Dental Radiography Reading: Let's Make It Black & White???

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1. Normal dental anatomy: To be able to recognize dental pathology, you must be able to recognize normal anatomy. When looking at a dental radiograph, note the size, shape, and appearance of the crown, roots, periodontal ligament space, pulp canal, alveolar bone, and periapical area. The crown and roots should be normal size and shape. There are instances when the ectodermal portions of a tooth (the enamel and root sheath template) are disrupted, such as enamel hypoplasia. In some of these cases, the root development is disrupted and the roots are abnormally short. The crown should also be of normal size and shape. Clinical oral examination will usually tell you all you need to know about the crown, but in some cases, the radiograph can be very helpful. The pulp canal size should be relatively uniform in all the teeth viewed within the same patient. Discrepancies may indicate pathology. Mineralizations within the pulp canal are occasionally seen, but do not always represent any significant pathology. The pulp canal is wide in immature teeth and continues to narrow with age. This information is particularly helpful when trying to determine the vitality of certain teeth(if a tooth has become non-vital, the pulp canal may be wider than adjacent or contralateral teeth). A clear thin line around the root is the periodontal ligament space. Loss of bone or loss of the clear periodontal ligament space may indicate disease. The alveolar bone is very important in the assessment of the periodontal health of a tooth. As periodontal disease progresses to periodontitis (the active breakdown of the alveolar bone), then radiographically we should be able to see the loss of alveolar bone around roots. Alveolar bone loss of less that 50% may be able to be managed with periodontal therapy. Traditionally, alveolar bone loss greater than 50% would be indication to consider extraction, but in some cases,

advanced periodontal bone regeneration can be attempted and some of the se teeth can be saved. Loss of the periodontal ligament integrity radiographically indicates resorption. Additionally, radiolucency at the periodical area may indicate endodontic infection or inflammation. A focal, uniform well defined area of bone lucency may indicate a benign bone lesion such as a cyst. Other, more generalized lucency in bone may indicate malignancy.

2. Periodontal Disease: While the periodontal probe is the most effective tool to detect clinical evidence of periodontal tissue loss, however, without dental radiographs, we are only able to estimate the actual damage. Dental radiographs are essential to see the true loss of alveolar bone and asses whether or not a tooth is salvageable. As a general rule, if greater than 50% of alveolar bone is lost on a root/roots, this tooth should be considered for removal. Also, evaluation of the alveolar bone in the furcation area of multicoated teeth may indicate furcation exposure clinically. A grade III (through and through) furcational defect is another indication for extraction.

3. Endodontic Disease: Necrosis +/- infection of the pulp canal within the tooth can result in decreased density and radiolucency around the apical area of the tooth root…periapical lucency. Some have estimated there needs to be a 40% reduction in the density of bone before these radiographic changes become visible. Therefore, in some cases, this periodical radiolucency may not be seen. Clinical signs may dictate treatment or follow-up radiography in 6-9 months may be indicated in suspect, but not clear cut cases.

Discolored Teeth: A discolored tooth is an infrequent occurrence, but can be a hidden source of infection within the oral cavity. Most traumatic insults to a tooth result in a fracture of the involved tooth with or without exposure of the pulp canal. If the pulp canal is exposed, this is a portal for entry for bacteria into the pulp tissue, death of the pulp nerve, and a potential source of tooth root infection or abscess. The discolored tooth presents a different dilemma. Teeth may discolor due to administration of tetracycline type antibiotics, internal resorption, external stains, mineral uptake from drinking water, or most commonly from trauma to the tooth that does not result in tooth fracture.

A tooth that has experienced blunt trauma without the force to fracture the crown may exhibit signs of pulpitis, an inflammation of the pulp tissue. Basically, what happens is the tooth receives a concussion that is not severe enough to break the tooth, but results in disruption of some of the tiny blood vessels within the pulp tissue along with the release of inflammatory mediators. The bleeding within the pulp canal allows blood pigments to seep into the porous dentin underneath the ceramic-like enamel that covers a tooth, giving the appearance of a pink discoloration. If this inflammation of the pulp is controlled early, then the pulp does not undergo death, but if the swelling continues within the rigid walls of the pulp canal, then the pulpitis may result in pulp death. Over

time, the blood pigments that have leached into the dentin of the tooth change color, so the tooth's appearance also changes from a pink discoloration to a grey or tan color.

Several years ago, we assumed these teeth were vital, but simply discolored. Recently, a study was published in the Journal of Veterinary Dentistry that reported the incidence of pulp death and/or clinical signs of pulp necrosis to be 92.2% (JVD, Vol. 18, No. 1, pp 14-20.). The study, done by Dr. Fraser Hale, DVM, Dipl. AVDC involved gross examination of the pulp tissue of 64 discolored teeth. Of those, only 2 (4.1%) had vital pulp tissue. Radiographic evidence of pulp necrosis (tooth death) was evident in 58.1% of the cases. The study concluded "that a distinct majority of teeth (92.2%) with pink/purple/grey/tan crown discoloration had either partial or total pulp necrosis based on visual examination of the pulp during root canal therapy or exploratory pulpotomy", and that "Radiographic signs of endodontic disease were not present in 42.4% of these teeth." Further conclusions included, "The results reported here support the treatment recommendation that all discolored teeth receive either endodontic (root canal) or exodontic (extraction) therapy."

