affect a pet's overall daily nutrient intake. Excessive feeding of treats, however, can markedly affect a food's cumulative nutritional profile. Therefore, it is important to assess the impact of treats with respect to the dietary needs of individual dogs or cats.

The impact of treats on daily nutrient intake depends on three factors: 1) the nutrient profile of the treat, 2) the number

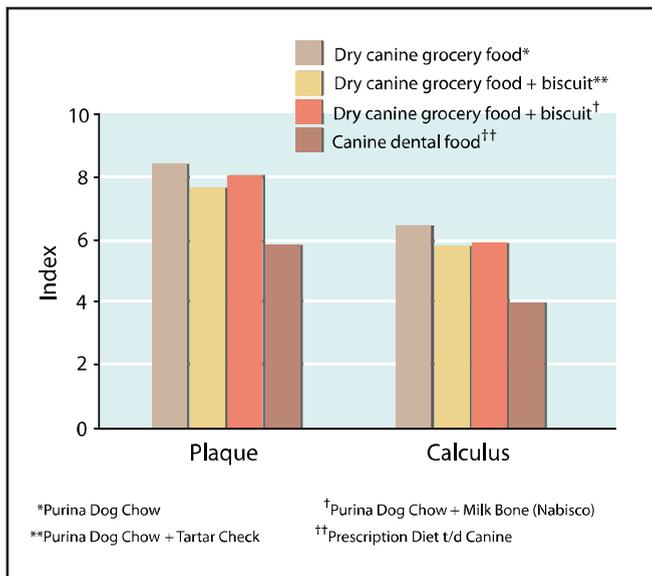


Figure 47-9. The effects of four different food regimens on plaque and calculus accumulation in dogs. Forty mongrel dogs were fed one of four food regimens: 1) Control (Purina Dog Chow), 2) Control plus two hexametaphosphate-coated biscuits/day (Tartar Check), 3) Control plus seven medium or four large (based on manufacturer's feeding directions) plain biscuits/day (Milk Bone) or 4) Prescription Diet t/d Canine. There was no significant difference in plaque or calculus accumulation in dogs fed Purina Dog Chow or Purina Dog Chow plus Milk Bone or Tartar Check biscuits. Dogs fed Prescription Diet t/d Canine had significantly less accumulation of plaque and calculus than dogs fed Purina Dog Chow or Purina Dog Chow plus Milk Bone or Tartar Check biscuits.

of treats provided daily and 3) the nutrient composition of the patient's regular food. Because meeting nutrient requirements is not the primary reason pet owners provide treats, commercial treats often are not complete and balanced. (See package labels.) If treats are fed, recommend that they be commercial treats that match the key nutritional factor profile recommended for the patient's lifestage. Generally, feeding excessive amounts (>10% of the total food intake on a volume or calorie basis) of any treat is not recommended. Ideally, the nutritional composition of treats and food should be combined and assessed as the entire dietary regimen. From a dental benefit standpoint, the efficacy of treats and non-food items such as rawhide chews should be evaluated just like dental foods. The safety of such products should also be considered.

Plain baked biscuits, although long thought of as "dental" treats, provide little additional plaque and calculus reduction when compared with feeding dry dog food alone (Figure 47-9). Additionally, manufacturers of some feline treats make a calculus control claim;^{c,d} however, two studies have failed to demonstrate an effect on plaque and calculus accumulation compared with feeding dry or moist foods alone (Logan, 1996a; Logan et al, 1997). Figure 47-10 describes the effect of dental treats on plaque and calculus accumulation in cats fed dry and moist foods with and without supplemental treats.

