Presents:

DENTISTRY FOR THE SMALL ANIMAL PRACTITIONER

Recognition and Selection of Appropriate Treatment Options in Dogs/Cats with Dental & Oral Pathology

With:

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Feline Dental and Oral Pathology
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The recognition and treatment of feline dental and oral pathology is an important component in successful management of feline health. Dental and oral lesions in cats may have a variety of presentations and treatment options. Feline dental and oral lesions include: periodontal disease, tooth resorptive lesions, fractured teeth, mandibular swelling, perialveolar osteitis, gingivostomatitis, feline oral neoplasia, mandibular fractures and temporomandibular luxations.

Periodontal Disease
Periodontal disease can be divided into two categories: gingivitis and periodontitis. Gingivitis is confined to gingival tissue, while periodontitis is a more severe form of disease involving loss of bone supporting the tooth. Cats with periodontitis, in addition to having gingivitis, may have gingival recession or increased pocket depth, alveolar bone loss, exposure of roots and furcations, tooth mobility, and eventual tooth loss. A periodontal probe is used to assess the level of attachment loss, and measure pocket depth.

The prevention and treatment of feline periodontal disease consists of regular dental prophylaxis every 6 to 12 months. A thorough dental prophylaxis can only be performed under general anesthesia and consists of supragingival and subgingival scaling, subgingival curettage, root planning and polishing the teeth. Broad spectrum perioperative antibiotic therapy is recommended perioperatively.

Two abnormalities may be associated with feline periodontal disease. These abnormalities are oral inflammatory diseases and resorptive lesions. When periodontal disease is complicated by either of these conditions, exodontia is the treatment of choice. In cats, dry-food diets, especially tartar control diets, result in improved gingival health compared to a soft-food or semi-moist diet. In addition, daily brushing to remove plaque is ideal.

Tooth Resorptive Lesions
Tooth resorptive lesions are common dental lesions in cats. A report reviewing 10 independent surveys of tooth resorptive lesions revealed that 20 to 67 per cent of all cats have 1 or more lesions with a mean of 2.3 to 4.1 lesions per affected cat. Tooth resorptive lesions are characterized by a clinically or radiographically evident defect in the enamel, dentin and/or cementum. These lesions may be hidden from view by plaque, dental calculus or inflamed gingival tissue. Clinically, resorptive lesions are areas in which tooth substance is missing and may be seen as actual absence of tooth substance or the missing hard tooth tissue is covered with granulation tissue. A dental explorer is used to detect these lesions. These teeth should be radiographed to determine the full extent of the defects. Full mouth radiographs are recommended in cats since multiple lesions are common.

In the past whole tooth extraction was considered the treatment of choice for teeth with severe tooth resorptive lesions. Teeth with advanced lesions are weak, brittle, ankylosed and have severe root resorptive lesions making extraction difficult which may result in iatrogenic trauma to the patient, loss of alveolar bone, and prolonged healing of surgical defects. A study by DuPont investigated the intentional retention of part or all of non-pathologic tooth roots following amputation of the crown and reapposition of the gingiva. Utilization of the DuPont technique requires preoperative dental radiographs to rule out evidence of endodontic pathosis. Teeth with endodontic pathosis, as evidence by the presence of periapical lysis, or teeth with periodontal pocketing must be treated by extraction rather than crown amputation with intentional root retention. Also cats affected with ulceroproliferative disease are not candidates for this technique. These cats require that all root structure and possibly the surrounding alveolar bone be completely removed. Teeth with an intact periodontal ligament space should be routinely extracted. After radiographing feline teeth with advanced resorptive lesions and ruling out the presence of endodontic pathosis, periodontal pocketing and confirmation of severe root resorption, a small envelope flap is created with a feline periosteal elevator. Two small interproximal gingival incisions located mesial and distal to the affected tooth are made using a #15 blade. The gingiva is minimally elevated from the
marginal alveolar bone with a small feline periosteal elevator. The gingiva is retracted and protected with the end of a small flat elevator while the crown of the tooth is amputated with a #3 round bur on a high speed handpiece at or slightly below the level of the alveolar crest. Sharp bony projections are smoothed with a bur and the gingiva is closed with 5-0 Monocryl.

**Fractured Teeth**
Fractured canine teeth usually result in pulpal exposure in cats because of the extension of the pulp canal into the coronal tip of the canine tooth in felines. Pulpal exposure is confirmed with a fine dental explorer. Teeth with confirmed pulpal exposure should be extracted or treated endodontically. Prior to endodontic therapy radiographs are taken to ensure that the apex is intact. Failure to treat fractured teeth with pulpal exposure may result in periapical abscessation, mucosal or cutaneous fistulation, chronic rhinitis, osteomyelitis, and ocular discharge.

**Mandibular Swelling**
Feline mandibular swelling is not readily recognized because of the ventral location of the mandible. Without palpation of the ventral aspect of the mandible, mandibular swelling may not be detected. Feline mandibular swelling may be benign or malignant. The most common cause of benign mandibular swelling in cats is osteomyelitis secondary to retained odontoclastic resorptive tooth roots and less frequently secondary to periodontal disease and endodontic disease. The most common cause of malignant feline mandibular swelling is squamous cell carcinoma and less frequently fibrosarcoma, lymphosarcoma, and osteosarcoma. Oral examination, dental radiography, and intraoral incisional biopsy will help provide a diagnosis. Treatment of feline mandibular swelling is dependent upon an accurate diagnosis. Benign mandibular swelling associated with dental disease requires recognition of diseased teeth. Oral examination with periodontal probing and examination with a dental explorer will assist in the recognition of periodontal pockets, pulpal exposure and retained root tips associated with resorptive lesions. Treatment of feline mandibular swelling associated with dental disease requires extraction of diseased teeth.

**Feline Perialveolar Osteitis**
A severe firm swelling around the root of the maxillary canine tooth may occur in middle-aged and geriatric cats. This bulbous maxillary canine tooth perialveolar swelling often occurs bilaterally and may be associated with periodontal or endodontic disease and should not be mistaken for neoplasia. Periodontal probing and dental exploration of the affected maxillary canine teeth often reveals a deep periodontal pocket or chronic pulpal exposure. A dental radiograph may reveal loss of trabecular bone pattern around the roots of affected maxillary canine teeth with a thin line of sclerotic bone surrounding the periradicular bone loss. Treatment includes extraction of the affected tooth, curettage and flushing of the alveolus with sterile saline. The firm perialveolar swelling may partially remodel over time however significant chronic residual swelling may remain.

**Gingivostomatitis**
The use of the term gingivostomatitis is recommended when describing the general inflammation of the gingiva and oral cavity. The prevalence of gingivostomatitis has been reported and depending on the patient population in the study the reported incidence of gingivostomatitis is quite variable. In a survey of its members by the AVDS, 72% of respondents indicated that they saw one or more cases of gingivostomatitis per week. In another study, ‘gingivitis’ was present in 13.1% of cats examined in private veterinary practices in the United States but the number of cats which were affected by feline chronic gingivostomatitis was not recorded. In a study involving 4858 cats visiting first opinion veterinary practices in North West England 34 cats presented with physical findings consistent with gingivostomatitis demonstrating a prevalence of 0.7%. The presenting clinical signs of cats with gingivostomatitis are symptomatic of the pain and inflammation in the mouth and may include the following: dysphagia (sometimes anorexia), preference for soft food, weight loss, halitosis, ptyalism (sometimes blood-stained), halitosis, pawing at the mouth and reduced grooming with a scruffy hair coat.

The patterns of distribution of feline chronic gingivostomatitis include: gingivitis with stomatitis, stomatitis with gingivitis and faucitis. Cats presenting with a pattern of distribution classified as gingivitis with stomatitis demonstrate gingival inflammation that extends past the mucogingival junction onto the buccal
mucosa and less frequently onto the palatal and lingual mucosa. These lesions are usually symmetrical and the premolar and molar regions are likely to be more inflamed than the incisor and canine regions. Cats presenting with a pattern of distribution classified as stomatitis with gingivitis demonstrate an inflammatory reaction which is more intense in the rest of the oral mucous membranes than in the actual gingivae. These cats often present with inflammation of the palatoglossal folds but there may be extensive ulceration or granulation of the gingival and/or buccal mucosa with the mucosa of the hard palate or tongue rarely affected. Cats affected with a pattern of distribution classified as stomatitis with gingivitis are more likely to exhibit signs of oral pain than cats with predominantly gingivitis. The term ‘faucitis’ is considered a misnomer because by definition the ‘fauces’ is the region medial to the palatoglossal folds and the inflammation which is commonly called ‘faucitis’ is largely confined to the palatoglossal folds and regions lateral to the folds. Inflammation of the gingiva in the premolar and molar regions is almost always present in these cases. The etiology of feline chronic gingivostomatitis remains uncertain, although a number of factors including various infectious agents, dental disease, genetic and breed factors have been implicated. The main factors which have so far been considered as playing a role are either infectious or related to a cat’s immune response. Infectious agents which have been implicated include feline calicivirus (FCV), feline immunodeficiency virus (FIV), and possibly feline leukemia virus (FeLV) or feline herpesvirus (FHV); certain anaerobic bacterial species have also been implicated. Immunological studies have found differences in cytokine expression and immunoglobulin profiles in cases compared with controls and it has also been suggested that imunosuppression caused by an unrelated health problem may play a role. It is likely that the cause of feline chronic gingivostomatitis is multifactorial.

The diagnosis and workup for cats with chronic gingivostomatitis has been previously described. A complete workup includes the following: testing for FIV, FeLV, CBC, chemistry, biopsy of affected tissues, dental radiographs to determine the presence of periodontal disease or odontoclastic resorptive lesions, retained roots or other lesions and Bartonella titers. Systemic diseases including chronic renal failure and diabetes mellitus, which may predispose to severe gingival inflammation, must be excluded prior to initiation of any treatment.

The intractable nature of chronic feline gingivostomatitis in combination with an incomplete understanding of the cause of this disease has resulted in an empirical symptomatic approach to the treatment of chronic feline gingivostomatitis. Unfortunately there have been few well controlled clinical studies documenting the efficacy of various treatment options. In a clinical study involving various treatment regimens including chlorhexidine rinses, antibiotics, corticosteroids and gold salts were investigated over a six-month period. In this study over the short term, methylprednisolone was shown to be the most effective treatment, however, over the long period, the individual clinical responses were found to be diverse and none of the treatment regimes demonstrated superiority. In another clinical study in which 30 cats with chronic feline gingivostomatitis were treated by extraction of most or all of the premolar and molar teeth, 24 of the 30 cats (80%) were significantly improved or clinically cured at the time of follow-up, 11-24 months following treatment. Based on the above studies, Gorrel recommends that treatment for cats with chronic gingivostomatitis include a combination of periodontal therapy and a home care regimen whereby plaque accumulation is kept to a minimum. This regimen may result in a reduction in inflammation in some cats, however, because most cats will not cooperate for home care plaque reforms and clinical signs persist. Cases in which medical management is unsuccessful, extraction of all premolars and molars or full-mouth extraction is the treatment of choice. This is facilitated by making a full-thickness gingival flap in each quadrant, using a small feline periosteal elevator to elevate the lingual and/or palatal and buccal aspects to provide adequate exposure to the underlying bone. The buccal bone is removed as needed, the teeth are sectioned and removed. The rough edges of bone are removed with a small round bur, the alveoli are curettaged, and all inflammatory tissue is debrided. The surgical site is flushed and closed without tension. Postoperatively these patients require appropriate intravenous fluid administration, antibiotic and analgesic therapy and may rarely require esophagostomy feeding tubes.