Since the tooth in essence dies at the time the irreversible pulpitis occurs, there may be radiographic evidence that will help confirm your diagnosis. An immature tooth will have a wide pulp canal as viewed on a radiograph. As the tooth matures, the dentin becomes thicker and the pulp canal diameter diminishes. Therefore, if a tooth receives blunt trauma, discolors, and dies at a young age, the affected tooth stops maturing at that point and the pulp canal stays suspended at that size indefinitely as the other normal, healthy teeth around it continue to mature. Over time, when the dead tooth is compared radiographically to the same tooth on the opposite side of the arch, a discrepancy in size of the pulp canal is noticed. This is a strong indication this tooth has undergone irreversible pulpitis and may likely have pulp necrosis. Remember however, only around 40% of these teeth with necrotic pulps will show radiographic evidence of death, so this is not a totally reliable test, but if it shows, then there is strong indication this tooth is in fact dead. Other radiographic signs may include discrepancy in size of the pulp canal between the crown and root or evidence of periapical bone loss suggestive of apical infection/abscess.

The major concern for these teeth is that the necrotic pulp can serve as a nidus for infection and this tooth could potentially abscess without ever showing any clinical signs. The result would be this pet would walk around with a chronic aching tooth and it's immune system would be constantly fighting an infection that could be remedied. As the study suggested, at this time, based on the low incidence of vital pulps in discolored teeth, either extraction of the tooth or root canal to save the tooth is indicated to remove this potential source of chronic infection and optimize the health of our patients.

Sub-orbital swellings: This is a common condition seen in small animal practice. In some cases, the swelling is rostral to the orbit, just below the orbit, or in the retro-orbital space. In any of these instances, I think of three common "rule-outs". In my experience the majority of these swellings have been either an

abscess, neoplasia, or cyst. Other less commonly seen problems include zygomatic salivary gland adenitis, buccal molar lymphadenopathy, or foreign body infection.

A. Abscesses: These are usually associated with a tooth root abscess and are typically endodontic in origin, but they can be the result of advanced periodontal disease. There is no age, breed, or sex predilection. Apical abscesses usually respond favorably to antibiotics while on the medication, but then recur once therapy is discontinued. The recurrence of the swelling may be immediate or take months to return. On physical examination, if a broken tooth with pulp exposure or discolored tooth is noted in the region of the swelling, then this is the likely suspect. Definitive diagnosis can usually be obtained with dental x-rays. Once the affected tooth/teeth is/are identified, then treatment options can be discussed with the owner. If the abscess is due to endodontic disease, then the owner has the option of either extraction or root canal therapy. Interestingly, only a small percentage of those broken teeth with pulp exposure actually progress to develop into suborbital swelling with obvious abscessation. The majority of broken teeth with infected pulp seem to smolder as a chronic periapical infection which may go on for years. If the tooth abscess is due to periodontal disease, the tooth has no alternative except extraction. Once the source of the infection is removed, the swelling should slowly resolve.
B. Neoplasia: Some suborbital swellings are due to the involvement of the caudal maxilla with tumor invasion. Usually these are seen in older animals and tend not to respond to antibiotic therapy. Again, dental x-rays can be very helpful in determining the cause of the swelling and can help show lysis caused by invasive tumors. The dental x-rays will help determine if surgical margins are possible. CT scans are also very helpful in determining the viability of surgery. The final diagnosis usually will require histopathologic examination of the involved tissue, and definitive treatment will depend on tumor type, evidence of metastasis, and the desires and expectations of the owner.
C. Cysts: While not all that common, cysts can be a cause of swelling in the sub-orbital area. The most common cyst that we see in the oral cavity of dogs and cats is the dentigerous cyst. This is a fluid filled sac that develops around an unerupted tooth. These can occur at any age, but are typically younger animals, between 1-3 years of age. Missing teeth in the area of a swelling might be an indication clinically that a cyst could be the etiology. Dentigerous cysts are more common in the brachycephalic breeds such as the Boxer, Boston Terrier, and Bulldog. The mandibular first premolar is the most commonly involved tooth, but this has been seen in the caudal maxilla and can result in a sub-orbital swelling.

Again, dental x-rays will be very helpful in diagnosis, and treatment is aimed at removal of the unerupted tooth and removal of the cyst lining.

4. Missing Teeth: See the discussion above regarding cysts. Other causes of missing teeth might be trauma or congenitally absent teeth. Many teeth simply don't develop. This is not a major problem for most dogs, but for some breeds of show dogs, such as Dobermans and Rottweiler, it can be a major fault.

6. Tooth Resorption: Clinically we know what resorptive lesions look like, but what is considered the standard of care for treatment. Dental radiographs again are essential to determine proper treatment. There are basically two types of resorptive lesions: Type I where the lesion is limited to a specific area of the crown/root such that the root is visible with a periodontal ligament space on a radiograph. In contrast, Type II lesions show the generalized loss of discernible root where the root is literally resorbing or dissolving into bone. In the case of Type I lesions, complete extraction of the tooth/root is indicated. In Type II lesions, if there is not significant vertical alveolar bone loss due to periodontal disease, there is no radiographic evidence of periapical osteolysis or clinical evidence of necrotic pulp, and the patient is not suffering from a form of stomatitis, then crown amputation and intentional root retention is a viable alternative.
More recently, teeth with one root that has the generalized lysis and another root without resorption has been categorized as a "Type III" resorption. In those cases, you treat the roots individually. The root without resorption is extracted and the root with type II resorption can be amputated and retained.

