Dental Radiograph Interpretation

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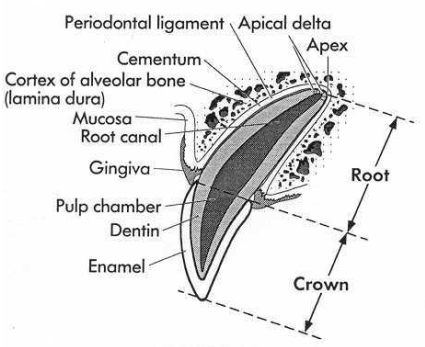
The interpretation of dental radiographs is similar to the systematic approach that we employ with standard radiography in our general practice. This document will review normal and abnormal radiographic anatomy of the tooth, supporting tissues, bone and regional anatomy so you may make clinical decisions on your patients.

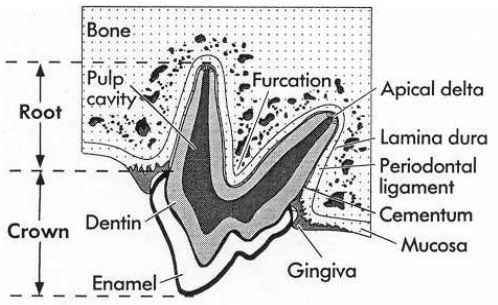
- AAHA standards recommends dental radiographs for all patients, combined with probing and visual inspection of the teeth and oral tissues.

Intra-oral dental radiographs are most commonly performed on a phosphor plate or rigid sensor. Intra-oral plates or sensors are small in comparison to standard radiographs. The most common phosphor plates used in the oral cavity, sizes #2 and # 4, are 1 ¼"x 1 5/8" and 2 ¼"x 3" respectively, while the digital sensor is a #2 size. A plate or sensor are strategically positioned intra-orally allowing you to isolate the tooth and bone without superimposition of the contralateral dentition. These images will have greater resolution when compared with standard radiograph images.

When viewing digital images it is helpful to have a high contrast monitor mounted at eye level and some prefer room lighting that is somewhat dimmed. The dental software will allow changes in contrast, magnification and the viewing of multiple images to fully evaluate the tooth and bone. Images can exported to the medical record, patient dismissal document and be emailed to specialist or us veterinarydentalcenter@gmail.com for case consultations.

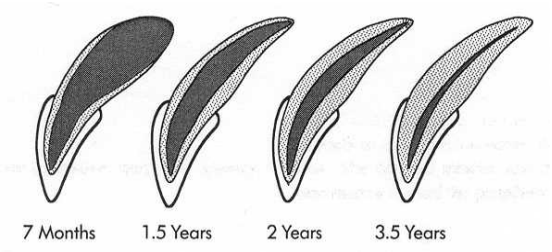
Tooth Anatomy





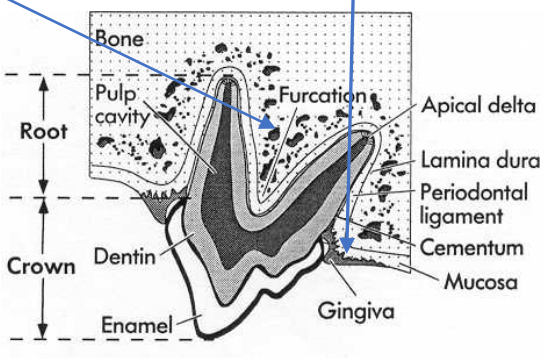
Each tooth is comprised of an enamel covering, a structurally strong dentinal wall beneath, and the centrally located pulp. The **crown** is the portion of the tooth visible superficial to the gum margin. It is covered with **enamel**, which is approximately 95% inorganic matter, making it the most radiopaque structure on the crown. The cervical portion of the tooth is the neck, located where the crown meets the root. This is the **cementoenamel junction**, where the enamel joins the covering of the root, the **cementum.** The structurally strong wall of the tooth is **dentin** and extends the entire vertical length of the tooth. Dentin is a dynamic living tissue that continues to grow over

a pet's lifetime. It is composed of approximately 70% inorganic material and is therefore less radiopaque than the enamel. In the center of the tooth is the **pulp** (blood and nerve supply of the tooth) which will appear as the radiolucent center of the tooth. Initially, the pulp canal is very large and the dentinal wall very thin. As the tooth matures the wall thickens (dentin), the root lengthens, and the apex closes between 9 months and 12 months of age. This maturation of the tooth can be used to assess viability when compared to the contralateral tooth.



The supportive tissues of the tooth is the periodontium. Four tissues comprise the periodontium: the gingiva (gum tissue), cementum, periodontal ligament, and alveolar bone. For radiographic purposes the periodontal ligament is our landmark. The **periodontal ligament (PDL)** is comprised of strong connective tissue fibers that suspend the tooth, like a shock absorber, in the alveolar socket. The PDL will appear as a thin, radiolucent (dark) line surrounding the root of the tooth. The PDL attaches to the alveolar bone, which is a dense cortical bone lining the socket or **lamina dura**. The PDL will appear wider in the young pet and will narrow with age.