The addition of hexametaphosphate (HMP) (Box 47-4) to

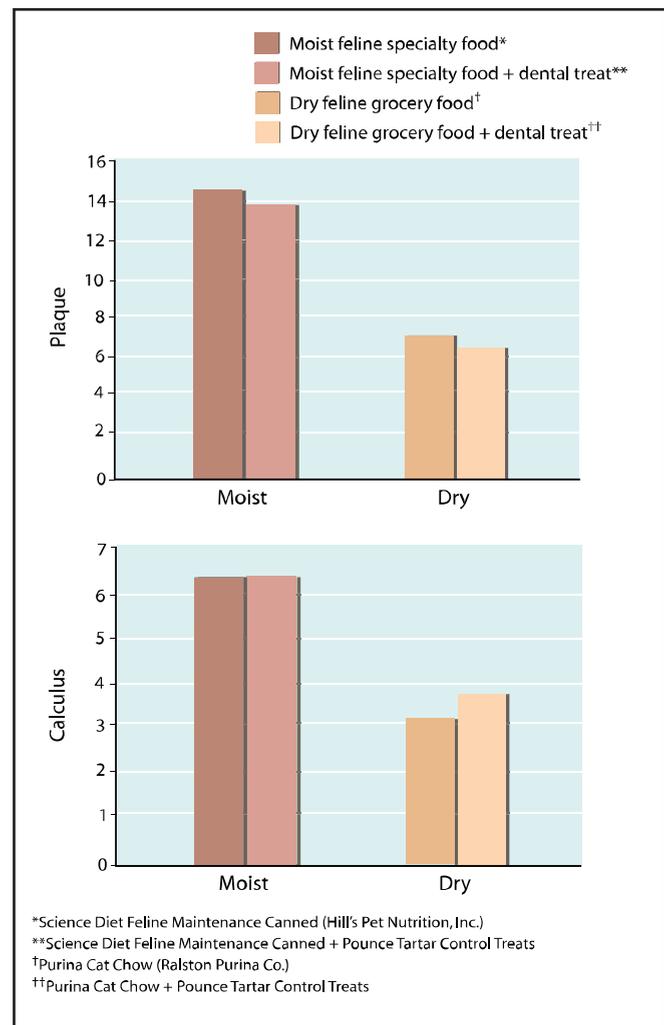


Figure 47-10. The effects of "dental" treats in cats fed commercial dry or moist foods. The top graph illustrates plaque accumulation in cats fed a moist or dry cat food or the same food plus dental treats. The bottom graph illustrates calculus accumulation in cats fed moist cat food or the same food plus dental treats. There was no significant difference in plaque or calculus accumulation with the addition of dental treats to either a dry or a moist cat food.

the surface of baked biscuits^e significantly reduced calculus accumulation in beagles over a four-week period compared with a regimen of plain baked biscuits and dry food alone (Stookey et al, 1995, 1996). One three-week study, however, demonstrated no significant differences in plaque and calculus accumulation in dogs fed dry food, dry food plus baked biscuits or dry food plus HMP-coated biscuits.^f A treat made of rice and whey and formed into a bone shape^g to promote chewing activity has been reported to reduce plaque and calculus accumulation in small dogs over a four-week period (Gorrel and Rawlings, 1996). The disadvantages of these products may include pet acceptance, potential for gastrointestinal side effects, cost of the recommended feeding dosage and nutritional influences such as caloric excess and nutrient imbalances (Crane, 1990).

Box 47-8. Chew Toys and Periodontal Disease in Dogs and Cats.

Chew toys are a category of products that claim an oral benefit for dogs (**Figure 1**). Many varieties are available with claims ranging from “flosses teeth” to “reduces harmful plaque;” however, few data in the literature substantiate these claims. One report claimed less calculus accumulation in 14 of 20 client-owned dogs when dogs were allowed access to a urethane chewing device^a for one month. Anecdotal reports of oral trauma (e.g., gingival lacerations and tooth fractures) resulting from aggressive chewing of some dental toys can also be found in the veterinary dental literature.

ENDNOTE

a. Nylabone. Nylabone Products, Neptune, NJ, USA.

The Bibliography for **Box 47-8** can be found at www.markmorris.org.



Figure 1. Manufacturers of many toys and devices make dental claims. Some of these claims include, “removes/reduces tartar, massages gums and flosses teeth.” In most cases, no scientific studies substantiate these claims and pet owners can easily be misled. There is clinical evidence, however, that suggests gum lacerations and fractured teeth may result from inappropriate use of toys and devices, including failure to match toy size to pet size, use of hard toys, particularly with puppies and toy use with pets that chew aggressively.