Dental radiographs are essential for proper diagnosis and determining treatment of all the previously mentioned lesions. They also document the pathology for medical records and can be used to monitor for progression at future visits. One of the most valuable aspects of dental radiography is client education. When clients can see the pathology and the treatment performed, they understand the importance of such and in turn, value is created.

DENTAL EXTRACTIONS: AVOIDING HEADACHES FOR YOU AND YOUR PATIENTS!

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In veterinary dentistry, our goal is to save teeth and maintain a healthy oral cavity if at all possible. There are indications, however, that call for extraction of teeth. Extraction of teeth can be relatively easy if periodontal disease is present and has destroyed the attachment of the tooth to the alveolar bone and gingiva, or in other cases, extractions can be difficult, time consuming, frustrating, and painful for our patients. Luckily, there are measures that can be taken to help avoid these problems. This presentation will focus on extraction instrumentation, pain management, basic steps for extractions, and tips for extraction of specific types of teeth.

Equipment/Instrumentation:
Like any other procedure, having good quality equipment can make the job much easier. On the other hand, lack of the correct equipment, or using equipment in disrepair can make for frustrating and time consuming work. A small investment in good equipment pays big dividends in the time saved and the quality of service performed. Many of the instruments and equipment used for veterinary dentistry last for 10 to 20 years if properly maintained.
Dental radiographs are not a necessity for extractions, but they can be helpful in many areas. They can help visualize potential problems such as fractured roots, a weakened or thin bone such as the mandible, or curved roots prior to extraction, thus avoiding potential complications. Dental radiographs also record pathology and are excellent tools for client education. They add value to the procedure and allow clients to understand why the tooth was better off removed and, in many instances, help them understand the fees associated with difficult extractions such as the large roots of canine teeth.

Other than dental x-ray equipment, here is a list of some common extraction equipment:

- Aspirating syringe-- used for injecting local anesthetic
- Local anesthetic—either Lidocaine (1 hr. duration) or Marcaine (8-12 hr. duration)
- Scalpel handle
- Scalpel blade-- #10, 11, or 15
- Periosteal elevator—examples include Molt #2, Molt #4, and Schein ST-7
- Scissors—one for cutting tissue (sharp) and one for cutting suture
- Thumb forceps
- Air driven high speed handpiece
- Burs for handpiece-- #701 and 701L work well for sectioning teeth, round burs for removing bone
- Dental elevators or dental luxators

- Small breed extraction forceps
- Suture—small size, absorbable
- Needle holders—small sizes seem to work better

Pain Management:

In recent years, pain management has come to the forefront of veterinary medicine. This has also been true with veterinary dentistry. In most cases, the dental patient will be under general anesthesia and therefore, may not feel the affects of a procedure until after waking from anesthesia. With newer anesthetics such as Isoflurane and Sevoflurane, patients recover very quickly with little to no post-operative analgesia. Local anesthetics can be utilized intra-operatively to block noxious pain stimuli before it is transmitted to the neural centers. Local blocks such as intraligamental injections into the periodontal ligament or regional nerve blocks can be used. Local anesthetic with epinephrine can have the added benefit of vasoconstricting vessels in the extraction area, reducing intra-operative bleeding. Use caution or avoid products containing epinephrine in patients with hyperthyroidism, cardiac disease, or under halothane anesthesia. Furthermore, local anesthetic allows the patient to be maintained at a lighter plane of general anesthetic, reducing the risk of anesthetic complications.

Non-steroidal anti-inflammatory medications (NSAIDS) and opioid based analgesics can be used pre-operatively and postoperatively in association with local anesthetics to enhance pain management. Morphine, buprenorphine, fentanyl, and butorphanol are commonly used as premedication for their analgesic as well as sedative effects. The sedative effects of these medications help with a smooth induction of anesthesia and recovery. NSAIDS such as carprofen and meloxicam are not controlled drugs and can be dispensed for continuing management of mild to moderate pain. If more significant discomfort is expected, fentanyl patches or controlled medication such as hydrocodone can be used, but abuse potential should be given consideration. Dosages for these medications should be followed according to manufacturer's recommendations or be reviewed in a current formulary prior to administration.

10 Basic Steps for Extracting Teeth:

1. Radiograph site: As mentioned earlier, dental radiographs provide vital information that can help avoid potential complications. They also serve to form a part of the medical record and assist in the decision making process for recommending extraction. Dental radiographs furthermore enhance the value of such a procedure by showing clients the actual pathology taking place with a particular tooth and the special considerations when extracting large or multirooted teeth.
2. Sever the epithelial attachment: A tooth is held into the bony socket by the peridontium: alveolar bone, cementum, periodontal ligament, and gingival. The first layer of peridontium to break down is the epithelial attachment of the gingival. This is easily done by incising through the attachment with a scalpel blade. The #11 scalpel blade works well.
3. Elevate the gingival: For surgical extractions, reflecting the gingival away from the alveolar bone and roots of the teeth helps visualize the extraction site and allows for alveoloplasty, removal of some of the alveolar bone to make extraction of large roots or multiple roots easier. Care should be taken when making incisions through the gingival

to avoid major vessels, nerves, and salivary ducts. Those of importance include the infra-orbital vessels and nerve as they exit the infra-orbital canal, the middle mental nerve as it exits the middle mental foramen, and the parotid and zygomatic salivary ducts.