Alveolar bone is slightly more radiolucent than tooth roots and appears mottled. The **lamina dura** is radiographically visible as a radiopaque line that represents the dense compact bone lining the alveolus. The **alveolar margin** is the cortical bone that extends within 1-2 mm apically to the cemetoenamel junction. This bone tends to be pointed in the rostral regions and somewhat flat as we move caudally in the dental arcade. **Furcational bone** is another important region to evaluate. This is the bone that lies between the roots of individual multirooted teeth.



Normal Dental Radiographic Anatomy

The key to successful interpretation of dental radiographs is to develop a working knowledge of dental anatomy and the common pathologic conditions unique to dentistry. A systematic approach should be taken with each radiographic image.

1. Start at one lateral margin of the radiograph and move to the other. **Assess each crown** and the general relationship of all tooth structures relative to the adjacent teeth.
2. The **level of periodontal bone** should be evaluated (interproximal bone and furcation bone).
3. The **periodontal ligament space** and bone surrounding each tooth should be assessed. The bone density as well as integrity of the lamina dura should be noted.
4. The **pulp chamber** of each tooth should be evaluated as well as pulp canal symmetry between teeth.
5. **Normal anatomical landmarks should be identified.** These include the nasal cavity, mandibular symphysis, mandibular canal, palatine fissures, and mental foramen. These all are considered in the diagnosis of disease as well as treatment planning (extractions…)

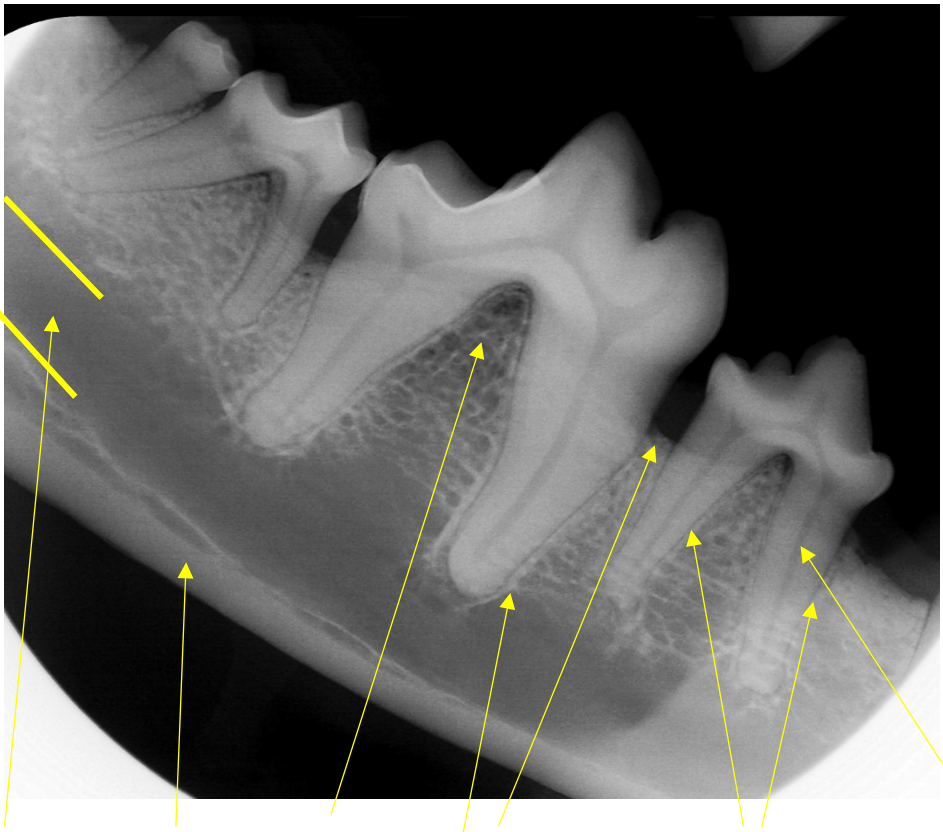


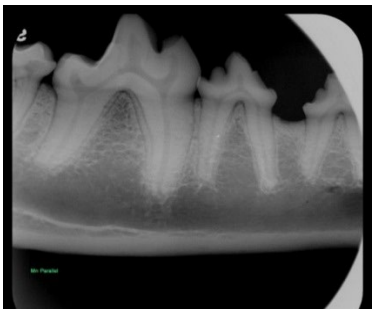
Image Orientation and Assessment

When evaluating dental radiographs we make two assumptions:

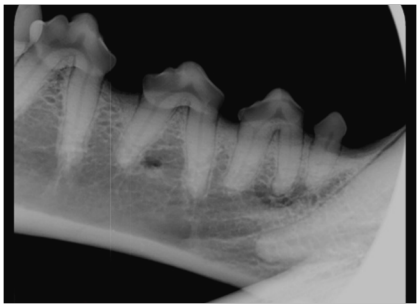
1. The plate/sensor was placed intra-orally (if an extra-oral technique is used the image should be "flipped" and annotated).
2. The plate/sensor was positioned correctly in the oral cavity so it was facing the radiographic tube head.

