Complications of Extractions and How to Avoid Them
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Fractured root tips
Roots break during extraction even when the most accomplished exodontist is at the helm. What separates the pros from the pretenders is how you handle it when it happens to you. Atomization (pulverization of roots with a bur on a high-speed handpiece), though described in some textbooks, is an imprecise and potentially dangerous way of dealing with stubborn root tips. The author has seen one case of fatal bleeding in a cat in which atomization of the palatal root of the maxillary fourth premolar was attempted. Attempts at atomization of roots of the mandible may result in dislodging of roots into the mandibular canal. When a root fractures during extraction, the first step is creation of a pedicle flap if it has not already been done. Raise gingiva and mucosa away from the buccal (aka vestibular) bone, and remove bone lateral to the root. This creates a window in the bone through which the root tip can be gently guided through. The bone lateral to the coronal portion of the root may be removed with a #1 or #2 round bur, but as the operator moves closer to the apical blood supply, a small ¼ or ½ round bur is safer to avoid damage to the neurovascular bundle apical to the root. The ¼ round bur may also be used to create a “moat” around the entire circumference of the root to allow room for placement of a root tip elevator on the lingual/palatal side of the root. Root tip elevators and root tip forceps are very important to have in these situations. Another trick to try to get a grasp on a persistent root is use of a small endodontic file threaded into the root canal to allow for traction in the coronal direction.

Displaced roots
Roots may become dislodged in the process of extraction, particularly when disease has caused bone loss in the apical third of the tooth, resulting in loss of apical periodontal attachment. Atomization can increase the likelihood of dislodging roots since pressure is placed on the root in an apical direction. Sometimes, especially in cats with hypercementosis of the roots, the apical root may be wider than the mid-root diameter, making removal particularly difficult. Using the guidelines described above for root tip extraction can decrease the chances of displacement of a root into the mandibular canal or nasal passages. When this complication does occur on the mandible, the root can usually be removed by extending the releasing incisions of the existing flap and removing more buccal alveolar bone to gain access to the wayward root. Since attempts to remove the root may result in movement of the root throughout the canal, serial radiographs with a radiopaque marker (gutta percha point or 25 g needle) may be necessary to assess exact location of the root.

Dehiscence of extraction sites
Extraction sites heal much more rapidly when closed with a flap. Food, hair and debris are prevented from entering the healing socket, and for this reason, even those extraction sites affected by severe periodontal or endodontic disease are debrided, lavaged and closed primarily. If a flap dehisces, it is usually due to excessive tension. Three tips for creating tension free flaps: 1) make releasing incisions long enough to provide exposure and closure of the tissue over the socket after extraction 2) if a large perforation is created during the act of elevating the flap, incorporate the perforation into the new edge of the flap by trimming gingiva 3) release the periosteum with a pair of Metzenbaum, Ragnell or Iris scissors and test the degree of tension of the flap by laying the flap over the defect without sutures and see if it recolls. If so, separate the periosteum further. Though “dry sockets” do not appear to be a common problem in dogs and cats after extraction compared to humans, this complication is thought to occur due to dislodging of the clot from the healing socket, resulting in severe alveolitis of the bone lining the socket. Suturing the extraction site may help to prevent the clot from dislodging.

Iatrogenic jaw fractures
Iatrogenic jaw fractures occur most often during extraction of firmly rooted teeth. The mandibular canine tooth is the most common site (cat and dog) and extraction of the mandibular first molar tooth in small breed dogs may also result in iatrogenic fracture since the roots of this tooth often end at the level of the ventral cortex. Creating generous windows of bone removal on the buccal surface of the root can help to prevent iatrogenic fracture by decreasing the amount of force necessary to pry the root from the mandible. If iatrogenic fracture occurs at the level of the mandibular first molar, stabilization after removal of the tooth is often necessary to maintain normal occlusion and appropriate healing. This stabilization may run the gamut from simple to complex: tape muzzle, interfragmentary wiring, interdental wiring and composite splint, titanium miniplate, external fixator. When iatrogenic fracture at the site of the mandibular canine tooth occurs, once the tooth is extracted and the soft tissues are sutured, there is often no displacement.
and minimal mobility at the fracture site. Stabilization efforts should be dictated by degree of mobility: in some cases, careful closure of the extraction site flap, soft food without hard toys or treats for four weeks, and appropriate pain medications may be sufficient.

**Excessive bleeding**
Occasionally, a larger vessel may be damaged in the process of extracting a tooth. The most important thing to remember in these cases is this: don’t panic. Place a gauze sponge over the bleeding area and hold it with firm digital pressure for three minutes, resisting the temptation to remove the gauze every 30 seconds to check the site. Often, bleeding from the mandibular canal or from the nasal passage is not arising from a vessel that can be easily ligated. Therefore, provide digital pressure to allow for a clot to form, and don’t get a false sense of security that the bleeding is under control if the mean blood pressures are low. Closure of a tightly sutured flap over the area will help to hold a clot in place. Various hemostatic agents may be tried: bleeding from the bone may subside with use of bone wax.

**Recommended reading**
Feline Dentistry: Stomatitis, Tooth Resorption and More
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Feline dentistry requires an observant eye and a gentle, skilled hand to treat the diminutive teeth and lesions that occur on and around them. Practice of feline dentistry also requires some specialized equipment above and beyond what is used for canine dentistry. This lecture will focus on the most common oral/dental problems seen in cats today.

Tooth resorption
Tooth resorption (TR) is common in cats. Most studies have found a prevalence rate of 20 to 70%, depending on the population of cats and the investigative methods employed.¹ The lesions are usually appreciated clinically at the cervical portion of the tooth, which may be hidden by gingiva. However, recent histological studies have found that these lesions begin on the root surface, and radiographic changes can often be seen before a clinical lesion is obvious.² When a lesion develops at the gingival margin, the adjacent gingiva often covers these lesions with a combination of hyperplastic gingiva and granulation tissue. A fine-tipped explorer (ODU #11/12 or Orban #17 explorers are good choices rather than the traditional Shepherd’s hook #23) should be used to check for irregularities where the explorer catches on a rough defect with distinct borders. In the past, these lesions have been treated by restoration with glass ionomer cements, but follow-up studies have shown poor long-term results with restoration.³ Therefore, extraction is the treatment of choice. Dental radiographs of these teeth are a complete and total necessity to evaluate the severity of resorption and to guide treatment.

Sometimes it is not possible to perform a complete tooth extraction due to severe root replacement resorption, where all or a portion of the root has been replaced by a reparative bone-cementum material. When this occurs, the tooth root becomes incorporated into the adjacent alveolar bone. Radiographs in this case suggest a non-inflammatory evidence of resorption, referred to as root replacement. Radiographic signs include loss of periodontal ligament space and decreased root density, approximating that of the surrounding bone density. When this radiographic appearance is seen, in the absence of: 1) periodontal pockets of affected tooth 2) endodontic disease (no brainer) 3) stomatitis or 4) immunosuppressive disease, it is possible to perform a crown amputation. Hard tissue with characteristics of tooth root is removed and resorbed root which has been replaced by bone is left in place. The tooth crown and coronal root segment are removed with a dental bur in a high-speed handpiece. The crestal alveolar bone is smoothed with a dental bur, and the gingiva is always closed with absorbable suture over the crown amputation site.⁴ Without dental radiographs, a determination cannot be made as to whether crown amputation is an acceptable technique.

Multiple etiologies have been proposed to explain TR, including extension of periodontal disease, genetic or anatomic anomalies, mechanical trauma, endocrine abnormalities, infectious disease, age-related changes, and dietary aspects. In a recent histological study, clinically and radiographically normal teeth of cats with TR on other teeth showed histological signs of periodontal ligament degeneration, hypercementosis, dentoalveolar ankylosis and resorption, suggesting that TR is a generalized disorder of all teeth rather than a focal disease of isolated teeth.² It is generally accepted that the prevalence of TR has increased over the past four decades at a rate that cannot be explained entirely by increased awareness and improved diagnostics.⁵ Also, feral cats exhibited a much lower prevalence rate than that seen in domestic cats.⁶ It is difficult to explain the increased prevalence of TR by physiological degradation associated with aging. The cause of TR likely resides in an environmental change or aspect of domestication that (1) has increased in popularity since the 1960s; and (2) is capable of causing changes to the entire periodontium of multiple if not all permanent teeth.