Some cats with chronic gingivostomatitis particularly those with extensive proliferative lesions in the caudal oral cavity and pharynx are refractory to treatment and warrant a guarded prognosis. This group of cats is somewhat small as reported by Hennet. Sixty percent (18/30) of all cats in this study were clinically
cured, 20% (6/30) has significant improvement, 13% (4/30) had little improvement and 7% (2/30) had no improvement.

Numerous treatments options have been recommended for the management of chronic feline gingivostomatitis including: gold salts (aurithioglucose), azathioprine (Imuran), chlorambucil (Leukeran), Vincristine (Oncovin), 5-fluorouracil, Lactoferrin, antibiotics including: azithromycin, clavamox, clindamycin, metronidazole, amoxicillin, ampicillin, enrofloxacin, tetracycline, glucocorticoids, nonsteroidal anti-inflammatory drugs, sulodexide, tacrolimus topical, thalomid, zinc sulfate, lysine, colchicines, IFNα (interferon Alfa-2A), cyclosporine, hypoallergenic diets (Hills Z/D low allergen diet or IVD duck and pea diet), laser thermoablation.

Unfortunately many of these treatments have varying degrees of toxicities and it is important to be familiar with the side effects of these drugs when they are utilized in patients with gingivostomatitis. Currently since the only treatment that consistently delivers 60-80 % cure without the use of follow-up medications is extraction, extraction of all teeth distal to the canines and in some cases all the teeth seems justified in cats with this debilitating disease. Refractory cases in which severe inflammation persists in spite of full mouth extractions warrant a guarded prognosis. These cases may benefit from either cyclosporine and/or laser thermoablation.

In a recent study in which oral cyclosporin was used to treat 23 cats with feline dermatoses which included 8 cats with nonresponsive stomatitis remission was observed in 4/8 cats and in the other 4 cats there was a partial to fairly good improvement of clinical signs (from 40% to 70%). The dose formulation of cyclosporine used in these cats in this study included: 30-50mg daily of Sandimmun® solution; mean dosage 10.3mg/kg (range 5.8-13.3mg/kg). The cyclosporine was administered 2 hours before or after meals for 4 weeks. The cyclosporine was continued every other day for 1 or 2 months until remission of the symptoms. A maintenance regimen was then installed with a twice-a-week administration of cyclosporine for an unlimited duration. Dosage adjustments may be necessary based on clinical response and given time to be effective (4-6 weeks). Serum levels can be evaluated at 4 to 6 weeks thru Antech Diagnostics and IDEXX Laboratories with dosage adjustments made based on these levels to produce trough levels in the blood >500ng/ml. Some veterinary dentists recommend dosage adjustments based on clinical response only and some patients require adjunctive therapy with corticosteroids.

Laser thermoablation has been recommended for cytoeducation of chronic proliferation of oral mucosa in cats with chronic gingivostomatitis. This modality has been suggested as an alternative for partial or full mouth extraction for cats in which owners decline partial or full mouth extraction or in cats which have persistence of clinical signs following partial or full mouth extractions. Laser thermoablation combined with cyclosporine therapy may give good results in some cases without extraction of teeth. Multiple treatments with a carbon dioxide laser have been recommended to control proliferative tissue. The CO2 laser can be used at 2-6 watts of power, with a 0.8-1.4mm tip in continuous wave mode to vaporize inflamed tissue. The beam is defocused to “paint” the entire inflamed tissue area which is repeated until there is minimal bleeding after the char is wiped away. Therapeutic success is achieved when there is elimination of proliferative tissue and inflammation.

**Feline Oral Neoplasia**

Oral neoplasia occurs frequently in cats. By far the most common type of feline oral neoplasia is squamous cell carcinoma. The second most common feline oral neoplasia is fibrosarcoma. Other less common feline oral neoplasia include: lymphosarcoma, osteosarcoma, and melanoma. Treatment of feline oral neoplasia is early radical resection including mandibulectomy and maxillectomy procedures. Other potential treatment modalities include chemotherapy and radiation therapy.

**Mandibular Fractures and Temporomandibular Luxations**

Successful treatment planning in dogs and cats with maxillofacial trauma is based on accurate assessment and diagnosis of the full extent of the injuries. In a recent prospective study including 9 dogs and 15 cats with maxillofacial trauma it was concluded that CT is superior to conventional skull radiography for identification of anatomic structures and traumatic injuries in dogs and cats. This study also found that skull radiography is useful for visualizing the mandibular body and dental occlusion.
The most common mandibular fracture in cats is the symphyseal fracture. Repair is accomplished with circumferential wiring which involves placing a wire around the mandible to achieve stabilization. Intercanine acrylic splinting between the mandibular and maxillary teeth can be utilized to stabilize caudal mandibular fractures and easily reduced but unstable temporomandibular luxations. Alternative techniques when possible are recommended because of the difficulty in managing patients with their mouths partially opened for a 3-4 week period. If other treatment modalities are likely to be unsuccessful in achieving stabilization then intercanine acrylic splinting between the mandibular and maxillary canine teeth will usually provide a successful result. Placement of an esophagostomy feeding in these patients is often beneficial in maintaining proper nutritional intake.

References:
Digital Dental Radiography
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Dental radiography is an essential component in the delivery of high quality dental care for dogs and cats. During the 1980s veterinarians began taking radiographs of teeth using standard radiographic units however these units made patient positioning difficult and often resulted in suboptimal films. In the 1990s dental radiographic units became a more common part of the veterinary dental diagnostic workup and by the year 2000 many state-of-the-art veterinary practices were switching over to digital dental radiography. This seminar will focus on the value of taking dental radiographs, how to take digital dental radiographs, special features available with digital dental radiographic units, advantages and disadvantages of digital dental radiography, indications for taking dental radiographs, positioning for optimal dental radiographs, critiquing dental radiographs and the importance of recognizing dental radiographic lesions.

The diagnostic value of full mouth dental radiography in dogs and cats has been previously reported.\textsuperscript{1,2} It was found that the diagnostic yield of full mouth radiographs in feline and canine patients is high, and routine full mouth radiography is justified. These studies found that if disease existed, radiographs were clinically useful in 86.1\% of the cases in the study (Table 1 & 2).\textsuperscript{1,3}

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<th>VALUE OF RADIOGRAPHS WHEN NO CLINICAL FINDINGS PRESENT</th>
<th>Dogs</th>
<th>Cats</th>
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<td>Incidental radiographic findings</td>
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<td>Clinically important findings</td>
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<td>41.7%</td>
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<td>Radiographs of no value</td>
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<td>53.6%</td>
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Table 1

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<th>VALUE OF RADIOGRAPHS WHEN CLINICAL FINDINGS PRESENT</th>
<th>Dogs</th>
<th>Cats</th>
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<td>Additional findings</td>
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<td>Clinically essential findings</td>
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<td>32.2%</td>
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<td>3.1%</td>
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Table 2

How to Take Digital Dental Radiographs and Special Features Available
There are two methods of acquiring digital dental radiographs, either DR (Digital Radiography) or CR (Computer Radiography). DR images are acquired by placing a sensor into the mouth in the same position as a film and exposing the sensor with a greatly reduced dose of radiation. The image is transferred within seconds for viewing on a computer. These images are then electronically stored and manipulated as needed for radiographic evaluation of a wide variety of dental lesions. CR images are an indirect way of acquiring digital dental radiographs. With this technology a reusable Phosphor Storage Plate (PSP) is exposed to x-rays and the PSP is then processed and converted to a digital image on a computer. The Scan X\textsuperscript{\textregistered}, a digital radiography system, produces a digital image by scanning PSPs of various sizes (0,2,3 and 4) which have been exposed to x-rays. The Scan X\textsuperscript{\textregistered} allows computer storage, processing, retrieval and display of the computed radiographic images utilizing a user supplied software package. The Scan X\textsuperscript{\textregistered} also has an in-line plate eraser function that removes the latest image from the plate immediately after scanning providing an efficient one-step scanning and erasing process leaving the PSP ready for the collecting the next radiographic image.

Digital dental radiographs can be manipulated for better visualization. The mouse can be used to adjust the contrast and brightness, a particular area of a tooth can be highlighted, magnified, labeled, flipped, rotated, measured or explanatory notes can be added.
The advantages and disadvantages of digital dental radiography have been previously reported.3,4

**Advantages of Digital Dental Radiography**

- There is a 50-90% reduction in radiation needed to expose an image
- DR images are displayed on the computer within seconds eliminating processing chemicals and reducing anesthetic time
- CR images are displayed after being inserted in the The Scan X® within approximately 30 seconds, CR images come in various sizes (#0, 2, 3 & 4) providing flexibility in imaging
- Phosphor Storage Plates (PSP) are very thin and flexible providing easy placement in confined spaces
- Errors in positioning and exposure can be corrected immediately, without waiting for film processing
- Computer storage makes retrieval and storage of the image easier than for conventional film and allows easy electronic transfer of radiographs to the patient file, consultant, or referring veterinarian
- Image can be adjusted for better visualization; the image can be enlarged, rotated, the contrast and brightness can be changed, and the image can be inverted or rotated
- Provides extremely efficient progress evaluation during endodontic and oral surgery procedures

**Disadvantages of Digital Dental Radiography**

- Sensors are initially expensive; however, over time they are less expensive than film-based radiology; digital dental imaging system cost $6,000-$15,000 in addition to the dental radiography unit
- At this time sensors are supplied only in periapical film size (#2); since occlusal size (#4) sensors are not currently available, multiple exposures with smaller sensors are required, and sensors are rigid and thicker than standard dental film or PSPs and make acquisition of images in confined spaces difficult.
- Possibility of sensor damage necessitating costly replacement
- Requires a computer in the dental operatory and extra time needed for computer patient input

**Indications for Taking Dental Radiographs**

Ideally full mouth radiographs should be taken on every patient; however, this may not be possible because of cost constraints or concerns for time under anesthesia in critically ill patients. Digital radiographs can help alleviate these concerns because of the decrease in time needed to acquire digital radiographs. If full mouth radiographs are not taken there are several indications in which teeth should be radiographed. Dental radiography is recommended in the evaluation of odontoclastic resorptive lesions, the evaluation of periodontal disease including animals with nasal discharge, the evaluation of endodontic disease including discolored teeth and facial swelling, retained roots, missing teeth, abnormally located teeth, malformed teeth, osteomyelitis, boney lysis secondary to neoplasia, metabolic bone disease, localization of dentigerous cysts, and evaluation of traumatic injuries. Dental radiography is indispensable in the development of an appropriate treatment plan.