The image will appear on the monitor and only require rotation for assessment. First, we must first determine if the view is a maxillary or mandibular view based on common landmarks:

- The **mandibular views** will have single or double rooted teeth in a dense alveolar socket with a dense ventral cortex. The incisor and canine teeth will also reside in this bone and be separated by a radiolucent midline or mandibular symphysis. For viewing, the mandibular teeth roots are pointed down and crowns upward.



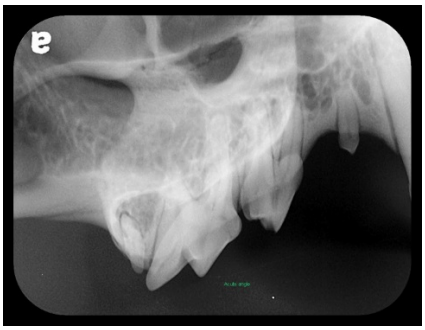
Caudal mandible



Rostral Mandible

- The bone of the **maxillary view** appears more uniformly dense and extends far beyond the apex of the teeth (palatine bone, nasal passages and sinuses). The incisor and canine teeth of the maxilla will have two symmetrical radiolucent oval structures which represent the palatine fissures. For viewing, the maxillary views should have the roots oriented upward and crowns downward.

Canine Maxilla



Feline Maxilla

Next, we must ascertain rostral from caudal *(In dental terms: mesial from distal)*, by visualizing the tooth & root anatomy. Quick anatomy note:

- The incisors, canine teeth, and first premolar (if present) are single rooted teeth. In the maxilla, the 2nd and 3rd premolars are double rooted and the 4th premolar, 1st and 2nd molars are triple rooted teeth. In the mandible, the 2nd premolar distally to the 2nd molar are double rooted teeth.

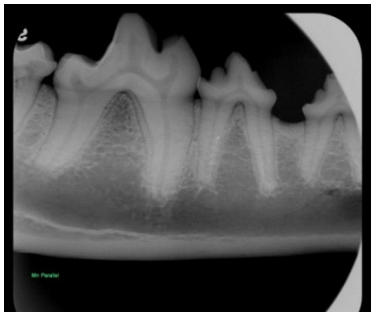
- An acrylic dental model is a useful aid at this time. In the maxilla try to identify triple and double rooted teeth on the image. Remember, that the triple rooted teeth are distal or caudal. In the mandible use the large first molar as a landmark and remember that the crown is larger mesially (use your acrylic model).

Finally, we are ready to determine right from left, so you may identify the teeth that are on the radiograph. While viewing the radiograph, imagine **where the patients nose is** pointing and visualize yourself looking at the patient face to face. **The direction the nose is pointing is the side you are viewing!**

FOLLOW THESE 3 SIMPLE STEPS:

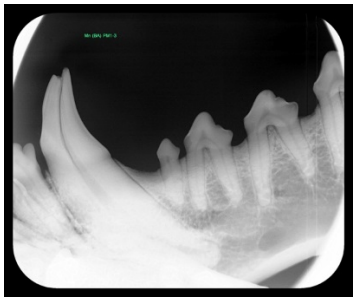
1. ***View the digital image on the monitor.***
2. ***Rotate the image***
    a. *Maxilla roots point up*
    b. *Mandible roots point down*
3. ***Decide which way the nose of the patient is***.
    a. *Visualize the number and size of the roots, crown shape, and size of the teeth*
    b. *Imagine facing the patient,* the direction the nose is pointing is the side you are viewing.