Recent findings suggest that one aspect of domestication related to diet may possibly be associated with the development of TR. A statistically significant increase in serum 25-hydroxyvitamin D concentrations has been found to be present in cats with TR compared to cats with no clinical or radiographic evidence of TR.³ Experimental oversupplementation of vitamin D and its metabolites in dogs and rats has revealed marked periodontal ligament degeneration, hypercementosis, hyperosteoindosis and alveolar bone expansion, and several other histological changes that parallel those seen in cats with TR.⁸ Cats are unable to produce vitamin D in their skin.⁹ Nutritional research has shown that plasma concentrations of 25-hydroxyvitamin D in kittens is directly related to the dietary intake of vitamin D.¹⁰ Vitamin D must be obtained from food, although the requirement for cats appears to be low. Based upon mean plasma concentrations obtained after feeding a diet of known vitamin D level, a minimum vitamin D concentration of 250 IU/kg dry matter has been recommended for commercial diets.¹¹ Marine fish, a common source of protein in dry and canned cat food, contains substantial levels of vitamin D. Mackerel flesh contains a mean of 9,500 IU/kg dry matter whereas mackerel viscera contains a mean of 144,000 IU/kg dry matter. Therefore, whole minced fish often contains 25,000 IU/kg dry matter.⁹ It has previously been determined that 36 of 49 (73%) canned cat foods tested had vitamin D concentrations greater than 1,500 IU/kg dry matter, and 15 of 49 (31%) foods tested were in excess of the Association of American Feed Control Officials’ (AAFCO) recommended maximum level of 10,000 IU/kg dry matter.⁹ Though this is compelling evidence supporting a role of vitamin D in causing changes to the periodontium, a cause-and-effect relationship between chronic increased dietary intake of vitamin D and development of TR has not yet been proven.
Experimental long-term feeding studies are imperative to definitively determine if vitamin D in the development of TR. There may be a connection between TR and other common feline oral pathology including alveolar bone expansion and tooth extrusion (supereruption), as cats with TR are significantly more likely to exhibit extrusion of their maxillary canine teeth. Stomatitis

Diffuse inflammation of the entire oral cavity is seen commonly in cats. When inflammation is confined to the gingiva, it is referred to as gingivitis. When the inflammation extends beyond the mucogingival junction in cats, it is called stomatitis, or feline gingivostomatitis (FGS). Stomatitis may be due to a variety of causes, including ingestion of a caustic substance, uremia, viral exposure, plant foreign bodies, allergic response to drugs, or most commonly, immune-mediated causes. Cats are often affected by a type of stomatitis referred to as lymphohematopoietic stomatitis (LPS), which can involve gingiva, alveolar mucosa, buccal mucosa, sublingual mucosa, and even the mucosa of the caudal oral cavity lateral to the palatoglossal folds. Cats often present with decreased appetite or anorexia, halitosis, dehydration, and blood-tinged saliva. This can be further characterized based on location. Rostral stomatitis refers to inflammation adjacent to the teeth, and caudal stomatitis refers to inflammation in the caudal oral cavity lateral to and sometimes including the palatoglossal folds. The cause of FGS is not clear, but it appears that cats develop inappropriate inflammation in the presence of even small amount of plaque accumulation. Many cats with FGS concurrently shed both herpesvirus and calcivirus. These viruses may have an effect on the immune system, resulting in an overzealous or deficient immune response to plaque. Therefore, plaque control in the form of frequent dental cleanings and home care is very important. Unfortunately, many FGS cats are so painful that home care is not feasible. Immunosuppressive agents such as corticosteroids and cyclosporine help in many cases, but when medical therapy fails or causes unacceptable side effects, full mouth extractions or nearly full-mouth extractions have been shown to provide clinical resolution of oral discomfort in approximately 70-80% of cases.

A review of the disease was written by Lyons in VCNA, 2005. There are some interesting questions that need to be answered regarding etiology and treatment of stomatitis. First, what is the role of Bartonella in the development of stomatitis? This is still unclear, though cats seropositive for Bartonella show an increased incidence of stomatitis. It appears that azithromycin is not the magic bullet we had hoped it would be. If Bartonella does play a role, it may not be in every case, but rather in cases where proliferative mucosal disease is present. Proliferative vascular lesions of the oral cavity are seen in humans affected by bacillary angiomatosis, which is caused by *B. henselae* and/or *B. quintana*. A study recently looked at the effectiveness of cyclosporine in treatment of stomatitis. Whole-blood cyclosporine levels >300 ng/ml were associated with significant improvement in oral inflammation in cats with chronic stomatitis that had previously undergone premolar-molar or full-mouth extraction. CO2 laser as an adjunctive treatment of refractory stomatitis has helped to contribute to a cure in some cases, but this technology is not a panacea.

Periodontal disease

Periodontal disease (PD) is the most common disease occurring in dogs and cats. The periodontium is composed of four supporting structures of the tooth: 1) periodontal ligament 2) gingival connective tissue 3) alveolar bone forming the tooth socket, and 4) cementum covering the surface of the root. Healthy gingiva has a sharp, tapered edge (margin) that lies closely against the crown of the tooth. The free gingiva forms a moat around the tooth called the gingival sulcus. The epithelial attachment to the tooth crown forms the bottom of the gingival sulcus. Periodontitis is caused by accumulation of subgingival plaque and the body’s response to it. Plaque is a white/tan film that collects around and within the gingival sulcus of the tooth. It is composed of bacteria, food debris, exfoliated cells, and salivary glycoproteins. Within as quickly as 24 hours if left undisturbed, plaque will mineralize on the teeth to form dental calculus (sometimes referred to as “tartar”), a light brown or yellow raised irregular deposit adherent to the tooth and root surfaces. This irregular, plaque retentive surface of calculus allows for further plaque accumulation. As the plaque accumulates within the gingival sulcus, it damages the gingival tissues by releasing bacterial by-products which can damage the periodontium. The patient’s immune response may also cause tissue damage through the release of inflammatory cytokines from white blood cells as they attempt to destroy the bacteria. In the early stages, the gingiva becomes inflamed and bleeds easily. As the disease progresses periodontitis results in attachment loss. Attachment loss is clinically detectable in its earliest stages by measuring pocket depths with a periodontal probe in the anesthetized patient. The depth of this sulcus is less than 1 mm in the cat. If the depth is greater than this, it is due to either pocket or pseudopocket formation. A pocket forms when there is loss of attachment of the junctional epithelium which allows the probe to extend deeper than normal.

A pseudopocket is caused by overgrowth of the gingiva, called gingival hyperplasia (histological diagnosis) or gingival enlargement (clinical diagnosis). Probing depths may be increased in these cases even though there is no loss of attachment of the junctional epithelium. Gingival enlargement is uncommon in cats compared to dogs. Removal of excess gingiva is necessary in cases where pseudopockets are present to prevent accumulation of plaque and hair in the pseudopockets. In contrast, treatment of true pockets is accomplished by use of curettes to perform subgingival curettage and root planing. The difficulty in performing advanced periodontal procedures in cats is that a gingival collar must be present or regenerate in order to provide a good long term prognosis for a tooth, and any degree of gingival recession may make it difficult to fulfill this criterion. In cases of advanced periodontal disease,
extraction of the affected tooth may be the most appropriate treatment, especially if home care is not feasible. Studies are ongoing to evaluate the degree of inflammatory mediators in cats detectable in serum before and after dental disease is treated.

