Interpreting dental radiographs can be daunting, but it is very similar to interpreting a standard boney radiograph. The major difference is that dental radiographic changes are often more subtle. In addition, there are pathologic states that are unique to the oral cavity. Finally, there are several normal anatomic structures that may mimic pathologic changes.

This lecture concentrates on the most common pathologies, which are illustrated by classic examples. Note that in practice, these lesions are often less obvious. The reader is directed to additional continuing education meetings to further their expertise. In addition, vetdentalrad.com is an excellent resource for questionable cases.

**Determining which teeth were imaged:**
The first step in radiographic interpretation is determining which teeth have been imaged. This requires not a firm knowledge of oral anatomy as well as the architecture of dental films. Digital systems with veterinary templates do not require this step as long as the images are properly placed (DO NOT ASSUME THIS WAS DONE CORRECTLY). If your system does not support a veterinary template, there is a mark on the image which is in a consistent location. Review the owner’s manual for instructions on its use.

The key to properly identifying the imaged teeth is the embossed dot, which is on one corner of the film. When exposing a radiograph, if the film is properly positioned, the convex surface will point towards the radiographic tube head. There is no way to expose a diagnostic radiograph with the film in backwards, due to the lead sheet on the back side of the film. Therefore, when interpreting the film, the embossed dot is facing out of the mouth.

First, place the dot towards you (this is done for you on most digital systems). This means you are looking at the teeth as if you are the beam.

Next, rotate the film so that the roots are in their natural position (up on maxillary and down on mandibular).

Canines and incisors: This orients the film so the right side of the mouth is on the left, and right side is on the left. This is like a VD abdomen radiograph.

Molars and Premolars: Ascertain mesial from distal. If the mesial side is on the left side of the film, it is a radiograph of the left side of the patient and vice versa for the right.
Normal radiographic anatomy:
There are numerous structures within the oral cavity that mimic pathologic states depending on the projection. Knowledge of normal radiographic anatomy will help avoid over interpretation.
Normal alveolar bone will appear gray and relatively uniform throughout the arcade. It is slightly more radiopaque “darker” than tooth roots. In addition, it appears slightly but regularly mottled. Alveolar bone should completely fill the area between the roots (furcation) and end at the cementoenamel junction (CEJ). The root canals should all be the same width; allowing for differences in the diameters of the root. There should be no radiolucent areas in teeth or bone. A regular thin dark line (periodontal ligament) should be visualized around the roots.
There are several normal anatomic findings that are commonly misinterpreted in dental images as pathologic. On radiographs of the mandibular cheek teeth, a thick, horizontal radiolucent line courses parallel to and just coronal to the ventral cortex of the mandible. This is the mandibular canal. In addition, there are three circular radiolucent areas seen in the area of the apices of the first three premolars, which are the mental foramina (rostral, middle, and caudal). On rostral mandibular views, a radiolucent line will be present between the central incisors. This is the fibrocartilagenous mandibular symphysis. In the rostral maxillary area: there are paired radiolucent areas distal to the intermediate incisors, which are the palatine fissures. Finally, a significant widening of the periodontal ligament at the apex of the cuspid teeth is normal. This may appear to be a periapical lesion, but is differentiated from pathology because it is very regular and v-shaped, as opposed to irregular and round.
Any questionable areas should be evaluated by exposing a comparative view. A suspicious periapical lucency (especially in the area of the mandibular premolars) should be evaluated with an additional film exposed at a slightly different angle (in the horizontal or vertical plane). If the lucency is still centered on the apex, it is likely real. If the lesion moves off the apex or disappears, it is an artifact. Suspect changes in the diameter of the root canal of a tooth should be compared against surrounding as well as contralateral teeth. Surrounding teeth can be seen on the same film with the “lesion”. The contralateral view should be taken at the same angle as the original. It is important to note that root canals are not exact cylinders (especially cuspids). A lateral view may have a much different canal width than a V/D view.