Right Maxilla



Right Mandible

Left Maxilla- young dog

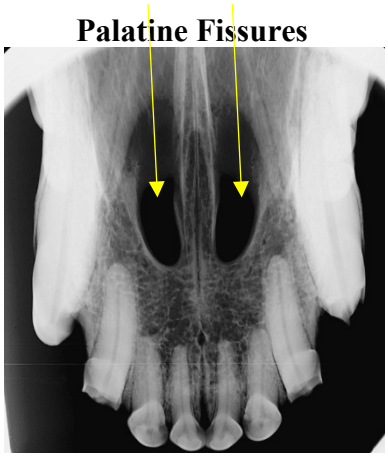


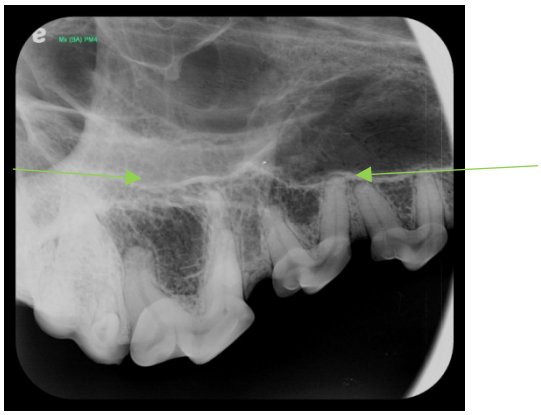
Left Mandible

Normal Anatomy Tips

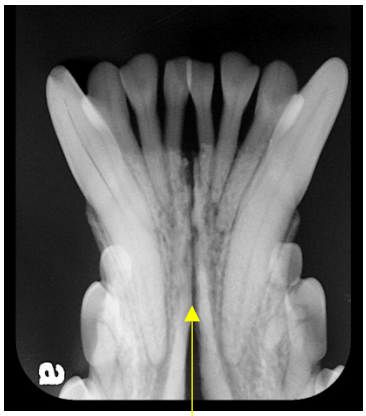
When imaging the rostral maxillary area, the paired radiolucent areas distal to the intermediate incisors are the ***palatine fissures (yellow arrow)****. Also, the maxillary premolar and molar area contains a radiodense line apical to the roots* ***(green arrow)****. This represents the junction of the vertical body of the maxilla and the palatine process (hard palate) of the maxilla. A skull model is helpful to identify these structures and their location relative to the teeth.*

Palatine Fissures

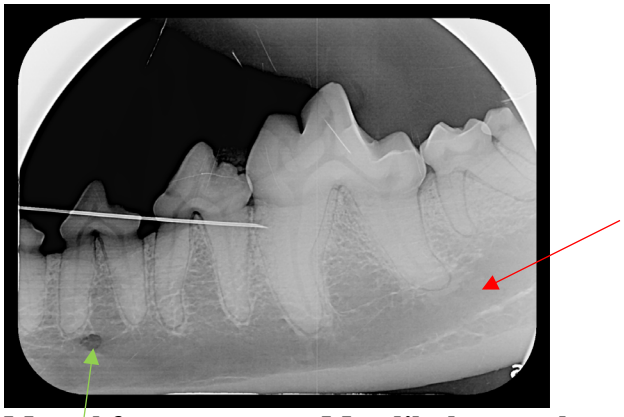




The radiolucent line between the central incisor teeth is the fibrocartilagenous ***mandibular symphysis (yellow arrow)****. Radiographic views of the mandibular molar and premolar teeth have several normal anatomic findings that may be misinterpreted as pathologic lesions. A horizontal radiolucent line near above ventral cortex is the* ***mandibular canal (red arrow).*** *Three circular radiolucent areas are usually present in the area of mandibular premolars are the* ***mental foramina*** *(rostral, middle, and caudal-****green arrow))****.*



Mandibular symphysis

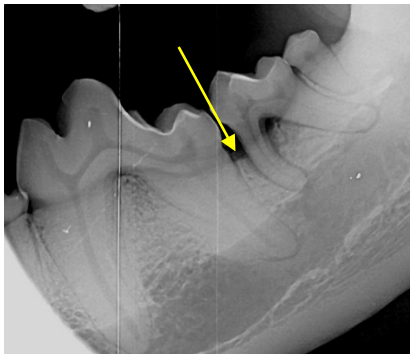


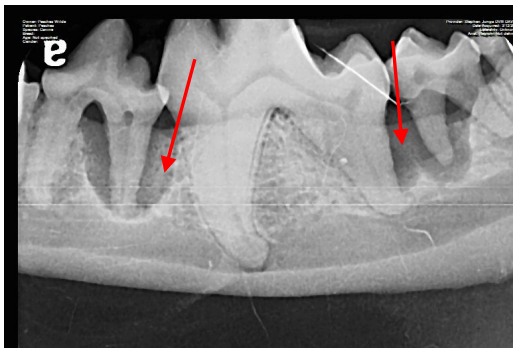
Mental foramen **Mandibular canal**

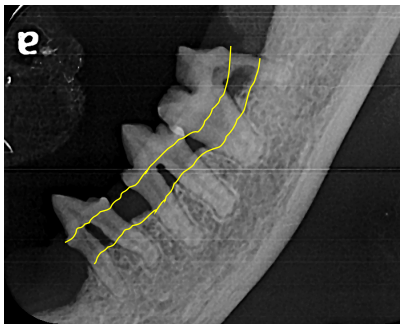
Periodontal pocket or bone loss=Periodontal Disease

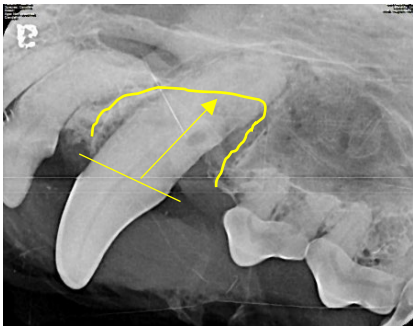
Periodontal disease causes resorption of the bone resulting in the level of bone being >2 mm below the cementoenamel junction or a loss of bone density in the furcation region. Remember, forty percent of the bone has to be destroyed in a region before the lysis becomes evident radiographically. Therefore, radiographic findings generally underestimate bone loss. Bony pockets may also be under diagnosed if the bone loss is confined to the lingual, palatal, or facial (buccal) surfaces and therefore hidden by superimposition of bone or tooth. Always interpret radiographs bearing in mind the results of the oral examination and probing. Brachycephalic breeds have tooth rotation/ crowding and imaging with cone beam CT allows improved, 3D assessment of teeth and bone in these breeds.