**Positioning for Optimal Dental Radiographs**

There are numerous publications that describe appropriate positioning for optimal dental radiographs.3-8 There are two specific intraoral radiographic dental techniques: the parallel technique and the bisecting angle technique. The ideal dental radiograph is produced by utilizing the parallel technique. When using the parallel technique the plane of the radiographic film is parallel to the long axis of the tooth and perpendicular to the plane of the radiographic beam. The parallel technique in dogs and cats can only be achieved with the mandibular premolars and molars. The flat shallow palate and the shallow caudally extending mandibular symphysis in dogs and cats prevent utilization of the parallel technique when radiographing the maxillary premolars and molars and the incisor and canine teeth. In these teeth the bisecting angle technique can be utilized. The film is placed as parallel as possible to the teeth being radiographed. An imaginary line that bisects the angle between the long axis of the tooth and the film is the bisecting angle line. The x-ray beam should be directed perpendicular to the bisecting angle line.
Improper utilization of the bisecting angle technique will result in an elongated, foreshortened, or an overlapped radiographic dental image.

A basic dental radiographic survey consists of six views: the rostral maxillary and mandibular projections, the right and left maxillary projections and the right and left mandibular projections. Additional radiographs may be necessary depending on the size of the patient. The upper fourth premolar requires additional radiographs to permit adequate visualization of all three roots. A 30-degree rostral oblique projection needs to be added to the bisecting angle technique to permit adequate visualization of the mesiobuccal and palatal roots.

Critiquing Dental Radiographs
Various organizations including the American Veterinary Dental College and the Academy of Veterinary Dentistry require dental radiographs for evaluation. Striving to follow these established guidelines will produce meaningful diagnostic films. These guidelines which have been previously published can be used as a guide to assist in self-evaluation of radiographs.3
- All teeth to be evaluated are clearly visible
- Radiographs are well positioned
- The maxillary cheek teeth should have the roots facing upward and the crowns downward
- The mandibular cheek teeth have the crowns facing upward and the roots downward.
- Maxillary incisors have the roots facing upward and the crowns downward
- Mandibular incisors have the roots facing downward and crowns upward
- When viewing the right side of the mouth, the anterior teeth are on the right side
- When viewing the left side of the mouth, the anterior teeth are on the left side of the radiograph.
- Proper angulation has been used.
- There is no foreshortening or elongation
- Visualization of all roots and apices is adequate
- Exposure and developing technique are adequate
- No artifacts appear on the film
- Contrast and density of the radiograph are correct

Importance of Recognizing Dental Radiographic Lesions
Proper evaluation of feline teeth with odontoclastic resorptive lesions can help determine the appropriate treatment option including either routine extraction or crown amputation with intention root retention. When retained roots are identified with dental radiography a decision to retrieve or retain these roots must be made. If the retained roots are an incidental finding in a patient that is asymptomatic and there is no evidence of periapical or apical lysis around the retained root tip and the root is covered by normal gingiva that is epithelized than no treatment is recommended. However, if the patient is symptomatic, there is an area of granulation tissue over the retained root tip or radiographically there is evidence of periapical or apical lysis than removal of the root is recommended.

Dental radiographs can be used to assess bone loss secondary to periodontal disease and help determine the most appropriate treatment plan. In cases in which there is greater than either 50-75% attachment loss or bone loss to the apex of a single root of a multi-rooted tooth is revealed on the dental radiographs, extraction is generally recommended.

Dental radiography can be used to evaluate for the presence of endodontic disease Abnormal radiographic findings associated with endodontic disease include: periapical lysis, apical lysis, large endodontic systems secondary to failure in normal development or resorption, radiographic loss of tooth structure to the pulp canal and secondary destruction of the periodontium. Periapical lysis appears as a dark halo around the apex of the roots caused by lysis of the bone around the apex of the tooth associated with endodontic disease. Apical lysis is lysis of the apex or tip of the root itself. Apical lysis is associated with chronic endodontic disease. It is important to recognize the presence of apical lysis since apical lysis precludes the performance of conventional root canal therapy alone and necessitates the performance of surgical endodontic therapy in combination with conventional endodontic therapy or exodontia. Large or asymmetrical endodontic systems may be secondary to failure in normal
development from early pulpal death from endodontic disease or may be secondary to internal resorption from pulp damage. The canals of affected teeth may be larger than the contralateral canals or larger than the canals of adjacent teeth or may be asymmetrical within a solitary affected tooth. Chronic endodontic disease can result in secondary destruction of periodontal structures along the root of a tooth with pulpal necrosis.

Dental radiography is recommended in the evaluation of missing teeth. In puppies with missing deciduous teeth a dental radiograph may be taken to determine if a permanent tooth bud is present. Early determination of the absence of a permanent tooth bud will help breeders determine if a dog is either show or pet quality. Dental radiography can also reveal the location of teeth that have been misplaced following trauma.

Teeth that appear malformed require dental radiographs to help determine the presence of endodontic disease. Developmental abnormalities such as dens-in-dente in which the enamel is enfolded may result in secondary endodontic disease. This condition appears to most frequently affect the lower 1st molar in the dog and often occurs bilaterally. These teeth appear to have an increased radiodensity in the crown, convergence of the roots, large pulp canals and the presence of periapical lysis.

Osteomyelitis may be detected radiographically. Osteomyelitis may be secondary to severe periodontal disease, endodontic disease or trauma. Osteomyelitis may appear as an increased bony density with loss of detail and periosteal reaction. Osteomyelitis should be treated by removal of diseased teeth and bony sequestra, and appropriate long term antibiotic therapy.

Radiographs should be taken in animals with multiple loose teeth in one region of the oral cavity. Severe boney lysis and displacement of teeth is suggestive of a malignant tumor. Biopsy of these lesions is required for a definitive diagnosis and for appropriate treatment planning.

Metabolic bone diseases, such as renal secondary hyperparathyroidism can be evaluated with dental radiographs. The initial radiographic finding associated with hyperparathyroidism is loss of the lamina dura which is the cortical plate of the alveolus that surrounds the tooth roots. As the disease progresses there is a loss of density of trabecular and cortical bone.

Dental radiographs are essential in the diagnosis of dentigerous cysts. When oral examination of dental patients reveals a soft, fluid filled gingival swelling in the region of a missing tooth a dental radiograph is recommended. Radiographs may reveal the presence of a dentigerous cyst which appears as a smooth-bordered radiolucent cavity typically adjacent to the cementoenamel junction of the unerupted, misplaced tooth.

Dental radiographs are important in the perioperative management of jaw fractures. Preoperative radiographs will assist in the evaluation of the fracture site, determine the location of tooth roots in and around the fracture site and assist the selection of appropriate treatment options. Dental radiographs are also essential in the postoperative evaluation of fracture fixation and reduction and assessment of proper healing of jaw fractures.

Summary
Dental radiography is an essential component in the daily delivery of high quality dental care for dogs and cats. Recently many state-of-the-art veterinary practices have switched over to digital dental radiography because of the speed and ease in which these images can be produced and evaluated. The real value in taking digital dental radiographs is improved patient care while at the same time providing a profit center for the hospital. The advantages of digital dental radiography far outweigh the disadvantages of this new technology. With proper orientation and training in the use of digital dental radiographic units this new technology can become an integral part of small animal veterinary. Following an appropriate training period veterinarians and veterinary technicians will be able to obtain high quality dental images which will result in the recognition of more lesions which can then be appropriately treated.
References

Feline Extractions: Indications, Techniques and Complications
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Decision making and techniques to simplify dental extractions in cats have been previously described.1-5 Proper perioperative planning and decision making regarding feline extractions can improve surgical outcome.

Preoperative Considerations in the Feline Dental Patient
It is important to properly assess the feline patient prior to the performance of extractions. This includes complete general physical and oral examinations and appropriate preoperative blood work. Once the patient has been properly assessed it is important to select an appropriate anesthetic protocol that will provide the feline dental patient with adequate perioperative pain management.

Oral Examination in the Awake Feline Patient
It may be difficult to perform a thorough oral examination in the awake feline patient however it is important to attempt to assess the oral cavity in the cat as completely as possible to help determine the general oral health of the patient. It must be remembered that all of the oral and dental lesions will not be readily apparent in the awake feline patient and a thorough oral examination including dental radiographs under anesthesia will be necessary to detect the full extent of the dental lesions. An oral exam is initiated by placing both hands gently around the patient’s head and neck and then gently parting the lips with the thumbs to visualize the buccal aspect of the canine teeth and cheek teeth on each side. The incisor and canine teeth may be visualized from the front of the patient using the index fingers and thumbs to retract the lips. The maxilla is then visually assessed for any evidence of asymmetry or swelling. The eyes and nostrils are evaluated for any signs of asymmetry or discharge. The mandibles are then palpated for any evidence of swelling or asymmetry. The mouth is then gently opened by placing the index finger and thumb of the nondominant hand just below the zygomatic arches and tilting the patient’s nose dorsally and then carefully placing the tip of the opposite index finger over the lower incisor teeth and gently pushing ventrally to open the mouth to permit visualization of the tongue, palate and pharynx. The thumb of the dominant hand is then placed in the intermandibular space with the index finger still on the lower incisors to displace the tongue dorsally to permit examination of the ventral aspect of the tongue. Abnormalities detected are discussed with the owner with the stipulation that additional abnormalities may be detected in the anesthetized patient.

Oral Examination in the Anesthetized Feline Patient
Oral examination in the anesthetized feline patient begins with a thorough oral examination including evaluation for missing or supernumerary teeth, malformed teeth, proper occlusion, periodontal probing and exploration of the teeth with a dental explorer to detect pulpal exposure and resorptive lesions. Abnormalities are noted on the feline dental chart.

Dental Radiography in the Feline Patient Prior to Extraction
Dental radiography is an important tool in the decision making process in feline dental patients. Dental radiography can help determine the most appropriate treatment modality in feline teeth affected with periodontal disease, endodontic disease and feline resorptive lesions.

Radiographic Changes Associated with Feline Periodontal Disease Requiring Extraction
Dental radiographs demonstrating less than 50% of attachment remaining on any mobile tooth indicates that extraction is indicated. In addition if dental radiographs indicate that there is loss of attachment to the apex of a single-rooted tooth or loss of attachment to the apex of any root of a multi-rooted tooth then extraction is indicated.
Radiographic Changes Associated with Feline Endodontic Disease Requiring Extraction or Endodontic Treatment
The presence of endodontic disease or disease of the pulp of a feline tooth requires extraction or endodontic therapy. Radiographic changes associated with endodontic disease include loss of tooth structure to the pulp of the tooth, asymmetrical endodontic canals, periapical lysis or apical lysis.

Radiographic Changes Associated with Feline Odontoclastic Resorptive Lesions Requiring Extraction or Crown Amputation with Intentional Root Retention
Dental radiography is extremely important in the assessment of feline odontoclastic resorptive lesions since the selection of the appropriate treatment is based on proper evaluation of the dental radiographs. Feline teeth with advanced root resorption, without periodontal or endodontal lesions are good candidates for crown amputation with intentional root retention. Conversely, a tooth with a feline odontoclastic resorptive lesion that has a well-defined periodontal ligament space, bone loss due to periodontitis, or a periapical lesion evident on radiographs requires standard extraction techniques with complete removal of the roots. In individual feline teeth in which one root has an advanced root resorptive lesion and another root has a well-defined periodontal ligament space it is acceptable to perform a crown amputation with intentional root retention on the root that has severe resorption and perform a routine extraction of the root that has a well-defined periodontal ligament space.

