With the high prevalence of periodontal disease in pets, and the potential for impacting systemic health, most of us are aware that providing periodontal care is good medicine. It is also good business, as a complete dental care program encompasses the entire life of the pet, particularly in the ‘micro-dog’ breeds (under 20-25 pounds as adults), as the prevalence of disease in these patients is higher than in larger breeds. An emphasis on senior care entails sound dental care also. Dental care is one facet of our practice that is preventable in most cases, so wellness programs that encourage regular visits should always include evaluation of oral and dental health.

**In the exam room**

Though some patients are presented for specific dental problems, it is more common that the veterinary team will examine, discover and point out areas of concern to the owner. The extent of plaque and calculus can be ascertained in most patients, and providing a photo to the client (on their own cellphone?) can help point out the problems seen. While some might not be impressed with the presence of plaque, calculus or even oral malodor, education as to the importance of managing the extent of infection in the oral cavity can help them decide to get professional care. At times, pointing out additional lesions – or red flags – such as tooth resorptions, broken teeth or areas of advanced infections, may be necessary to encourage care.

**Complete dental examination**

Having the patient under general anesthesia is the only way a complete evaluation – with intraoral radiographs – and thorough treatment can be provided. The tissue of the periodontium surrounding the tooth are the structures that are evaluated, and their loss can lead to tooth loss.

- **Attached gingiva** – the first line of defense, the attached gingival is secured to underlying alveolar bone by connective tissue rete pegs. A minimum of 2-3 mm of attached gingival is preferred for optimal periodontal health
  - Free gingival margin – borders the gingival sulcus
    - Normal sulcus: 2-3 mm for dogs; 0.5mm for cats
  - At the mucogingival border/junction – transitions to looser alveolar mucosa
- **Cementum** – the outer layer of the tooth root, is partially cellular, allowing for the attachment of the periodontal ligament that suspends the tooth in the alveolar socket
- **Alveolus** – indentation in the jaw as the tooth socket – provides support for the tooth as it is suspended in the alveolus by the periodontal ligament
- **Periodontal ligament** – a connective tissue shock absorber that keeps the tooth root in the alveolus; evaluation of the periodontal ligament space is key in periodontal assessment.

**Progression of periodontal disease**

The term periodontitis refers to inflammation of these tissues, and is initiated by bacteria, collecting with a matrix of salivary glycoproteins and extracellular polysaccharides deposit on the tooth surfaces. This plaque then becomes mineralized to form calculus, upon which additional plaque accumulated. While the calculus can be quite extensive, it is not as active as the plaque in the actual progression of oral disease. The bacteria in supragingival plaque on the crown tend to be Gram-positive, non-motile, aerobic cocci, but as the debris accumulates and the infection progresses deeper into the sulcus, the population evolves into Gram-negative, motile, anaerobic rods and flagellates that are more virulent. The direct effect of the bacteria and toxins cause significant periodontal inflammation and destruction, but it is also the hosts’ response to the bacteria that can cause additional loss of attachment.

The different levels of periodontal inflammation can be determined by complete evaluation of the tissues, including a thorough oral examination, probing of periodontal pockets and oral radiography. The levels of plaque, calculus and gingival inflammation are all important markers on the extent of debris accumulation and inflammation, but it is attachment level that determines the actual stage of disease. One of the most important ways to assess periodontal disease is to determine the depth of the periodontal sulcus or pocket.

When the bacterial plaque and host response cause inflammation of the periodontal tissues, their destruction can lead to formation of periodontal pockets. The periodontal probe should be used around the tooth to determine the depth of any pockets, and these are then accurately recorded. At times, there will be sufficient gingival and bone loss that the levels recede down the root, causing root exposure and even furcation (the space between two roots of the same tooth) exposure. The true level of attachment loss is a summation of root exposure and periodontal pocket – measuring the loss of attachment from where it once was.
With all cases, it is vital to take intraoral radiographs to see the extent of bone loss, as well as the type of bone loss. A level amount of bone loss across the roots of several adjacent teeth is termed horizontal bone loss. If the gingival is not loss, this will cause the formation of periodontal pockets. If the gingival recedes as well, then root surfaces will be exposed, and sometimes no pocket will be formed. If the attachment loss extends down a specific root or area, a deep infrabony pocket is formed between the tooth root and the wall of the pocket. With enough tissue loss, a tooth may become mobile and even be lost eventually.

Stages of periodontal disease
Stage I Periodontal disease refers to those cases with inflammation primarily in the gingiva itself, with no actual loss of attachment in the sulcus - soft or osseous. At times the sulcus depth will be greater than normal, but this is an increased height of the gingival margin due to inflammation and edema. Once the area is thoroughly cleaned, the inflammation should resolve, returning pocket depth to normal values. As such, this is the one stage of periodontal disease that is considered reversible. Therapy consists of professional cleaning as needed, with regular home care to minimize further damage. The term “prophylaxis” to describe dental cleaning is probably accurate only at this stage, since it is true prevention; once periodontal attachment loss is realized, prevention is no longer possible, so “periodontal therapy” is a more accurate term.

Stage II Periodontal disease, or early periodontitis, is the first stage with measurable amounts of attachment loss. Amounts of loss up to 25% in this stage necessitates a thorough cleaning and evaluation, in order to adequately treat the areas and arrest any further loss. More frequent cleanings and more advanced periodontal therapy (root planing, perioceutics) can minimize any further damage, and home care to keep plaque and calculus from extensive accumulation can be vital in preserving the teeth.

Stage III Periodontal disease includes cases with up to 50% attachment loss, as determined by periodontal probing and radiographs. Some teeth in this category will start to become mobile, and if continued care cannot be given, occasionally extractions may be necessary. This can be appropriate with particular teeth (non-strategic) such as lower corner incisors or fourth premolars or upper third premolars that are adjacent to larger, more strategic teeth. If the smaller teeth continue to contribute to bone loss that could also affect their neighbors, sometimes the smaller teeth should be extracted to be able to maintain the larger teeth’s health. More extensive periodontal therapy, including perioceutic therapy and even regenerative therapy may be selected to improve the prognosis on important teeth such as the canines or carnassial teeth.

Stage IV Periodontitis involves teeth that have greater than 50% attachment loss, and as such are often candidates for extraction. With such extensive loss, particularly if osseous, heroic attempts at salvaging will require more advanced periodontal therapy and owners committed to regular care, both professional and at home. Without such care, retention of such teeth will often result in the persistent presence of plaque, calculus and bacteria in the deeper pockets, putting the patient’s overall health at risk. While saving teeth is a noble cause, if extraction will improve the general health, it is sometimes the best choice.

Periodontal therapy
When looking at periodontal disease, therapy is determined by a number of factors, such as the stage of the disease, and the desired outcome. There are several goals to set, including removal of all debris or biofilm (plaque, calculus), keeping the maximum amount of attached gingiva, minimizing attachment loss and minimizing the pocket depth. Certainly, all foreign material, from bacteria to desquamated cells must be removed from the tooth surfaces and pockets in order to attain healing. Since the attached gingiva is the first line of defense against bacteria, a minimum of 2-3 mm is necessary to protect underlying tissues, as the looser alveolar mucosa doesn’t afford that protection. The inability to halt attachment loss will eventually lead to tooth loss, and with smaller cat teeth, tooth loss can occur quickly, due to small alveolar bone mass. Minimizing pocket depth is related to attachment loss, but is a more specific parameter, because pocket depth in itself directly affects the ability for effective home care and maintenance. There are even times where excessive gingiva will be removed to decrease pocket depth (hyperplastic gingiva) or the gingiva will be sutured further down the root (apically repositioned flap) for the same effect.

These goals are best realized with a comprehensive program of dental care for the patient. At every patient visit, the oral exam should be evaluated. When appropriate, professional care under general anesthesia should be administered, and effective home care can help keep the tissues as healthy as possible. Periodontal disease is ultimately a preventable disease, with a lifetime of dental care.

Professional dental care
The most common dental procedure performed in practice is usually called a prophylaxis. Since this term means “prevention”, about the only time it is truly applicable is in Stage I Periodontal disease cases with just gingivitis present. All other procedures would more correctly termed “periodontal therapy”, because you truly are treating the periodontium. By staying with a methodical process following the correct steps, you can offer the best treatment possible for your patients. Since the aerosolization of bacteria occurs during dental cleaning, both operators and patients should be protected. Flush the oral cavity at the beginning of the procedure with chlorhexidine solutions can help decrease the bacterial assault.
Certainly, the gross removal of calculus and plaque is the most obvious step of cleaning, but this is literally only scraping the surface! Most practices have some form of dental scaler, often an ultrasonic type. There are many units available, and you should be familiar with your particular unit. Most units can generate some heat, and so should be used with adequate water flow. Some newer units have tips with water flow that can be introduced under the gumline in shallow pockets, but for the most part this should be avoided with other models, as damage can be caused to the root surface. Sonic units (on a high-speed handpiece, air-driven unit) don’t generate as much heat, but require adequate air pressure for maximum effectiveness. Rotary burs on a highspeed handpiece can be quite damaging, especially to feline teeth, and should be avoided.

A periodontal probe is one of the most vital tools in dealing with periodontal disease. The probe is marked in millimeters, so the depths of pockets can be accurately measured. Especially with inflamed pockets, it is important to use the probe gently, as force can push the probe tip through the fragile junctional epithelium at the bottom of a pocket. Measuring pocket depth at six points around the tooth will give a fairly accurate picture of the extent of the pocket. The explorer tip of the instrument is a thin, sharp-tipped hook that can be used as a tactile instrument in pockets (gently) to detect remaining calculus or debris. The tip can also be used to determine if the pulp canal is exposed in broken teeth, if a carious lesion is present (soft enamel), or if a resorptive lesion is present on the tooth surface.

For most areas of subgingival scaling, periodontal curettes are the instrument of choice. They differ from hand periodontal scalers in that the curettes have a rounded back and toe as compared to the scalers’ sharp tip and back (triangular in cross-section). While pocket formation is not as common in cats as in dogs, it is important to clean these areas. You should choose a curette with a small, delicate working head that can be inserted gently into the pocket without causing more damage or stretching of the gingiva. The curette is introduced gently into the depth of the pocket and pulled against the tooth with its cutting edge (regular sharpening is essential) to scrape biofilm off the tooth and root surfaces. Overlapping strokes help clean the root surface thoroughly (root planing), avoiding excessive force. Curettes can be used in closed root planing (pockets up to 5 mm – a pretty deep pocket for most cat teeth), and the upper edge of the curette can also gently scrape the inner lining of the gingival sulcus or pocket, termed subgingival curettage. Both root planing and subgingival curettage should not be done too aggressively. Placing a doxycycline hyclate gel in moderate pockets that have been scaled has been shown to help decrease pocket depth.

With pockets deeper than 5-6 mm, often a gingival flap must be elevated to allow further exposure of the lesion. Hand curettes can’t reach further than that effectively, and visualization is nearly impossible. Teeth with this much attachment loss should be thoroughly assessed, because few teeth with pockets of this depth are salvageable.

Polishing should always follow a scaling procedure, to smooth the roughened tooth/root surface, but damage can be caused if it is done improperly. The rotational speed of the prophy cup should not exceed 3000 RPM (watch the speed on variable slowspeed units), and the foot of the cup should be gently splayed, with adequate amounts of prophy paste used. Complete irrigation of the teeth, including reaching into the sulci or pockets (use a blunt-tipped needle), with anything from water to saline to dilute chlorhexidine or fluoride will wash away any remnants of biofilm and even prophy paste. If any material is left in the sulcus, a periodontal abscess may result. Complete charting of any lesions is essential, not only for good medical records, but also to be able to follow out the progression of the disease n the future.