4. Section the tooth: Section multi-rooted teeth into single root segments, then elevate them one root at a time. These teeth have diverging roots that are meant to "lock" the tooth into the bone. By sectioning the teeth, the root segments should be removed easier. To section a tooth, use a crosscut fissure type bur such as a 700, 701, or 701L in the high speed handpiece.
5. Remove alveolar bone: If necessary, some of the buccal alveolar bone can be removed to enhance visualization and access to the roots of some teeth. This is done with a round ball bur in a high speed handpiece with water cooling to prevent thermal necrosis of the remaining bone. See figures 1 and 2 for alveoloplasty sites for large and multirooted teeth.

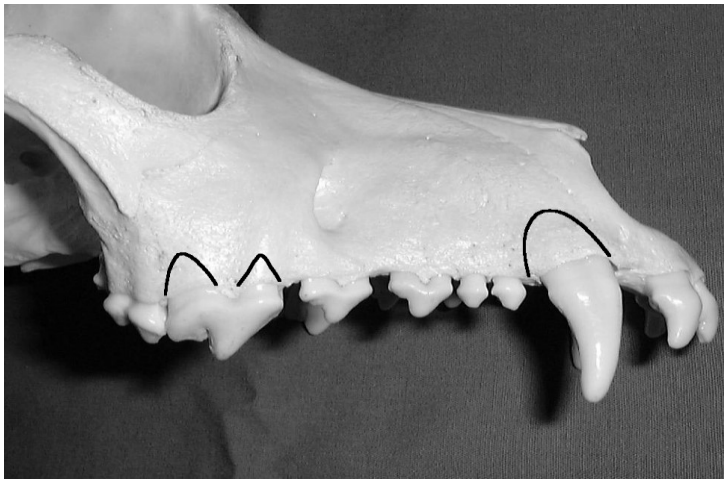

Figure 1: Alveoloplasty sites for the maxillary canine and 4th premolar.

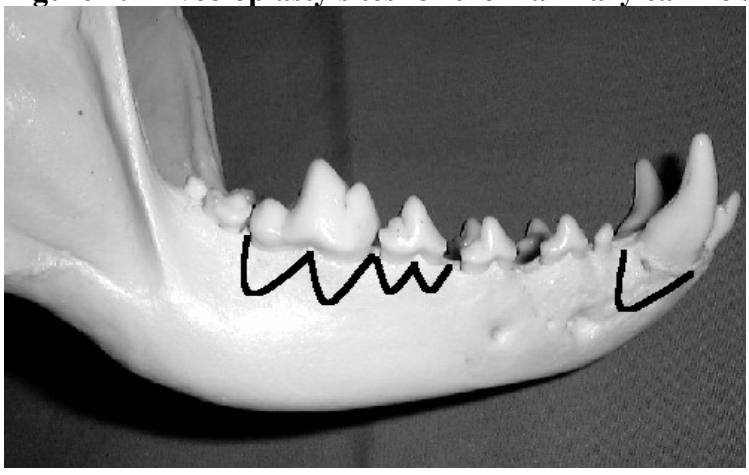

Figure 2: Alveoloplasty sites for large teeth of the mandible. Note the middle mental foramen below the second premolar.

6. Elevate or luxate tooth: Using elevators or luxators, break down the periodontal ligament attachment to the tooth root. One tip when using elevators is to use them with steady force for a period of 30-60 seconds in different directions to fatigue the periodontal ligament.
7. Extract the tooth/ root segments: Once the tooth or root segments start to loosen, grasp the tooth as close to the root as possible with extraction forceps and gently turn while extracting the root, like opening a door. Only use this technique when the root segments are loose, otherwise, the tooth may break at the crown-root junction.
8. Debride/ alveoloplasty: Once all teeth/ roots are removed, the empty alveolar socket should be flushed, and all infected tissue removed by curettage. Bony prominences or spicules can be smoothed with a bur in the high speed handpiece or with rongeurs. This prepares the extraction site for closure of the gingival.
9. Alveolar Ridge Maintenance (ARM): ARM is the preservation of the integrity of bone in an extraction site by placing an osseopromotive substance in the extraction site prior to suturing the gingival closed. This is not necessary in all extraction sites, but can be helpful in areas that might be weakened by bone atrophy after extraction of large roots, such as the mandibular canine tooth and the mandibular first molar. These areas are susceptible to pathologic fracture if periodontal disease has already weakened them.
10. Suture/close the gingival: Most extraction sites can be closed relatively easily following extraction. One key principle to successful healing is to ensure there is no tension on the gingival when closed. One way to help reduce the tension of a gingival flap closure is to cut the periosteal attachment on the underside of the flap to "release" the flap and allow it to be more elastic to cover larger defects without tension. One area difficult to close is the maxillary first molar due to its caudal location ond lack of soft tissue for repositioning without potential to adjacent structures such as the parotid salivary duct. Use of hemostatic agents such as aluminum chloride solution with steady pressure will allow clot formation and granulation of the site.