Proper Equipment and Instrumentation for Feline Extractions
A high-speed handpiece with fiberoptics is extremely helpful when performing surgical extractions in cats. The fiberoptic handpiece provides a light source directly on the surgical site. Burs utilized frequently include small round burs for the removal of buccal bone and tapered fissure burs for sectioning multi-rooted teeth. Essential hand instrumentation for performing feline extractions have been previously described. Hand instrumentation specifically designed for feline extractions is available through numerous veterinary supply companies. Instruments for feline extractions may be packaged together in a feline extraction pack and steam sterilized prior to each use. Instrumentation in feline extraction packs include: scalpels handle upon which a #15 blade can be placed prior to surgery, a small feline periosteal elevator, a soft tissue retractor, a variety of dental elevators and luxators, small extraction forceps, needle holders, Adson tissue forceps, suture scissors and an iris scissors for cutting soft tissue. A small root forceps is also helpful for reaching down into an alveolus and obtaining a firm grasp on a loose root tip. It is imperative to routinely sharpen dental extraction instrumentation to insure optimal functionality.

Anatomic Features of Feline Teeth
The dental formula in the adult cat is: 2 (I 3/3, C1/1, P3/2, M1/1) = 30. The anatomy of the mouth and teeth of the cat has been previously described. Feline teeth are much smaller and narrower than canine teeth. All the incisors and canine teeth have one root. The small maxillary second premolar usually is a small single-rooted tooth which may have two roots which may be fused together. The maxillary 3rd premolar has 2 roots with a supernumerary root sometimes present, the maxillary 4th premolar has 3 roots and the maxillary 1st molar is very small with two roots that may be fused. There are 3 mandibular cheek teeth. The 3rd and 4th premolars each have two symmetrical roots and the 1st molar has two asymmetrical roots with a large mesial root and a small distal root.

Techniques for Performing Feline Extractions
There are several different techniques for performing feline extractions. These techniques include a simple extraction, multi-rooted extraction, single-rooted surgical extraction, partial or full-mouth extractions for the treatment of feline stomatitis, and crown amputation with intentional root retention for the treatment of feline resorptive lesions.

Simple or Closed Extraction
The incisors, the maxillary 2nd premolar and the maxillary molar teeth are generally small single rooted teeth in the cat and can be removed using simple or closed extraction techniques. Simple or closed extraction techniques have been previously described. The procedure is initiated by cutting the gingival attachment around the whole circumference of tooth using a No. 11 scalpel blade in a handle or a sharp luxator. A luxator that matches the curvature of the tooth is selected and is placed into the gingival sulcus at a slight angle to the tooth and pressed into the periodontal ligament space and worked around the
entire circumference of the tooth using gentle apical pressure. The operator may now elect to continue
the extraction using a dental elevator or continue using a luxator. A dental elevator may be used once
adequate space has been created for the thicker tipped instrument. An appropriate sized elevator is
selected, placed in the periodontal ligament space and worked around the tooth with a gentle rotational
pressure held at each point for 10-15 second to help break down the periodontal ligament. Once the tooth
becomes loose it can be removed digitally or gently grasped with a small dental extraction forceps placed
as far apically on the tooth as possible and with a gentle rotational movement of the forceps in the long
axis of the tooth, the tooth may be gently rotated and removed from the alveolus.

**Multirooted Extraction**

Extraction of multirooted teeth in cats requires additional consideration because of the tendency for these
roots to fracture during extractions. A modified technique for extracting multirooted teeth in the cat has
been reported. This technique involves raising both buccal and lingual flaps and removing adequate
alveolar bone to expose the furcation. The furcation is then sectioned using a size 2 round bur making
two cuts from the furcation at 45°, one distally and one rostrally thereby removing a significant portion of
the crown leaving only a small portion of the crown mesially and distally. A size 2 or 4 round bur is then
used to remove the interradicular bone between the mesial and distal roots to the apical region of the
roots without invading the nasal cavity or mandibular canal. This results in support of the roots by 3 sides.

An appropriately sized luxator or elevator can be eased into the interradicular space created by the bur
and into the periodontal ligament of the roots to gently remove the roots independently. Additional buccal
bone may be removed as necessary. Sharp edges of bone are removed with a small round bur, the
surgical site is flushed and the flap is closed with 4-0 chromic or 4-0/5-0 poliglecaprone on a small
reverse cutting needle.

**Single-Rooted Surgical Extraction**

The canine tooth in cats often requires a surgical extraction. The maxillary canine tooth can be removed
through a labial flap with two releasing incisions with a broad base. Minimal bone is removed over the
labial aspect of the tooth to permit delivery of the tooth using the luxators and dental elevators as
previously described. Extraction of the mandibular canine tooth in the cat can be performed using a labial,
lingual or alveolar marginal approach. The labial approach utilizes a labial flap with labial bone removal,
the lingual approach utilizes a lingual approach with lingual bone removal and the alveolar marginal
approach uses a dorsal approach to the canine root through a single incision over the root of the tooth
from the distal aspect of the canine tooth distally toward the mesial aspect of the mandibular 3rd premolar.

In this approach the bone is removed over the root along the alveolar ridge in the edentulous space
between the canine tooth and the 3rd premolar. Care must be taken when elevating this root to direct the
elevator along the sides of the root and not straight down the distal aspect of the tooth since this type of
elevation will direct the elevator into the root of the canine tooth instead of into the periodontal ligament
space. Care must also be taken when extracting the mandibular canine teeth in cats to not apply
excessive rotational forces with the elevator since this may result in mandibular fractures.

**Partial or Full-Mouth Extractions for the Treatment of Feline Stomatitis**

In cases of feline gingivostomatitis in which medical management is unsuccessful, extraction of all
premolars and molars or full-mouth extraction is the treatment of choice. This is facilitated by making a
full-thickness gingival flap in each quadrant, using a small feline periosteal elevator to elevate the lingual
and/or palatal and buccal aspects to provide adequate exposure to the underlying bone. The buccal bone
is removed as needed; the teeth are sectioned and removed as previously described. The rough edges of
bone are removed with a small round bur, the alveoli are curettaged, the surgical site is flushed and the
surgical site closed without tension.

**Crown Amputation with Intentional Root Retention for Treatment of Feline Resorptive Lesions**

Properly screened teeth with feline resorptive lesions can be treated by crown amputation with intentional
root retention. Pre-extraction radiographs are imperative in case selection. Teeth with advanced root
resorption, without periodontal or endodontal lesions, are good candidates for crown amputation with
intentional root retention. Teeth with an intact periodontal ligament and no severe root resorption or teeth
with periodontal or endodontal lesions or cats with stomatitis require routine extractions. The procedure is
initiated by making a small mucogingival flap and amputating the crown with a small round diamond burr.
on a high-speed handpiece. The site is checked with a dental explorer to insure complete amputation of the entire crown. Any residual crown and irregular alveolar bone is removed with the round burr. The residual pulp in the surgical will bleed on appropriately screened teeth. The site is flushed and closed.

Complications Associated with Extractions
Complications associated with extractions include the following: root fracture, hemorrhage, delayed wound healing and infection, oronasal fistula, ocular injuries, salivary duct injury, misplacement of roots fragments into the nasal cavity or into the mandibular canal, damage to adjacent teeth and mandibular fracture. Careful extraction techniques and appropriate perioperative management can help minimize these complications.

References:
The recognition and treatment of canine dental and oral pathology is an important component in successful management of canine health. Many dental and oral lesions occur frequently in dogs but may have a variety of presentations and treatment options. Commonly occurring canine dental and oral lesions include: variations in number of teeth and roots, periodontal disease, endodontic disease, dental caries, dental attrition/abrasion, discolored teeth and oral masses (benign and malignant).

**Variations in Number of Teeth and Roots**

Dogs normally have 42 adult teeth. The permanent dental formula in the dog is as follows: 2(I3/3C1/1P4/4M2/3). Oligodontia or decreased number of teeth is more common in dogs than cats. Although oligodontia is not a serious medical problem, it can be a problem for breeders since it is considered a genetic imperfection. Puppies with missing deciduous teeth will also be missing the same adult teeth.

Supernumerary teeth or extra teeth may result in crowding and malalignment of teeth predisposing to the development of periodontal disease. Various teeth in the dog may be supernumerary. Supernumerary teeth that are not causing crowding or malalignment of teeth require no treatment. Supernumerary teeth that result in crowding should be extracted. Prior to extraction supernumerary teeth should be radiographed to evaluate their root structure. It is important to differentiate supernumerary teeth from overly retained deciduous teeth. In dogs, the canine teeth are the most frequently retained teeth; however, the incisors and premolars may also be retained. Retained deciduous teeth should be extracted as soon as they are diagnosed so that permanent teeth may erupt into their normal positions. When retained deciduous teeth are not removed, permanent teeth are deflected lingually, except maxillary canine teeth, which are deflected rostrally. Deciduous teeth are smaller than their permanent counterparts. When difficulty is encountered in determining which tooth is deciduous and which tooth is permanent a dental radiograph should be taken. The root of the permanent tooth in a 6-month-old animal will have a wide pulp canal with thin dentinal walls and an open apex compared to the deciduous teeth which will have a much thinner but more developed root.

Occasionally teeth may have extra roots this condition is known as supernumerary roots. Supernumerary roots are generally incidental findings on oral examination and generally occur as extra roots in teeth that normally have only two roots. It is important to recognize the normal and abnormal root structure in teeth requiring extraction. This permits appropriate sectioning prior to extraction. Dental radiographs can also assist in the localization of supernumerary roots.

**Periodontal Disease**

Periodontal disease is the most common disease affecting dogs today. The common clinical presentations of periodontal disease in the dog include mobile teeth, periodontal and periapical abscesses with secondary facial swelling, gingival recession and furcation exposure, mild to moderate gingival hemorrhage, and deep periodontal pockets with secondary oronasal fistulas resulting in a secondary chronic rhinitis. Less frequently, severe gingival sulcus hemorrhage, pathologic mandibular fractures, painful contact buccal mucosal ulcers, intranasal tooth migration, and osteomyelitis have been reported.

The treatment of periodontal disease is based on one major factor: a clean periodontium results in a healthy periodontium. There are numerous treatment modalities associated with the management of periodontal disease. These treatment modalities include: supragingival and subgingival scaling, root planing, subgingival curettage, polishing/irrigation, gingivectomy, open-flap curettage with augmentation of bony defects, treatment of endodontic/periodontic lesions, periodontics, exodontia, oronasal fistula repair, and home care. Prior to administration of various treatment modalities for periodontal disease a thorough assessment of the patient’s general health stasis is mandatory. Many animals with periodontal
disease may have concurrent problems including diabetes, cardiopulmonary problems, hepatic, renal, and other metabolic problems. Once these diseases are recognized and managed appropriately, anesthetic protocols can be selected based on the individual patient’s requirements.

**Endodontic Disease**

Endodontic disease refers to disease of the pulp, the inner aspect of the tooth. Dental trauma with or without pulpal exposure is the most common cause of endodontic disease in dogs. The canine teeth and the maxillary 4th premolars are the most frequently fractured teeth in dogs. Depending on the amount of tooth structure fractured off the pulp may or may not be exposed. A dental explorer is used to determine if the pulp has been exposed.