Horizontal bone loss (yellow arrows) occurs when there is generalized bone loss of a similar level across group of teeth. With horizontal bone loss, the buccal, lingual, and interdental bone will undergo resorption. **Vertical (angular) bone loss (red arrows)** occurs in an apical direction along a specific root surface with little effect to the surrounding bone of the region.

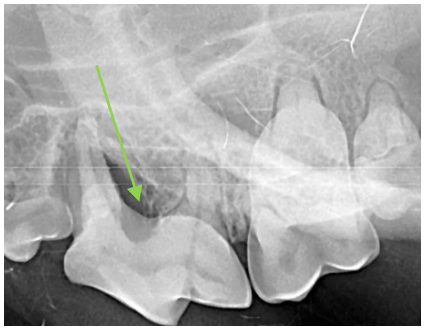


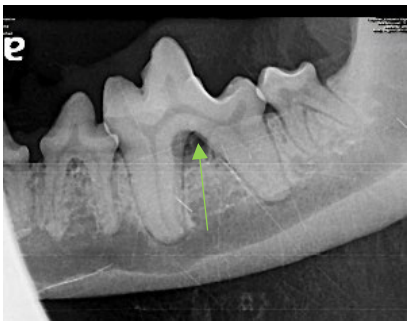






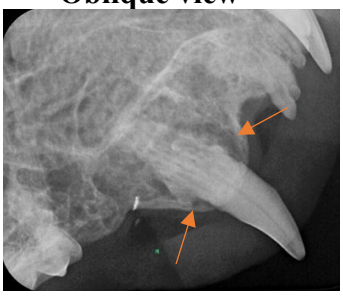
Furcation bone loss is visualized by a loss of bone density in the region of the furcation. Remember to correlate your periodontal probe findings with your radiographic findings as these lesions are underestimated radiographically (Class 1 & 2). Class 3 disease results in total bone loss and will appear as a radiolucent area and the probe will pass through this region.





Feline Chronic Alveolar Osteomyeltis clinically appears as **buccal bone expansion (arrows)** of the maxillary or mandibular canine teeth. Radiographically these lesions appear as expansive buccal bone growth and vertical bone loss (infrabony pocket) along the root surface. The radiographic changes should be evaluated in the maxillary occlusal view as well as oblique images.

Oblique view

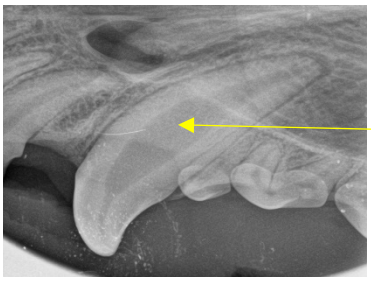


Occlusal view

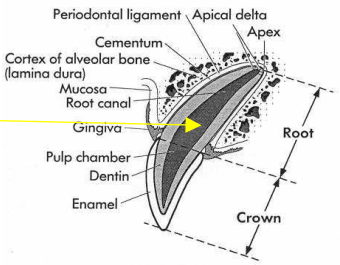
Tooth Trauma=Endodontic Disease

Radiography is essential for the evaluation of a discolored tooth, abrasively worn tooth or fractured tooth. The pulp is the radiolucent canal or cavity with the tooth (root and crown) and represents the blood vessels and nerves of the tooth. Endodontic disease may be diagnosed radiographically based on bone or tooth changes.