Besides commercial treats, rawhide strips have been reported to control calculus accumulation, provided the dog actively chews the strips daily (Lage et al, 1990). Two rawhide chews each day are typically recommended.^h Compacted rawhide treats in the shape of balls and bones can cause tooth fractures if chewed aggressively or if used as “catch” toys. Flat rawhide chews coated with an enzymatic systemⁱ are also available commercially; however, there are no published data demonstrating that these products are any more effective than plain rawhide strips. Although not foods, chew toys are a category of chewable products that claim an oral benefit for dogs. **Box 47-8** provides a brief discussion of the potential benefits vs. risks of these products.

Assess and Select the Feeding Method

The method of feeding is often not altered in the nutritional management of periodontal disease. If a new food is fed, the amount to feed can be determined from the amount of the previous food being fed (calorie basis), particularly if the patient is in optimal body condition (body condition score of 2.5/5 to 3.5/5). The food dosage may need to be changed if the caloric density of the new food differs from that of the previous food. Otherwise product labels or other supporting materials can be used as starting points. The food dosage and feeding method should be altered if the patient’s body weight and condition are suboptimal. Initially, the patient should be weighed every two weeks or so to ensure the food dosage is correct. Although most healthy dogs and cats do not experience digestive upsets with typical food changes, a gradual transition to a new food may benefit some patients. Progressively exchanging the new food for the usual food over four to seven days will minimize unto-

ward effects and food refusal. Chapter 1 contains more in depth information about feeding methods and food transitions.

Good compliance is necessary for effective clinical nutrition. Enabling compliance includes limiting access to other foods and knowing who feeds the pet. Communicating the need for and the methods of effective plaque control may improve oral hygiene compliance.

REASSESSMENT

Monitoring depends on the: 1) degree of oral pathology, 2) level of periodontal therapy and 3) ability of the owner to provide routine oral hygiene. An annual oral examination and professional prophylaxis should be adequate for adult dogs and cats with good oral health and normal occlusion. As the severity of oral disease increases, the degree of periodontal therapy required to treat the condition will increase as well. An increased level of oral hygiene will be necessary to prevent disease progression toward advanced stages of periodontal disease (e.g., periodontitis, etc.).

Initially, patients should be rechecked weekly to monitor healing and oral hygiene. If both are satisfactory, the time between recalls can increase to three-month intervals. If the patient has severe pathology affecting plaque retention or if the owner is unable to provide effective plaque control, the time between periodontal therapies will need to be adjusted to maintain oral health. These recommendations are initial guidelines. Veterinarians must decide appropriate recall for each case, depending on the degree of oral pathology, periodontal therapy and owner compliance.

ACKNOWLEDGMENTS

The authors and editors acknowledge the contributions of Drs. Karl Zetner and John J. Hefferren in the previous edition of *Small Animal Clinical Nutrition*.

ENDNOTES

- Prescription Diet t/d Feline. Hill's Pet Nutrition, Inc., Topeka, KS, USA.
- Prescription Diet t/d Canine. Hill's Pet Nutrition, Inc., Topeka, KS, USA.
- Pounce Tartar and Plaque Control. Del Monte Pet Products, Pittsburgh, PA, USA.

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- Tartar Check. Del Monte Pet Products, Pittsburgh, PA, USA.
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- Purina Chew-eez. Nestle Purina Pet Care Products, St. Louis, MO, USA.
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REFERENCES

The references for **Chapter 47** can be found at www.markmorris.org.

CASE 47-1

Oral Foreign Body in a Doberman Pinscher

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Patient Assessment

A five-year-old, 30-kg, male Doberman pinscher was presented for removal of a large beef knucklebone that was lodged in its mouth. The dog was excited, salivating profusely and difficult to handle. The bone was lodged caudal to the canine teeth between the dental arcades and was holding the dog's mouth open to the point of causing strain upon the jaws. Attempts to remove the bone while the patient was awake were unsuccessful. The dog's excited condition and the obstructing bone made a complete physical and oral examination impossible before sedation. After the dog was sedated, it was possible to gradually extricate the bone without further damaging the teeth or oral tissues (**Figures 1A** and **1B**). The dog was intubated and anesthetized to allow a comprehensive oral examination.