Fractured teeth are often noted as an incidental finding on physical examination. However, a series of events may occur in some fractured teeth with exposed pulp which can result in significant clinical presentations. This series of events includes the following conditions: (1) exposed pulp, (2) bacterial pulpitis, (3) pulp necrosis, (4) periapical granuloma, (5) periapical abscess, (6) acute alveolar periodontitis, (7) osteomyelitis, and (8) sepsis.

The time required for this progression varies from months to years. When a tooth is fractured and the pulp is exposed the pulp will bleed. Pulpal exposure is extremely painful and animals with an acutely fractured tooth with pulpal exposure will hypersalivate, be reluctant to eat, and exhibit abnormal behavior. Over several months the pulp becomes necrotic and the animal is no longer painful until an inflammatory reaction occurs around the apex of the tooth at which time the animal becomes painful again. An endodontically diseased tooth is not only painful but it also is a potential source of infection for other parts of the body. An endodontically diseased tooth may present clinically as a discolored tooth which is painful on percussion. Soft tissue fistulas may occur secondary to endodontic disease. These fistulas are usually located apical to the mucogingival line. Endodontically diseased teeth may present with severe maxillary or mandibular swelling. Endodontically diseased teeth may also cause nasal discharge or hemorrhage or ophthalmic signs. All endodontically diseased teeth should be either treated or extracted.

**Dental Caries**

Dental caries is demineralization of the tooth and results in subsequent loss of tooth structure. Early dental caries may appear as a dark brown spot and have a sticky or slightly soft feel when probed with a dental explorer. Once dental caries perforates the enamel, the caries can progress rapidly in the dentin, destroying the tooth and eventually resulting in pulpitis and pain. This may be followed by pulp necrosis and periapical infection. The teeth most commonly affected in dogs with dental caries are the maxillary first molar, and the mandibular first and second molars. When dental caries occur in the dog, the lesions are often multiple and advanced. Dental radiographs should be taken of teeth with dental caries to rule out any associated endodontic pathology. Treatment of dental caries includes extraction or restoration of affected teeth.

**Dental Attrition/Abrasion and Cage-Biter Syndrome**

Dental attrition is the gradual and regular loss of tooth substance resulting from normal mastication. Excessive wear caused by malocclusion resulting in tooth-to-tooth contact is called pathologic attrition. Dental abrasion is the mechanical wear of teeth caused by mechanical wear other than by normal mastication or tooth-to-tooth contact such as wear caused by chewing rocks, cage bars, or wire. In cases of dental attrition the pulp responds to rapid wear by laying down tertiary or reparative dentin, which is visible as a dark brown spot on the affected tooth. The dark brown spot is solid and cannot be entered with a dental explorer. No therapy is usually required in these cases. Occasionally, very rapid dental attrition can result in pulpal exposure. These cases require endodontic therapy or extraction.

Cage-biter syndrome can be seen in dogs who chronically chew on their cage bars. The unique pattern of dental wear associated with cage-biter syndrome includes dental wear on the distal aspect of the canine teeth. Dogs affected by severe wear on the distal aspect of their canine teeth may be affected with dentinal hypersensitivity, endodontic disease, and crown weakening resulting in dental fractures. Dental radiographs should be taken of teeth affected with cage-biter syndrome to help rule out the presence of endodontic disease. If endodontic disease is present, affected teeth should be endodontically treated or
extraextracted. Full or three-quarter prosthetic crowns can be placed on teeth affected with cage-biter syndrome. A three-quarter crown is preferred in teeth that are not endodontically treated so that if endodontic treatment is required at a later date the ideal access site can be easily created without damaging the prosthetic crown.

**Discolored Teeth**

Hemorrhage or necrosis of the pulp results in lysis of red blood cells. This results in hemoglobin breaking down into pigments which penetrate into the dentinal tubules and result in a variety of discolorations of the affected tooth. The color of the traumatized crown may vary from pink-red to blue-gray or dark gray. When intrapulpal hemorrhage is minor the pulp may remain vital and the blood pigment may be resorbed and the crown discoloration may be temporary. In a recent clinical study reviewing the incidence of localized intrinsic straining of teeth due to pulpitis and pulp necrosis in dogs, it was found that a distinct majority of teeth (92.2%) with pink/grey/tan crown discoloration had either partial or total pulp necrosis based on visual examination of the pulp during root canal therapy or exploratory pulpotomy. However, radiographic signs of endodontic disease were not present in 42.4% of affected teeth indicating that dental radiographs should not be relied upon to indicate pulp vitality in discolored teeth. This study recommended that all discolored teeth receive either endodontic or exodontic therapy. An obvious concern for practicing this treatment rationale routinely would be that vital, discolored teeth may undergo unnecessary endodontic therapy or extraction. However, the risk of unnecessary dental treatment would be acceptably low (<10%) in exchange for the assurance of potential pain alleviation.

Yellowish discoloration of teeth may be caused by tetracycline staining. When tetracycline is administered during pregnancy and the development of deciduous and permanent teeth, the tetracycline will combine with the calcium in the teeth to form a tetracycline-calcium orthophosphate complex that results in a yellowish discoloration of the teeth. To prevent tetracycline staining of teeth avoid administering tetracycline to pregnant and young animals.

Enamel hypoplasia is defined as an incomplete or defective formation of the organic enamel component. Enamel hypoplasia is caused by disruption of the ameloblasts during the first several months of life while the teeth are developing which may be associated with periods of high fever, infections (especially canine distemper), nutritional deficiencies, disturbances of the metabolism, and systemic disorders. Shortly after eruption, the soft, brittle enamel peels off exposing the underlying dentin which is soon stained yellowish-brown by extrinsic factors. In cases of enamel hypoplasia, there exists a deficiency in the thickness of the enamel: the defects in the enamel can be limited to a circumscribed area or be recognized as a single narrow zone of smooth or pitted hypoplasia. Disturbance in enamel formation over a longer period of time results in a more generalized distribution of lesions. When enamel hypoplasia is limited to a solitary tooth the most likely cause is trauma.

**Benign and Malignant Oral Masses**

Oral tumors occur frequently in dogs and cats. Oral tumors account for approximately 6% of all malignant tumors in dogs with malignant cancer of the mouth and pharynx occurring 2.6 times more frequently in dogs than in cats. Oral tumors may be benign or malignant. Unfortunately, diagnosis of oral malignancies frequently occurs when the tumor is quite advanced, necessitating more extensive treatment. Thorough oral examination during routine physical examinations and during dental procedures can permit early detection of oral tumors providing patients with a better prognosis. Early diagnosis of oral tumors, appropriate staging, wide surgical resection and alternative treatment modalities can improve survival time.

When an oral mass is detected during a routine dental procedure a dental radiograph should be taken to determine the presence of underlying boney lysis which may be seen with malignant oral tumors. The mass should be biopsied to determine whether or not the tumor is benign or malignant. Biopsy of large oral masses must be deep, because superficial biopsies may reveal only inflammation or gingival hyperplasia. A deep wedge biopsy or a deep Tru-cut is recommended. The use of electrosurgery for obtaining oral tumor biopsies is not recommended.
Non-neoplastic reactive lesions that occur as a result of chronic low-grade irritation such as focal fibrous gingival hyperplasia and pyogenic granulomas occur at the gingival margin and are treated with a gingivectomy and treatment of the underlying cause of the inflammation which is most frequently periodontal disease. Sublingual and buccal mucosal areas of excessively loose mucosal folds that are indurated and hyperplastic secondary to repeated self-inflicted trauma have also been described as “gum-chewers lesions” because the behavior of dogs with these lesions may mimic that of a person aggressively chewing gum. These lesions may become quite large and may be painful when they are repeatedly traumatized by chewing on the lesions with the molar teeth. When these lesions become ulcerated and become a source of pain for the patient surgical excision is recommended. The resected tissue should be submitted for histopathologic evaluation to rule out the presence of neoplasia.

Malignant oral tumors require more aggressive surgical treatment to help prevent local recurrence including various partial mandibulectomy and maxillectomy procedures depending on the location of the oral tumor. It is important to properly stage all dogs suspected of having malignant oral tumors to rule out distant metastasis.

References:
Periodontal disease is probably the most common disease in dogs.¹ Most dogs greater than 5 years of age have significant periodontitis. Periodontal disease increases significantly with increasing age, and decreases significantly with increasing body weight and is particularly obvious when comparing toy and small dogs with medium and large dogs.² Periodontal disease is caused by the accumulation of bacteria in the form of plaque on the surface of the teeth which results in gingival inflammation and if left untreated results in the destruction of periodontal tissues which can result in clinically significant local and systemic problems. Periodontal disease occurs in two forms gingivitis and periodontitis. Gingivitis is a reversible inflammation of the gingiva. Periodontitis involves deeper inflammation with loss of tooth support and permanent damage. The purpose of periodontal therapy is to prevent gingivitis from progressing to periodontitis and to delay the progression of periodontitis once it is established.

Systemic antibiotics are not recommended for the routine prevention of periodontal disease, nor are they recommended for routine scaling of healthy dogs teeth without periodontal disease.⁴ However, perioperative antibiotics are recommended in animals with moderate to severe periodontitis, patients with painful oral ulcerations, animals who do not receive any home oral hygiene, those with systemic disease that may be worsened by bacteremia (turbulent blood flow caused by heart valve lesions or chronic renal failure), and patients undergoing concurrent clean or clean-contaminated surgical procedures.⁴ The antimicrobial of choice for clinical use in dogs with periodontal disease is Clavamox.³ The length of time recommended for the perioperative administration of antimicrobials varies from 2 to 10 days depending on the severity of periodontal disease. Perioperative antibiotics should be administered so that a therapeutic blood level is obtained prior to induction of the bacteremia caused by the dental therapy.⁴

**Stages of Periodontal Disease**

In Stage 1 (gingivitis) periodontal disease, gingivitis with no attachment loss is present. Some dogs may have significant dental calculus with minimal gingivitis while others may have severe inflammation with minimal plaque and calculus. This stage of periodontal disease results in inflammation, edema, plaque and calculus accumulation, possible bleeding on probing, and possible pseudopocket formation.⁵ In Stage 2 (early) periodontal disease, the initial signs of destructive periodontitis are evident. Periodontal probing and radiographic examination may indicate attachment loss of up to 25%, teeth remain stable and pocket depths of 3-5mm are present.⁶ In Stage 3 (moderate) periodontal disease, the probing and radiographic signs of attachment loss are between 25% and 50% of the root length.⁶ Probing depths of 6-9 mm may be present with the presence of vertical defects and infrabony pockets. If gingival recession is present there may be only a minimal increase in probing depth indicating the importance of assessing attachment loss not only by pocket depth but also by measuring attachment loss from the cementoenamel junction to the depth of the periodontal pocket. Teeth may be mobile. In Stage 4 (severe) periodontal disease, the attachment loss is greater than 50%, there is severe loss of supporting tooth structures and pocket depths are greater than 9mm and teeth become loose. Significant infrabony pockets may be localized to a single area, such as the deep palatal pockets seen in maxillary canine teeth.⁶

Diagnosis of the various stages of periodontal disease is based on a thorough oral examination, periodontal examination with a periodontal probe, and dental radiography. Animals with gingivitis, the reversible form of periodontal disease, have a swollen gingival margin that will bleed after the application of light pressure. Serous or purulent exudate is produced from the gingival sulcus. Halitosis is commonly present. Periodontal examination with a periodontal probe is normal and radiographically there is no evidence of bone loss around the teeth. Periodontitis in dogs is usually characterized by hyperplasia, gingival recession and pocket formation which progresses to tooth loss if untreated. Severe gingival inflammation with various amounts of calculus and debris are present with periodontitis. Periodontal probing will reveal the presence of periodontal pockets. Dental radiographs will reveal bone loss which is associated with periodontal disease. Bone loss may be horizontal or vertical. Horizontal bone loss is bone
loss parallel to the cementoenamel junction which separates the anatomic crown from the anatomic root. Vertical bone loss is bone loss parallel to the long axis of the root.