**Oral neoplasia**

Oral tumors account for approximately 4-12% of all feline neoplasia. These tumors are often aggressive and prognosis depends on early detection. The most common oral tumor in cats is squamous cell carcinoma (SCC), which accounts for approximately 70% of all oral tumors in cats. To be able to provide a cure for SCC, early detection is particularly important in cats due to the patient’s smaller size and need to obtain clean surgical margins while still maintaining adequate function. Cats that undergo radical maxillectomy or mandibulectomy for removal of an oral tumor generally function well postoperatively, and the majority of clients are pleased with long term quality of life and appearance. Cats do recover more slowly from maxillectomy and mandibulectomy than dogs and often require placement of a feeding tube (usually an esophagostomy tube) during the recovery period, whereas dogs usually eat and drink within 24 hours after surgery. One study found that 12% of cats undergoing mandibulectomy never regained the ability to eat.

A number of “take home points” for cats with suspected SCC follow. First, it is important to obtain a biopsy in suspected cases, because SCC lesions can look similar to other lesions such as feline stomatitis or eosinophilic granulomas. Use of advanced diagnostics such as dental radiographs or CT scan is very important in determining which patients may be cured with surgery. Although SCC in cats is historically considered unlikely to metastasize, aspiration of mandibular lymph nodes is warranted prior to mandibulectomy or maxillectomy, since the author has seen a number of cases which have metastasized to the mandibular nodes. Finally, the possibility of a surgical cure is not always possible depending on location and size of the tumor. Sublingual and caudal maxillary masses are unlikely to be cured surgically. However, rostral and mid-body mandibular masses may be amenable to radical resection by an experienced oral surgeon.

One study which looked at risk factors for development of feline SCC showed an increased risk in cats who wore flea collars. Other risk factors included intake of tuna and a diet consisting of predominantly canned foods. A review of the disease was published in 2015 in the Journal of Veterinary Dentistry.

**References**

Why should we take dental radiographs?
Use of dental films in veterinary medicine was first documented in 1958, and digital technology has made its use easier than ever. Intraoral radiographs are essential for both planning and assessing outcomes of dental treatment, particularly in cats. Radiographs provide the clinician with an important diagnostic tool to detect pathologic conditions that are not clinically visible in the mouth. The following are types of pathologic findings for which dental radiographs are useful: root resorption, caries, periapical radiolucency (often seen with tooth root abscesses), periodontal bone loss, retained root tips, unerupted teeth, osteomyelitis, neoplasia, tooth and jaw fractures, foreign bodies, and disease of the temporomandibular joint (TMJ). The veterinary patient must be heavily sedated or, better yet, anesthetized for quality dental radiographs to be obtained. Intraoral dental radiography is becoming more routine in general veterinary practice, and it is not possible to make well-informed decisions about treatment planning in cats without taking dental radiographs.

The results of a prospective case-control study was published in 1998 in the American Journal of Veterinary Research which looked at the diagnostic value of full-mouth dental radiographs in dogs. Radiographs of teeth without clinical lesions yielded incidental and clinically important findings in 41.7 and 27.8% of dogs, respectively. Radiographs of teeth with clinically visible lesions yielded additional or clinically essential information in 50.0 and 22.6% of dogs, respectively. The conclusion of this study was the diagnostic yield of full-mouth radiography in new canine patients referred for dental treatment is high, and routine use of full-mouth radiography is justified.

Equipment
The dental x-ray machine may be wall mounted, or it may stand on the floor with wheels that permit storage when not in use. The unit is composed of three primary parts: the control panel, a long (72- to 86-inch) arm that extends from the control panel, and a tube head that is attached to the end of the arm. The control panel, which typically is mounted to a wall near the dental workstation, contains the power switch, selector buttons for kilovoltage and milliamperes, a dial or buttons for changing exposure time, and a button that is located at the end of a 6-foot coiled cord. Many dental x-ray units have an internally set level of kilovoltage and milliamperes, and only exposure time may be changed for a darker or lighter technique. The timing selection may be located at the end of the cord of some newer models. An indicator light and an audible sound are emitted from the control panel when exposure is attained. The dental radiograph machine should be inspected regularly for leakage. Many states require such inspections.

The milliampere (mA) setting regulates the intensity of the electrical current that heats the filament (cathode), thus controlling the quantity of electrons available to bombard the target (anode). Milliampere-seconds (mAs) describes the quantity of radiation, which is determined by multiplying the milliampere by the exposure time. For example, a film exposed for \( \frac{1}{2} \) second at 10 mA would have an exposure of 5 mAs. The peak kilovoltage (kVp) is a measure of electrical force that regulates the speed at which electrons travel between the negatively charged cathode (filament) and the positively charged anode (target), thus controlling the quality of the x-ray beam. When electrons hit the anode at a higher force, x-rays produced have greater penetrating power at the surface of the skin. Most dental machines operate at 60 or 70 kVp. Low kilovoltage settings result in images with high black-white contrast; this is useful in detecting caries or resorption. High kilovoltage settings result in low contrast with a wider gray scale between black-white densities; this is useful in monitoring periodontal disease.

The cathode and the anode are housed in the Coolidge tube, which is located in the tube head at the end of the articulating arm. Within the tube head, the Coolidge tube is immersed in oil to help absorb the heat produced at the target. The position-indicating device (PID) contains a collimator that controls the beam size. Ranging from 8 to 16 inches in length, the PID extends from the tube head to the patient’s mouth and aids in minimizing scattered radiation.

Safety
All veterinary staff members should be familiar with radiation safety guidelines. The timer switch can be remotely wired and mounted outside of the dental treatment room, or at least 6 to 8 feet away from the tube head. Standing at a distance behind a barrier or at a 90-degree to 130-degree angle that is perpendicular to the beam will place the technician in a safe position, away from the direction of the beam. The film should never be held in the patient’s mouth by the technician while the radiograph is taken; therefore, anesthesia is necessary not only to ensure diagnostic quality films, but also for safety reasons. The machine should be inspected regularly for leaks by a competent radiation expert, as may be required by state regulations. Development of skills will minimize unnecessary radiation from retakes resulting from poor technique or positioning.
Radiographic positioning techniques

Three techniques are commonly used to obtain dental radiographs: parallel, bisecting angle and occlusal techniques. Each technique varies in the relationship of the beam to the film and the teeth to be imaged. Film of proper size is placed into the mouth and is held in position with gauze. The parallel technique requires the film to be placed parallel to the long axis of the tooth, therefore, only the mid-and caudal mandibular body can be imaged using the parallel technique. The beam is directed at a right angle to the film/sensor and is positioned to aim for the center of the film. Parallelism can be used only on the mandibular cheek teeth, where the film can easily be placed medial to the mandible. To ensure the roots of the mandibular third premolar are captured on the image, place a gauze square or a paper towel in the mouth dorsal to the sensor to push the sensor further into the Intermandibular space.

The symphysis at the rostral portion of the mandible and the flat palate of the maxilla prevent use of the parallel technique. To minimize inherent distortion of dental structures when the parallel technique is not an option, the bisecting angle technique is used. The X-ray beam is projected at a right angle to an imaginary line that cuts in half (bisects) the angle formed by the plane of the film and the long axis of the tooth.

The occlusal technique places the film on the occlusal plane and directs the beam at a right angle to the film. Typically, this view is of value in showing larger areas on one film, with applications available to view nasal disease and to identify root remnants by shooting through their long axis.