Figure 1A. A large bone lodged in the oral cavity of a Doberman pinscher.



Figure 1B. The same patient after the bone was removed. Note the size of the bone in relation to the patient's head and mouth.

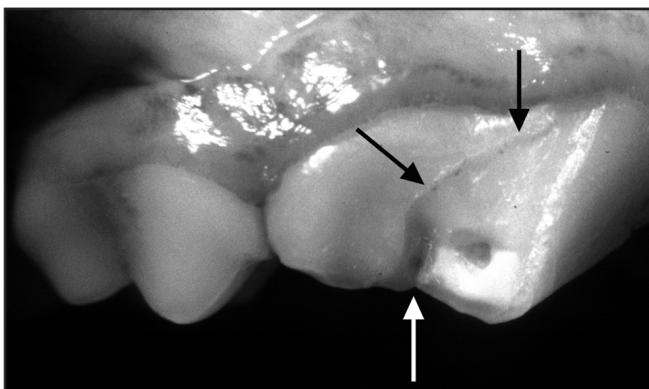


Figure 2. Slab fracture (dark arrows) of the maxillary fourth premolar with an exposed pulp chamber (white arrow).

The jaw had a full range of movement and no crepitation was detected over the temporomandibular joints. A laceration about 7 mm long and of moderate depth was found ventrally on the right side of the tongue in the proximity of the distal premolars. This laceration probably occurred as a result of the tongue pressing against the lower premolars.

The right carnassial teeth (maxillary fourth premolar and mandibular first molar) had Class VI/VI, cusp-type slab fractures. A slab of tooth was lost from the buccal side of the maxillary fourth premolar (Figure 2) and from the lingual side of the mandibular first molar. This type of injury commonly affects these tooth surfaces. Both fractures involved the pulp chamber; the exposed sites were dark and open. The pulp of these teeth was nonvital. Calculus accumulation and gingivitis were present on both arcades.

Assess the Food and Feeding Method

The owner had been feeding the dog various dry commercial dog foods sometimes mixed with water or moist foods. When the dog was examined and vaccinated by the referring veterinarian approximately seven months earlier, the owner had been informed that the teeth were in generally good shape but there was slight calculus accumulation. The veterinarian had recommended a dental prophylaxis, which the owner declined. Shortly thereafter, the owner had begun feeding bones to the dog at the suggestion of a friend who said that bones could clean the dog's teeth. All bones had been cooked before they were given to the dog. This was the first time the dog had received a large knucklebone.

Questions

1. What are the treatment options for the two fractured teeth?
2. What safety concerns are associated with feeding bones to dogs?
3. What recommendations should be made concerning the dog's food?
4. When should a dog's teeth be cleaned?

Answers and Discussion

1. There are typically six options for treating fractured teeth: 1) leave them as they are, 2) smooth the fractured edges and seal the dentinal tubules, 3) place a restoration, 4) perform a pulp capping, 5) perform a root canal or 6) extraction. Small enamel chips of vital teeth may be left as is; however, the jagged edges of these teeth should be smoothed. In this case, the pulp was exposed; therefore, leaving the teeth untreated could lead to abscessation or more likely to a chronic active granuloma at the root apex or tip. Chronic shedding of bacteria into the bloodstream may gradually damage organs such as the heart, kidneys and liver. It would be medically unsound to leave these teeth untreated. The most common repair technique for fractures of vital teeth that extend into the dentin is to smooth the fracture edges and seal the dentinal tubules with a dentinal bonding agent and possibly apply a restorative agent. This technique is also used in association with a pulp capping or root canal procedure. For this patient, this treatment would be appropriate only if done in conjunction with an endodontic procedure. Restoratives, such as a metal, composite, glass, porcelain or porcelain fused to a metal crown or inlay, are also used to repair fractures of vital teeth that extend into the dentin. These are also used in association with a pulp capping or endodontic procedure. Treatment with a restorative would be appropriate for this dog only in conjunction with an endodontic procedure. Pulp capping procedures are used for repair of fractured teeth with pulp exposure in which the pulp is still vital or alive. Successful pulp capping procedures inconsistently maintain the vitality of the tooth. At least 20% of the procedures fail even when performed under optimal circumstances. The severity of the trauma, amount of contamination, elapsed exposure time and degree of pulp exposure all play a crucial role in the success of pulp capping procedures. In this case, the teeth have Class VI/VI fractures and the pulp is nonvital, so a pulp capping procedure would be inappropriate.