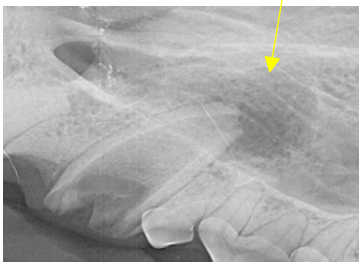
Intact canine



Pulp location



Fractured canine w/ lucency

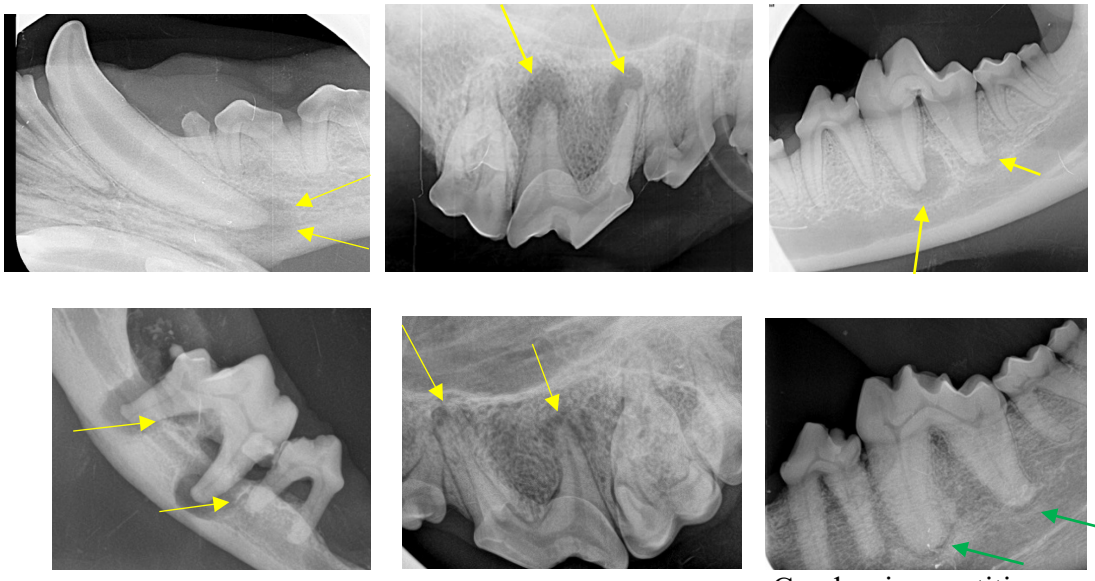


Tooth viability: As a tooth matures, secondary dentin is produced causing a decrease in pulp canal width. When a tooth becomes non-vital, the production of dentin stops, resulting in a wider root canal than the surrounding vital teeth (this takes 6 months-year to become visible). The most accurate assessment is to compare the affected tooth to the contralateral tooth. Every attempt should be made to expose the views at the same angle when comparing teeth since root canals (especially in canine teeth) are not perfect cylinders. A change in the beam angle may affect the apparent canal diameter.

Recent fracture with Symmetrical pulp canals

Fracture 12 months prior note Asymmetry- Non-vial tooth

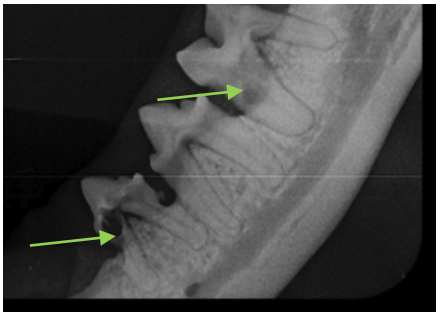
Periapical disease is a pathologic process surrounding the apex of one or more roots. Radiographically periapical disease may appear as a widened periodontal ligament space, a thickened or discontinuous lamina dura, or radiolucent (halo) defect at the apex (**yellow arrows)**. This may occur when the inflammatory/infectious agents extend through the apex of the tooth resulting in osteoclastic bone resorption. Chronic lesions or infection may have a more radiopaque appearance and are described as osteosclerosis or condensing osteitis (**Bottom right radiograph).** Use your probe to evaluate the tooth for pulp exposure of the crown or deep periodontal pocket on these questionable teeth.



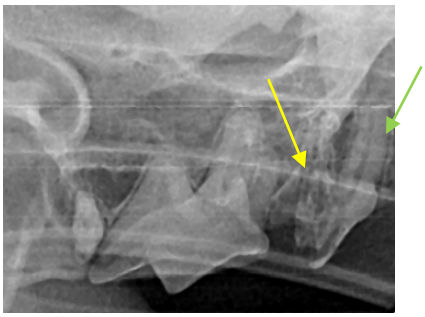
Condensing osetitis

Tooth Resorptive Lesions (TR)

This disease is common in cats, affecting 50% of cats by age 5. Radiographically, teeth with **type I lesions (green arrows)** have normal root density in some areas as compared to surrounding teeth and a well-defined periodontal ligament space around the tooth. These teeth will often have a definable root canal in the intact part of the tooth. **Type I lesions typically retain a viable root canal system and require complete extraction of all the root structure.**