Radiographic interpretation

To assess the presence of intraoral pathologic conditions on radiographs, it is essential to have knowledge of the appearance of normal radiographic anatomic structures. The radiodensity of the components of the teeth and supporting structures varies widely; therefore, the terms radiopaque and radiolucent are used to describe the relative radiographic appearance of oral and dental structures. Radiopaque structures, such as cementum, dentin, bone and enamel absorb or deflect radiation, causing that portion of the radiographic image to appear light or white. The thin layer of enamel covering the crown is the most radiodense structure of the tooth. The lamina dura, which is a cribriform plate of bone lining the tooth socket, appears as a white line adjacent to the periodontal space surrounding a healthy tooth. Beyond the lamina dura, the trabecular pattern of bone may vary in radiodensity. The cortex of the mandible is radiodense. In contrast, radiolucent structures, such as soft tissue and periodontal ligament space, appear dark or black because X-ray photons can easily pass through to the film or sensor. The periodontal ligament fibers are not visible on the film; however, the space they occupy can be traced as a black line between the root surface and the lamina dura. Because pulp is soft tissue, it appears as a dark area (less radiodense) in the center of the tooth. The radiolucent mandibular canal lies apical to most of the mandibular tooth roots. In dogs, the middle mental foramen is located ventral to the apex of the mesial root of the second premolar tooth and can be misinterpreted as a periapical pathologic condition.

The periodontium refers to the attachment structures of the teeth. The four components of the periodontium are alveolar bone, periodontal ligament, cementum of the root surface, and gingival connective tissue. It is important to know the normal number of roots. The cementum and the underlying root dentin have the same radiodensity. Alveolar bone is very dense where the periodontal ligament attaches and this results in a radiodense white line that is referred to as the lamina dura. The periodontal ligament space is filled with soft tissue periodontal ligament fibers, and therefore shows up as a black space of equal thickness around the entire root, except where it may be wider around the apex of certain teeth (such as the maxillary canine tooth 104, 204). The soft tissue center of the tooth is seen on radiographs as the pulp chamber in the crown of the tooth and the root canal in the root(s) of the tooth. The root canal width should be similar to its contralateral tooth if vital. If the canal is wider than expected, this may be a sign that the tooth died previously and is not maturing like it should.

The only tooth in the mouth of a cat that has three roots is the maxillary fourth premolar (teeth 108, 208), but the maxillary third premolar (teeth 107, 207) has a third root in approximately 10% of cats.

Foramens are openings in the bone through which neurovascular bundles travel. The infraorbital foramen in the maxilla of the cat is not likely to become superimposed over tooth root apices, but the middle mental foramen of the mandible is superimposed over the apex of the mandibular canine teeth (teeth 304, 404). A caudal mental foramen is often positioned between the two roots of the mandibular third premolar tooth and can be of a very variable diameter.

Normally, there is much superimposition of maxillary and nasal structures over the maxillary teeth, including nasal conchae, incisivomaxillary canal, palatine fissures and incisive foramen.

Periodontal disease

Periodontal disease is the most common dental disease in dogs. The first radiographic sign of periodontal disease is a blunting of the alveolar margin of bone at the cementoenamel junction. As bone loss progresses, it may manifest as vertical bone loss along the long axis of the root, which will result in an infrabony pocket on probing. Diffuse bone loss resulting in decreased alveolar bone height along the long axis of the mandible or maxilla is called horizontal bone loss.

Tooth resorption

External tooth resorption is perhaps the most common dental disease in cats, rivaled only by periodontal disease. These diseases look very different radiographically. External tooth resorption is an entirely different process than internal resorption, occurring on the root
surface and often extending to the cervical portion and the crown of the external tooth. Internal tooth resorption, in comparison, occurs within the endodontic system of the tooth as a focal widening of the root canal or pulp chamber. For external resorption, a variety of appearances may occur depending on the type of tooth resorption. Since the degree of root replacement resorption dictates the proper treatment for an individual tooth root, dental radiography is critical in feline dentistry. Type 1 radiographic appearance of tooth resorption describes a focal lesion with normal tooth root density and normal periodontal ligament structure. Type 2 describes the radiographic appearance of root replacement resorption, where the density of the root approximates that of the surrounding bone, and loss of periodontal ligament structure is seen (the black line is replaced with bone density). Type 3 radiographic appearance describes a tooth that has both Type 1 and Type 2 lesions in different parts of the tooth.

**Tooth extrusion and alveolar bone expansion**

Tooth extrusion and alveolar bone expansion are seen commonly in middle aged and elderly cats. Extrusion is seen with the maxillary and mandibular canine teeth and may be related to loss of attachment due to periodontal disease, but it is sometimes seen in the absence of any significant periodontal bone loss. Alveolar bone expansion, also referred to as buccal bone expansion, is seen mostly around the maxillary canine teeth. When biopsied, this expanded bone may show signs of alveolar osteitis or normal woven bone.

**Endodontic disease**

Endodontic disease is also common in dogs, either in teeth with crown fractures, discolored crowns, or as an incidental finding in clinically normal teeth. The cardinal signs of a non-vital tooth include a lack of normal maturation of the canal (the canal should get more narrow with age), lucency of periapical bone, loss of normal periodontal ligament structure in the apical area, and periapical root resorption. Not all of these findings are present in every case of endodontic disease. In dogs, a normal anatomic variation may mimic periapical lucency associated with endodontic disease. This normal anatomic variation has been referred to as a “chevron” lucency. These lucencies tend not to be much wider than the tip of the root, unlike a true periapical lucency that is often wider than the tip of the root.

Endodontic disease can sometimes be difficult to discern in cats since periapical bone loss is not always as apparent as it may be in dogs with a non-vital tooth. However, as in dogs, the cardinal signs of a non-vital tooth include a lack of normal maturation of the canal (the canal should get more narrow with age), lucency of periapical bone and loss of normal periodontal ligament structure in the apical area.

**Tooth and jaw fractures**

Pulp exposure is best diagnosed on clinical examination rather than by reviewing the appearance of the crown on dental radiographs. Most canine tooth fractures in cats have exposed pulp, since the pulp is often a millimeter or less from the cusp of the tooth. A tooth that has pulp exposure is referred to as a complicated tooth fracture. If the pulp-exposed tooth fracture is limited to the crown, it is called a complicated crown fracture. If the pulp-exposed fracture extends beneath the gingival margin, it is called a complicated crown-root fracture.

Jaw fractures in cats are most commonly occurring around the symphysis or caudally in the ramus/TMJ area. The most common mandibular injury is a symphyseal separation, which is not truly a fracture but rather a tearing of the fibrous joint that connects the left and right mandibles rostrally.

**Neoplasia**

The most common oral neoplasia in cats is feline oral squamous cell carcinoma (SCC). It often manifests differently on the mandible than on the maxilla. Maxillary SCC often shows radiographic evidence of severe decreases in bone density and loss of multiple teeth. Mandibular SCC often shows a prominent “sunburst” appearance due to periosteal proliferation surrounding lytic areas.

**Temporomandibular joint luxation**

Temporomandibular joint (TMJ) luxation typically occurs in a craniodorsal direction, and therefore it can be diagnosed on a dorsoventral view of the mandibular condyle and the mandibular fossa of the temporal bone. Easier to capture on a size 4 dental film than the standard size 2 sensor, the space between the mandibular condyle and the mandibular fossa will be significantly wider than the normal contralateral side. Clinically, the luxation results in a shift of the jaw to the side opposite of the luxation and tooth-to-tooth contact of the caudal premolars and molars. Another disease that may mimic TMJ luxation is Open Mouth Jaw Locking (OMJL). Open mouth jaw locking is common in Persian cats and may be due to TMJ dysplasia, which results in laxity of the joint either unilaterally, or more commonly, bilaterally. Eventually, this laxity may allow the coronoid process to be caught on the ventrolateral surface of the zygomatic arch.

**Recommended reading**


Flaps are our friends!
When I speak with general practitioners about extraction of firmly rooted feline teeth, sometimes they will begin the conversation with a confession: “we don’t do flaps here”. To this I will pose an analogy. Trying to extract large, firmly rooted premolar, molar or canine teeth without a flap is analogous to trying to exit a building through a window instead of a door. It can be done, but not reliably, and not without much frustration!