Extraction of Specific Types of Teeth:

Maxillary Canine

Maxillary canines are a very challenging extraction due to the significant length of the root. In addition, the very thin (less than 1-mm) plate of bone between the root and the nasal cavity often results in the creation of an oronasal fistula.

Vertical incisions are usually necessary for exposure and closure. At least a distal incision should be performed, and performing a mesial and distal incision will allow for increased tissue for closure.

The distal releasing incision is typically created at the mesial line angle of the first premolar. An exception exists if the first premolar is very close to the canine. In this case, carrying the horizontal component to the mesial line angle of the second premolar is recommended. This is to allow sufficient exposure for bone removal, as the root curves back to over the second premolar.

If a mesial incision is performed, it should be in the diastema between the canine and third incisor. Classically it was made at the line angle of the canine or third incisor. However, in this author's opinion, the mesial line angle of the canine does not allow sufficient exposure and there is no reason to risk damaging the third incisor and increase surgical trauma. It is critical to fully incise the interdental gingiva to avoid tearing the flap. This is particularly challenging in the area mesial to the canine. Make sure to cut all the way to the bone. Following the creation of the vertical incisions, the flap is carefully elevated. If it is not elevating fairly easily, ensure that the interdental tissue is fully incised.

Once the flap is raised, approximately ½ of the buccal bone is removed. Make sure to remove some of the mesial and distal bone as the tooth widens just under the alveolar margin.

After the bone removal, elevate the tooth carefully. Do not torque the crown too much bucally as this will lever the apex into the nasal cavity. Once the tooth is elevated to a point of being very loose, it can be carefully extracted with forceps. The bone is then smoothed with a coarse diamond bur.

Closure is initiated with fenestration of the periosteum. When this is performed the tissue should stay in position over the defect. If it does not, tension is present and the flap will dehisce. It is critically important to relieve all tension if an oronasal fistula is present. Close the flap starting at the corners to avoid having to start over if it does not close correctly.

Maxillary fourth premolar

The first step when extracting this tooth is to create a gingival flap. Classically this is a full flap with one or two vertical releasing incisors. This will allow good exposure, as well as providing sufficient tissue for closure. However, an envelope flap is sufficient for small and toy breed dogs, as well as cats.

Full flaps are created by making full thickness, slightly divergent incisions at the mesial and distal aspect of the tooth. These incisions should be carried to a point a little apical to the mucogingival junction. Be careful to avoid cutting the infraorbital bundle as it exits the foramen above the third premolar. The flap is then gently elevated with a periosteal elevator.

Following flap creation, buccal bone is removed to a point approximately ½ the length of the root. Next, the tooth is sectioned. The mesial roots are separated from the distal by starting at the furcation and cutting coronally. Next, the mesial roots are separated by sectioning in the depression between the palatal and buccal roots. Another way to visualize this is to follow the ridge on the mesial aspect of the tooth. When performing this step, a common mistake is not fully sectioning the tooth. The furcation is fairly deep, so make sure that you have it fully sectioned by placing an elevator between the teeth and twisting gently. If fully sectioned, the pieces will move opposite each other easily.

Mandibular first molar

In canine patients, these extractions are further complicated by a groove on the distal aspect of the mesial root. In addition, the mesial root is often curved. Finally, in small breed dogs, there is commonly a significant hook at the apex. Moreover, this tooth is the most common place for an iatrogenic mandibular fracture and it is possible to damage the mandibular nerve and vessels. This is much more likely in small and toy breed dogs, because the roots of these teeth are much larger in proportion to the mandible than large breeds. Bony resorption can significantly weaken

the bone and predispose to a mandibular fracture. It is advised to warn clients of these potential complications. Dental radiographs are required to demonstrate the level of remaining bone. Finally, consider referral for these extractions (or possible root canal therapy).
The first step when extracting this tooth is to create a gingival flap. Classically this is was full flap with one or two vertical releasing incisors. However, this author finds that an envelope flap is sufficient in virtually all cases. Following flap creation, buccal bone is removed. Next, the tooth is sectioned and the extraction proceeds as for single rooted teeth

Mandibular canine
These are quite simply the most difficult extraction in veterinary dentistry. This is due to the length and curve of the root, the hardness of the mandible, and the minimal bone near the apex. Furthermore, extraction of this tooth will greatly weaken the jaw and further predispose the patient to an iatrogenic fracture either during or after surgery. This tooth often holds the tongue in, and therefore it is not uncommon for the tongue to hang out following the extraction. Finally, the patient loses the function of the tooth. Therefore, it is strongly recommended to avoid extraction of this tooth. Referral for root canal therapy is a much better solution, if possible.
Some authors recommend a lingual approach to this extraction since less bone needs to be removed as to tooth curves lingual apically. However, this author prefers the standard buccal approach. This is because superior exposure is afforded and the flexible buccal mucosa allows for easier closure.
The flap for this extraction is generally triangular with just one distal vertical flap. A horizontal incision is created along the arcade to the mesial line angle of the first premolar. Then a distally divergent vertical incision is created. Next, the flap is carefully elevated and the buccal bone is removed to a point about 1/3 of the way down the root. More bone can be removed if necessary, but be careful with creating a larger flap or taking more bone as the mental nerve and artery exit approximately 3/4 of the way down the root. The tooth is then carefully elevated and extracted. Debridement and closure is as above.