Home care
The level of home care attainable will depend on both the pet and the owner, and their ability to “cooperate”. Cats in particular can pose a variety of problems with attempts at brushing, but if the owner starts out slowly, gently rubbing the side of the face with a small cat toothbrush and using solutions with good flavors initially (save the water from a can of tuna), many pets can tolerate at least some brushing. There are many products available for use, so become familiar with a few that you can keep in stock. Soft-bristled toothbrushes or finger cots are useful, and specific toothpastes formulated for pets come in many flavors. Clients should be instructed never to use human toothpastes on their pets, as they contain detergents for foaming and fluorides, which can upset the stomach and cause renal toxicity, if ingested on a regular basis. Oral antimicrobials, such as chlorhexidine in paste or solution, and oral cleaning solutions with zinc ascorbate can be used in patients that resist brushing efforts. However, chlorhexidine products can sometimes be bitter, and gels that are more viscous are more effective than solutions. Newer gel products have removed the ascorbic acid that can sometimes have a negative taste effect. Fluoride gels can be used in select cases with sensitive or worn teeth, but sparingly with monitoring for renal function.

Whether an uncomplicated case of periodontal disease or a patient with advanced disease, regular and systematic examination and therapy can help provide optimal oral and dental health for these patients. Education of the clients is critical is getting them involved in the total process. Treating the oral cavity can also have a positive effect on the rest of the patient. Providing a broader range of dental care to more patients can help make your practice healthier as well!
The extent of periodontal disease you might encounter in patients can vary from patient to patient and even from tooth to tooth in the same patient. From minimal inflammation and no attachment loss in Stage 1 Periodontal Disease to the beginnings of attachment loss (up to 25%) in Stage 2, then deeper pockets (up to 50% attachment loss in Stage 3) and even compromised teeth (greater than 50% loss) in Stage 4, you must be able to tailor the treatment to the problem. Beyond the dental cleaning, being able to provide advanced periodontal management for your patients is not only good medicine, but good business. By adding simple instruments, materials and skills to your dental armamentarium, you can identify and treat those teeth that may have been extracted in the past.

Therapy goals
When looking at periodontal disease, therapy is determined by a number of factors, such as the stage of the disease, the involved tooth, the client’s commitment and the desired outcome. There are several goals to set, including removal of all debris or biofilm (plaque, calculus), keeping the maximum amount of attached gingiva, minimizing attachment loss and minimizing the pocket depth. Certainly, all foreign material, from bacteria to desquamated cells must be removed from the tooth surfaces and pockets in order to attain healing. Since the attached gingiva is the first line of defense against bacteria, a minimum of 2-3 mm is necessary to protect underlying tissues, as the looser alveolar mucosa doesn’t afford that protection. The inability to halt attachment loss will eventually lead to tooth loss. Minimizing pocket depth is related to attachment loss, but is a more specific parameter, because pocket depth in itself directly affects the ability for effective home care and maintenance, and deeper pockets can harbor more virulent strains of bacteria. There are even times where excessive gingiva will be removed to decrease pocket depth (hyperplastic gingiva) or the gingiva will be sutured further down the root (apically repositioned flap) for the same effect. Attachment loss without pocket formation occurs when gingival tissue and bone is lost at the same time, exposing the roots and even furcation areas.

The ability to take intraoral radiographs is essential, in order to determine the extent and characteristics of bone loss. With recession of gingiva and bone across several roots and/or teeth, a horizontal bone loss pattern will often result in exposed roots. With a deeper osseous loss down one root surface, an infrabony pocket may result from the vertical bone loss, and specific therapy may be needed to address that specific defect. These deeper pockets are more difficult to treat and maintain, and anaerobic infections may persist.

Attachment loss – treatment decisions
In evaluating teeth at either end of the spectrum – minimal disease with stage 1 or 2 teeth, or extensive stage 4 disease – the decision process is pretty straight forward. With stage 3 periodontal disease affected teeth – there is more of a challenge to decide whether to extract or try to save. The extent and type of attachment loss is a part of the decision process, as is the consideration of the relative importance of the tooth itself. Major teeth (canines, carnassials) will often be considered for advanced procedures, and adjacent, smaller teeth that are contributing to the infection should be considered for extraction, as their removal will allow better access to the strategic tooth. By extracting the middle tooth in the middle of three rotated, crowded premolars can often enhance the health of the remaining two teeth.

If the attachment loss results in root exposure with minimal pocket formation, professional cleaning and home care may be easier. Any involvement of the furcation puts the tooth at higher risk, due to challenges of continued care. If a pocket is present, it should be thoroughly evaluated: how deep is it? is it suprabony or infrabony?

Patient health status is also evaluated: patients with systemic disease would like benefit more from extraction with the immediate removal of the infection, and a decreased anesthetic time. Clients also are involved in the decision: advanced periodontal therapy requires excellent home care and more frequent professional visits.

Advanced periodontal therapy
Periodontal therapy initially concerns itself with removing all plaque, calculus and debris possible. This is of particular importance if there is any attachment loss or pocket formation, because the surfaces must be thoroughly cleaned to help remove the destructive action of the bacteria and moderate the host response as well. With addition of a few instruments and materials, most procedures can be done in most practices.

Supportive care
Additional care beyond the periodontal work is often necessary to maximize the outcome. Assistance with various antimicrobial agents can help the patient fight off the bacterial onslaught, by using everything from oral rinses and gels to medically appropriate prescriptions of systemic oral antibiotics. Even pain management must be considered, because the conditions alone can be painful, and any surgical procedures must be covered as well.
Non-surgical periodontal therapy
With suprabony pockets (soft tissue only) of up to 5 mm in depth, closed root planing and placement of a perioceutic can provide excellent care for the defect.

Root planing/ subgingival curettage
This is by far the most important aspect of periodontal therapy. If the debris is not thoroughly removed from the pocket depths, the disease will remain and intensify. The rounded tip of the curette, and it’s rounded back, makes it ideal for subgingival therapy, as opposed to the sharp tip and back of a hand scaler. Certain ultrasonic scalers are modified for subgingival treatments, but most are not. If root surfaces are exposed, or if the pocket depth is less than five mm, closed root planing and subgingival curettage may be performed. Using a curette subgingivally with overlapping strokes in horizontal, vertical and oblique directions, root planing removes calculus, debris and necrotic cementum to provide a clean, smooth surface. The curette can also be angled slightly to engage the gingival surface for removal of diseased or microorganism-infiltrated tissues. When pocket depth exceeds 5 mm, or other pathology exists, more invasive procedures are warranted.

Perioceutic therapy
In moderate pockets of up to 5 mm in depth (and generally deeper than 2 mm), once the area is debrided, placement of a local perioceutic gel containing doxycycline hyclate can not only provide a direct antibacterial affect against any remaining bacteria, but the anticollagenase activity can help “rejuvenate” the soft tissue of the pocket. The combination of the cleaning and therapy can often help reduce the pocket depth in moderate situations.

Once mixed, the tip of the cannula is gently placed to the depth of the treated pocket, and the material is slowly inserted into the pocket, until a small amount extrudes from underneath the gingival edge. By using light digital pressure on top of the gum, and by gently scraping the cannula tip on the tooth surface, the cannula can be removed without taking the gel with it.

The gel firms up on its own within a minute or two, or a drop of water can be placed on the material to speed up the process. Once firm, the visible material should be gently packed into the pocket, using an instrument such as a W-3, or beaver tail instrument. The owner should be instructed not to brush for about a week in the region (gels and solutions are recommended), nor to pick at the ridge of material that may become visible (light yellow-brown). The material is biodegradable and does not need removal. Sometimes periodontal sealants can be placed after a procedure.

Surgical periodontal therapy
Many standard pieces of equipment and supplies can be used, including scalpel blades (15C works well), scissors (sharp/sharp for gingival remodeling), and sutures (usually absorbable, from 3-0 to 5-0). It is important to other equipment as well for unique oral situations, including periodontal curettes for scaling root surfaces and periosteal elevators (Molt No. 2 or No.4) for elevating gingival.

When pocket depths exceed 5 mm but with minimal bone loss or diseased soft tissue that needs removal, a simple envelope flap allows access and improved visibility for open curettage and root planing. Insert the scalpel blade into the sulcus and follow the scalloped contour to sever the epithelial attachment and use the periosteal elevator to expose the area to be treated. For large areas requiring treatment, vertical-releasing incisions can be made at the mesial and distal ends of the initial incision (at line angles of adjacent teeth). Using a periosteal elevator, the gingiva is reflected to expose the root surfaces. A polishing of the root surfaces and irrigation with dilute chlorhexidine follows thorough root planing and subgingival curettage. After repositioning the flap, sometimes further apically down the roots, it is sutured interdentally with absorbable, interrupted sutures. While this procedure is most commonly performed on facial and lingual surfaces, deep pockets on the palatal aspect of the maxillary canines can be exposed using a similar technique for treatment.

If an adjacent, smaller tooth is involved in the area of attachment loss, its extraction is sometimes the best way to get access to the larger, more strategic tooth’s surfaces. The releasing incision is made away from the tooth being treated, allowing a complete attached gingival coverage of the treated site. Extraction of the middle of three crowded teeth also allows better exposure and treatment of the remaining teeth.

Guided tissue regeneration
In an infrabony defect, where the attachment loss has occurred down the surface of a tooth, forming a deep pocket in between the root and alveolar bone, inadequate therapy can lead to even further attachment loss and even tooth loss. While attachment loss is generally considered irreversible, materials can be place that can help encourage regrowth of bone at the site. Typically the soft tissues (gingival epithelium, gingival connective tissue) will grow back into a defect faster than the more important supportive tissues of the periodontium (alveolar bone, periodontal ligament).

By placing a barrier between the instrumented root surface and the gingival flap, it can act as a deterrent to exclude the gingival epithelium or gingival connective tissue from populating the root structure. This barrier then provides an area for the progenitor cells of the periodontal ligament and/or alveolar bone to have free access for migration. Bone development being slower than the soft
tissues of the periodontal ligament, it is hoped that it should develop prior to bony incursion. It is generally believed that periodontal cells have the greatest potential to promote new attachment, but that bone also plays a significant role.

While some barriers are actual membranes, bulk material can also be placed to keep the soft tissue out. When a substance that promotes osseous growth is placed, alveolar bone stands a better chance of filling the defect. There are even products that stimulate periodontal ligament re-growth. An essential key to such a procedure is adequate exposure and debridement of the area. A gingival flap is necessary to allow for thorough curettage of all material in the infrabony pocket in between the tooth and root, including the removal of any granulation tissue. Once healthy bone and tooth surfaces are clean, the bone graft material is packed into the defect, and the gingival closed over it.

Post operatively vigorous home care and plaque control is essential. Antibiotics for up to three weeks post surgically are generally recommended. Non-absorbable membranes are normally removed one to nine months following surgery. Some materials do not need removal.

Two sites that are most commonly selected for GTR involve the distal root of the mandibular first molar (often with extraction of the second molar for exposure) and the palatal aspect of the maxillary canine, before the defect results in an oronasal fistula. Mesial and distal releasing incisions can be made extending out from the maxillary canine towards the adjacent teeth, on the gingival papillae. Exposure with this method can be somewhat limited, like an envelope flap, and closure involves using a sling suture technique, running the suture in a semi-circle pattern within the palatal mucosa from a mesial to distal direction, exiting distal to the canine and re-entering near the same site, reversing the semi-circle pattern to exit mesial to the tooth, and tying off the two ends, tightening the flap against the tooth. Incisions made directly into the palatal mucosa not only can cut the palatine artery, but make a flap that is more difficult to hold against the canine.