**Treatment of Periodontal Disease**

Ideally the prevention of periodontal disease is preferred over the treatment of already established periodontal disease. Dogs can manage well without teeth, in fact dogs with very severe periodontal disease are better off without teeth because loss of diseased teeth is the most dependable way to eliminate this source of chronic infection. However, teeth should be retained whenever practical for functional and aesthetic reasons. It is recommended that occluding pairs of teeth particularly, the carnassial teeth or the canine (and maxillary third incisor) teeth be retained as functional units whenever practical.

The treatment of periodontal disease includes a variety of techniques including: supragingival and subgingival scaling, root planing, subgingival curettage, polishing, gingivectomy, open-flap curettage and augmentation of boney defects, utilization of perioceutics, periodontopathogen vaccine, extraction, oronasal fistula repair, and home care.

**Supragingival Scaling**

Supragingival scaling refers to the removal of dental calculus above the gingival margin. This is most easily accomplished in small animals utilizing power scalers. In a recent study the efficacy with which four different power scalers (ultrasonic magneto-strictive, sonic, ultrasonic piezoelectric, and rotosonic scalers) removed dental calculus in the dog was compared. The ultrasonic piezoelectric scaler removed calculus significantly faster than all the other power scalers. The ultrasonic magnetostrictive scaler was faster in the removal of calculus than the sonic scaler and the sonic scaler was faster in the removal of calculus than the rotosonic scaler. Electron microscopy of teeth scaled were all similar except the teeth that were instrumented with the rotosonic scaler. The surface of the enamel of these teeth contained multiple deep groves.

Prior to ultrasonic scaling the patient’s mouth is lavaged with a 0.12% chlorhexidine solution to reduce external bacterial counts. Gross calculus is gently removed with an extraction forceps by gently closing the forceps across the calculus. A power scaler is used to remove the remaining plaque, calculus, and debris. Adequate water flow is essential when using power scalers to cool the oscillating tip and flush away the debris. The side of a sickle-shaped scaling tip is placed on the tooth surface and moved gently and continuously over the tooth surface. Continuous scaling of any one tooth for more than 15 seconds must be avoided to prevent pulp tissue injury from excessive heat and potential production of subsequent pulpal necrosis.

**Subgingival Scaling**

Subgingival scaling removes debris that has accumulated below the gingival margin which causes inflammation of the supporting structures of the teeth. Failure to remove subgingival calculus promotes the progression of periodontal disease. Subgingival calculus is removed with a curette. The instrument is inserted with the face of the blade flush against the tooth. When the instrument reaches the bottom of the pocket the working angulation of the instrument, usually 45 degrees, is established. The instrument is then pushed against the tooth and pulled coronally. This process is repeated until all subgingival calculus is removed. Root planing is the smoothing of the root surface using curettes. This procedure is not a distinct entity from subgingival scaling or cleaning of the root surfaces but rather a continuation of the process. When the root is adequately planed it should feel smooth and hard like glass.

**Subgingival Curettage**

Subgingival curettage is the removal of diseased soft tissue from the periodontal pocket. While one edge of the curet engages the root surface, the other edge engages the soft tissues of the periodontal pocket. Although this process is often not thought of as a deliberate procedure it removes the diseased soft tissue portion of the periodontal pocket.
Polishing
After the removal of all calculus the teeth are polished with a rubber cup placed on a prophylaxis angle attached to a slow-speed handpiece. Prophy paste is placed on the teeth and the cup is rotated over all tooth surfaces at a low speed. The cup is then pressed gently but firmly at the gingival margin to permit polishing of the root surface adjacent to the crown.

Irrigation
After polishing, the gingival sulcus is irrigated with a 0.12% chlorhexidine solution using a blunted 23-gauge needle and a 12 ml syringe. Irrigation of the gingival sulcus removes loose calculus, prophy paste and debris and reduces the bacterial counts.

Gingivectomy
Gingivectomy is the removal of gingival pockets by the excision of gingiva. There are several indications for gingivectomy including the following: gingival hypertrophy or hyperplasia, excisional or incisional gingival biopsy, elimination of shallow supraboney pockets with retention of adequate attached gingiva. A gingivectomy is performed by measuring the depth of the periodontal pocket and marking the depth of the pocket with the tip of the periodontal probe by pressing it into the gingiva perpendicular to the tooth to create a bleeding point. This is repeated every few millimeters to mark the pocket depth. A No. 15 blade is used to create a beveled incision starting 1 to 3 mm apical to the bleeding points (depending on the thickness of the gingiva) to produce an anatomically correct gingival margin.

Open-Flap Curettage and Augmentation of Boney Defects
Open-flap curettage is indicated in cases of periodontal disease in which pockets are greater than 5-6 mm deep and do not respond to conservative therapy. The purpose of flap surgery is to reflect soft tissue and gain access to deeper periodontal structures which can then be more thoroughly treated with the benefit of direct visualization. The most common indication in dogs for open-flap curettage and augmentation of periodontal boney defects are deep periodontal defects on the palatal aspect of the maxillary canine teeth.

To repair a deep palatal periodontal defect a semilunar flap from the palatal surface of the affected canine tooth is raised four millimeters palatal to the edge of the boney defect. The periodontal pocket is debrided with a curette removing all calculus, granulation tissue, and debris. The area is flushed with 0.12% chlorhexidine solution. A bulk matrix osseous replacement packing material which generally consists of small particulate granules can be placed in the defect in the hopes that they will be incorporated as a matrix into the initial blood clot that is subsequently replaced by supportive tissue, either bone or periodontal ligament, while deterring the ingrowth of gingival epithelium and connective tissue. A bulk matrix osseous replacement packing material available in the veterinary market is Consil (Nutramax Labs). Freeze-dried canine or feline bone may also be used. After placement of the bone graft material into the defect the palatal gingival flap is sutured in place with 4-0 absorbable suture material such as Monocryl adapting the flap closely to the underlying bone and tooth with as little tension as possible.

Periodontopathogen Vaccine
Recently, the development of a trivalent canine periodontitis vaccine has provided veterinarians with an additional treatment option in the management of canine periodontitis. Incorporation of this new vaccine into a treatment plan may help prevent periodontitis in dogs. When considering the incidence of periodontitis in dogs, the serious local and potential systemic effects of the disease on our patients, the
lack of owner compliance, product safety, and the potential degree of protection provided by a vaccine, vaccination is recommended, particularly in patients at high risk for developing periodontitis.

**Extraction of Teeth with Periodontal Disease**
The most common reason for extracting teeth with periodontal disease is Stage IV or severe periodontal disease. Teeth with less than 20-30% of remaining bone height have a poor prognosis. Extraction is recommended in those teeth in which the periodontal pocket has reached the apex of at least one root of a multirooted tooth. Animals with Stage III or moderate periodontal disease in which the client is unwilling or unable to provide appropriate periodontal care may be candidates for exodontia rather than advanced periodontic treatment regimens. Also those animals that may not be good candidates for multiple anesthetic episodes, or have severe mucogingival disease may benefit from exodontia versus advanced periodontic therapeutic techniques. Owner preference should also be considered when determining the most appropriate treatment protocol for a particular patient.

**Oronasal Fistula Repair**
Oronasal and oroantral fistulas are most frequently caused by advanced periodontal disease. Signs associated with oronasal and oroantral fistulas include sneezing and mucopurulent or hemorrhagic nasal discharge. The most common location of oronasal fistulas in the dog is the palatal aspect of the maxillary canine tooth. Other teeth that can potentially cause oronasal fistulas are the maxillary incisors and maxillary premolars and molars. Teeth affected with Stage IV periodontal disease should be removed and the oronasal or oroantral fistula should be repaired with a mucoperiosteal flap.

**Home Care**
Home care following periodontal therapy is an important part of treatment and prevention of periodontal disease. There are several aspects of home care that need to be recommended following periodontal therapy including: antibiotic therapy, administration of analgesics, tooth brushing with dentifrices, chemical plaque control, and dietary/chew toys to reduce plaque and calculus formation.

**References:**
Decision Making and Extraction Techniques in Dogs
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Decision making and techniques to simplify dental extractions in dogs have been described.\(^1\)\(^-\)\(^5\) Proper perioperative planning and decision making regarding canine extractions can improve surgical outcome.

**Preoperative Considerations in the Canine Dental Patient**
It is important to properly assess the canine patient prior to the performance of extractions. This includes complete general physical and oral examinations and appropriate preoperative blood work. Once the patient has been properly assessed it is important to select an appropriate anesthetic protocol that will provide the canine dental patient with adequate perioperative pain management.

**Oral Examination in the Awake Canine Patient**
Oral examination in the awake canine patient is similar to the oral examination in the awake feline patient. Abnormalities detected are discussed with the owner with the stipulation that additional abnormalities may be detected in the anesthetized patient.

**Oral Examination in the Anesthetized Canine Patient**
Oral examination in the anesthetized canine patient begins with a thorough oral examination including evaluation for missing or supernumerary teeth, malformed teeth, proper occlusion, periodontal probing and exploration of the teeth with a dental explorer to detect pulpal exposure, worn teeth and dental caries. Abnormalities are noted on the canine dental chart.

**Dental Radiography in the Canine Patient Prior to Extraction**
Dental radiography is an important tool in the decision making process in canine dental patients. Dental radiography can help determine the most appropriate treatment modality in canine teeth affected with periodontal disease, endodontic disease, dental caries and other lesions.

A dental radiograph taken prior to performing a difficult extraction will provide the veterinarian with important information regarding the tooth. Radiographic evaluation of the tooth will determine if other treatment options may be possible so that the owner can be offered alternatives to extraction. In cases of severe periodontal or endodontic disease extraction may be the best treatment option for the patient. Dental radiographs prior to extraction will also reveal structural abnormalities that might be present in the tooth or surrounding bone. These structural abnormalities include: severe periradicular bone loss secondary to periodontal or endodontic disease, supernumerary roots, abnormal root angulation including convergent roots and excessive curvature of the apical portion of the root, ankylosis and hypercementosis. Knowledge of these structural abnormalities prior to initiation of the extraction will provide important information regarding the most appropriate technique for the extraction and will help reduce the incidence of complications.