Root canal or complete endodontic procedures are used when fractured teeth have pulp cavity exposure and the pulp is either in a state of irreversible pulpitis or already nonvital. A root canal procedure is an option for this patient. The determining factors for selecting this treatment include the extent of damage to the tooth crown, the state of the external root structure, the condition of the pulp cavity, the status of the periodontal tissues and the ability of the owner to eliminate or nullify causative agents. If these conditions are all favorable, this procedure plus some form of restoration would be the treatment of choice to maintain the function of the carnassial teeth.

The above procedures require advanced training and dental equipment. Extraction (exodontia) is a treatment option for damaged teeth, teeth affected by severe periodontal disease, highly mobile teeth that cannot be stabilized and teeth with root frac-

tures. The tooth type and location, number of roots, status of surrounding periodontal tissues and supporting bone and indications of root abnormalities (i.e., dilacerated, ankylosed, etc.) determine the type of extraction process. Extraction is a reasonable alternative for veterinarians who lack the training or equipment to perform the treatments discussed above.

2. Some pet owners believe that feeding cooked bones to domesticated pets helps control calculus accumulation. However, there are no reliable, published studies showing dental benefits derived from bone chewing. This practice has gradually fallen into disfavor among many veterinarians because bone consumption often results in health problems such as fractured teeth, bone lodgments, constipation, intestinal or rectal blockages and esophageal, gastric and intestinal perforations.

Recently, some veterinarians have again begun recommending the feeding of bones. However, the recommendation is to feed raw bones with meat attached, sometimes designated “raw and meaty bones.” Current theory proposes that uncooked bones are not as hard as cooked bones and do not fracture teeth or cause other problems associated with cooked bones. However, anecdotal reports suggest the health concerns presented with cooked bones also occur commonly with raw, meaty bones. Feeding raw, whole chicken or chicken parts has been suggested as providing dental benefits without the risk of dental fractures because chicken bones are smaller. However, feeding raw meats, particularly chicken, raises food safety concerns (Chapter 11). The safety and efficacy of feeding bones, regardless of type, remain undetermined. Veterinarians should be cautious about recommending bones for dental benefits.

3. There is little reliable scientific information about the dental benefits of most commercial dog and cat foods or about the dental benefits of one food compared with those of another. In general, dry foods have been accepted as causing less calculus and plaque accumulation than moist foods, even though controversies and inconsistencies exist in the literature. A commercial canine veterinary therapeutic food, Prescription Diet t/d Canine^a has valid data documenting effective dietary cleansing. Research has demonstrated this food influences the control or reduction of plaque, calculus, stain and gingivitis. Prescription Diet t/d Canine would be an appropriate food for this dog.
4. Teeth cleaning and professional dental prophylaxis are not always synonymous. The term prophylaxis means to prevent disease, whereas teeth cleaning means to prevent or treat disease. Teeth should be cleaned when calculus accumulations occur, or when stomatitis and periodontal disease develop. The professional dental prophylaxis, if taken literally, must be performed at intervals needed to prevent stomatitis or periodontal disease from developing. There are no definitive time intervals for the veterinary professional dental prophylaxis. The veterinarian must combine information about the pet’s health status, oral and tooth pathology, degree of successful homecare, foods offered to the pet and the pet’s chewing behavior to customize a professional dental prophylaxis program. A reasonable starting point is every six to 12 months for large-breed dogs.

Progress Notes

The tongue laceration was sutured and a comprehensive oral examination was completed at the initial visit. The clinical findings and treatment options were discussed with the owner. Three days after the original incident, a root canal procedure was performed on the dog’s two fractured carnassial teeth and the tooth crowns were prepared for restoration. A dental prophylaxis was also performed at that time. About two weeks later the crowns were cemented, seated and adjusted. Initial owner instructions included restricting the dog’s access to all bones and excessively hard chew toys. After endodontic treatment and crown preparation, the dog was fed a soft food to avoid injury to the prepared teeth. Following crown placement the dog was fed Prescription Diet t/d Canine.