One alternate method is making a crescent-shaped flap in the palatal mucosa, extending from a point just mesial to the canine in the incisor-canine interdental space, and running medial to the canine to a point just distal to it. When the flap is elevated, there will be hemorrhage from the rostral severing of the palatine artery, but it can be tied off at that extent and preserved within the flap itself. Once elevated, good exposure allows for thorough cleaning of the infrabony pocket, though care must be taken to avoid puncturing the remaining alveolar bone separating the pocket from the nasal cavity (oronasal fistulation), else the tooth would have to be extracted. Once the pocket is cleaned and filled, simple interrupted sutures can hold the crescent flap in place. If some gaps appear, a small amount of the mesial extent of the flap can be trimmed, to bring the gingival margin closer to the tooth. Sutures can be placed to join the cut edge of the flap back to the palatal mucosa, as long as no tension is placed on the flap that would cause it to pull away from the tooth. A small gap between the cut edge of the flap and the remaining palatal mucosa will typically heal without complication.

In some areas there will be horizontal bone loss and suprabony pockets (bone loss occurs at same level of attachment loss but no defect in between the tooth and alveolar pocket). Once the area is exposed, all root surfaces areas should be thoroughly cleaned using curettes. In some cases, if the bone loss includes interdental spaces, the flap can be sutured in place so the gingival margin is actually placed further down the root than originally positioned (apically repositioned flap). This can help minimize the pocket depth, though the actual level of attachment is still the same, just more root structure is left exposed. These sites are not amenable to osseopromotive products.

Special conditions

Gingival hyperplasia (gingival enlargement)

Gingivectomy/gingivoplasty

Occasionally, significant local or generalized increases in pocket depths without attachment loss will occur with conditions such as gingival hyperplasia or associated with an epulis. In these cases, gingivectomy removes redundant gingiva to reduce the suprabony pseudopocket depths to facilitate the cleaning of tooth surfaces while maintaining at least 2 mm of attached gingiva. Pocket depth is measured and a corresponding bleeding point is made with the probe at several junctures around the affected teeth. A beveled incision is made with a scalpel blade, connecting the bleeding points, maintaining a scalloped edge gingival appearance and preserving adequate tissue. A 12-fluted bur can be used to contour the gingival margins, and Tincture of Myrrh and Benzoin placed (several layers) as a gingival dressing.
Most dental conditions found in practice are often chronic in nature – from progressive periodontal disease or tooth resorption to the tooth that has been broken for years. Occasionally a patient is presented with a true dental emergency – often due to some type of trauma – or due to the fact that the owner finally noticed something that had been happening for some time. If trauma has occurred, it is important to quickly assess the extent of injury and the stability of the entire patient. A life-threatening condition should be addressed first. Injuries should be "staged" as to their relative importance, and handled accordingly, until the patient is stabilized. Pain management before, after, and during surgery is an integral part of the treatment plan.

There are occasions where trauma in the oral region can endanger the pet, such as when the airway becomes obstructed, or when hemorrhage cannot be controlled. Once stable, it is then important to regain normal function of the oral cavity as quickly as possible. Getting a patient to eat, drink, and even groom normally is an important part of the healing process.

**Oral trauma**
An event of oral trauma requires complete evaluation, from soft tissue that might require hemorrhage control or reconstruction to osseous damage such as fractures and luxations. Dental trauma may involve individual teeth, or teeth involved in more extensive damage, making decisions for combined care necessary. No matter how the mouth is fixed, it is important to be able to maintain a functional occlusion.

**Soft tissue trauma**
A degloving trauma to the mandible can often be managed with conservative means, gently cleaning and debriding the area before replacing the soft tissue. Areas of necrotic tissue should be debrided, but remain on the conservative side, as blood supply to the oral tissues is usually extensive. The tissue can either be sutured to remaining soft tissue, or stay sutures can be placed around the lower canines to hold the lower lip in place until it is healed.

Tears in the gingiva sometimes require repair as well. The entire site should be thoroughly evaluated, to determine if any underlying pathology exists (fractures, pockets, etc). Often a simple interrupted suture pattern of a small, absorbable material is sufficient. Attempts should be made to preserve as much viable attached gingiva as possible, because this is an important tissue in periodontal defenses.

Damage to the tongue, such as is seen in electric cord trauma from chewing on it, should include conservative debridement of noticeably necrotic regions, and suturing cut areas. Salvage as much of the tongue as possible in the cat, as it plays important roles both in eating and grooming.

**Osseous**
The first step with osseous tissues is to completely determine the extent of damage, as multiple injuries may be present. In cats, the most common osseous oral fracture is that of the mandibular symphysis. Always evaluate the temporomandibular joints (TMJ), because luxation in the presence of another fracture is not uncommon. It is essential to have proper occlusion throughout, as even a small discrepancy in the distal oral cavity can translate into a large variation in the front of the mouth. Any occlusal interference will then disrupt the stability of the fracture repair, further complicating matters. If necessary, a pharyngostomy tube should be placed, so occlusion can be assessed at regular intervals perioperatively.

With mandibular body fractures, the direction of the fracture (especially mid-body) will determine the form of stabilization. A fracture from the ventral surface running caudally to the dorsal surface benefits from muscle placement that helps to keep the fracture reduced (Favorable). Often a single interosseous wire is sufficient here. On the other hand, a fracture line from dorsum to ventrum (caudally) will have muscular forces working to separate the two pieces, so a triangulation of two interosseous wires will be necessary.

Every tooth at a fracture site should be closely examined for viability. If severe periodontal bone loss around a tooth had contributed to the fracture, the tooth might have to be extracted anyway, but most in a fracture line should be preserved to help with stabilization, at least temporarily. With non-invasive methods, the presence of teeth is essential, especially with wire or splint placement. If the injury involved the apical region of a tooth, future endodontics may be necessary if the blood supply was compromised.

One of the most common, and most challenging, areas of mandibular fracture can be the region around the lower first molars. Not only can extensive periodontal bone loss around these teeth significantly compromise the strength of the jaw, but any extraction attempts can potentially result in jaw fracture. With any injury in the area, stabilization with interosseous wiring or suturing (use osseopromotive substance to help strengthen bone) can often be supplemented with a splint if surrounding teeth remain.
Wiring
The steps of osseous wiring are not too complicated, but basic rules are essential – such as avoiding tooth roots, apical structures and other vital landmarks such as the mandibular canal. In cats, it is more challenging to place wires, so sometimes large gauge suture material (non-absorbable or long-lasting) may be used. Obviously, intraoral radiographs are necessary during these procedures. Either with gingival flaps, or external to the gingiva, holes can be drilled used round burs on a highspeed handpiece, IM pins, or even larger 16 to 18 gauge needles. These methods can provide sufficient stability without having to go to more invasive methods with external fixators, plates or screws in most cases.

Interdental wiring methods are even less invasive, even when placed through the gingiva in between teeth (soft tissue healing occurs after removal). Learning the technique of wiring is the difficult part, but the benefits are great. Splints (acrylic or composite) may also be used as a non-invasive technique, either alone, or in combination with wiring.

- Stout’s Multiple Loop – 2-3 teeth on either side of a fracture
  - Static wire – long lead – facial aspect
  - Working wire – lingual/palatal – passed in interdental spaces – loops (IV tubing)
  - Two ends tightened, then tighten loops
  - Acrylic or composite splint to reinforce and cover loops

- Circumferential wiring – mandibular symphysis
  - Midline ventral incision – use large gauge needle to guide wire distal to canines
  - Tighten ends, cover tip with composite

Splints
Splints for fixation of fractures in the oral cavity can be a good conservative way to provide stability, with minimal invasiveness or complications. With adequate ventilation, nearly any practice can use the dental acrylics for splints. Once the teeth are flour pumiced and acid-etched, and the surrounding soft tissue protected with petroleum jelly, the jaw fracture should be reduced, and the pieces held into place (with proper occlusion). The “salt and pepper” technique of adding small sequential amounts of acrylic powder and liquid allow for a directed placement of the material, as well to help to minimize the hyperthermic reaction that takes place during the polymerization of acrylics. This type of splint material can be “molded” into desired shapes before the full set-up, and acrylic burs can be used later to trim down excess amounts or to smooth rough edges.

Composite materials, especially temporary ones, are also suited for splint placement. Again, the teeth should be cleaned, flour pumiced and acid etched (rinse well) before the placement of the product and/or a bonding agent below it. Most products require a special dispenser or mixer and are self-cure, allowing sufficient time for shaping of the material. Even without the bonding agent, some of these material will cause staining of the teeth once removed. (Acid-etch and bond lingual/palatal surfaces only; this minimizes staining labially)

Complicated fractures
Comminuted or non-union fractures pose special problems, particularly if there is extensive bone loss, either prior to injury (periodontal disease) or after (gunshot, necrosis). With a gap in the bone, it is difficult to place interosseous wiring, and there may be too many missing teeth to provide a framework for a splint. IM pins placed at several sites, distal and mesial, to a fracture site may be joined with tubing filled with acrylic or composite, to form a type of external fixation, but care must be taken to avoid further injury to tooth roots.

With some of the newer osseous implant materials, if some level of stability can be attained, osseous bridging may occur in some cases. Working with a modified splint, tape muzzles, or even bonding opposing canines in a locked position (mouth slightly open to allow the lapping of water or liquid diets), enough stability may be possible in order for these materials to be effective.

With more severe unstable fractures, especially those with poor bone quality and missing teeth, wiring is usually impossible, and the possibility of a partial mandibulectomy may arise. Most animals tolerate such a procedure fairly well, and a commisureplasty may be performed to close the mouth a little further to help keep the jaw from hanging down. Some patients may even tolerate the long term use of a tape muzzle device, with owners that can periodically remove and change the muzzle.

TMJ injuries
A good percentage of patients with injuries to the temporomandibular joint (TMJ) come in after trauma such as being hit-by-car, and will present with an open mouth, unable to close it. The condyle can be luxated, either caudally or rostrally (most common), and can often be reduced by using a dowel placed between the upper and lower carnassial teeth with gentle force to press the jaws back together (distal pressure if luxated rostrally, and vice-versa).

Fractures of the condyle will often be painful, and lead to chronic arthritic changes and pain, even if “repaired”. Mandibular condylectomy will help to remove the source of pain, and most animals recover well
Tooth injuries
While most dental or oral injuries may enjoy the luxury of not requiring immediate attention, a few situations occur where the prognosis of the treatment is enhanced with timely intervention. Other than cases such as osseous fractures that need stabilization as soon as the patient can undergo treatment, cases of tooth avulsion or fractures of immature teeth also benefit from prompt response.

Tooth avulsion/luxation

**Complete avulsion**
If the tooth is completely avulsed from the mouth, it is essential to handle it properly to have any chance of it being saved. As soon as the owner reports the incidence, they should be instructed to place the tooth in a container of fresh milk, to keep it moist and to help preserve any periodontal ligament (PDL) cells that may be present on the root. Sterile saline is the preferred storage medium, if it is available. Once the patient and tooth are presented, the tooth should be gently flushed with sterile saline, and the alveolus flushed (dexamethasone) and gently debrided. Care should be taken with these tissues, as you want to keep as many PDL cells viable as possible. With radiographs, evaluate the area for signs of advanced periodontal disease (including chronic osteitis/alveolitis with extrusion of maxillary canines) or osseous changes associated with neoplasia, that may have predisposed the patient to tooth loss. Such teeth are not viable candidates for reimplantation.

With a completely avulsed tooth, it is often easier to do a retrograde endodontic procedure since it is already out, if you have the capability. The tooth is then replanted into the alveolus, any fractures reduced, and the site stabilized. Stabilization of the fracture alveolus or jaw is best done with non-invasive techniques, with interdental wiring and acrylic or composite splints. Soft tissue defects should also be closed at this time. The interdental wiring will actually allow some of the normal minute movements of the tooth within the alveolus – so rigidity is not necessarily the best option.

If an endodontic procedure was not performed initially, standard root canal technique may be performed 2 to 3 weeks after this time. This gives the patient time to recover from the first anesthetic event, and to give supportive tissues time to start to heal, but removes the chance of a periapical abscess from interfering with continued healing. The wire and splint can usually be removed in 4 to 6 weeks, once radiographic and physical signs of healing are present.