**Proper Equipment and Instrumentation for Canine Extractions**
A high-speed handpiece with fiberoptics is extremely helpful when performing surgical extractions in dogs. The fiberoptic handpiece provides a light source directly on the surgical site. Burs utilized frequently include a variety of round burs for the removal of buccal bone and tapered fissure burs for sectioning multi-rooted teeth. Essential hand instrumentation for performing canine extractions have been previously described.\(^1\)\(^-\)\(^5\) Hand instrumentation specifically designed for canine extractions is available through numerous veterinary supply companies. Instruments for canine extractions may be packaged together in a canine extraction pack and steam sterilized prior to each use. Instrumentation in canine extraction packs include: scalpel handle upon which a #15 blade can be placed prior to surgery, a periosteal elevator, a soft tissue retractor, a variety of dental elevators and luxators, extraction forceps, needle holders, Adson tissue forceps, suture scissors and an iris scissors for cutting soft tissue. A small root forceps is also helpful for reaching down into an alveolus and obtaining a firm grasp on a loose root tip. It is imperative to routinely sharpen dental extraction instrumentation to insure optimal functionality.
Anatomic Features of Canine Teeth
The dental formula in the adult dog is: 2 (I 3/3, C 1/1, P 4/4, M 2/3) = 42. The incisors and canine teeth all have one root. The 1st premolars and the lower 3rd molars have one root. The upper 2nd and 3rd premolars and the lower 2nd, 3rd, 4th premolars and 1st and 2nd premolars have two roots and the upper 4th premolar and 1st and 2nd molars have 3 roots. Knowledge of the location of the furcation of the teeth will permit accurate sectioning of teeth during surgical extractions.

Techniques for Performing Simple and Multi-Rooted Extractions in Dogs
There are several different techniques for performing extractions in the dog. These techniques include a simple extraction, multi-rooted extraction and surgical extraction.

Simple or Closed Extraction
The incisors, the maxillary and mandibular 1st premolars and the mandibular 3rd molar are generally small single rooted teeth in the dog and can be usually be removed using simple or closed extraction techniques. Simple or closed extraction techniques have been previously described.1-5 The procedure is initiated by cutting the gingival attachment around the whole circumference of the tooth using a No. 11 scalpel blade in a handle or a sharp luxator. A luxator that matches the curvature of the tooth is selected and is placed into the gingival sulcus at a slight angle to the tooth and pressed into the periodontal ligament space and worked around the entire circumference of the tooth using gentle apical pressure. The operator may now elect to continue the extraction using a dental elevator or continue using a luxator. A dental elevator may be used once adequate space has been created for the thicker tipped instrument. An appropriate sized elevator is selected, placed in the periodontal ligament space and worked around the tooth with a gentle rotational pressure held at each point for 10-15 second to help break down the periodontal ligament. Once the tooth becomes loose it can be removed digitally or gently grasped with a dental extraction forceps placed as far apically on the tooth as possible and with a gentle rotational movement of the forceps in the long axis of the tooth, the tooth may be rotated and removed from the alveolus.

Multi-Rooted Extraction
Extraction of multi-rooted teeth in dogs begins by cutting the gingival attachment to the tooth with either a No. 11 or 15 scalpel blade in a handle or an appropriately sized sharp luxator. The furcation(s) of the tooth are located using visual inspection of the gingiva and alveolar crest. Furcations may be located by observing where the gingiva and alveolar crestal bone raises slightly coronally. Removal of a small amount of bone in this area with a round bur will help visualize the furcation. Once the furcation is visualized the tooth is sectioned by placing a tapered fissure bur (#701 or #701L) at the furcation and sectioning the tooth through the crown. One cut is made in 2 rooted teeth and two cuts are made in 3 rooted teeth to divide the tooth into multiple single units. To confirm that the tooth has been successfully sectioned, a dental elevator is placed between the segments and gently rotated. If the segments move slightly apart then the sectioning is complete; if the segments do not move following slight leverage between the cusp segments then the sectioning is likely to be incomplete and addition burring is necessary to complete the sectioning. Once the sectioning is complete the individual roots are extracted independently as previously described for simple extractions.

Techniques for Performing Surgical Extractions in Dogs
A complicated or surgical extraction technique is generally reserved for teeth that are difficult to extract because of their large root structure including the canine teeth, mandibular 1st molars and the maxillary 4th premolars. A surgical extraction may also be performed when teeth are ankylosed or when attempting to retrieve a broken root tip. The teeth most commonly requiring surgical extractions include the canine teeth and the carnassial teeth.

Surgical Extraction of Canine Teeth
Surgical extraction of the maxillary canine tooth is initiated by making divergent incisions mesial and distal to the canine tooth and creating a mucoperiosteal flap. The buccal alveolar bone is removed as needed with a large round bur to easily extract the tooth with luxators and dental elevators. Care should be taken
to avoid creating an oronasal fistula during the extraction. The periosteal layer of the flap is incised apically to relieve tension on the flap prior to closure.

There are two approaches for the surgical extraction of the mandibular canine teeth including the labial and lingual approach. The labial approach utilizes a mucoperiosteal flap located on the labial aspect of the tooth while a lingual approach utilizes a lingually located flap. Equal amounts of alveolar bone are present buccally and labially so there is no advantage of one technique over the other with regard to bone removal. The mental artery, vein and nerve exit through the mental foramen located near the labial aspect of the apex of this tooth. A lingual approach avoids potential damage to these structures.

**Surgical Extraction of the Maxillary 4th Premolars**
When performing a mucoperiosteal flap for the surgical extraction of the maxillary 4th premolar several structures should be carefully avoided. When making the mesial (rostral) portion of the incision the infraorbital artery, vein and nerve should be avoided as they exit the infraorbital canal immediately rostral to the periapical bone of the mesiobuccal root of the maxillary 4th premolar. These structures can be avoided by digitally retracting them dorsally and not extending this incision too far apically. When making the distal (caudal) part of the incision the parotid and zygomatic salivary duct papillae should be visualized and avoided. After raising the mucoperiosteal flap the furcations are located using a round bur. The tooth is then sectioned through the furcation between the mesiobuccal and distal roots with a #701L tapered fissure bur from the furcation through the crown. Alveolar bone over the distal root is removed as needed to remove the distal root. At this point some operators prefer to amputate part of the remaining portion of the crown. The bur is placed in the furcation perpendicular to the tooth at the base of the palatal wall of the mesiobuccal cusp to section the mesiobuccal and palatal roots. The alveolar bone over the mesiobuccal roots is removed as needed to remove the mesiobuccal root. The interradicular bone between the mesiobuccal and palatal roots can be removed as needed to expose the palatal root. When extracting the palatal root it is important to direct the luxator in a slightly palatal direction to follow the palatal direction of the apex of this root. The extraction site is débrided, flushed and closed in a routine manner.

**Surgical Extraction of the Mandibular 1st Molars**
The surgical extraction of the mandibular 1st molar is initiated with a mucoperiosteal flap with two divergent releasing incisions on the mesial and distal aspect of the buccal aspect of the tooth. The mucoperiosteal flap is raised and the furcation is located and sectioned. The distal and mesial edges of the cusps of the tooth may be removed to provide straight access to the periodontal ligament space. This is particularly helpful in teeth that are crowded. Buccal alveolar bone is removed as needed to extract the segments. Rough edges of the alveolar bone are reduced with a large round bur, the extraction site is débrided and flushed with sterile saline. The periosteal layer of the flap is released and the flap is closed in a simple interrupted manner.

**Extraction of Fractured Root Tips**
Surgical techniques for extraction of fractured root tips has been described. When a tooth root fractures it should be determined if the root must be retrieved and in most cases root fragments should be completely removed. Roots of endodontically and periodontally diseased teeth must be removed. However, teeth undergoing severe bony replacement/odontoclastic resorption may be best treated conservatively. When extracting fractured tooth roots a mucoperiosteal flap is raised and some of the buccal alveolar bone over the retained root is removed. When attempting to localize the fractured root the operator should examine the extracted coronal segment to mentally determine the anatomic features of the residual root structure. In addition, the operator should look for a white, hard, non-bleeding structure with a central pulpal red or black spot. Dental radiographs can help locate the fractured root tips. Other techniques that have been described include using the flat end of a cylindrical diamond bur on a high-speed handpiece to flatten the coronal aspect of the fractured root and a small area of the surrounding bone until the root is clearly visible in cross-section. A small round bur (# 1/2) is used to create a “gutter” or space around the root to place an elevator into the expanded PDL space. It is important to locate the periodontal ligament space while elevating a root because failure to locate this space often results in inappropriate placement of the dental elevator or luxator either on the alveolar bone or tooth. Elevation on the alveolar bone or tooth is ineffective and until the dental elevator or luxator is directed into the
periodontal ligament space removal of the root will not proceed efficiently. A luxator is placed in the space and gently rotated and held for 10-20 seconds around the entire circumference of the root. The periodontal ligament space will fill with a small amount of blood and can be observed as a thin red line located between the alveolar bone and the root. The dental elevator or luxator should be directed into this space to permit more effective elevation and efficient extraction of the root until it becomes loose and is easily extracted. The surgical site is débrided, flushed and closed routinely.

References:
Management of Challenging Oral Cases in Dogs
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Management of unusual oral cases include the management of osteomyelitis and bone sequestra, dentigerous cysts, dens-in-dente, base-narrow mandibular canine teeth, palatal defects, pharyngeal mucoceles, inability to open or close the mouth, electrical injuries, non-healing oral lesions, and ophthalmic manifestations of dental diseases.

Osteomyelitis and Bone Sequestra
Osteomyelitis and bone sequestra occur infrequently in dogs and cats and may be a complication of advanced periodontal disease, extraction complications or maxillofacial fractures. Several cases of severe osteomyelitis with secondary necrosis of bone have occurred in Cocker Spaniels and less frequently in other breeds. These animals are usually presented for examination because of fetid breath, severe oral pain, facial swelling, reluctance or inability to eat and have severe purulent nasal discharge if the osteomyelitis or bone sequestra are located in the maxilla. Dental radiography is performed to assist in the diagnosis. All necrotic bone and teeth in necrotic bone must be removed and the surrounding bone must be curettaged to the level of healthy, bleeding bone. Intraoperative samples should be collected and submitted for bacterial culture and sensitivity testing. Samples of tissue should also be submitted for histopathologic examination to rule out the possibility of an underlying neoplasia. The surgical site should be liberally flushed with sterile saline and closed with a mucoperiosteal flap using 3-O PDS in a simple interrupted pattern.

Dentigerous Cysts
Dentigerous cysts occur infrequently in dogs, however, the diagnosis of dentigerous cysts should be a primary consideration in young dogs presenting with fluid filled oral swellings. Additionally, the possibility of an iatrogenic dentigerous cyst must be considered in those dogs in which a deciduous tooth was extracted or a traumatic episode had occurred in a puppy and subsequently the permanent tooth fails to erupt. Definitive diagnosis of a dentigerous cyst is based on history, physical examination, radiography, and histopathologic examination. Dentigerous cysts arise from the cellular components of the developing dental follicle. The cyst contains one or more embedded teeth and usually surrounds the coronal aspect of the tooth. As the tooth bud continues to develop but fails to erupt, the cyst becomes filled with fluid. Fluid pressure within the cyst results in a smooth-bordered radiolucent cavity typically adjacent to the cementoenamel junction as viewed radiographically. The treatment of a dentigerous cyst usually involves surgical extraction of the affected tooth and thorough removal of the entire epithelial lining of the cyst wall which is submitted for histopathologic examination. Complete excision of the tooth and the cystic epithelium is curative.