Extraction of retained roots
Root fracture is a very common problem in veterinary dentistry. While it seems that removal of retained root tips is a daunting task, with proper technique and training it can be fairly straightforward. The first step is to create a gingival flap. Depending on the anticipated amount of exposure necessary to retrieve the fragments, this can either be an envelope flap or a full flap with one or two vertical releasing incisions.
Following flap creation, buccal cortical bone is removed with a carbide bur to a point somewhat below the most coronal aspect of the remaining root. If necessary, the bone can be removed 360 degrees around the tooth, but this author tries to avoid this aggressive approach.
Once the root(s) can be visualized, careful elevation with small, sharp elevators is initiated. Once the tooth is mobile, it can be extracted normally. After radiographic confirmation that the tooth is fully extracted, the bone is smoothed and the defect closed.

Oronasal fistula repair
In most cases, the single layer mucogingival flap technique is sufficient to repair ONFs, especially when done correctly the first time. This is the most common surgical treatment used to repair ONFs and therefore will be presented here.

The single layer mucogingival flap is created with either one or two vertical incisions. Depending on the size and location of the fistula as well as presence of the offending tooth, a horizontal interdental incision may also be necessary for successful repair. Proper design of the mucogingival flap will allow maximum exposure of the area for extraction of the tooth (if necessary), debridement of the fistula, and critically important tension-free closure.

Incisions are created with a number 15 or 11 scalpel blade. As described previously, the vertical incision(s) were classically started at the line angle of the teeth. A line angle is a theoretic corner of a tooth. When repairing an ONF associated with a maxillary canine tooth, the distal incision is made at the mesial line angle of the first premolar, and the mesial incision is started at the mesial line angle of the canine (if present). However, it is not necessary to cut over to a line angle if there is a diastema. If the tooth is already absent, the incisions are made at the mesial and distal edges of the fistula.

When making flap incisions, adequate pressure should be placed to ensure full thickness of the soft tissue is incised down to the bone. Any vertical incisions should be created slightly divergent as they proceed apically. Divergent incisions allow for adequate blood supply for the newly created pedicle flap. It is important to choose the location of the incisions to ensure that sutured margins will have adequate bony support and will not lie over a defect.

The mucogingival flap is gently elevated off the bone using a periosteal elevator. Approximately 2-3mm of palatal mucosa is also gently elevated/lifted off the palatal bone so that fresh epithelial edges are created. Any margins of the flap associated with the oronasal fistula should be debrided using a LaGrange scissors or coarse diamond bur to remove 1-2mm of tissue, leaving fresh epithelial edges.

A coarse diamond bur on a high-speed handpiece is used to smooth the edges of the remaining maxillary bone (if necessary) and to remove any epithelial remnants between the fistula and the nasal cavity.

As with any closure in the oral cavity, the key to success is to ensure there is no tension on the incision line. Fenestration of the inelastic periosteum (see previous section on surgical extractions) is performed to increase the mobility of the flap and allow for a tension free closure. This is accomplished by a combination of sharp and blunt dissection with a LaGrange scissors to ensure the overlying mucosa is not damaged.

The gingival flap is then placed over the defect so that it remains in position without being held. Once this is accomplished (i.e. no tension is present), the flap is ready to be sutured into place. Placing a subcuticular layer can improve the chances of healing. A few buried horizontal mattress sutures will help maintain the flap as well as smooth out the incision line. Finally, this layer cannot be licked out by the patient.

Closure is performed as described in previous sections, with the initial sutures placed at the corners of the flap. This will avoid having to resuture the flap if it does not align correctly. This is not necessary if a subcuticular layer has been placed.

The remainder of the flap is then sutured over the defect in a simple interrupted pattern every 2-3 mm using an absorbable suture material. Suture lines should always be placed over healthy bone.

References:

1. Lobprise, H.B. and Wiggs, R.B., The Veterinarian's Companion for Common Dental Procedures, AAHA Press, Lakewood, CO, 2000.

2. Wiggs, R.B. and Lobprise, H.B., Veterinary Dentistry Principles & Practice, Lippencott Raven Publishers, Philadelphia, PA, 1997.
3. Harvey, C.E. and Emily, P.P., Small Animal Dentistry, Mosby--Year Book, Inc., St. Louis, MO, 1993.
4. Manfra Marretta, S., Problems in Veterinary Medicine, Dentistry, Vol. 2, No. 1, J.B. Lippencott Co., Philadelphia, PA 1990.

Oral Tumors In Dogs and Cats

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The word "tumor" can be scary to many pet owners because the term invokes visions of malignant cancers. While some tumors are malignant not all tumors in dogs and cats are malignant. In dogs, 50% of oral tumors are malignant, but the good news is 50% are benign and typically not life threatening. Even some malignant tumors can be slow growing and slow to spread to other parts of the body (called metastasizing) and if caught early, can be successfully removed completely with surgery. Other malignant tumors respond very favorably to radiation or chemotherapy. In cats, however, most oral tumors end up being malignant (usually squamous cell carcinoma) further emphasizing the importance of early detection and treatment.

Early recognition, accurate diagnosis, and tumor staging are vitally important and significantly affect the patient prognosis. Some important criteria to determine are tumor type, tumor size, location, bone involvement, and evidence of metastasis. In general, the smaller a tumor is when diagnosed, especially if it is malignant, the better the prognosis and the more likely the mass may be able to be adequately removed surgically. Masses that may appear insignificant because they are small should be biopsied because the earlier the diagnosis, typically the easier they are to treat and the better they respond.