**Partial avulsion**
Teeth that retain a portion of their attachment are treated similarly, especially if the apex is completely separated from its bed. If just the coronal portion is avulsed, there may be a chance that the apical blood supply was not disrupted, so replantation and stabilization may be the only treatments necessary. Such teeth must be monitored on a regular basis, to determine if apical blood supply remains viable. If any signs indicate that the pulp was injured or has become non-vital, endodontics must be performed. If any tooth avulsion or even invulsion are due primarily to severe periodontal disease that compromised the periodontal tissues, often extraction is the best treatment option.

**Tooth fracture**
In most cases a fractured tooth has been present for some length of time in a pet, and unless it abscesses, will seldom seem to cause discomfort (though it needs treatment). Occasionally, a tooth with periapical abscess will have an active episode, or suddenly flare up, and these “phoenix abscesses” can be quite painful. At other times, the infection turns into an area of swelling or a draining fistula (suborbital for upper fourth premolars), which may be the first time an owner even realizes there is a problem.

**Acute tooth fracture – mature teeth**
With very astute owners, sometimes the actual fracture event is noticed immediately, and in these cases, there is a window of opportunity to treat the fracture and exposed pulp. With mature teeth, if the pulp is treated within 5 days (see below), with immediate administration of antibiotics and anti-inflammatories (to reduce infection and inflammation potential), sometimes the remaining pulp can be kept alive, and the tooth can remain vital. Because of the narrow canal and subsequently a smaller population of odontoblasts, sometimes even timely therapy is not sufficient to keep the remainder of the pulp viable in a mature tooth. If this is the case, and even as a primary decision in a number of cases, immediately therapy with a standard root canal procedure or even extraction is always an option with mature teeth.

**Acute tooth fracture – immature teeth**
With teeth in patients under 18 months of age, lack of apical closure, thin dentinal walls, and a richer blood/odontoblast supply make options other than standard root canal more likely. In fact, if the fracture happened up to 2 weeks prior to presentation (or if the pulp is exposed iatrogenically during a crown reduction), the chance to treat the tooth with hopes of keeping the pulp alive should be taken. Administration of oral antibiotics and anti-inflammatory is an important step to start until the patient can be seen, though medications that interfere with normal platelet function should be avoided (hemorrhage control is an important step in the therapy).

In these patients, therapy is aimed at removing the coronal portion of the pulp that has been exposed to the environment and bacteria, and placing medicaments so the remaining healthy pulp can form dentin at the exposure site, and continue to help in the tooth’s maturation process, including apical closure (apexigenesis) and continued dentinal wall deposition (odontoblasts).

- Partial pulpectomy – sterile round bur to remove exposed pulp to a depth of at least 3-5 mm
- Hemorrhage control – sterile saline flush, then apply blunt end of a paper point
  - Hemostatic agents – local anesthetic with epinephrine, oxymetazoline

198
Persistent hemorrhage – remove additional pulp

- Place MTA to stimulate the pulp to form a dentinal layer
- Intermediate layer – glass ionomer or flowable composite
- Restorative closure of opening

It is essential to follow these patients closely, in order to assess the continued vitality of the pulp. Intraoral radiographs taken every six months for the first year or two will allow the practitioner to monitor continued maturation of the tooth. Comparison with both the opposite tooth and previous radiographs will show if the canal continues to narrow, and if the apex continues to mature and close, signs that the pulp and odontoblasts are still alive and healthy. A more subjective evaluation would include the appearance of a dentinal bridge, though this may be less distinct. Certainly, there should be no periapical bone loss, which might indicate pulpal death and infection.

**Summary**

It is important to be able to thoroughly assess traumatic injuries to the oral cavity and decide when and how to treat. Often, more conservative methods work well, so be sure not to cause more damage with invasive techniques, preserving teeth and occlusion at all times.
Oral Tumors- the Hidden Challenge
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As we continue to provide optimal care for our patients, including dental care, we are seeing an increase in the senior population of pets. With advancing years comes the increased incidence of oral tumors, though some masses can occur in younger individuals as well. Early detection of oral tumors can be challenging, because they are often not as obvious as more visible tumors. Regular dental care, including home care and professional care, can help increase the potential for detecting any abnormality early in its development, thus improving the chances for treatment.

**Detection and identification**
Recognition of a lesion prior to any clinical symptoms or signs become apparent is unusual. Typically a patient may present with problems that range from discomfort with eating, swelling, bleeding, changes in the color of the gingival or mucosa, displacement of teeth, or a decrease in grooming (cats). Gross appearance of a mass may offer some clues, but additional diagnostics are needed for accurate identification. Most oral lesions don’t exfoliate well, and surface impressions may just contain contaminants. Fine needle aspiration or core needle biopsy may be employed on soft tissue lesions, as long as a representative sample is taken. Often some degree of surgical biopsy must be used, such as an incisional biopsy if the mass is large, or if initial identification is needed prior to staging the disease. An Excisional biopsy may be performed if the practitioner feels the lesion is well enough defined by visual assessment and imaging to be able to remove it all at once.

**Juvenile tumors – dog**
While many masses are seen in mature or senior patients, there are a few tumors that are known to be found primarily in younger animals

   **Papillomatosis**
   This virally induced disease typically consists of multiple, pedunculated, tan to pink wart-like masses of the cutaneous and mucous membranes. Its appearance in younger dogs is somewhat diagnostic, though biopsy of a lesion will show fronds of epithelium. Most cases regress spontaneously, but if they are excessive in number and interfere with eating or cause extensive bleeding, some debulking may be necessary. It is thought that the self-limitation occurs due to the animal ‘self-innoculating’ itself by consuming some of the tissue. Heat-activated autogenous vaccines have been considered, but their use is controversial.

   **Oral papillary squamous cell carcinoma (OPSCC)**
   Once thought to be found in dogs less than 9 months of age, additional studies have found this invasive tumor in adults as well. A subtype of squamous cell carcinoma, this tumor can have a variety of appearances, with either a cavitating or non-cavitating appearance. It is found in the maxilla 80% of the time, and frequently in the rostral portion. Treatment is excision with wide surgical margins of 1-2 cm, though in humans, 1 cm has been documented. For those with unresectable tumors, piroxicam has been used palliately, with 46% of patients showing some degree of remission or stabilization of disease.

   **Odontoma**
   This group of tumors arise from odontogenic cell lines, either epithelium or mesenchyme. The more classical forms include the complex and compound odontoma, with each containing fully differentiated dental components. The complex odontoma will have tissues found in teeth, but no tooth-like structures, while the compound variety has everything from denticles present to fully formed teeth (sometimes multiples).

   The ameloblastic fibro-odontoma (AFO) also arises from odontogenic cell lines, but presents more as osteolysis with mineralization. It requires more aggressive surgical removal, while the complex or compound masses can often be managed with enucleation and intracapsular excision with aggressive debridement of the cyst walls.

**Common masses in dogs**

   **“Epulis” – current terminology changes**
   The term ‘epulis’ refers to a gingival mass of any type, and previous classifications included fibrous (FE), ossifying (OE) and acanthomatous (AE) epulides, all though to arise from the periodontal ligament tissues. The fibrous and ossifying types have now been grouped in a fibromatous group (some with mineralization) that contain PDL-like stroma and are considered benign. Recent conjecture theorizes that these possibly develop in response to chronic stimuli or inflammation.

   Within the fibrous group, focal fibrous hyperplasia (FFH) is an inflammatory, non-neoplastic hyperplastic change without the presence of odontogenic epithelium. When the mass contains rests of odontogenic epithelium, is highly cellular with fibroblastic connective tissue and variable amount of bone and collagen, it is now identified as a peripheral odontogenic fibroma (POF). Similar in components to POFs found in humans, these are most likely to be found in the rostral maxilla, with a higher prevalence in males. They
may not have well-defined borders radiographically, and teeth may be displaced. With surgical excision of 1 cm margins and clean borders, this carries a good prognosis. Recurrence is likely, however if not completely excised.

The canine acanthomatous ameloblastoma (CAA) is also considered ‘benign’ with cords of squamous epithelium in connective tissue and minimal cell atypia with few mitotic figures. However, it demonstrates aggressive infiltrative growth and can be locally very aggressive, most frequently found in the rostral mandible. Radiographs can show significant osseous changes and expansion into adjacent spaces, and advanced imaging (CT) would be preferred to detail the extent of the invasiveness of the tumor. With the goal of at least 2cm margins for resection, partial mandibulectomy or maxillectomy should be performed. With non-resectable tumors, options for radiation therapy or intralesional bleomycin injections may provide some management.

**Melanocytic tumors**

Considered the most common malignancy in the dog, these very aggressive tumors are considered to already have micro-metastases by the time the tumor is detected. Up to 1/3 of these are poorly pigmented, so the presence or absence of black tissues is not diagnostic in itself. Early detection is critical to have any chance at tumor management with aggressive surgery with complete clinical staging, lymph node removal and other options of radiation therapy, chemotherapy and even consideration of the vaccine in Stage II and III tumors.

**Fibrosarcoma (FSA)**

As the third most common tumor in dogs and the second most common in cats, these tumors contain mesenchymal cells, malignant spindle cells and collagen, and are typically gingival in origin. In dogs, these are typically found in large male dogs (sometimes younger) as aggressive local disease with about 20-30% metastasizing. Particularly in golden retrievers, these tumors can appear low grade histologically, yet act high grade biologically with very aggressive local behavior, invasion into bone and metastasis to lymph nodes.

Survey skull radiographs can be helpful to show larger areas of local invasion while advanced imaging such as CT should be recommended for maxillary masses, larger mandibular ones, or ones in the caudal mandible. Margins of 2-3 cm are recommended, with adjuvant radiation therapy, or radiation therapy alone if the mass is inoperable.

**Squamous cell carcinoma (SCC)**

The second most common tumors in dogs, and the first most common tumors in cats (with three variants), the malignant tumor of the squamous epithelium tends to have more impact locally, with only 10-20% metastasizing in dogs (less if rostral SCC). In cats, the three types are gingival, lingual and tonsillar.

Gingival SCC in cats can be very locally invasive, and while metastasis is less likely, full staging of the thorax with radiographs and lymph node assessment is recommended. With recommended margins of at least 2 cm, in cats with mandibular masses, mandibulectomy is recommended. Prognosis is better with rostrally occurring tumors. Combinations with radiotherapy, chemotheraphy (dogs have more options) and even photodynamic therapy have all been reported.

Lingual SCC is the most common lingual tumor in cats and is often hidden in the sublingual tissues. Cats that have dysphagia, anorexia and are not grooming should always have the tongue examined, particularly the ventral portions. Most are inoperable, as they would require aggressive excision, and most cats would not do well with loss of a substantial portion of their tongue, whether it is rostral or longitudinal. Dogs respond better to near total glossectomy, learning how to eat and drink in a new manner. There are no effective agents for lingual SCC, though piroxicam can provide some palliation.

Tonsillar SCC is more common in dogs than cats, with rapid invasion from the tonsillar fossa into regional lymphoid tissue. This is typically unilateral, but with early metastasis. It is thought that toxins from urban environments may increase the incidence. Full staging is necessary with this tumor and while likely unresectable (with clean margins), excision may alleviate airway obstruction. Chemotherapeutic drugs used in dogs include cisplatin, carboplatin and piroxicam with regional radiotherapy for partial response or palliative management. A recent study in cats with radiation and carboplatin provided more favorable prognosis than previously thought.

**Treatment planning**

The possibility for early detection provides the best chance for a reasonable success with oral tumors. Intraoral radiographs and skull radiographs can outline where osseous changes have begun, while advanced imaging provides much better analysis of all tissues involved. Biopsy can be used as part of the diagnostic process, whether incisional for initial identification or excisional for a combination treatment and diagnosis.