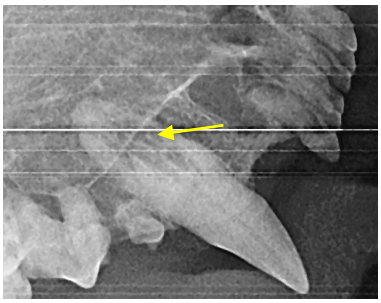


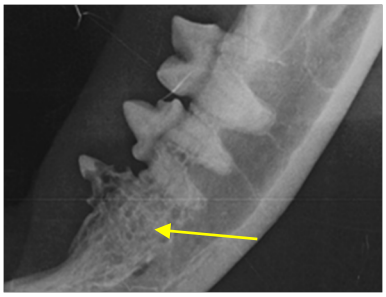
Intact root- Type 1

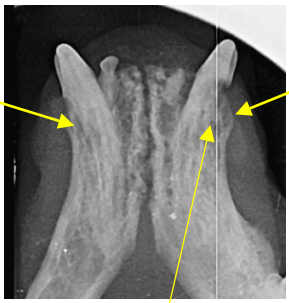


****Resorbing and intact root**

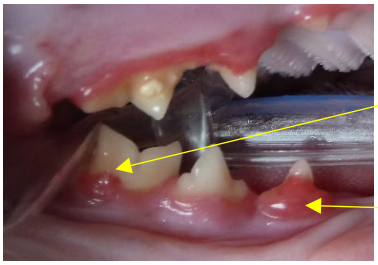
The radiographic appearance of teeth with **type II lesions (yellow arrows)** shows roots that have undergone variable replacement resorption and have a different radiographic density as compared to normal tooth roots. These teeth will have a loss of periodontal ligament space (dentoalveolar ankylosis), decrease in root density and loss of visible root canal. **Type II lesions, have no periodontal ligament, root ankylosis, root resorption and maybe treated with crown/root amputation therapy.**

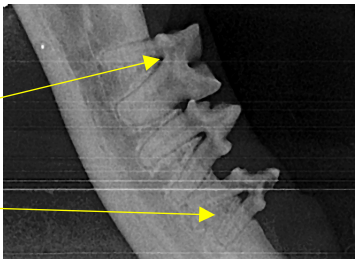


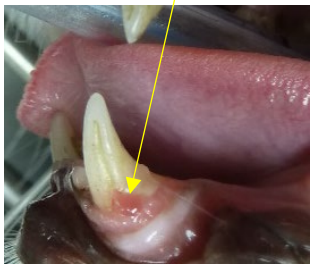




Clinical photos for review

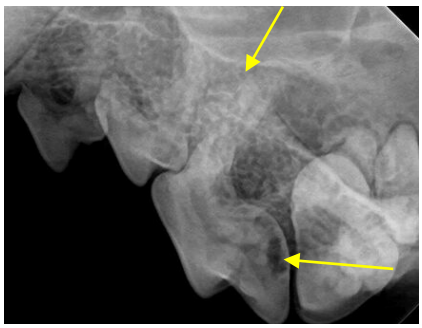


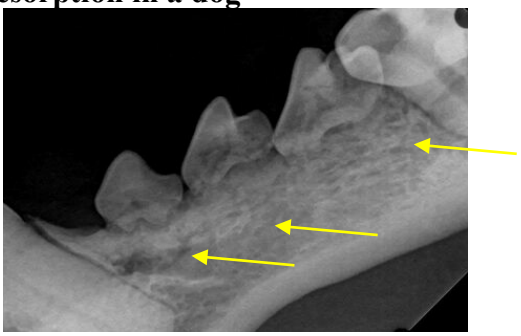




Although less common, tooth resorption in dogs are similar to feline lesions: painful and progressive. These teeth require extraction therapy. The roots are fragile and are challenging cases. In some cases resorbing roots must be retained, however there are no long term studies on root retention/resorption in canine patients. Cone beam CT offers improved imaging of early lesions by elimination superimposition of root or crown structures.

Root and tooth resorption in a dog





Tooth Impacted

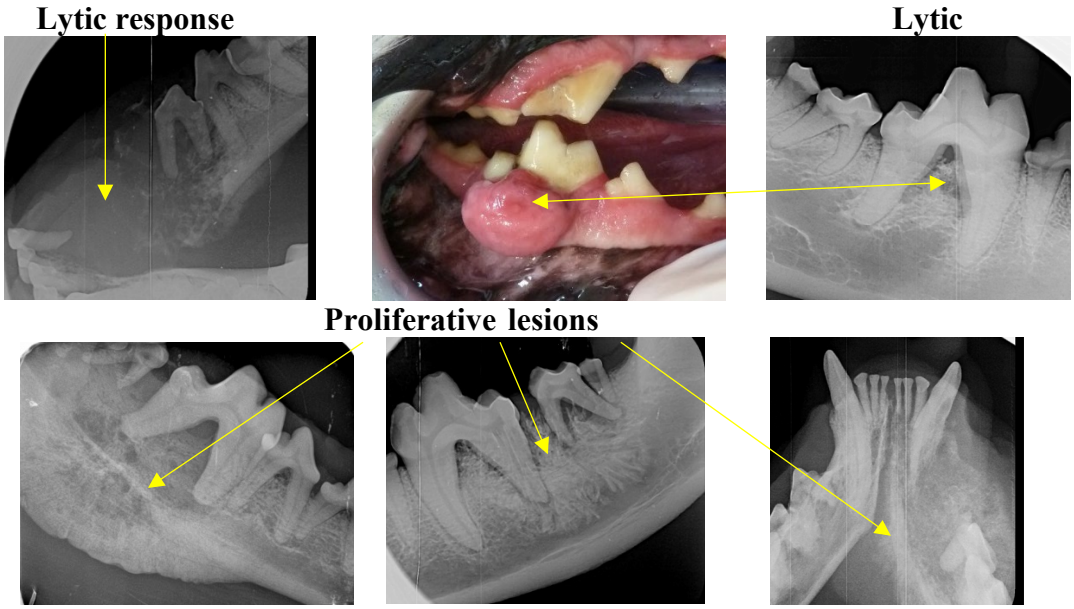
Missing teeth require a dental radiograph to rule out a retained root structure(s) or impacted tooth. Retained root structures need to be extracted as well as impacted teeth. Impacted teeth are prone to the development of a dentigerous cyst. This is an expansile (lytic) bone lesion that may occur since the enamel organ that secreted enamel is still intact. These pets typically do not present with signs of oral pain and depending on the location a focal swelling may be visible. Treatment involves a mucoperiosteal flap, complete enucleation (curettage) of the cystic lining, biopsy of the cystic lining and evaluation of adjacent teeth.