The tongue had healed well when examined at the time of crown placement. When the dog was reexamined six months after the incident, no calculus accumulation was present and the gingivitis had resolved. The dog’s general condition was very good. Its current weight was 31 kg with a body condition score of 3/5.

Endnote

a. Hill’s Pet Nutrition, Inc., Topeka, KS, USA.

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CASE 47-2**Inappetence in a Cat**

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Patient Assessment

A three-year-old, 3.4-kg, neutered female domestic shorthair cat (body condition score 3/5) was referred for inappetence, salivation, periodic gagging and resistance to oral examination. The condition began suddenly two days earlier. The cat's abdomen was painful when palpated. Cervical lymph nodes and the thyroid glands were normal, although the patient resented palpation of the lower neck region. Eyes and ears were normal.

The cat's resistance to the oral examination limited the initial assessment. Moderate calculus accumulation and gingivitis were noted, however. A raised, non-inflamed mass of gingival tissue was present where the crown of the lower left third premolar should have been located. Due to the cat's agitation, the teeth and their associated sulci could not be examined with a dental explorer/probe. The lips, alveolar mucosa, dorsal surface of the tongue and hard and soft palate appeared normal. Examination of the ventral tongue base revealed a string foreign body.

Following sedation, the string was found to extend across the base and caudally around the lateral sides of the tongue into the pharyngeal region. The two leaders of the string extended into the esophagus. The tongue was lifted and the string grasped with Brown-Adson thumb forceps and gently pulled rostrally out of the mouth with no resistance. The string appeared to be a cotton-like material, 32 cm long. Endoscopic and radiographic examination of the esophagus and stomach were recommended.

The cat was intubated and anesthetized with isoflurane. Radiography showed the left mandibular gingival mass covered the roots of the lower third molar and that the majority of the crown was absent. The mass appeared to be a Stage V feline tooth resorption (Table 1). Other findings included moderate calculus accumulation and mild gingivitis.

A dental prophylaxis was performed and the cat was given antibiotics for 10 days.

Assess the Food and Feeding Method

The cat was fed a variety of moist foods purchased from grocery outlets.

Questions

1. What are the safety concerns of string-type chew toys?
2. What should be done concerning the gingival mass?
3. What recommendations should be made concerning the cat's food?

Answers and Discussion

1. The foreign body was similar to material from one of the cat's toys. When purchased, the toy was a ball made from loops of a cotton-like string, which purportedly would help clean and floss the teeth when the cat chewed on the toy. The toy came with a package of coarsely ground dried catnip with instructions to sprinkle the catnip on the toy to entice the cat to play with and chew on it. The owners said that it was one of the cat's favorite toys, especially when the catnip was applied. String, thread and pieces of fabric commonly cause problems when ingested by cats. Apparently, the type, diameter and length of fiber and the proportional length of fiber to cat size all play an important role in whether these fibers cause problems or pass through the gastrointestinal tract. No studies concerning these factors have been published. Short lengths of a multi-stranded, absorbable material would seem more appropriate, but more research is needed to determine safety requirements. Some string and rope chew toys are promoted for their "flossing effect." However, no research documents these claims. Additionally, some packages instruct the owner to use the toys in a tug-of-war with the pet to attain the flossing action. Strings tangled around teeth can avulse or fracture teeth. Therefore, these types of chew toys for dogs and cats should be recommended with extreme care, particularly for patients with moderate to advanced periodontal disease and mobile teeth. Clients who use string and rope-type chew toys should be encouraged to supervise their use and dispose of them at the first sign of unraveling or fraying.
2. The gingival mass was a Stage V feline tooth resorption (Table 1). There are three options for treating these lesions: 1) restoration of the tooth, 2) extraction of the tooth and 3) no treatment (leave the lesion as it is). Restorations, usually with glass ionomers, are generally used in repair of Stage I and, to a limited degree, Stage II lesions. Success of restoration for Stage II lesions is generally poor, but is an option the client should be given. Stage II to IV lesions can be extremely painful and should be treated. Careful extraction of tooth roots should be considered in Stage V lesions if inflammation is present in the gingival area overlying the retained roots. If inflammation is not present and the lesion is not painful or sensitive to the patient, the roots may be left in place. Often the roots will completely resorb with no further problems. In this case, there was no inflammation associated with

the mass and no treatment was performed.