For our discussion today, let’s use the scenario of a feline patient whose right mandibular cheek teeth need to be extracted (third premolar (407), fourth premolar (408) and first molar (409) teeth. This raises an important point about extraction of adjacent teeth. If you identify a tooth that needs to be extracted, assess the adjacent teeth to determine if these teeth also need to be extracted. If so, rather than raising multiple flaps for each individual tooth, a single flap can be raised to extract multiple teeth. For our example of extraction of teeth 407-409, a single flap is raised, starting with a releasing incision just caudal to the labial frenulum. The labial frenulum is the triangular, raised tissue that sits between the crown of the canine tooth and the crown of the mandibular third premolar tooth in cats. The releasing incision is started with a #15 scalpel blade at the most mesial (front) aspect of the gingiva of the third premolar and is continued ventrally for approximately 8 millimeters. The tip of the scalpel blade is then inserted into the sulcus of tooth 407 from the releasing incision caudally and extended into the sulcus of lateral 408 and 409. The incision is finished approximately 5 mm caudal to the caudal aspect of the crown of tooth 409. A releasing incision may not be necessary caudal to tooth 409 but can be done if necessary. The flap is carefully raised with a small periosteal elevator, and a suture may be placed to reflect the flap without trauma.

Use your drill to make extractions easier
Now that a flap is raised, use a high speed dental drill with a #2 carbide bur to remove a window of bone over the roots of all teeth being extracted (Figure 1). How much of the root should be exposed? I usually expose 60-70% of length of the root to allow for minimal force to pry the crown-root segments from the windows created. Once the windows have been created and the furcations slightly exposed with the #2 bur, use a #701 crosscut fissure bur to section the multi-rooted teeth into single-rooted crown-root segments. A few notes about this portion: 1) to fully separate the roots from each other, the bur usually needs to go slightly deeper into the furcation than you might expect. 2) the furcations of teeth 407 and 408 are where you’d expect them to be, but the furcation of tooth 409 is caudal to the mid-point of the crown. The mesial (front) root is larger than the distal (back) root. 3) always wear eye protection when using burs, especially thin crosscut fissure burs.

Patience, patience and more patience
Once the teeth are sectioned and the windows are created, we are ready to elevate the crown root segments from their sockets. Cat teeth are designed to stay seated in their sockets: millions of periodontal ligament fibers (Sharpey’s fibers) are preventing you from simply “pulling” the tooth, and these fibers need to be fatigued, stretched and torn to allow for delivery of the tooth. For teeth 407-409, I use a winged dental elevator 2 mm in width. I will begin elevation by placing the winged elevator into the space created by sectioning of the multi-rooted teeth. This allows for weakening of the periodontal ligament on the distal surface of the mesial root and the mesial surface of the distal root. Once I see some progress from elevating in this area, I will move to another spot, usually the distolingual or the mesiolingual surface of the crown root segments. The winged elevator is seated into the periodontal ligament space and gently twisted so a wing of the elevator pushes the crown-root segment out of the window on the lateral surface of the root. A few notes on this portion of the procedure: 1) be patient-with time you will get a feel for how much force is too much when rotating the wings of the elevator. 2) controlled force is the key: except for the initial seating of the elevator in the periodontal ligament space, force is not being directed in an apical direction-the force is being created by a gentle twist of the wrist. 3) always keep your index finger extended down the shaft of the elevator so if your elevator does slip, your index finger will catch on something hopefully before any significant sublingual trauma occurs. 4) if you hear the dreaded “crack” of the crown-root segment as you elevate, don’t fret. Think of this as an opportunity to remove the pesky crown so you can see the remaining root better!

If you break a root, make a moat
Even the best veterinary dentists have roots break during extractions. Some reasons include ankylosis (fusion of the root to surrounding bone) and hypercementosis (the reason for those challenging “bulbs” on the tip of the root), usually in geriatric patients. When you need to retrieve a root tip, reach for your high-speed drill. Rather than using the drill to pulverize the root (and possibly adjacent neurovascular structures) to oblivion, use a moat technique. A surgical length ½ round carbide bur can be used to enlarge the window on the lateral surface of the remaining root, and a 2 mm deep moat is created around the circumference of the root to allow for
Steps of surgical extraction

1. Place appropriate nerve block.
2. Take a preoperative radiograph.
3. Ensure a protected airway: the cuff of the endotracheal tube should be leak-free but not overfilled. Place a laparotomy sponge in the caudal pharynx. During the procedure, position the patient’s head so the tip of the nose is slightly ventral to caudal pharynx.
4. Raise a flap: flaps come in different shapes and sizes, and the key to efficient extraction is choosing the proper flap. A pedicle flap involves divergent releasing incisions at each edge of the flap. This flap provides the most exposure. A periosteal elevator is used to raise the gingiva and mucosa, with care to avoid perforation of the flap at the mucogingival junction. Blunt and sharp dissection of the periosteum from beneath the flap is accomplished by inserting a closed pair of Metzenbaum scissors (for small flaps, a 5-inch pair of curved tenotomy or small Metzenbaum scissors-work well) into the space between the mucosa and the periosteum at the edge of the releasing incision at the base of the flap. Once placed, the scissors may be opened to stretch the periosteum and separate it from the mucosa. The periosteum is transparent and may be bluntly or sharply dissected from the mucosa to mobilize large amounts of tension-free mucosa. This step is done prior to extraction to ensure adequate visualization and allow for rapid closure once the tooth is removed. A stay suture may be placed to reflect the flap with minimal trauma.
5. Remove a window of bone from the buccal (vestibular) surface of the root. Use a round carbide bur (size 1 or 2) on a high-speed, water-cooled handpiece to create a window in alveolar bone over buccal root surfaces. About 60 percent of root length is exposed, and if the tooth shows no signs of movement during elevation, more bone may be removed in the direction of the root tip (apically). Take care when using burs in the apical area to avoid bleeding and damage to neurovascular structures near the apex of the tooth roots.
6. Use a 1/2 round carbide bur to further expose the root structure. After bulk removal of vestibular bone with a size 1 or 2 round carbide bur, the root can be further excavated and the true outline of the root discerned with the light touch of a high-speed handpiece equipped with a quarter round bur.
7. Use a 699, 700, or 701 surgical carbide bur to section multi-rooted teeth. These are crosscut fissure burs that sections multi-rooted teeth into separated one-rooted tooth/crown segments. The bur must extend slightly into furcational bone to ensure complete separation of one root from another.
8. Ensure that the roots of multi-rooted teeth are separated. Insert a dental elevator into the space created by the 699-701 bur to observe whether subtle movement is visible when leveraging the elevator between separated crown/root segments.
9. Begin elevating the tooth. Place a winged dental elevator along the long axis of the root in between the separated crown segments of the multi-rooted tooth to begin to loosen both roots simultaneously. Continue to elevate along the long axis of each root with an appropriately sized elevator to separate the periodontal ligament. Place the elevator within the periodontal space, twist to generate slight movement of the root, and hold for 10 seconds. Twist and hold in the opposite direction for 10 seconds. As periodontal ligament fibers become stretched, elevators can be placed farther down the root toward the apex. Smaller elevators are more likely to fit in the periodontal ligament space and less likely to accidentally fracture the root.
10. If a root breaks off during elevation, remove more bone from the buccal surface and use a round bur to carefully create a moat around the remaining root. Use a smaller dental elevator or root tip elevator to pry the root through the buccal window. Avoid generating forces in the apical direction so the root isn’t displaced into the mandibular canal or nasal passage.
11. Use extraction forceps. Once the root is “piano key loose,” use extraction forceps to grasp the crown/root segment. Twist and hold in one direction for 10 seconds, in the other direction for 10 seconds, then gently pull. For fractured tooth roots, use diamond-coated root-tip forceps to grasp small roots.
12. Debride and lavage sockets. Use a bone curette to debride the socket and flush with 0.12 percent chlorhexidine, 0.9 percent saline or lactated Ringer’s solution.
13. Elevate soft tissue. Use a periosteal elevator to raise soft tissue on the lingual or palatal side of the exposed bone. This allows for easier suture placement.
14. Prepare the flap edge for closure. Trim tattered edges of the flap with Metzenbaum or Ragnell scissors.
15. Remove sharp bone edges. Use a large round diamond bur (No. 23) or a #2 carbide bur to smooth sharp edges of alveolar bone before flap closure.
16. Take a postoperative radiograph. This step provides assurance of a job well done and documentation in cases of postoperative complications.
17. Suture the extraction site. Closure allows for more rapid healing and prevents food and hair from accumulating in the site. Even extraction sites of overtly infected teeth can and should be closed after thorough debridement and lavage.
18. Close the flap starting with a suture at the gingival margin at the corner of a releasing incision using 4-0 (medium and large dogs) or 5-0 (cats and small dogs) absorbable monofilament on a tapered needle, simple interrupted pattern, about 3 mm apart.
19. Inspect the oral cavity: remove the laparotomy sponge and inspect the pharynx.