Initial diagnostic approach to oral tumors should include anesthetized oral exam of the mass: determine the tissue involvement (i.e. is it on a stalk--pedunculated or dispersed broadly throughout the soft tissues), careful measurement of the dimensions of the tumor in three dimensions, radiographs of the associated teeth/bone--ideally dental radiographs, careful examination of regional lymph nodes--fine needle aspirate if any are palpable, and mass biopsy. In general (these are not hard and fast rules), those tumors that are pedunculated or push teeth out of their normal position tend to be benign. Those masses that show bone lysis or invade soft and hard tissue without disrupting the normal location of teeth tend to be malignant. Good biopsy techniques will help give an accurate diagnosis. Adequate sample size and sample location is helpful to get a representative sample for histopathologic exam. 0.5-1.0cm cubed sample taken from the middle or most representative area of the tumor taking care not to incise into normal tissue should be adequate. Also, take samples after all other dental surgery has been done or completely change out instrumentation to avoid potential iatrogenic spread of tumor cells. If possible, take digital photos of the mass before and after biopsy sampling and provide a copy of the photos to the pathologist along with a detailed description of any radiographic abnormalities and regional nymph node aspirates. Once the mass is evaluated histologically and the tumor type is determined, then further tests can be done if necessary to see the full tumor extent and if there are any signs of metastasis such as chest radiographs, abdominal radiographs/ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and regional lymph node removal for more complete exam. Once the tumor is staged (see the World Health Organization Tumor Staging classification), then treatment recommendations/options can be discussed with

the owner regarding prognosis, extent of surgery (if indicated), and quality of life following surgery.

In dogs, there are several benign oral tumors, from overgrown normal gum tissue (called focal fibrous hyperplasia) to benign tumors originating from the tooth structure (odontogenic tumors) to non-tooth origin tumors (such as papillomas -- viral caused tumors). Most of these are treated by removing the mass with a very small amount of normal tissue around them +/- including the teeth they are associated with. In some cases, even benign tumors may invade the bone of the associated tooth it originated from and some bone removal may be necessary when removing the teeth. As long as these lesions are detected early, a small amount of bone removal combined with losing a few teeth, while not perfect, should not interfere with the pet's overall quality of life.

Treatment for oral malignant tumors varies depending on the specific tumor type, size of the tumor, local invasion into the tissue surrounding the mass, and spread to distant tissues (metastasis). This further underscores the importance of oral biopsy, dental x-rays, chest x-rays, abdominal x-rays or ultrasound, and evaluation of the regional lymph nodes that drain the area where the mass is located. If there is no evidence of distant spread of the tumor, surgery to remove the mass may be the best chance for a cure. Different oral malignancies require different amounts of normal surrounding tissue to be removed, called "margins", to give the best chance of eliminating the tumor completely. Substantial amounts of both the upper and lower jaw can be removed when removing oral malignancies and these patients actually adapt quite well. In general, the smaller the malignancy and the more forward in the mouth, the easier it is to achieve "clean margins", and consequently a higher rate of success.

Some of the more common oral tumors to be familiar with include:

Benign Tumors:

1. **Focal fibrous hyperplasia** (previously called gingival hyperplasia)
Probably the most "benign" of gingival masses, however these can be extensive in nature. Boxers, bulldogs and other brachycephalic breeds seem to be the most represented. Excision of the redundant tissue is advised to help prevent "pseudo-periodontal pockets" along the surfaces of the adjacent teeth that collect food and debris, potentially leading to periodontal disease. Gingival hyperplasia may be induced by certain drugs such as phenytoin and cyclosporin. Azithromycin has been proposed to counteract the effects of cyclosporin induced gingival hyperplasia and some veterinary dentists have advocated using an azithromycin gel topically on a daily basis. There are no controlled studies to report the effectiveness of this to date. Reduction of the dose of cyclosporin to the lowest effective dose may be beneficial.

2. **Peripheral odontogenic fibroma** (previously called fibromatous epulis)--some of these mineralize internally and may be called "ossifying epulis"

These tumors arise from the periodontal ligament of the associated tooth and may recur with incomplete excision. If the mass was excised at the time of biopsy, careful monitoring is advised. If the mass recurs within a short amount of time (less than a year) then excision of the mass along with extraction of the associated tooth and alveoloplasty should be curative.

3. **Acanthomatous ameloblastoma** (previously called acanthomatous epulis and adamantinoma)
For the canine acanthomatous ameloblastoma, the breeds most predisposed (in order) were the Golden Retriever, Akitas, Cocker Spaniel, and Shetland Sheepdog. This is contradictory to another study of canine epulides by Yoshida et al in 1999, who reported the Shetland Sheepdog to be much more predisposed than any other breed. The most common location of the CAA was found to be on the rostral mandible. In general, the CAA is technically a benign tumor in the respect that this tumor has never been reported to metastasize, but they are considered to be locally invasive into surrounding bone and therefore treatment dictates excision of the mass with at least 0.5cm margins of clinically and radiographically normal tissue. Clean surgical margins equates to an excellent prognosis with a very low incidence of recurrence (less than 2%). These tumors are also radiosensitive and those that cannot be resected surgically should respond well to radiation therapy. One recent study by Kelly et al reported in 2010 also found good results with intralesional bleomycin injections. One study, published in 2017 (Bell, Goldstein, and Soukup: JVD 34(4)) revealed surgical margins larger than 5-7mm may not be needed for excellent long term results.