Incisional biopsy of a small portion of a larger mass, or one that aggressive surgical decisions are needed, can provide valuable information as to the tumor type in order to determine margin placement. In lesions that are possibly FFH (hyperplasia) or POF, excision of the present mass without attempts at wider margins may be all that is needed, or for regular management. With proliferation in the oral cavity, an incisional biopsy may not be representative of deeper tissues, so non-diagnostic histopathology reports are possible: always consider what the mass looks and acts like, and consider additional attempts.

201
Excisional biopsy may be performed, with anticipated margins based on physical and radiographic signs. This will not be as accurate as in cases with previous histopathology or advanced imaging, but in many cases, pet owners prefer one surgical procedure. Choosing 1, 2, or 3 cm margins is based on the anticipated tumor type, and is often dictated by the relative size of the patient as well.

Ectomies
When the decision for excisional biopsy has been made, there are a number of considerations to consider when planning the surgical approach. If advanced imaging is not available, over-estimate the extent of the lesion seen radiographically. Since margins are planned on distance away from the tumor edge, larger dog have the advantage of being able to lose more structures before critical areas are reached. Once the extent of excision has been determined, evaluating the area closely for closure options is also important. Adequate release of surrounding soft tissue must be afforded, and at times, (rostral mandibulectomy), sections of soft tissue (lips, skin) might need to be resected to provide a cosmetic closure.

If the tumor is located in the mandibular body, full thickness segmental removal can contribute to instability and drift, and this should be considered in long term management, both for self-induced trauma from the opposite side drifting, as well as TMJ stress. If the mass is on the dorsal portion of the mandible, and the bone is large enough, a rim excision could be considered, removing that portion of mandible dorsal to the mandibular canal. With any cut, the edges should be rounded – for better stability in the rim excision and closure for full segmental removal. Rostral mandibulectomies should always address the extent of the symphysis that may need removal. The structures in the mandibular canal, including the large mandibular artery, should be addressed whether encountered distally or rostrally at the mental foramina.

Hemimandibulectomy may be used for masses that encompass most of the mandible, or the caudal portion, particularly in cats and small dogs. While fairly uncomplicated in cats, TMJ resection in dogs is more challenging. Again, considerations of mandibular drift and contralateral TMJ degeneration should be evaluated.

Maxillectomies can provide a number of challenges, based on the depth of excision required. The palatal artery should be taken into account, from its distal aspect to the rostral branches at the level of the palatine foramina. Any excision that exposes the nasal cavity may have challenges in closure, and with significant rostral maxillectomies, soft tissue reconstruction around the nares can be very difficult. Mid- or caudal en-bloc resections also need to manage the infraorbital canal and structures, as well as the palatal artery and nasal or sinus cavity exposure. Margin delineations need to consider the structures of the zygomatic region, pterygoid fossa (caudal aspect of the infraorbital canal) and the orbital region.

Summary
Like with other regions of the body, monitoring for any unusually masses is recommended; however, many oral tumors remain hidden until they are quite advanced. Being able to identify the mass accurately to make appropriate treatment plans can have a substantial impact on the prognosis for the patient. Most oral surgeries are possible in most practices, though some might be challenging.
As the pet population continues to get more ‘gray’, with care that can extend the lifespan of our patients, we have to pay closer attention to issues that can arise with these mature, senior and geriatric pets. Certainly, monitoring these individuals for medical parameters that can indicate a disease state is crucial, as early detection of any problem, from cancer to diabetes, can be helpful to the outcome of treatment.

What is aging?
In articles, aging is described as “the progressive changes that occur after maturity in various organs, leading to a decrease in their functional ability,” and “the sum of deleterious effects of time on the cellular function, microanatomy, and physiology of each body system… not a specific disease, but rather a complex process of genetic, biological, nutritional and environmental factors all contributing to the progressive regression.” There is high degree of variability of aging amongst species, breeds, individuals, and even organ systems within an individual. As an individual ages, the physiological reserves of an organ system, or multiple organ systems, are depleted.

While most of these specific alterations and mechanisms are not well defined, on a cellular level, cumulative DNA damage leading to genomic instability, oxidative damage and telomere shortening have all been discussed. Specific organ systems are often evaluated extensively, both on an individual basis (tracking renal function), and on a population basis (looking at the prevalence and risk of chronic renal disease within an age group).

Since the process of aging ultimately results in the demise of the patient, much attention has been given to the trends of aging and relative life expectancy for particular breeds, and in relation to dog size, or healthy weight range for a breed or individual. Since excess weight, taken to the extreme in obese pets, is known to have direct impact on the health of an individual, this should also be taken into account when evaluating a pet.

Relative age
For an owner, and the veterinary staff, the first step is to determine the relative age of the pet, as compared to human years. The old adage of one dog year equaling 7 human years can provide an estimate, but dogs and cats age at different rates, primarily based on their size. Smaller pets have longer expected life spans and giant breeds are often considered senior at 5-6 years of age. Several resources have tables that allow you to determine your pet’s relative age – but each animal is an individual, so these are starting guidelines to assess their senior status. Keep in mind, if the pet was adopted as an adult, there is a chance that the age on record might be an estimate, sometimes on the low side, when trying to determine their relative age.

Starting the care early – wellness from maturity
And just because a pet is growing older doesn’t mean those twilight years can’t be healthy ones. Think of the concept of “healthspan” when dealing with mature pets, not just “lifespan”: recognizing changes that are within normal limits for the pet and dealing with those changes that are not healthy. Within that “healthspan”, it is important to determine when the level of care for the different life stages needs to be adjusted. According to the AAHA Senior Care Guidelines for Dogs and Cats, the comparable start to the senior years in humans is around 56 – 60 years of age, or approximately the last 25% of the expected lifespan of the pet. The clinical screening of healthy pets prior to this stage can set baselines for comparison when the pet’s systems begin to experience changes. From a chart estimating the relative age of a dog or a cat in human years, this senior stage is reached at around 10 years of age for pets up to 20 pounds, 9 years of age for those between 21 and 50 pounds, 8 years for those between 51 and 90 pounds, and 7 years for dogs over 90 pounds.

Body condition and senior nutrition
Many practices now enjoy assessment of the Body Condition Score (BCS) to determine if a patient is in its correct weight range. Certainly, excess body weight can be accompanied by higher risks of osteoarthritis, diabetes and other metabolic diseases. On the other hand, with aging pets, weight loss can be a significant issue as well. While the basal metabolism rate of dogs continues to slowly decline with age, at around 11 years of age in cats, that decline changes to an increase in BMR, and an increased need for high quality nutrients. This is another reason, besides chronic disease, to also monitor a patient’s lean body mass or LBM. By tracking both BCS

and LBM, nutritional adjustments can be made for that particular patient’s needs. In some older cats, increased protein of a high quality might be recommended in the absence of renal failure. In fact, even in renal cases, dietary protein levels do not cause or alter the course of kidney disease. Low dietary protein only decreases the symptoms associated with kidney failure, not slow it or cure it. Geriatric pets require the same or more protein than younger animals, especially active seniors. Old pets may be special, but not with regards to protein.

Other conditions may require nutritional adjustments as well, from sodium restriction in cardiac disease to special gastrointestinal needs or an increase in antioxidants. Unfortunately, there are no specific guidelines from AAFCo for senior nutritional needs (as there are for growth vs maintenance), so the wide variation in nutrients can be quite confusing.

Mobility/exercise/enrichment
If a patient has a high BCS, managing the diet might be accompanied by increased exercise, but it is important to do a full evaluation on the musculoskeletal health of the individual. If they are already overweight, osteoarthritis may limit their mobility, and this has been identified in many dogs and even cats. Starting an exercise program gradually, with supplements or medications to ameliorate any discomfort can help that patient reach an ideal weight much more quickly. Exercise and environment enrichment (that can also adjust food intake appropriately) is also thought to help with the patient’s overall health and attitude.

Cognitive dysfunction
As many pets age, there can be a noticeable change in activity and attitude and in some pets, certain signs may not be attributable to a medical cause, and “he’s just getting old” isn’t enough of an explanation. Just as in humans, dogs and cats can experience diminished cognitive function, beyond what can be expected in the normal aging process. The DISHA acronym found in many publications can help alert you and the client to potential issues:

- **D** – Disorientation – may appear lost, confused
- **I** – Interaction – may not respond to familiar faces, or be clingy
- **S** – Sleep-wake cycles – sleep more during day, less during night
- **H** – Housetraining – eliminates inappropriately
- **A** – Activity levels – aimlessly wanders or decreased focus

Cognitive Dysfunction Syndrome (CDS) can be devastating to a family, when their life-long friend is disoriented, gets ‘lost’, forgets housetraining, doesn’t interact with others, or has a disrupted sleep cycle that can impact everyone. Most of the previous studies and data have been focused on canine patients, and while many of the signs are similar, excessive vocalization, irritability and decreased self-hygiene seem to be more prevalent signs in felines. This new emphasis on feline patients is supported by a recent study that investigated cognitive decline in cats. Behavior modification, environment enrichment, various supplements and even prescriptions can help decrease some of these signs, but the best results are found with earlier intervention.

Dental health
Dental care and senior care often go hand-in-hand, as dental disease can affect appetite, comfort levels and associations with organ disease. Using the need for dental care is a reason to complete diagnostic recommendations, and when a thorough senior health care check has been done, that can be a good time to catch up on dental care.

Senior care programs
There are many recommendation for starting and implementing senior care programs, but one important aspect that is often overlooked is the ability to measure how well your program is performing, or if you have met the goals you set at the beginning. Here is an example of one approach:

- Bi-annual exam
- Annual CBC, U/A, chemistries
  - Mini-chem at 6-7 years of age (or at ‘mature’ status)
  - Full chem at 8-10 years of age (or at ‘senior’ status)
  - Add in Thyroid profile for cats at 8, dogs at 10
- Add in disease related
- Chest radiographs, ECG
- Behavior and Nutrition counseling

If you are just starting a senior wellness program, trying to do too much at once can be challenging and some client might be resistant.

- Sudden introduction with additional costs may be challenging to implement
  - Phased-in program with Mature Wellness first
    - “Silver Elite” status
Step-up to Senior Wellness with more comprehensive evaluation and testing
- “Gold Elite”
- Promotion to Geriatric Care – likely with disease related therapy
  - “Platinum Elite”

Diary – daily functions
- Body condition, skin condition, masses - photos
- Appetite – increased, decreased, change in food type preference, difficulty prehending, chewing, swallowing?
- Water consumption/elimination – increase, decrease, change in habits?
- Activity – amount, frequency, type
  - Encourage interaction
- Alertness – Cognition or sensory (sight, hearing?)
- Sleep patterns – increased, decreased, change patterns, vocalization
  - Resting parameters – respiratory rate, cardiac rate
- Senses – sight, hearing
- Comfort level – watch gradual changes, response to medication
- Regular pictures for comparisons

Client education and involvement
The key for having a successful senior care program – and healthier senior patients – is getting the clients involved with every stage of patient care; and that takes education. Discussing wellness and preventive care throughout the pet’s life stages will help prepare the owner for the increased needs as their pets’ age. Using the tools such as the Daily Diary will keep the owner aware of gradual, subtle changes, and can help prepare them when those changes add up to conditions that need management. Working as a team, with the owners’ input and clinical diagnostics and therapies, will help provide optimal care for your senior patients.
It has been shown that periodontal disease increases in prevalence as age increases, and as body weight decreases (small dogs vs large dogs). With any chronic process, particularly one with loss of tissues (gingival and bone), the disease is likely to get worse without intervention until the final phase of periodontal disease, which is actually tooth loss. The co-influence relationship of dental disease with diabetes and even renal disease underscores the importance of addressing issues in senior pets before they cause more problems.

**Senior dental issues**

Periodontal disease has increased incidence in older pets, as does any of the conditions that can increase over time, such as tooth resorption or stomatitis in cats. Extensive periodontal disease that has destroyed mandibular bone at the level of the first molar can lead to pathological fractures, sometimes bilaterally, that have insufficient osseous structure for stabilization. Older cats may exhibit a thickening of the alveolar bone surrounding the canine teeth, especially the maxillary ones, with a concurrent super-eruption of the teeth, making them look longer than normal. This chronic osteitis/alveolitis may be minor, with periodontal management sufficient for treatment. If the tooth is mobile or the surrounding tissues inflamed, extraction may be the best route.