Impacted PM4

Dentigerous cyst -impacted PM1

Neoplasia

Malignant and some benign neoplasms generally invade bone. Initially these appear as a irregular lytic "moth eaten" bone pattern and as they progress they may become more lytic (radiolucent) in appearance, while other diseases result in a proliferative bone response. If bone involvement occurs with a benign lesion, the bone changes are far less dramatic and less likely to result in tooth movement. Some neoplasms can present with a proliferative bone response, while others will exhibit bone lysis.

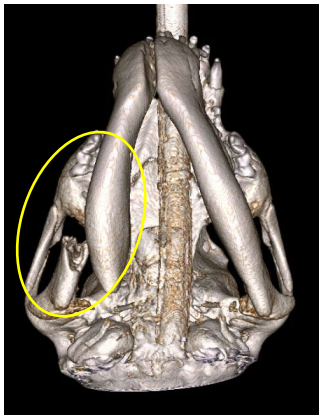


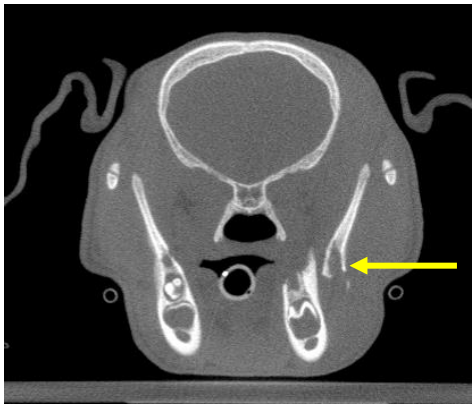
Histopathologic assessment is always necessary for a proper diagnosis since benign and malignant neoplasms, osteomyelitis, or cystic structures can look similar radiographically. Note the type and extent of bony involvement (if any) on the histopathology request form. Dental radiographs maybe used as an assessment of the extent of the lesion for surgical planning and to ensure no tooth roots have been left behind after respective oral surgery.

Oral Trauma

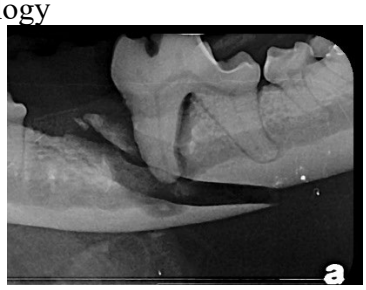
Radiographic evaluation of patients with oral trauma is necessary for treatment planning. Cone beam CT or standard CT are the preferred imaging method for maxillofacial trauma cases. Rapid image acquisition, evaluation of fracture(s), teeth, and bones of skull in multiple planes with 3D reconstruction leads to improved treatment planning and improve treatment success. Dental radiographs are still useful for some fractures, however intra-oral, extra oral and oblique techniques are needed to identify the fracture and assess the dentition.

Mandibular fracture – Cone beam CT



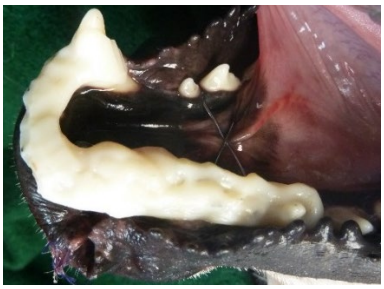


Mandible fracture- Dental radiology



Example of treatment:
Alveolar fracture

Composite splint/wire stabilization



The primary method of stabilization in these patients is interdental wiring and composite splinting as traditional bone plates/external fixator stabilization is associated with trauma to tooth roots and vital structures (mandibular canal, nasal cavity). This is minimally invasive, patients can eat/drink and function without occlusal interference and this is removed in 6-8 weeks. Trauma cases that involve the maxilla, mandible and/or the TMJ may require interdental bonding of the canine teeth or elastic chain stabilization of the canine teeth and esophageal tube feeding strategies. Although titanium locking plates are being used for caudal mandibular fractures and some maxillary fractures.

Best Dental Radiographic Reference BVook

Dupont G, Debowes L: *Atlas of Dental Radiography in Dogs and Cats*, Saunders 2009