4. **Sublingual granuloma**
Hyperplastic mucosa from repeated trauma under the tongue or in the cheek mucosa. Usually a response to this tissue getting caught between the occlusal surfaces of the teeth when chewing. These have been referred to as “gum chewers lesions” previously. Excision is advised, although some may recur.

5. **Odontoma** (compound or complex)
Benign abnormal division of cells of tooth origin. The compound odontoma will radiographically appear like a sac of multiple teeth whereas the complex odontoma will appear radiographically as a soft tissue density mass within the bone. Both are treated the same, open exploration with curettage of all contents and cavity lining. Submission of the contents and/or lining is advised to confirm the clinical diagnosis.

6. **Cysts:** dentigerous, radicular, etc.
Unerupted teeth are usually the etiology of epithelial lined cysts within the mandible or maxilla. The mandibular 1st premolar teeth in brachycephalic breeds are commonly unerupted. Dental radiographs of all patients, even in areas where there are clinically missing teeth will help detect these unerupted teeth. Extraction prior to cyst development can be very beneficial. Clinically, dentigerous cysts appear as soft, fluctuant swellings in the gingiva or mucosa and often have a bluish tint. Fluid aspirated with usually straw colored +/- blood. The dentigerous cyst develops from the dental sac surrounding the crown of the unerupted tooth. Treatment is aimed at open exploration, removal of the unerupted tooth and the cyst lining and closure of the defect. Any removed cyst lining should be submitted for histopathology.

7. **Plasmacytoma**
Extramedullary plasmacytomas can occur in the oral cavity of dogs and rarely metastasize, however, they can be locally invasive. Surgical excision is the treatment of choice with 1cm margins of clinically and radiographically normal tissue surrounding the mass. If clean margins are achieved, there is a favorable prognosis.

Malignant Tumors:

1. Malignant melanoma (MM)

The most common oral malignancy in dogs' mouths. These are locally invasive (57% involve bone) and relatively quick to metastasize (50-75% metastasize to regional lymph nodes and lungs). Regional lymph nodes should be aspirated or biopsied as lymph node size is an inaccurate indication of metastasis along with chest radiographs to accurately stage this neoplasm prior to surgery. MM less than 2cm carry a more favorable prognosis. Surgical excision should include 1.5-2cm of clinically and radiographically normal tissue surrounding the mass. Careful follow up is advised for local recurrence and metastatic development with lymph node palpation and chest radiographs every three months for 18 months following surgery. Adjunctive therapy such as radiation, immunotherapy, or chemotherapy may be helpful. Consultation with a veterinary oncologist is advised.
Be aware, recently, a "low-grade" form of oral melanoma has been described with a very favorable prognosis (Esplin , DG, "Survival of Dogs Following Surgical Excision of Histologically Well-differentiated Melanocytic Neoplasms of the Mucous Membranes of the Lips and Oral Cavity", Vet Pathol 2008 45: 889)

2. Squamous Cell Carcinoma (SCC)

The most common malignancy in the oral cavity of the cat and the second most common oral malignancy in the dog. Relatively slow to metastasize (except the tonsillar form in cats) and typically spreads to the lungs (20-30%) and regional lymph nodes. These tumors can be locally invasive and most (75%) show local osteolysis. Surgical excision should include at least 1cm (more if possible) of clinically and radiographically normal tissue surrounding the mass. The prognosis is good for surgery with clean margins, better in the mandible (10% local recurrence) than the maxilla (30% recurrence rate locally). Poor prognosis for cats with tonsillar SCC or caudal sublingual SCC.
Be aware of the papillary SCC, which can occur in very young dogs. This tumor is locally invasive, but carries a very good prognosis with clean surgical margins. Consultation with a veterinary oncologist is advised.

3. Fibrosarcoma (FSA)

In the oral cavity, these tumors are typically slow growing and slow to metastasize, but are very locally invasive. Approximately 25% metastasize to the regional lymph nodes and 6% to the lungs. Surgical excision should include 2cm of clinically and radiographically normal tissue surrounding the mass. Even with clean margins, local recurrence (46%) is common.
Be aware of the Histologically Low Grade, Biologically High Grade FSA: This is a very invasive and aggressive form of FSA that affects relatively young dogs (Golden Retrievers) and

histologically may appear to be a “well differentiated fibroma”. Consultation with a veterinary oncologist is advised.

4. Osteosarcoma (OSA)

A less common malignancy in the dog and cat that is typically slow to metastasize in comparison to the osteosarcoma of the appendicular skeleton. Surgical excision with 1-2cm margins are advised and if margins are wide and clean, a good prognosis is expected. Careful follow-up for local recurrence and evaluation of local lymph nodes as well as periodic chest radiographs are advised. Consultation with a veterinary oncologist is also recommended.

***An excellent resource is the Veterinary Society of Surgical Oncologists website: www.vsso.org

***If you notice, many of these tumors look alike, therefore...the bottom line is to look often, detect early, and treat as soon as possible when it comes to ALL oral tumors.