Oral tumors are also seen more frequently in mature/older patients, and early detection and identification of any mass can provide the only possibility for adequate management. In dogs, melanocytic tumors, fibrosarcoma and squamous cell carcinomas (SCC) are some of the most frequent types found, while the three forms of SCC (gingival, lingual, tonsillar) are the most common types found in cats.

**Treatment concerns**

Yet, as the increase in periodontal disease would warrant professional care, it is the presence of the co-morbidities that can make the necessary anesthetic procedure potentially riskier. In very few instances is the level of disease so severe, or unresponsive to management, that the dental care should be avoided completely. Most cases can be evaluated pre-operatively to identify underlying issues, and those identified disease processes can be treated to return the patient to a more stable level, to decrease the risk an anesthetic procedure would entail. In each patient, the risk of retaining the dental disease its potential effects on the rest of the body typically is outweighed by the benefits of treatment.

Individualized treatment plans are essential for senior and geriatric patients: from the pre-operative evaluation and stabilization therapy (if needed) to the immediately pre-operative period and peri-operative time frames. Many comparisons can be made to guidelines for human patients for dental procedures, including the benefit of pre-operative laboratory screening, but we have to realize that our patients can give us details on how they are feeling. In fact, dentistry and blood work can help support each other’s efforts: if a recent senior screening has been done, that might be a good time to get dental work accomplished, and if dental care is needed, it is a good time to update that patient’s lab work profile (especially if it has been declined in the past). While not always common, it is possible to pick up on underlying, inapparent disease of a patient when doing the pre-op screening.

For those patients in the mature-senior-geriatric categories, utilizing the patient anesthetic risk classification is a good starting point for evaluation and for determination of what level of assessment should be done. ASA levels of I and II might require basic blood work, UA and ECG, while adding additional chemistries to the levels III-V. Monitoring urine output (1-2 mg/kg/hr) is seldom done, but can provide beneficial information.

Pre-operative medications often play a role in these patients, including evaluating what medications could have an impact on anesthetic and analgesic drugs utilized. Decisions may have to made about what medications need to be given on the day of the procedure, and how fasting may influence diabetic patients. For most patients, while food should be taken up the evening before, small amounts of water can be given until they are admitted to the hospital.

Antibiotic use and selection will always generate plenty of discussion, and again, while human dental recommendations are to be considered, adding in the complications of anesthesia, with possible hypovolemia, hypotension and hypothermia, should be considered in each patient. If it is determined that the individual has some systemic risk (cardiac disease, borderline renal disease, etc), it may be appropriate to use a broad spectrum antibiotic (such as amoxicillin-clavulanic acid) just prior to the procedure, or to consider interoperative administration of an IV ampicillin/amoxicillin. In some patients with extreme dental infection, prior use of an antibiotic such as clindamycin has greatly improved the health of the dental tissues, and also the patient, in this author’s opinion.

**Pain management**

Another very important aspect of dental care is pain management. By customizing the analgesia and anesthesia protocols for each patient, appropriate use of pre-operative agents can reduce the anxiety and stress on the patient in the pre-operative stage, which could
have a positive effect on stress-induced immunosuppression. With good pre-operative, multi-modal analgesia, combined with local and regional blocks, the level of general anesthetic needed for the patient can be reduced significantly. If NSAIDs are chosen (renal-healthy), perfusion with fluids is important.

For local and regional blocks, the total dose should be calculated, particularly in small dogs and cats. Bupivacaine (0.5%) premixed with epinephrine (1:200,000) provides a longer time for analgesia, with some hemorrhage control, but should not be used in cases with contraindications (cardiac arrhythmias, hyperthyroidism). It also needs to be placed 10-20 minutes before the extraction or periodontal procedure for maximum effectiveness. Lidocaine doesn’t last as long, but does provide quicker analgesic effects.

**Patient care**
Perfusion before and throughout the procedure is critical in dental anesthetic cases, to maintain adequate blood volume, particularly for renal function. An initial bolus (5-10mg/kg) may be provided preoperatively, with 5-10mg/kg/hr for a maintenance dose. Cardiac patients might have a decreased fluid capacity, so monitor patients closely for any signs of overhydration, including increased pulmonary sounds or even monitoring HCT. This interoperative replacement of fluids will offset loss of water by evaporation, third space losses into traumatized tissues, and even volume replacement for hemorrhage loss in some cases.

Maintain body temperature in dental cases can be quite challenging at times: most are older, smaller, and the oral cavity is constantly wet, or being rinsed. Geriatric patients in particular can have exaggerated hypothermia with a decreased basic metabolism rate. Body temperatures less than 98 degrees can alter mentation, the immune competency of the patient, and can affect wound healing. Decreased body temperature can also impact recovery time. Keep the patient as dry as possible and provide patient warming devices where appropriate. Passive and active surface rewarming with warm water blankets, air warming devices or conductive fabric blankets can be helpful, as can active core rewarming with warmed isotonic fluids.

**Patient monitoring**
The reason we have more confidence in safer anesthesia events is the combination of individualized analgesia/anesthesia protocols and the level of patient monitoring that can be provided. General anesthesia depresses many systems of the patient that may already be compromised: respiratory, cardiovascular, CNS, thermoregulatory, hepatic and renal, to name a few. Monitoring should be constant throughout the procedure, and into the post-operative period as well, where most unexpected deaths occur.

With all the advances in monitoring equipment available, the best monitor is still a good technician. Observation of general parameters, in addition to readings from monitoring equipment can provide the best assessment of the depth of anesthesia, or when changes indicate a need for intervention. Heart rate and respiration recorded every 5 minutes can be combined with pulse oximetry, blood pressured, CO2 levels, body temperature and continuous ECG readout. CNS evaluation of the muscle tone of the jaw and eye position/palpebral reflex are more subtle indicators of anesthetic depth.

A dental procedure can sometimes be lengthy, and in particular with older patients, this can lead to concerns about decreasing body functions as the time goes on. Maintaining perfusion and blood pressure with fluids can decrease body temperature, as can moisture associated with the procedure. Anesthetic levels should be kept to as low of a level as possible to help maintain blood pressure, without waking the patient. There are situations, either due to the patient’s body systems, the length of time needed, or the extent of treatment needed that could necessitate ‘staging’ the procedure and completing a portion of the surgery at a later date.

Emergency situations should be anticipated ahead of time with printed protocols for the common drugs that may be needed in such events. Regular monitoring should consider any trends in parameter changes that could precede an emergent event, and if patient response is inadequate, immediate recovery should be instigated.

**Recovery**
Patient management and monitoring should not end when the anesthesia is turned off, or when the endotracheal tube is removed. In fact, since the patient is not observed as closely as during the peri-operative period, the recovery time is when many adverse events happen, sometimes leading to patient death. Brachycephalic patients in particular should be closely monitored, as the challenges to their air passages return once the tube is removed, so the tube should remain in place for as long as possible. Any swelling, hemorrhage or pain flare-up can add to the morbidity of the case. In patients with emergent delirium, a very low dose of dexmedetomidine may be administered (if not contraindicated) to help relieve the anxiety, stress and pain for a smoother, slower recovery. If a patient show significant pain beyond that, additional opioids may be required.

If a patient had issues with hypotension, fluid administration and even inotropes may be considered in the post-operative period, with close monitoring. Bradycardia may be present due to the effects of anesthesia, as well as any prolongation of hypothermia. If any medication (alpha 2) was used, a reversal agent would be recommended, and an anticholinergic may be used, with caution. Providing a safe means of keeping the patient warm – and dry - is also recommended.

Monitoring urine output, either a specific measurement, or encouraging conscious voiding, can assess if addition fluids are needed. With smaller patients, and certainly those with diabetes mellitus, monitoring blood glucose during and after anesthesia can point out those that might need supplementation.
Post-operative
Returning the patient to normal function as quickly as possible helps in the recovery process. Post-operative medications from analgesics to antibiotics should be discussed with the owner for proper administration. Eating and drinking small amounts should be encouraged that evening, though the food may need to be softened for a period of time after the procedure. Supplemental feeding may be necessary, to include anything from syringe feeding to a peg tube, depending on the case. Phone recheck the next day and a physical exam in two weeks allows for continued monitoring of the patient with plans for ongoing management.

Summary
While senior pets may present with particular circumstances that make anesthesia planning more complicated, in most instances appropriate patient evaluation and care will provide the opportunity for good dental care. If dental health can be improved in a senior patient, their overall health is likely to improve as well.
The use of intraoral radiography is critical in being able to accurately diagnose oral and dental disease, to assess the results of treatment, and to monitor therapy success in the long run. While films don’t have to be perfect to be diagnostic, adequate technique is necessary to be able to determine if changes are present. Practice in taking radiographs can increase the quality of the images provided, and practice in reading the radiographs taken will improve diagnostic skills.

**Identification of teeth or region**

Most digital intraoral radiography software systems have precise ways of taking images to correspond with the appropriate teeth. While this is very helpful in record keeping, if anesthetic time needs to minimized, or if images are unlabeled or mislabeled, it is important to be able to identify a tooth or structure in any image taken.

With actual digital films, part of this identification process deals with how the film is placed in the mouth. A dot is embossed on the film (through the packet), so the raised dot faces the x-ray beam source. In reviewing hard films, placing the film so the raised dot is facing you orients the image in the same way as digital films are viewed, as if you are looking onto the outward surfaces of the patient. Having models or skulls are helpful guides when starting out, until you become familiar with structures, including the differences between maxillary and mandibular images.

With either digital or actual films, there are a few quick steps to take to be able to identify what teeth are being viewed:

- First, orient or rotate the film/image until the roots are pointing in the appropriate direction
  - Maxillary roots pointing up
  - Mandibular roots pointing down
- If the teeth imaged are incisors or canines – “Shake hands”
  - The patient’s right is on your left, and vice-versa
- If the teeth images are premolars and molars -
  - Ask – “which way is the nose?”
  - If the nose is to the right – it is the right side, and vice-versa
- It is VERY important to only rotate the image digitally – NEVER “FLIP”
  - Flipping the image – horizontally or vertically – reverses right and left
- However, for images taken with the sensor or film placed extraorally:
  - Then right and left are reversed
  - This should be noted on the film/image that it was taken extraorally

**Know normal**

By reading lots of films/images, you will become more familiar with normal structures of the oral cavity. Superimposition of the nasal cavity, the mandibular canal, foramina and osseous structures such as the zygomatic arch can complicate evaluation of the films. An apex of a tooth superimposed over a less dense structure, such as the nasal cavity or mandibular canal, may give the impression of a wider periodontal ligament space, or even bone loss. This chevron effect should be verified by imaging the tooth on the opposite side, or taking multiple views at different angles. Further evaluation for tooth vitality, such as transillumination, can provide additional input. Imaging both sides can also help identify lucencies that may appear as lesions that are actually mental foramina. Adjusting technique and angles to ‘move’ the zygomatic arch away from maxillary premolars can allow you to visualize certain tooth portions better.

**Evaluation of periodontal bone**

In the evaluation of periodontal disease, it is important to be able to assess the extent of periodontal bone loss, as well as the type of bone loss. This information, along with probing depth and visual assessment, will give a complete picture of the staging of the disease for that tooth or region, and will guide treatment decisions. Each tooth in a patient’s oral cavity can have a different bone loss pattern, and the pattern can differ from root to root of the same tooth.