- Commercial cat foods are available that provide effective dietary cleansing through mechanical reduction of plaque and calculus accumulation (Prescription Diet t/d Feline^a, Friskies Dental Diet^b and Purina Veterinary Diets DH Dental Health Brand Feline Formula.^c

Table 1. Staging feline dental resorptive lesions.

Stage I	Lesion extends into cementum or enamel only
Stage II	Lesion extends into the dentin
Stage III	Lesion extends into the pulp cavity
Stage IV	Extensive structural damage to tooth, root or both
Stage V	Root retention with complete loss of crown

Progress Notes

Fiberoptic and radiographic examination of the esophagus and stomach revealed no abnormalities. The cat's food was changed to Prescription Diet t/d Feline. The cat was reexamined three weeks after the initial presentation. The gingival mass appeared unchanged to slightly smaller with no inflammation. The cat was eating well and no calculus accumulation was present.

Endnotes

- Hill's Pet Nutrition, Inc., Topeka, KS, USA.
- Friskies Pet Care Co., Glendale, CA, USA.
- Nestlé Purina PetCare Co., St Louis, MO, USA.

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CASE 47-3

Periodontal Disease in a Geriatric Miniature Schnauzer

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Patient Assessment

A 12-year-old, 10-kg male miniature schnauzer was examined for severe halitosis and reluctance to eat dry food. Physical examination revealed a grade 1/6 heart murmur and a body condition score of 3/5. Abnormal oral findings included moderate accumulations of plaque and calculus on both dental arcades, gingivitis, furcation exposure and attachment loss, most prominent around the mandibular caudal premolar and molar teeth.

After the initial oral examination, the dog was given enrofloxacin (Baytril^a) to control infection while further evaluations were performed. Results of a complete blood count were normal. Results of a serum biochemistry profile were normal except for mild azotemia (BUN = 42 mg/dl, normal = 10 to 25). A cardiac evaluation indicated mild valvular endocardiosis.

Assess the Food and Feeding Method

The owner had been feeding various commercial dry and moist grocery brand dog foods. Approximately six months earlier the dog became reluctant to eat dry foods and was currently eating only moist foods.

Questions

1. At what age should periodontal therapy be discontinued due to anesthetic risks?
2. When are antibiotics appropriate in periodontal therapy?
3. What medications may have adverse oral effects, particularly in geriatric dogs?
4. Is maintenance of alveolar bone under the tooth (alveolar ridge) a concern when extracting permanent teeth?
5. Outline an appropriate feeding plan for this geriatric patient.