**Recommended reading**

Why do we love encountering the zebra diagnoses? They are real-world tests that walk through our door at any given moment. The zebra diagnosis adds variety to the more frequent common presentations. When encountered, accurate assessment of the zebra diagnosis allows us to utilize our years of training for the good of our patients.

A question for those of you who are veterinarians: when was the first time you heard of the disorder of sublingual linear foreign bodies? Was it when you worked in veterinary practice prior to veterinary school? Or was it during veterinary school? I vividly remember learning about sublingual linear foreign bodies in a second-year course of veterinary school. The professor described this as a common occurrence when cats ingest a piece of string or thread, which wraps beneath the ventral surface of the tongue. This results in sublingual swelling and often vomiting if the piece of string is long enough to cause irritation of the stomach or plication of the intestinal tract. I recall thinking “this has got to be a rare occurrence—I doubt I will see many cases of this throughout my veterinary career.” Just like “hardware disease” in cattle, truth is sometimes stranger than fiction. These things happen all the time.

Due to its frequency of occurrence, a sublingual linear foreign body in a young cat is not considered a zebra diagnosis. However, a sublingual linear foreign body in an elderly dog is certainly a zebra diagnosis, with neoplasia being much higher on the list of differentials in an old dog with sublingual pathology. What is considered a zebra diagnosis in a patient of a certain signalment may be considered common in a patient of a different signalment. A dog presents with a diffusely thickened tongue with pitting edema and a triangular pattern of ulceration in the frenulum area in a 10-year-old dog. Initially, a biopsy was done due to concern for a neoplastic process, but close inspection at the time of biopsy revealed, in the deepest area of ulceration, a linear foreign body embedded in the sublingual tissues. This dog enjoyed chewing on golf balls, and he was able to remove the cover of a golf ball and ingested some twine from the inside of a golf ball. An exploratory laparotomy showed the twine extended into the stomach and intestines, and multiple enterotomies were performed to successfully remove the linear foreign body.

Wegener’s granulomatosis is another zebra diagnosis in the dog. Until 2006, this immune mediated disease was never documented in the veterinary literature.1 It manifests as severely ulcerative or proliferative gingivitis and mucositis, and its aggressive appearance can mimic neoplastic processes such as squamous cell carcinoma.

A 7-year-old neutered male corgi presented with a large ulcerative lesion on his rostral maxilla of three weeks duration. Attempts to treat with clindamycin for two weeks and metronidazole for one week resulted in no change. One incisor tooth fell out prior to presentation. Interestingly, the dog had a similar lesion near the rostral mandibular canine tooth five months earlier. The mandibular lesion was treated by a previous veterinarian via excisional mandibulectomy due to a high suspicion of squamous cell carcinoma or other aggressive neoplasia. The portion of mandible was submitted for histopathology, which showed no signs of neoplasia. The maxillary mass was biopsied and this also showed no evidence of neoplasia. Histopathological findings were consistent with Wegener’s granulomatosis, or other immune mediated vasculitis. The patient was placed on prednisone therapy at 1 mg/kg/d for two weeks, then 0.5 mg/kg/d until the one month recheck. One month later, the patient presented for reexamination, and significant clinical improvement was seen, however severe gingival recession in the area would necessitate future extraction of four maxillary incisors.

This case illustrates a few important clinical points: 1) lesions other than neoplasia can have a very aggressive appearance, 2) incisional biopsy is always a good idea when owners can afford this expense as an initial step rather than an immediate curative attempt, 3) zebras are out there be on the lookout!

Signalment (age, breed and sex) may be a very important component of the information gathered when creating a list of differential diagnoses. Take the example of a patient that presents for a ventral mandibular swelling. Many a mandibular swelling has been caused by a non-vital tooth with endodontic infection, often as a result of a tooth fracture, or extension of periodontal disease to the level where it can invade the endodontic system of a tooth. However, numerous other possible causes exist. If unilateral mandibular swelling is seen in a 14-year-old dog, the non-zebra diagnosis of neoplasia would come to mind. However, if nonpainful swellings were occurring in both mandibles of a similarly aged dog with a history of severe chronic renal failure, fibrous osteodystrophy due to secondary renal hyperparathyroidism might come to mind.

What if the patient presenting with a mandibular swelling was a juvenile? There are many possibilities that could cause such a swelling, including bone fracture, callus formation, cellulitis, soft tissue abscess, tooth root abscess, dentigerous cyst, developmental abnormalities, fibrous osteodystrophy, odontoma, osteomyelitis, benign neoplasia, and malignant neoplasia. If the patient with a mandibular swelling is a 9-month-old West Highland white terrier, craniomandibular osteopathy (CMO) would come to mind as a top differential, particularly if the swelling was occurring on both mandibles, and if there was pain and limited range of motion when opening the mouth. If a mandibular swelling arises in a 4-month-old Labrador retriever, the cause of the swelling might be periostitis ossificans, a newly described entity in dogs. A case series of 5 large breed dogs affected by periostitis ossificans was published in the Journal of Veterinary Dentistry in 2010.2 The five dogs identified in this retrospective study ranged from 3 to 5 months of age, with a
The median age of 4.1 months. All were large breed dogs: two Labrador, one Dogue de Bordeaux, one Great Dane, and one Great Pyrenees. All dogs were males. The swellings appeared clinically to be unilateral in all 5 puppies, and pain on palpation was not detected when patients were assessed for pain. The swellings were centered at the level of the mandibular first molar tooth in all five cases. Character of the swellings in those dogs who were palpated was consistent: firm ventrally and fluctuant on the lateral intraoral component of the swelling. Dogs whose rectal temperatures were checked on presentation were within normal limits. Radiographically, each patient showed a consistent finding on the lateral intraoral radiographic view of the affected caudal mandible: a double cortex appearance at the ventral aspect of the mandible. Histopathological examination in each case tested revealed periosteal new bone formation with no inflammatory or neoplastic disease. Samples obtained from the core of the fluid-filled swelling in one dog revealed acute inflammation, fibrin deposition, and small pieces of necrotic bone embedded within inflammatory foci surrounded by marked proliferation of immature granulation tissue and new blood vessels. Treatment of these 5 patients varied, but the take home point of periostitis ossificans is this: regardless of treatment or lack of treatment, all 5 cases appeared to self-resolving. This is in contrast to CMO, which can be a life threatening disease due to progressive production of bone in the caudal mandible, TMJ area and calvarium. Long-term steroids are our treatment of choice for CMO due to their catabolic effects on bone.

Compare the radiographic appearance of CMO in a 9-month-old West Highland white terrier with the radiographic appearance of periostitis ossificans in a 4.5-month-old Labrador retriever. Clinical differences between these two diseases include level of discomfort, likelihood to see bilateral changes, and decreased range of jaw motion seen in CMO due to hypermineralization in the TMJ area, the calvarium, and the tentorum cerebelli. Radiographically, when comparing changes of the mandibular body, the periosteal reaction of CMO tends to be more severe with no evidence of the “double cortex” seen with periostitis ossificans.