- Stage of disease – with each subsequent stage of disease, there is an increase in the percentage of attachment loss, which included bone
  - Stage 1 – no attachment loss
  - Stage 2 – up to 25% attachment loss
  - Stage 3 – 26 to 50% attachment loss
  - Stage 4 – greater than 50% attachment loss
• Type of bone loss
  o Crestal bone loss – initial loss of the rounded alveolar crest in between teeth
    ▪ There is typically little periodontal pocket formation
  o Horizontal bone loss – bone loss proceeds in a linear fashion across a tooth or several teeth
    ▪ If accompanied by gingival recession, roots can be exposed, and even the furcations of multi-rooted teeth, with variable extents of soft tissue pockets that will be suprabony
    ▪ If there is no gingival recession, the horizontal bone loss will result in the formation of soft tissue or suprabony pockets
  o Vertical bone loss – bone loss extends down the length of a root or roots
    ▪ This will form an infrabony pocket that can be challenging to access without gingival flaps or surgery
    ▪ If the vertical bone loss extends to the apex of a root, the infection will enter the root canal system at that point and infect the pulp, eventually killing the pulp
      ▪ This may lead to endodontic or apical bone loss of additional roots of a multirooted tooth

Endodontic disease evaluation
There are several ways to assess the health of the endodontic system: if the pulp is exposed by fracture, resorption or caries, treatment (extraction or root canal) must be performed, even in the absence of radiographs signs or lack of transillumination. Discolored teeth should likely be considered to be non-vital, though transillumination may help in the evaluation. The absence of radiographic signs does not mean the tooth is vital, as osseous changes may be very subtle, may take extended periods of time to occur, or may be missed. When present, however, radiographic signs are confirmation of pulpal compromise and can also be used to determine the best course of therapy.
  • Apical bone changes – apical periodontitis
    o If the periodontal ligament at the apex is wide, this may be an early indication that infection or compromise is present
    o The typical ‘mushroom’ area of bone loss – often termed an apical abscess – won’t be found in every case, and in theory, cannot be termed an abscess unless histopathology or culture is done. Some lesions could be sterile granulomas
    o Chronic lesions may also show resorption of the root itself
      ▪ Significant changes would decrease the likelihood that an endodontic treatment would be successful, so extraction may be needed.
  • Canal width – normal aging changes includes a narrowing of the pulp canal as the dentinal walls increase in width with a healthy pulp and odontoblasts
    o A wide canal, in comparison to a relatively more narrow canal of a similar tooth, may indicate the pulp became non-vital at some time in the past (the tooth stopped growing)
      ▪ This comparison is used to assess teeth that have sustained injury (pulpitis) or have been treated (vital pulpotomy) to make sure they continue to mature
    o Internal resorption – irregular areas of wider canal
      ▪ Indicative of an inflammatory process occurring in the pulp – likely non-vital or compromised
  • Combination periodontal and endodontic diseases
    o Type 1 Perio-endo lesion – an initial endodontic lesion at the apex extends up the root length coronally until it reaches the base of the sulcus (J-shaped)
    o Type 2 Perio-endo lesion – an initial periodontal lesion (deep infrabony pocket) extends down the root to the extent that the infection reaches the apex of the tooth and the infection compromises the pulp; a periapical bone loss pattern may occur on other roots of multirooted teeth
    o Type 3 Perio-endo lesion – concurrent periodontal lesion and endodontic lesion – either separate or eventually coalescing

Tooth resorption
While classically thought of as feline odontoclastic lesions (FORL), the term tooth resorption (TR) refers to any resorptive or erosive lesion of the hard tissues of the teeth (enamel, dentin, cementum), internal or external, dog or cat. Both the type and extent of resorption should be determined radiographically. (AVDC Website)
  • Severity of resorption
    o Stage 1 – mild dental hard tissue loss (cementum or enamel)
Stage 2 – moderate dental hard tissue loss (cementum or cementum and enamel with loss of dentin) that does not extend to the pulp cavity

Stage 3 - deep dental hard tissue loss (cementum/enamel/dentin) – extends to pulp cavity but most of the tooth retains its integrity

Stage 4 – extensive dental hard tissue loss, extends to the pulp cavity, most of the tooth has lost its integrity

Stage 5 – Remnants of dental hard tissue are visible only as irregular radiopacities and gingival covering is complete (usually odontoclastic)

- Types of resorption
  - Type 1 – focal or multifocal radiolucency is present in the tooth with otherwise normal radiopacity and normal periodontal ligament space
  - Type 2 – there is narrowing or disappearance of the periodontal ligament space in at least some areas and decreased opacity of part of the tooth
  - Type 3 – features of both 1 and 2

**Oral masses**
Radiographic evaluation of the osseous tissues surrounding any oral mass can be important in trying to determine the extent of involvement of the mass beyond visual review. Full skull radiographs can be helpful to look at broader involvement or extensive into parts of the calvarium. Advanced imaging is preferred for complete evaluation, as radiographic changes may be subtle or less apparent in some aggressive tumors. Tooth position should be compared to other teeth, or to a model, skull or other radiographs if an entire region is involved. Any tooth displacement may indicate a more aggressive lesion. The extent of osseous destruction or proliferation should be noted, including the pattern of excessive bone production.

**TMJ**
While the temporomandibular joints of smaller patients may be imaged on dental radiographs, even the smaller sensor, standard survey films of the entire skull would be an simpler method of evaluating the TMJs bilaterally for comparison. Open mouth technique, dorsal-ventral or ventral dorsal views, and oblique films can be taken for full evaluation.
Extractions: Headache or Triumph?
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Extraction decisions
Sometimes it is easy to decide when to keep a tooth and when to extract, but at others time, the choice is not as obvious. Of the three criteria to evaluate, examining the tooth in question is the first step. If periodontal attachment loss is greater than 50% or the pulp is compromised or there is extensive tooth resorption, then it is typically best to remove. If periodontal disease is moderate, then you consider the relative importance of the tooth and if the disease around it can impact a more strategic tooth. For instance, if either the fourth premolar or second molar adjacent to the large mandibular first molar can compromise the health of that important tooth, it may benefit the patient to extract the smaller tooth, thus giving better access to treat the adjacent surface of the first molar. The same would apply to the mandibular third incisor or even the maxillary third premolar. If the decision is still up in the air, the health of the patient is to be considered: any patient with an ongoing systemic issue (heart murmur, diabetes, renal disease) would likely benefit more from an extraction that will remove the source of infection in one visit, as compared to extended anesthetic times and more frequent procedures. And third, consider the owner: if an advanced periodontal procedure or root canal is to be done, are they willing to consider the additional expense, and be committed to thorough home care and regular re-treatments? If not, then again, extraction may be optimal.

Requirements

Equipment

- Periosteal elevator – Molt #2 and Molt #4 – for elevating flaps
- Means of sectioning –
  - High speed handpiece/unit is preferable, but sectioning teeth can be done with a low speed unit, just have someone dripping water on the site for cooling
  - Set up regular maintenance schedule, including daily oiling
  - Sectioning burs – replace regularly, they get dull quickly
    - 700L – dog teeth
    - 699 – cat teeth
    - #2 or #4 – round burs for alveoloplasty
- Dental elevators
  - Winged, not too thick – to fit in the PDL space
  - SHARPEN on a regular basis, even during the procedure
    - If used and sharpened regularly, they will wear down and will need to be replaced
- Dental luxators – thinner, more delicate – be careful not to bend
- Extraction forceps – small breed
- Blade – 15C
- Suture – 4-0 to 5-0 poliglecaprone
  - Reverse cutting for dogs
  - Tapered for cats
- Magnification – better posture

Pain management
Apply general principles of surgical pain management to every dental patient, even if not performing extractions. Pre-operative analgesia with opioids, alpha 2 agents, and NSAIDs when appropriate, with post-operative dispensing of NSAIDS, opioids. Perioperative regional, local and splash blocks can minimize the amount of general anesthesia used, help keep the patient more stable, and provide better post-operative analgesia for a smoother recovery. While lidocaine and bupivacaine can be mixed, if surgery sites are identified early in the procedure, use bupivacaine alone if it can be administered 20 minutes prior to extraction. Bupivacaine with 1:200,000 epinephrine premixed will provide longer analgesic effect and reduce bleeding. Watch total dose, not to exceed 1 mg/kg for cats and 2mg/kg for dogs.

Regional blocks can be very effective when placed accurately and not causing damage. Adequate training should proceed any attempts on patients, as nerve damage can result. If a regional block cannot be placed (infraorbital on brachycephalic, inflamed purulent tissue, etc), then at least place a linear local block in the alveolar mucosa above/below the tooth, and you can place additional material directly at the site when open (splash block).
Radiographs

Extractions are one of the major reasons to use intraoral radiographs, particularly when challenging procedures are encountered. Preoperative radiographs should be closely evaluated to determine the presence and condition of the periodontal ligament (PDL), as this is the structure that elevation attempts to impact. If there is no periodontal ligament space, indication of ankylosis or even tooth/root resorption, then elevation will not go as planned. Radiographs will also alert you to abnormal root structure (or number), and if there is any compromise to the jaw strength. Radiographs will not always be decisive in evaluation teeth with compromised pulps, so use transillumination and examination to assess those teeth. Post operative radiographs are a good medical and legal record, to show the correct tooth was extracted completely, without any complications (root tip, fractured jaw).

Steps of extractions

Flaps

With few exceptions (very loose incisors, premolars where envelope flaps are sufficient), most extraction sites benefit from full thickness mucoperiosteal flaps with releasing incision(s).

- Flap design – broad base, not directly over bone defect if possible
  - Extend releasing incision just past mucogingival junction, into alveolar mucosa
  - Maxillary canine – two releasing incision
  - Maxillary fourth premolar – one releasing incision mesially (rostral)
  - Mandibular canine – T- or Y- shaped distal incision, mesial incision
    - Follow the ‘path’ of the root – angled lingually
    - Elevate buccal flap completely
    - Elevate lingually to expose distal aspect of root
  - Maxillary first molar – if extracted on its own, a flap will not be reasonable

- Flap elevation and release
  - Debride gingival margin before elevating – cut 1-2mm away
  - Periosteal elevation to lift full thickness flap off of bone – past MGJ
    - Only elevate as far as you need for adequate access
  - Use blade or iris scissors to snip the fibers of the periosteum on the under side of the flap

Alveoloplasty/sectioning

- Maxillary Canine
  - Make a groove at mesial and distal aspects of the root – place for elevator – to the widest part of the root, then connect across

- Mand Canine
  - Remove bone from buccal, distal and lingual surfaces, as well as a groove at the buccal-mesial aspect

- Multi-rooted teeth
  - Shave away buccal bone until furcation is visualized
  - Using crosscut fissure bur – section from furcation through the crown
    - Max fourth premolar – one cut from furcation into developmental groove; second cut from furcation mesially to remove ‘diamond’ shaped piece of crown
      - Access to furcation between two mesial roots now visible, section those two apart
    - Mand first molar – section from furcation to just past mesial crown, but not at too much of an angle
    - Max molars – section palatal root away from two buccal roots, then separate the two buccal roots

Elevation – the goal is to fatigue the periodontal ligament to the extent that the tooth can be elevated from the socket

- Advancing the sharpened tip of the dental elevator down the root, in the periodontal ligament space, with rotational hold, is the best force to use
- Elevating in between crown portions with the fulcrum of force below the alveolar ridge – teeth may break
- Elevate tooth/section against adjacent tooth – make sure that tooth is very stable
- Gently grasping the tooth/segment with the extraction forceps and putting rotational force can help fatigue the ligament and/or tell you where you need further elevation
- If there is no movement and Radiographically the PDL was healthy, remove more buccal or interseptal bone.
  - In the maxilla, additional buccal bone removal is reasonable (window washer movement of the bur on the bone surface)
  - In the mandible, particularly of small dogs, preserve as much buccal bone as possible (cortical bone)
    - To access adjacent roots, remove one first, then remove the cancellous bone that was in between the roots to get better access for elevation without having to remove buccal bone
- Once fully elevated, radiograph to confirm
Finishing

- Elevate the lingual/palatal mucosa once the tooth is gone for better exposure for alveoloplasty and to facilitate suturing
- Smooth any rough edges of the alveolar bone (alveoloplasty)
- Curette any debris or infected tissue from the alveoli
- Determine if any bone graft material is needed
- Small breed dog – mandibular canines and first molars, incisor?
- Osse conducive or promotive?
- Scarify any epithelial edges
- Simple interrupted, bite through palatal, lingual mucosa first, then buccal flap

Complications

One of the most important resources in performing extractions is a load of patience. As soon as you lose focus or are distracted, that’s when you hear the ‘crack’. If that sound is a root tip breaking off, go through these steps to manage the situation:

- On radiographs – was the PDL intact and healthy
  - Elevation should continue – more bone may have to been removed
    - Buccal bone removal at maxillary teeth – ‘shave’ the cortical bone away to expose the root further
    - Mandibular teeth – try to preserve buccal bone, but remove the cancellous bone that was in between the teeth for better access
    - Palatal root – dig a trench around the root and make sure there are no overhangs
  - If there is any periapical bone loss (and the pulp is dead or infected), the root HAS to come out
    - Avoid aggressive elevation toward the apex – the root could punch through into the nasal cavity or mandibular canal
    - Work the root tip from side to side – use a root tip pick
  - If the root tip goes into the nasal cavity or mandibular canal, every effort should be made to remove it THEN! – this is your best chance to remove it while it is still loose and not encased in scar or fibrous tissue
    - Take radiographs at several angles to localize where the tip is
    - Open the hole it pushed through even more (watch for important vessels)
    - If you can gently grasp it without damaging other structures, attempt to do so – but it will usually move further away
    - Once the hole is wider than the root tip without overhangs, uses copious water to flush the area, and adjust the head to allow ventral drainage
    - Many times you won’t even see the tip flush out – so re-radiograph often.