Dens-in-Dente
Dens-in-dente is a rare developmental disturbance in tooth formation which results in an invagination of the epithelium associated with coronal development into the area of the tooth which was destined to become the pulp space. Following calcification of the tooth there is an invagination of enamel and dentin into the pulp space and a distortion of this space and the root contour to accommodate this invagination. This results in secondary endodontic disease and often convergence of roots in multirooted teeth which may be evident radiographically as large pulp canals and periapical lysis. This condition is often frequently bilaterally symmetrical and appears to most frequently affect the lower 1st molars in dogs. Treatment includes either exodontia or endodontic therapy.

Base-Narrow Mandibular Canine Teeth in Dogs
Base-narrow mandibular canine teeth in dogs often results in traumatic occlusion of the lower canine teeth with the soft tissues of the hard palate. This malocclusion can result from an extreme retrognathic mandible (more caudal than normal location of the mandible), brachygnathic mandible, excessive anisognathism (uneven jaw size), or retained deciduous canines that have directed the lower canines into
a more lingual than normal base narrow position. Since all of these conditions are considered to be genetically linked breeding of these animals is not recommended.

Some cases of base-narrow mandibular canine teeth may be corrected by encouraging dogs to play and chew on a large ball positioned in the front of the mouth. Malocclusions that are not successfully treated utilizing this simple technique may be corrected with direct bite planes. Bilateral inclined planes are constructed between the maxillary canines and third incisors so that the tip of the mandibular canine teeth hit the inclined planes in such a way as to redirect the mandibular canine teeth into a more normal location thereby eliminating the traumatic malocclusion. The time required for tooth movement utilizing this technique is usually between 2 and 6 weeks.

**Palatal Defects**

Animals with congenital palatal defects are usually presented for signs related to incomplete separation of the oral and nasal cavity including: drainage of milk from the nares during or after nursing; gagging, coughing, or sneezing while eating; and respiratory infection including rhinitis and/or aspiration pneumonia.

Once the decision is made that surgical intervention is an appropriate treatment option, the appropriate surgical procedure is selected based on the location and size of the palatal defect. Timing of the surgical repair is also critical and if possible the repair should be delayed until the patient is approximately 4 months old. The best chance of success is with the first surgical procedure and the larger the animal is at the time of surgery, the more tissue available for repair of the defect.

Two basic techniques have been described for the repair of congenital hard palatal defects including the medially repositioned double flap technique and the overlapping flap technique. The medially repositioned double flap technique involves creation of bilateral releasing incisions approximately 2mm from the upper dental arches. The epithelial margins are removed from along both edges of the defect. The mucoperiosteum is undermined bilaterally on both sides of the defect carefully avoiding laceration of the palatine arteries as they exit the palatine foramina palatal to the upper fourth premolars. The flaps are repositioned medially and sutured over the defect.

The overlapping-flap technique is generally preferred for repair of midline hard palatal defects because this technique is associated with less tension on the suture line, the suture line is not located directly over the defect and the area of opposing connective tissue is larger, which results in a stronger scar.

The overlapping-flap technique is initiated by making an incision the length of the palatal defect on the patient’s right side 2-3mm palatal to the maxillary dental arch. Perpendicular incisions are made at the rostral and caudal ends of this incision extending to the cleft. The caudal incision should be preplanned so that it lies over the hard palate and not through the soft palate to prevent creation of an oronasal fistula. A blunt tipped curved Freer periosteal elevator is used to carefully elevate the mucoperiosteal layer carefully avoiding the palatine artery as it exits the palatine foramen approximately 10mm palatal to the maxillary fourth premolar. When elevating in the area overlying the palatine fissure, a partial thickness elevation is recommended so that the deepest layer remains with the bone thereby preventing exposure of the palatine fissure and formation of an iatrogenic oronasal fistula. Care must also be taken when elevating this flap not to penetrate the medial edge of the cleft where the oral mucosa is contiguous with the nasal mucosa.

A second incision is made in the mucoperiosteum on the left side of the patient’s cleft along the entire length of the defect and the mucoperiosteum is elevated approximately 8-10 mm along the entire length of the defect.

The mucoperiosteal flap from the right side of the defect is hinged or folded over the defect and positioned between the hard palate and the mucoperiosteal flap on the left side of the cleft. The hinged flap should cover the defect and overlap beneath the opposite mucoperiosteal flap approximately 6mm without tension. In very wide defects, a secondary releasing incision 2-3 mm palatal to the left dental arch may be required to permit adequate overlap without tension. The hinged flap is sutured in place using
multiple interrupted horizontal mattress sutures using 3-0 monofilament absorbable suture material. These sutures should be preplaced from caudal to rostral and tagged temporarily with hemostats. Following placement of all sutures the sutures are tied from caudal to rostral. The defect created by the raised hinged flap is allowed to heal by second intention and usually takes 3-4 weeks to completely granulate and reepithelialize.

Midline soft palatal defects commonly accompany hard palatal defects. Soft palatal defects may occur when hard palatal defects are absent, however, they are more frequently identified when hard palatal defects are present. Midline clefts of the soft palate are most commonly seen and are located medial to the palatine muscles. Unilateral or bilateral congenital defects of the soft palate occur less commonly and are located lateral to the palatine muscle. Midline clefts of the soft palate can often be corrected utilizing a double layer appositional technique as long as no tension is created during closure of the defect.

Animals with hypoplastic soft palates with bilateral soft palatal clefts have significantly shortened soft palates. Oropharyngeal examination in these patients typically reveals a near absence of the soft palate with a small uvula-like projection that extends from the mid-caudal aspect of the hard palate. Various recommendations have been made concerning the most appropriate treatment for hypoplasia or congenital absence of the soft palate ranging from surgical correction to euthanasia. Normal compensatory mechanisms, proper dietary management, combined with surgery if necessary may permit dogs with congenitally shortened soft palates to lead a relatively normal life.

Prior to surgical repair of acquired palatal defects it is important to carefully decide what therapeutic plan is likely to be most successful in a particular type of defect. Therapeutic decision making in these cases is usually based on the cause, the size and location of the defect and whether or not there has been any prior surgical intervention. The best chance of success for repair of palatal defects is with the first surgical procedure; therefore, appropriate treatment planning is crucial. Various single-layer surgical techniques can be used to repair acquired palatal defects, including buccal flaps, rotation flaps, advancement flaps, tongue flaps, split palatal U-flaps, and island palatal flaps. In general, the technique that provides the largest flap with no tension and an adequate blood supply is recommended.

Pharyngeal Mucoceles
Dogs with pharyngeal mucoceles typically are presented because of difficulty breathing or swallowing. Confirmation of pharyngeal mucoceles is made on oral examination and aspiration of a clear or blood-tinged, ropey fluid that is consistent with saliva. The animal should be preoxygenated if possible prior to induction and entubated rapidly to prevent anoxia secondary to obstruction of the upper airway by the pharyngeal mucocele. Pharyngeal mucoceles are treated by marsupialization of the mucoceles and removal of the ipsilateral mandibular and sublingual salivary glands.

Inability to Open the Mouth
Several pathologic conditions in the dog can cause a dog to be unable to open the mouth. These conditions include masticatory muscle myositis, adhesion of the zygomatic arch to the ramus of the mandible following trauma, neoplasia in the region of the temporomandibular joint and craniomandibular osteopathy.

Inability to Close the Mouth
Several pathologic conditions in the dog can cause a dog to be unable to close the mouth. These conditions include idiopathic trigeminal neuropathy also known as canine dropped jaw syndrome and displacement of the coronoid process lateral to the rostral part of the zygomatic arch in dogs with dysplastic temporomandibular joints. Displaced teeth maloccluding with the opposite dental arch may prevent proper closing of the mouth. Foreign bodies wedged over the teeth may also prevent proper closing of the mouth.

Electrical Injuries
Chewing on electrical cords is the most common cause of electrical injuries in dogs and cats. Electrical burns occur primarily on the lips, gingiva, palate and tongue. Initially affected areas may appear charred, pale gray or tan. Edema occurs one to 2 days following the injury. The full extent of the injuries may not
be apparent for 2 to 3 weeks. Treatment of patients with electrical injuries includes assessment for pulmonary edema and treatment with diuretics, aminophylline and morphine. Repair of damaged tissues should be delayed until the full extent of the injuries is firmly established. Minor injuries often heal by second intention. Oronasal fistulas should be repaired with appropriate mucoperiosteal flaps. Necrotic bone must be debrided and teeth affected by electrical injuries should be appropriately treated.

**Non-Healing Oral Lesions**

When middle aged to older animals are presented because of difficulty eating the oral cavity should be carefully examined for oral lesions. When a non-healing oral lesion is found it should be examined closely. A fine needle aspirate should be taken for cytologic evaluations. In addition tissue samples should be taken for impression smears and histopathologic examinations. The possibility of a neoplastic process must be considered in these cases and treated appropriately.

Partial glossectomy may be necessary in dogs with extensive tongue trauma or tongue tumors. A type of trauma that may necessitate a partial glossectomy includes trauma caused by paper shredders. The most common malignant tongue tumor in dogs is a squamous cell carcinoma. A previous report in which major partial glossectomies were performed in five dogs demonstrated that major partial glossectomies were well tolerated by dogs and partial glossectomies may be viable treatment options for aggressive tongue tumors and other conditions that render the tongue unsalvageable. Performance of a partial glossectomy involves amputation of the tongue caudal to the lesion and in the cases of lingual squamous cell carcinomas up to 2 cm caudal to the lesion to help insure clean surgical margins. To perform a partial glossectomy a surgical marker is used to mark the proposed glossectomy site. A Doyen clamp may be placed cranial to the resection site to help prevent backbleeding during the surgical procedure. The amputation is begun on one side of the tongue and vessels are ligated as they are encountered advancing the incision across the tongue while closing the suture site intermittently. The mucosa of the dorsal aspect of the tongue is sutured to the mucosa of the ventral aspect of the tongue in a simple interrupted pattern. Adjunctive therapy should be considered in these cases because of the possibility of lymphatic and vascular invasion associated with lingual squamous cell carcinomas.

**Ophthalmic Manifestations of Dental Diseases**

There are several ophthalmic manifestations of dental disease including periorbital and orbital emergencies and are most frequently associated with periodontal and endodontic disease of the maxillary 4th premolar, 1st molar, and 2nd molar. Periorbital signs are usually depicted as acute painful periorbital swelling. Orbital signs are usually depicted as exophthalmus, elicitation of pain upon opening the mouth, and corneal ulcers. Conformation of a primary dental problem is achieved with a thorough oral examination and dental radiography. Severe periodontal disease with deep periodontal pockets, fractured teeth with pulpal exposure and endodontically diseased teeth without pulpal exposure may be the cause of the underlying ophthalmic signs. Treatment includes extraction of diseased teeth.

**References:**