Hopefully this list of differentials will help with your next case of mandibular swelling. Odds are good that the next mandibular swelling you will be due to the common tooth root abscess, but keep an eye out for the zebra diagnoses so they won’t catch you off guard! If you make an interesting craniofacial zebra diagnosis, send me an email to tell me about it at jlewis@northstarvets.com.

Recommended reading
The history is the first important step to making appropriate diagnostic and therapeutic decisions. Some simple approaches to obtaining a history will increase chances of gaining helpful information. Use of open-ended questions allows a client to tell his/her full story and provides the clinician with a full understanding of the owner’s perspective when coupled to attentive listening. Providing structure is necessary to redirect the conversation if open-ended questions result in tangential conversation. Pointed questions probe deeper in areas that seem important to explore. A good history taker allows the client to tell his or her story to obtain a complete understanding of what is occurring with the patient, and what is important to the client.

The physical examination provides the foundation for making decisions and brings the clinician to a diagnostic and therapeutic plan. A patient with the presenting complaint of halitosis leads us toward the diagnosis of periodontal disease even before we perform our physical examination, but it is important to thoroughly examine even the most straightforward of presenting complaints. Periodontal disease is the most common cause of halitosis, but any given case of halitosis may be due to a necrotic tumor, endodontic disease, idiopathic osteomyelitis/osteonecrosis, stomatitis, lip fold dermatitis, uremic ulcers or gastrointestinal disease. Ten to twenty percent of all cases of human halitosis are due to systemic causes such as gastric, hepatic, pancreatic and renal insufficiencies, trimethylaminuria, upper and lower respiratory tract infection, and medications.¹

The physical examination provides information necessary to assess risk of elective anesthetic procedures. Auscultation is performed in a quiet area to listen for cardiac murmurs or arrhythmias. The lungs are ausculted to listen for evidence of pulmonary pathology that may affect anesthetic plans. The trachea is palpated, especially in the proximal neck and thoracic inlet area of small breed dogs, to check for a cough that may be indicative of collapsing trachea.

The head, neck and oral examinations are done after the general examination, since the patient may be painful in these areas if presenting for an oral problem. The head and neck examination begins with extraoral observation of the head, face, eyes, ears, and neck using visual observation, palpation, and smell. Using gloved hands to avoid disease transmission, palpate each side of the face, head, and neck for symmetrical comparison. Assess the temporal and masseter muscles for the presence of atrophy, enlargement, or pain. Palpate the ventral, lateral, and medial surface of the left and right mandibles for the presence of swelling that could be evidence of neoplasia, infection, or fracture.

Visually inspect the ears and note evidence of discharge, odor or pain on palpation. Pain upon opening the mouth may be a result of severe middle ear disease. The eyes are palpated using thumbs on the closed eyelids to gently push (retropulse) both eyes at the same time. Bilateral retropulsion allows for symmetrical comparison of depth and firmness. If a space-occupying mass (as a result of neoplasia, inflammation, or infection) is present behind or beneath the eye, retropulsion may find a decreased ability of the globe to move caudally in the orbit on one side when compared with the opposite side. The normal ability to retropulse varies depending on facial conformation: brachycephalic dogs and cats have shallow orbits and less ability to retropulse. Observe for evidence of ocular discharge, which may be due to blockage of the nasolacrimal duct by a pathologic process, such as a tooth root abscess or neoplasia.

Evaluation of the neck includes palpation of the right and left mandibular salivary glands beneath the skin of the ventral neck. The three other major salivary glands are the facial glands, the sublingual glands which are often too diffuse to palpate easily (parotid, sublingual glands) or are not superficial enough to palpate (zygomatic gland). The mandibular gland is easily distinguished from the mandibular lymph nodes because it is softer, larger than, and caudomedial to the mandibular lymph nodes. Once the salivary glands are located, palpating cranially and superficially to the mandibular salivary glands may identify the mandibular lymph nodes. The mandibular lymph nodes are palpated bilaterally for symmetry and firmness. In the cat, mandibular lymph nodes may be small and difficult to palpate, unless they are enlarged. In the dog, mandibular lymph nodes are almost always palpable, ranging in size from 0.5 to 1.5 cm in diameter depending on the size and age of the patient. Other nodes that drain the head (retropharyngeal, parotid) are not normally palpable. Nine percent of dogs have an additional lymph node that is palpable in the subcutaneous tissue dorsal to the maxillary third premolar tooth. This node is referred to as the facial or buccal lymph node and may be seen unilaterally or bilaterally.²

The occlusion should be evaluated before intubation by noting any teeth that are positioned incorrectly. Attention is paid to discrepancies of jaw length, the spatial relationship of the teeth as they erupt, and the relationship of the erupting teeth with the soft tissues and dental structures of the opposing jaw. Class 1 malocclusion refers to a single or multiple teeth that are deviated from their normal occlusion in the absence of a jaw-length discrepancy. Class 2 malocclusion refers to a mandible that is abnormally short (mandibular distoclusion). Mandibular mesioclusion (Class 3 malocclusion) refers to a mandible that is longer than it should be. As part of the oral examination in immature patients, note any deciduous teeth that have not exfoliated by the time their permanent counterpart has erupted. Persistent deciduous teeth may create increased risk of periodontal disease due to crowding and abnormal position of permanent tooth eruption.
The intraoral examination consists of evaluation of the soft tissues of the oral cavity, the dental structures, and the periodontium, a term that describes the supporting structures of the teeth. Some of this information can be obtained in the conscious patient, but assessment of the periodontium requires anesthesia. Begin by observing the skin and mucosa of the upper and lower lips. Some breeds are prone to lip fold dermatitis caudal to the mandibular canine tooth that can cause oral malodor unrelated to periodontal disease. Vestibular or labial mucosa refers to the mucosa that begins at the mucocutaneous junction and lines the cheeks and lips. Alveolar mucosa refers to the mucosa that lies against the bone of the upper or lower jaw, which meets with the gingiva at the mucogingival junction. The normal appearance of the mucosa may be pink or pigmented, and the mucosa should exhibit no lesions, ulcerations, or swellings. Mucosa that lies adjacent to periodontally diseased teeth because the bacteria in the plaque may have painful mucosal ulcerations, often referred to as contact stomatitis or mucositis. Observe the caudal cheek lining in the region of the carnassial and molar teeth. This mucosa frequently becomes pressed between the teeth during chewing, creating a condition known as “cheek chewing lesions”. Similarly, mucosa beneath the tongue may also show signs of chewing lesions referred to as “tongue chewing lesions,” which are usually bilateral. These lesions usually do not require treatment unless the lesions are not bilaterally similar or if the lesions are ulcerated. In these cases, the affected mucosa may be removed and submitted for histopathological evaluation.

Two raised bumps are found on the alveolar mucosa dorsal to the maxillary fourth premolar and first molar teeth. Salivary secretions from the parotid and zygomatic salivary glands travel through ducts leading to these duct openings. Two similar raised bumps can be found beneath the tongue just caudal to the mandibular symphysis, which are the caruncles of the mandibular and sublingual glands. Care should be taken to avoid trauma to these structures when possible to avoid development of sialoceles.

Small-breed dogs with advanced periodontal disease may be affected by bone loss and pathologic fracture of the mandible, which may be found as an incidental finding in the examination room. If severe periodontal disease is suspected in a small breed dog, care should be taken to avoid creating a pathologic fracture when opening the mouth during the conscious exam or during intubation.

The roof of the mouth is composed of the hard and soft palate. The hard palate is covered by palatal mucosa arranged in prominent ridges, called rugae. These rugae range from eight to ten in number. In brachycephalic dogs, the rugae are closely positioned, and hair and debris can accumulate in these rugal folds. On the midline of the hard palate, just caudal to the incisor teeth, the incisive papilla is a round, slightly raised structure. Lateral to the incisive papilla, a small bilateral communication with the incisive duct and vomeronasal organ exist. The vomeronasal organ is a sensory organ involved in detection of pheromones and other volatile compounds. Palpation of the area lateral and caudal to the incisive papilla may normally feel as if there is air trapped beneath the mucosa as a result of the communication between the mouth and these nasal structures. The soft palate consists of mucosa and muscle that separate the oropharynx and nasopharynx. Two prominent bony structures can be palpated just lateral to the midline of the soft palate that are the hamular processes of the bilateral pterygoid bones. If one or both hamular processes are difficult to palpate, this may be due to the presence of a nasopharyngeal mass.