Periodontal disease:
Periodontal bone loss results from the combination of bacterial induced inflammation and host response creating osteoclastic resorption of bone. This resorption will result in crestal bone loss to a level below the cementoenamel junction. This decrease in bone height may also create furcational exposure. Horizontal bone loss is the most common pattern in veterinary patients is horizontal. This appears as generalized bone loss of a similar level across all or part of an arcade. The other pattern is angular (vertical) bone loss. The radiographic appearance of angular bone loss is one area of recession below the surrounding bone. The surrounding bone may be normal or be undergoing horizontal bone loss. Therefore it is common to have a combination of the two types in the same arcade.
Bone loss does not become radiographically evident until 30-50% of the mineralization is lost. Therefore, radiographic findings will always underestimate bone loss. In addition, bone loss on only one surface (i.e. lingual, palatal, or facial) may be hidden by superimposition of bone or tooth. This may result in a non-diagnosed bony pocket. Always interpret radiographs in light of the complete oral examination findings.

**Endodontic disease:**
Endodontic disease may be demonstrated radiographically in several ways. An individual tooth may have one, some, or all of the different changes listed below. However, only one need be present to establish a presumptive diagnosis of endodontic disease. Radiographic changes can be broken into two major classifications: 1) changes in the surrounding bone, or 2) changes within the tooth itself.

**Bony changes:** The classic and most obvious finding is periradicular rarefaction. This appears as a radiolucent area surrounding the apex of a root. On rare occasions, this may also be seen mid-root, but these will virtually always be associated with periapical disease. Other, more subtle changes include a widened periodontal ligament, a thickened or discontinuous lamina dura, or even periradicular opacities. It is important to be aware of superimposed lucencies which are artifactual. These structures (i.e. mental foramina) can be imaged over an apex and falsely appear as osseous rarefaction. There are several clues that superimposed lucencies are artifactual. First, superimposed artifacts are typically seen on only one root, whereas it is very rare to find a true periapical lesion on only one root of a multi-rooted tooth. In addition, artifacts tend to be regular in appearance, whereas true periapical lesions are ragged.

If any area is in question, it is best to expose an additional film with a slightly different angle. If a periradicular lucency is still centered over the apex, it is likely real and not an artifact.

**Tooth changes:** The most common change in endodontic disease within the tooth itself is a root canal with a different diameter. As a tooth matures, secondary dentin production will cause a decrease in canal width. When a tooth becomes non-vital, this development stops secondary to the death of the odontoblasts. Consequently, non-vital teeth have wider root canals than the surrounding vital teeth. Conversely, on rare occasions, pulpitis may result in increased dentin production, and create an endodontically diseased tooth with a smaller root canal. This is especially common in teeth that are also periodontally diseased. This could potentially lead to a misdiagnosis of the endodontically diseased tooth as healthy and vice versa with the contralateral tooth. Hence it is important to evaluate the adjacent teeth as well as the contralateral.

Width discrepancy can be compared to any tooth (taking the size of tooth into consideration) but it is most accurate is to compare to the contralateral tooth. Endodontic disease may also be manifested radiographically as internal resorption. This results from osteoclastic activity within the root canal system due to pulpitis. These changes create an irregular, enlarged region within an area of the root canal system. Finally, external root resorption can be seen with endodontic disease. It will appear as a defect of the external surface of the root, generally accompanied by a loss of bone in the area. External resorption most commonly occurs at the apex in companion animals and is quite common in cats with chronic endodontic disease.
Feline Tooth Resorption (TR’s)

TRs are the result of odontoclastic destruction of feline teeth, and are classified as either type 1 or type 2. In type 1 there is no replacement by bone, whereas in type 2 there is replacement of the lost root structure by bone.

TRs are very common in our feline patients. Studies have reported up to a 70% incidence in felines over 6 years of age! The etiology at this point is unknown. They are not bacterial in nature, although in some cases the inflammation which activated the odontoclasts may have been bacterial in nature. There are numerous theories; however none have been proven at this time. Osteoclastic resorption will generally begin at the cervical line of the tooth and progress at varying rates until in some cases no identifiable tooth remains.