Answers and Discussion

1. Many owners and veterinarians are reluctant to anesthetize geriatric patients for periodontal procedures. There is no specific age, however, when a patient cannot be anesthetized. An appropriate preanesthetic assessment should be made in all cases to identify potential risks and define an appropriate anesthetic regimen. Placing an intravenous catheter and administering fluids during periodontal procedures reduces the risk of anesthetic complications. Periodontal disease is associated with bacterial infection. The potential for systemic disease due to chronic showering of the bloodstream with oral bacteria may pose a greater risk to the patient than the anesthesia required for appropriate periodontal therapy.
2. Antibiotics may be used before, during or after dental procedures. Each period has specific justification. Antibiotics used before dental procedures help control the existing periodontal infection, thereby decreasing inflammation, which allows for more accurate clinical assessment and helps when making therapeutic choices. Antibiotics used during dental procedures are generally administered to protect the body from infection resulting from bacteremia. Healthy immunocompetent patients clear this bacteremia within 20 minutes. However, patients with organ pathology or a compromised immune system may be predisposed to sequential infection. Antibiotics given after dental procedures are generally prescribed to prevent oral reinfection during the healing stages.
3. Many medications can affect oral physiology, particularly salivary flow. Saliva is rich in proteins, glycoproteins, electrolytes and lipids and provides a protective barrier to oral tissues. Reduced salivary flow is associated with an increased prevalence of caries, periodontal disease and oral irritation in people. Patients receiving medications that alter the oral environment may need additional professional or homecare to maintain oral health. Examples of such drugs include narcotic analgesics, anticonvulsants, antihistamines, antiarrhythmics, antineoplastics, antiemetics, diuretics and tranquilizers.
4. Alveolar ridge maintenance is a concern, particularly if the mandibular incisor, canine or carnassial teeth are extracted. Atrophy of the alveolar ridge and mandibular weakening are common following extraction of these teeth, and may result in future pathologic or iatrogenic fractures. Packing extraction sites with osseopromotive material may reduce and in some cases prevent alveolar ridge atrophy.
5. Because aging affects all body systems, there is a high likelihood of multiple problems in older pets. A thorough systems review, which should include a complete history, physical examination and extended laboratory database, is important in older pets. This review enables the veterinarian to define problems accurately, prioritize the problems and establish appropriate diagnostic, therapeutic and feeding plans. Chronic valvular heart disease (endocardiosis) and renal failure are common causes of morbidity and mortality in older dogs. Because these conditions are so common, geriatric dogs may benefit from a food that avoids excess levels of phosphorus, protein, sodium and chloride (Chapters 36 and 37). Other nutrient levels and the feeding method may need to be adjusted based on body condition of the patient and results of the comprehensive systems review.

This dog has clinical and laboratory evidence of dental disease, chronic valvular heart disease and renal disease. Accordingly, it may benefit from a food that avoids excess levels of phosphorus, protein, sodium and chloride. In addition, oral care at home should be initiated to prevent accumulation of dental substrates and further periodontal disease. A food or dental treat that enhances mechanical cleansing of teeth would be appropriate.

Prescription Diet t/d Canine^b is a dry veterinary therapeutic food formulated to reduce accumulation of plaque and calculus and reduce gingivitis. This food is most effective when fed as the sole maintenance food for adult dogs. However, some pets with dental disease should receive food(s) with different nutrient profiles because of concurrent disease.

Progress Notes

The dog was given a vasodilator (isosorbide dinitrate) and a moist veterinary therapeutic food that avoids excess phosphorus, protein, sodium and chloride (Prescription Diet k/d Canine^b).

Therapeutic options for the oral problems were discussed with the owner and the decision was made to proceed with periodontal therapy. The dog was anesthetized with isoflurane (administered via mask and intubation), and supragingival scaling followed by root planing and subgingival curettage was performed. Severe periodontal disease was present around the left mandibular fourth premolar and first molar teeth. Advanced bone loss was noted around the distal roots (**Figure 1**); a mobility index of 3/3 (severe mobility) was present. Both teeth were extracted by crown sectioning and elevation. The alveolar sockets were curetted and bony spicules were smoothed. An osseopromotive bioactive material (Bioglass^c) was placed into the sockets to aid in alveolar ridge maintenance. The extraction sites were closed with sutures and the remaining teeth were polished. Oral clindamycin (Antirobe^d), an oral ascorbic acid/zinc gluconate rinse (Maxiguard^e) and the moist veterinary therapeutic food (Prescription Diet k/d Canine) were pre-

scribed for two weeks. After two weeks, the dog was reexamined. The extraction sites were healing well and the owner commented that the dog was more active than it had been for many months. The dog was fed the dry form of the same renal food (Prescription Diet k/d Canine) and the owner was instructed to provide daily oral care through toothbrushing and feeding four kibbles of Prescription Diet t/d Canine/day. The combined foods were calculated to deliver approximately 500 kcal/day (2.1 MJ/day).

Endnotes

- a. Bayer Animal Health, Shawnee, KS, USA.
- b. Hill's Pet Nutrition, Inc., Topeka, KS, USA.
- c. Nutramax Laboratories, Inc., Baltimore, MD, USA.
- d. Upjohn Veterinary Products, Kalamazoo, MI, USA.
- e. Addison Laboratories, Fayette, MO, USA.

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Figure 1. Radiographic evaluation indicating severe alveolar bone loss around the distal roots of the mandibular fourth premolar and first molar.