The pharynx should be evaluated for evidence of inflammation or neoplasia. When the patient’s mouth is open, bilateral folds of pharyngeal mucosa will be evident lateral to the tongue. These are the palatoglossal folds, and this area and the mucosa lateral to these folds may be inflamed in cats with caudal stomatitis.

Gently hold the tip of the tongue to enable visual examination of the dorsal, ventral, and lateral surfaces. The firm, tubular structure palpable on the midline of the rostral tongue is called the lyssa, which helps to provided structure and coordinated movement of the rostral tongue. Lift the tongue to observe the mucosa of the floor of the mouth and the base of the tongue. In the conscious patient, the examiner’s thumb may be used extraorally to push the tongue dorsally for better visualization of the ventral surface of the tongue. The dorsal surface of the tongue is covered by thousands of papillae, some of which contain taste buds. The large, distinctive papillae located at the caudal third of the tongue are the vallate papillae, which are spaced in a curved line separating the body from the root of the tongue. Depress the tongue to visualize the tonsils, noting any enlargement or change in color or texture. The color of a normal tonsil is typically more hyperemic than the color of the adjacent mucosa. Normal tonsils may be fully contained within the tonsillar crypt and may be difficult to visualize.

The next step in the intraoral examination is evaluation of the teeth and their supporting structures. First, determine the presence or absence of teeth in each quadrant. Missing teeth can be documented on the dental chart by darkening or circling the missing tooth. Radiographic evaluation of areas of missing teeth is imperative because dentigerous cysts can develop as a result of an unerupted tooth. A periodontal probe and dental explorer are used to evaluate the tooth and its attachment structures. These dental instruments are important clinical tools for obtaining data about the health status of each tooth. Consider the adult canine mouth containing 30 patients, each patient requiring a thorough evaluation and treatment plan. The periodontal probe has a round or flat working end, which is marked in millimeter increments, ending in a blunt tip. The probe is used like a miniature intraoral ruler to measure attachment levels, sulcus and pocket depths, loss of bone in furcation areas, and size of oral lesions. It is also used to assess the mobility of teeth and the presence of gingival bleeding. Periodontal probes are available in an assortment of styles, with variations in thickness of the diameter of the working end and variations in increments of millimeter markings.

The dental explorer has a slender, wire-like working end that tapers to a sharp point. It is used to explore the topography of the tooth surface. When the explorer is held with a light modified pen grasp, the examiner acquires a tactile sense to locate tooth surface
irregularities, including caries, tooth resorption, calculus deposits, and pulp exposure. The explorer is also used to determine the completeness of treatment following calculus debridement and to ensure smooth transitions of dental restorations. Several designs of explorers are available. Varying degrees of flexibility contribute to the degrees of tactile sensitivity.

The assessment of the periodontium and teeth should begin at the midline of the mouth and systematically evaluate each tooth, one at a time, by using both visual observation and tactile use of the probe and explorer. Begin detecting excessive tooth mobility by placing the tip of the probe against the tip of the tooth and gently attempting to move the tooth in a buccolingual direction. Movement is estimated on a scale of 1, 2, or 3, based on the distance beyond normal physiologic mobility the tooth moves in one direction. A slight amount of movement is normal as a result of the periodontal ligament that connects the tooth to alveolar bone. The most severe mobility, a classification of 3, includes any tooth with vertical movement. As each tooth is approached to check for mobility, visually notice the characteristics of the gingiva for color, shape, texture, and consistency. Healthy gingival tissues are pink (except where normally pigmented), stippled (orange peel appearance), firm, tapered to a thin margin, and scalloped to follow the contour of the cementoenamel junction (CEJ) and underlying alveolar bone. Any area of the gingiva that deviates from these normal characteristics should be examined closer by use of the probe.

The probe is gently inserted into the sulcus (physiologic term) or pocket (pathologic term), ensuring that the probe is kept as close to parallel to the long axis of the root as possible, with the side of the probe tip in contact with the tooth. When physical resistance is felt at the base of the sulcus or pocket, note the marking level on the probe that is adjacent to the gingival margin. The probe is then “walked” around the tooth to assess the entire circumference of the tooth. Abnormal measurements (those greater than 3 mm in dogs, greater than 1 mm in cats) should be noted on the dental chart along with the specific location of the pocket measurement (i.e., MP for mesiopalatal). Probe measurements between millimeter markings are rounded up to the larger measurement. For accurate readings, it is essential to develop skills in consistent probing forces (between 10 to 20 g of pressure). This pressure amount can be practiced by pressing the probe tip into the pad of a thumb until the skin is depressed approximately 2 mm.

In areas where the height of the free gingival margin has migrated apically toward or beyond the CEJ, the probe is used to measure gingival recession. Recession is measured in millimeters from the CEJ to the level of the gingival margin. Attachment loss is a term that truly describes the periodontal state of a tooth because it accounts for both pocket depth and gingival recession. Gingival hyperplasia occurs when the free gingival margin migrates toward the crown of the tooth. An increased pocket depth may be due to hyperplasia or attachment loss, so clinical examination findings are necessary to determine if the increased probing depth is due to a true pocket or a pseudopocket.

When multi-rooted teeth are approached, the probe is used to assess loss of bone in the areas between and around the roots. A bifurcation is the furcation between two-rooted teeth and should be assessed from the buccal and lingual-palatal surfaces. Trifurcations of three-rooted teeth should be assessed between each of the three roots. The extent of bone loss determines the furcation classification.

During the periodontal evaluation of each tooth, also observe the hard structures of the tooth and use the dental explorer when noticing any chips, fractures, pulp exposure, or abnormal wear patterns of abrasion or attrition. Abrasion refers to tooth wear associated with aggressive chewing on external objects, such as toys, rocks, bones, and ice cubes. Attrition refers to two possible scenarios. Physiologic attrition refers to the normal wear associated with tooth-to-tooth contact of a patient over time with normal mastication. Pathologic attrition is caused by a malocclusion resulting in abnormal wear of teeth as a result of contact with teeth of the opposing jaw.

Dental caries (commonly referred to by the lay term of “cavities”) result from demineralization of the enamel and dentin from acids produced by certain oral bacteria. These lesions occur most commonly on occlusal (flat) surfaces of the molar teeth. Gently explore for pits and fissures of the occlusal surfaces of the maxillary first and second molars and the distal half of the mandibular first molar, feeling for areas of demineralization. Use the explorer to check for clinical signs of tooth resorption by dragging the sharp point horizontally across the cervical portion of each tooth. Sometimes it is challenging to determine whether a concavity in the area of a furcation is a resorptive lesion or merely mild furcation exposure. If tooth resorption is present, the explorer tip will “catch” on the edge of the concavity, whereas the explorer will freely move out of the concave area as easily as it fell into it when encountering mild furcation exposure. When tooth fractures are present, gently drag the sharp point of the explorer across the tooth surface, feeling for any openings into the pulp. Teeth with significant abrasion may have a brown or black spot in the center of the worn tooth. This can be a sign of either chronic pulp exposure or a reparative material produced by the tooth in response to chronic wear (tertiary dentin). Pulp exposure can be distinguished from tertiary dentin by use of an explorer. If a tooth has pulp exposure, the tip of the explorer will “fall into a hole,” whereas a discolored area caused by tertiary dentin will feel smooth as glass when the explorer is run over this area. This is an important clinical distinction because treatment of pulp-exposed teeth is necessary, but worn teeth without pulp exposure often require no treatment if radiographically normal.4

References