If you hear the big ‘crack’ – the jaw breaking – hopefully you had pre-operative radiographs and have told the owner that the jaw could be fragile. If this is a pathological fracture due to extensive periodontal disease, it will be a difficult area to stabilize, as the affected teeth usually have to be extracted anyway. Sometimes a partial rostral mandibulectomy is the best option for the patient.

Tooth resorptions

The term Tooth Resorption (TR) is now used to describe any level of root and/or crown erosion or loss due to a variety of processes. While this is most commonly seen in cats, dogs can also exhibit signs of TR. The ‘typical’ tooth resorptive lesions that are diagnosed are those in cats, frequently in the premolars (mandibular third premolar) where radiographically it appears as if the root is being turned into bone. This odontoclastic lesion is a Type 2 TR, and should be distinguished from the less common Type 1 inflammatory lesion. The inflammatory lesions may appear similar to odontoclastic lesions in the physical appearance of the crowns (some crown loss with gingival tissue growing into the defect), but radiographs will show roots with intact periodontal ligament space(s) and intact roots, other than where the resorption is taking place. If this type is diagnosed, careful extraction of the entire root(s) is necessary.

If the radiograph shows root structure that is not distinct, with no clear periodontal ligament (PDL) space (as the root is being converted into bone, the PDL space is obliterated), and if there is no indication of apical bone loss or infection, then a modified extraction technique may be appropriate. While some of these roots can still be gently elevated, if the PDL is damaged, elevation will not be able to fatigue the ligament for extraction. If this is the case, after radiographic evaluation and initial attempts at elevation result in the crown breaking off, the modified technique may be done: remove the remainder of the crown and coronal aspects of the root (if possible), and smooth the alveolar bone before suturing the gingival closed. These areas should be radiographed post-operatively, the client should be informed that there was intentional root retention of the resorbing roots, and that the patient should be monitored for any persistent inflammation in the area.
Post-operative
Most patients benefit from appropriate pain medications, and some may require antibiotics after the oral surgery. Depending on the extent of surgery, a softened diet may be needed, and in rare instances, supplemental feeding may be needed. Active tooth brushing may be delayed for two weeks, until the oral recheck, but oral rinses and gels may be used immediately post-operatively to help with tissue healing and antimicrobial needs.

Summary
With the right equipment, training and patience, extractions in practices can be successful surgical procedures with minimal complications. Often these patients will clinically be much healthier once the infection in their oral cavities have been managed with extractions.
Radiology is a vital tool in veterinary dentistry assisting in diagnosis, treatment planning, and monitoring of oral disease. Diagnostically, being able to assess normal anatomy helps to determine if abnormalities exist, including variations in development (missing or aberrant teeth) or acquired diseases that may affect the bone and tooth structure (CMO, hyperparathyroidism, neoplasia). When determining the possible treatment for problems such as feline cervical line lesions, endodontically compromised teeth and periodontal disease, radiology can help the practitioner make a more accurate assessment. Preoperative radiographs can help monitor extractions by revealing abnormal root structures, impacted teeth, tooth resorption and ankylosed roots. Post-operative films check treatment success. Endodontics requires several films during the procedure to evaluate routine treatment and reveal complications.

**Basics of equipment**

**Radiographic unit**
The most commonly used x-ray generator is a standard dental model, which is either wall-mounted or supported by a mobile stand. There are also hand-held units available for greater ease in transportation or use in multiple sites. Staff should minimize their exposure by standing at least 6 feet from the tube head and always at an angle of 90 to 135 degrees from the path of the primary beam.

**Films**
Intraoral films provide isolation of a specific tooth with excellent detail, with a non-screen, double-coated emulsion film. The No.2 periapical film is the most commonly used, and is similar in size to most digital sensors. Occlusal films (No.4,) are 2 1/4 X 3 inches in size and often used for imaging the incisal areas, to include the canines of larger dogs, and can be useful for nasal imaging. A raised dot imprinted on the film and packet indicates the side that should face the X-ray tube, placing the concave "dimple" away from the tube. Once developed, this dot helps determine the orientation and identification of the teeth. The film is encased in an inner black paper sheet with a layer of lead foil on the backside that reduces backscatter from deeper oral tissues, all in a plastic or paper cover. These films can be hand developed in small containers in a dark room, using a chairside developer, or an automatic developer.

**Direct digital**
For convenience, increased use and decreased patient anesthetic time, investing in a digital dental system often pays for itself in a matter of months, and greatly increases the learning curve for new users. While the sensors are not inexpensive, being able to immediately see the image on the computer screen is of great benefit for both diagnostic purposes and to be able to adjust the angulation or technique to get a reasonable image. A downside to direct digital is the single size (No.2) of the sensor.

**Indirect digital**
As a compromise between standard films and direct digital, indirect digital radiography may be accomplished using phosphor plates that are photostimulatable. The phosphorus sensor uses an image plate that can be reused (the outer sleeve is replaced), then the plate is placed in a scanner, so the image can be transferred to a computer. There are more steps with the indirect method and it takes longer than the direct method, but varying sizes of plates can be utilized.

**Technique**
There are many ways to teach and take dental radiographs; the author’s preference is to have the patient in lateral recumbency and slightly adjust the head position using towels, depending on the image needed. Others prefer dorsal and ventral recumbency for taking radiographs - determine what works best for you and your staff.

**Parallel**
While a parallel technique (film and object parallel with x-ray beam perpendicular) would be ideal to minimize distortion, most areas of the oral cavity do not lend themselves easily to this positioning. The only region where the film can be placed parallel to the teeth is that of the mandibular premolars and molars, with a corner of the film pressing into the intermandibular space. The most mesial (rostral) roots and teeth may not be visible on this view, as the film may be limited by the mandibular symphysis, but aiming the radiographic beam from a slightly rostral oblique position may allow these roots to be imaged.

**Bisecting angle technique**
For the rest of the teeth in the oral cavity, a parallel positioning is not possible, so, a film is placed as close to a parallel plane to the object (root or tooth) as possible. Remember to place the film so the roots will be imaged, not necessarily the crown. One option is to use a bisecting angle technique for these films by aiming the beam at a line that bisects the angle formed by the long axis of the object (tooth) and the film.
Modified technique
Another way of determining beam position is to first line up the beam (or similar object such as a 2-inch roll of tape) perpendicular to the film. This would result in an image that is too short (shadow of a tree at noon). Next, line up the beam perpendicular to the root (tooth); this image would be too long (shadow of a tree at daybreak). Then, split the difference between these two positions, and the resulting image will be approximately the same size as the object, thus minimizing the distortion (and the beam will be perpendicular to that bisecting line mentioned earlier). Helpful devices, such as connecting two tongue depressors with a pushpin, and using a roll of tape to invisualize where the beam will travel, can help you determine the two positions (perpendicular to film; perpendicular to tooth), so you can aim the beam halfway between the two. This perspective will also help you make appropriate adjustments to an image; if you want to make the image shorter, move the beam to a position more perpendicular to the film.

Challenging radiographs – the cat quick 6
- With the cat in lateral recumbency (e.g. – left side down), take the first image of the mandibular premolars and molar with a parallel technique.
  - If the mesial (rostral) root of the mandibular third premolar does not show, adjust the xray head further ventral and forward
- Take an image of the lower canines and incisors: roll the tongue back into the pharyngeal area to keep the sensor in place better; use the modified technique
- Take an image of the upper canine and incisors with the sensor ‘wide’ across the palate
  - If you need to isolate the right canine tooth apex better, come slightly off midline
  - Take an image of the maxillary premolars
  - Place the sensor up against the palate
  - Using a tape roll, visualize where the beam would be, if aimed directly perpendicular to the teeth: you will not be coming directly laterally to the maxilla, but slightly from in front
  - Then visualize where the beam would be perpendicular to the film
  - Split the difference
  - The zygomatic arch will always be in the way – if you elongate the image by moving the xray beam more perpendicular to the teeth, the arch ‘moves’ a little more out of the way.
- Using a clear feline mouth gag (cut part of a tuberculin syringe); place the sensor under the head on the left side (extraoral); the left maxillary premolars will be placed nearly flat on the sensor in this position.
  - Using the tape roll, and angled from the back of the head, look across the arch at an oblique/angle, until you see the palatal surfaces of the left maxillary premolars without the right premolars superimposed over them
    - Make sure the sensor is placed far enough forward and dorsal that the angled beam will go through the teeth and hit the plate.
- 5 of the 6 films are done!
  - Adjust the cat to left lateral recumbency and take the left mandibular premolars

Challenging dog radiographs
- Maxillary incisors – in most dogs with a normal head shape, then ventral portion of the nares will be lined up with the base of the xray cone when positioned
- Maxillary canine apex – palpate where the apex is positioned by running your finger up the buccal jugae to the tip (it is usually somewhere over the second premolar
  - Place the sensor centered at the maxillary second premolar
  - Adjust the xray beam from midline to a slight oblique so the canine is not superimposed over the premolars in the image; make sure it is centered on the spot where you palpated the canine apex
- Maxillary molars – with a skull or model, observe how the molars are in a different ‘line’ than the premolars
  - Place the sensor in the mouth lined up with the two molars (usually angled in a palatal direction)
  - Aim the beam almost directly onto the sensor (just a slight adjustment)
- Mandibular canines
  - If you place the sensor across both lower second premolars and aim the beam perpendicular to the sensor, you will have both canine apices for good comparison
- Mandibular premolars
  - Since the symphysis restricts the sensor from going far enough forward to get a true parallel image of the first and second premolars, adjust the beam to come from in front of and below the teeth to ‘push’ them onto the image (or take it extraorally)
- Brachcephalic dogs
Use extraoral shots as is done for cats

Troubleshooting radiographs

- Teeth are too long, or the apex is not on the film
  - Place the sensor deeper into the palate – you want to see the roots, not the crown
  - Adjust the beam to be more perpendicular to the film – ‘shortens’ the teeth
- Teeth are too short
  - Adjust the beam to be more perpendicular to the tooth – ‘enlongates’ the teeth
- Image shows unexpected bone loss (and crowns are burnt out)
  - Decrease time of exposure; if at lowest time, move xray cone an inch or two away from object