Type 1 TRs are typically associated with inflammation such as gingivostomatitis or periodontal disease. Thus, they are commonly associated with periodontal bone loss on dental radiographs. In these cases, it is believed that the soft tissue inflammation activated the osteoclasts. The teeth will have normal root density in some areas and a well defined periodontal space. In addition, there is often a definable root canal in the intact part of the tooth. This type will have significant resorption of the teeth and tooth roots that is not replaced by bone.

Type 2 TRs are usually associated with only localized gingivitis on oral exam, in contrast to the more severe inflammation due to periodontal disease or gingivostomatitis seen with type 1. In these cases, the gingival inflammation is secondary to the TR. The radiographic appearance is that of teeth which have a different radiographic density as compared to normal teeth, as they have undergone significant replacement resorption. Findings will include areas with no discernable periodontal ligament space (dentoalveolar ankylosis) or root canal. In the late stages, there will be little to no discernable root structure (ghost roots). In these cases, the lost root structure will be replaced by bone.

The importance of dental radiography in TR cases cannot be overstated. Type 1 lesions typically retain a viable root canal system, and will result in pain and endodontic infection if the roots are not completely extracted. However, the concurrent presence of a normal periodontal ligament makes these extractions routine. With type 2 lesions, there are areas lacking a normal periodontal ligament (ankylosis) which also demonstrate varying degrees of root resorption, which makes extraction by conventional elevation difficult to impossible. The continued resorption in type 2 teeth is the basis for crown amputation therapy. It is this author’s opinion that teeth with an identifiable root canal on dental radiographs MUST be extracted completely, while teeth with no discernable root canal may be treated with crown amputation. If there is any question, always err on the side of complete extraction.
Neoplasia:
Neoplasia is defined as the abnormal growth of cells that is not responsive to normal growth control. Neoplasms can be further classified by their biologic behavior as benign or malignant.
Benign masses: Most benign neoplastic growths will have no boney involvement on dental radiographs. If bone involvement does occur with a benign growth it will be expansive, resulting in the bone “pulling away” from the advancing tumor leaving a decalcified soft tissue filled space in the tumor site. Bony margins are usually distinct. Finally, this expansive growth will typically result in tooth movement.
Cysts: Cystic structures will appear as a radiolucent area with smooth bony edges. Similar to other benign growths, they grow by expansion and thus displace the other structures (eg teeth). Dentigerous cysts are typically seen as a radiolucent structure centered on the crown of an unerupted tooth.
Malignant neoplasia: Malignant oral neoplasms typically invade bone early in the course of disease, resulting in irregular, ragged bone destruction. Initially, the bone will have a mottled “moth eaten” appearance, but radiographs late in the disease course will reveal a complete loss of bone (the teeth will appear to float in space). If the cortex is involved, an irregular periosteal reaction will be seen.
Histopathologic testing is always necessary for accurate diagnosis of oral masses since a variety of benign or malignant tumors appear radiographically similar. In addition, osteomyelitis can create the same radiographic findings as malignant tumors. Finally, aggressive tumors will show no bone involvement early in the course of disease. The prudent practitioner will note the type and extent of bony involvement (if any) on the histopathology request form (and may include copies of the radiographs and pictures) to aid the pathologist. It is key to interpret the histopathology result in light of the radiographic findings. A diagnosis of a malignancy without bony involvement should be questioned prior to initiating definitive therapy such as aggressive surgery, radiation therapy, or chemotherapy. Conversely, a benign tumor diagnosis with significant bony reaction should be further investigated prior to assuming that the patient is safe.
Additional diagnostic tests in questionable cases include complete blood panel, urinalysis, bacterial and/or fungal culture, as well as fungal serology.

Retained tooth roots:
Persistent tooth roots following extraction attempts are a common occurrence in veterinary medicine. In the vast majority of cases, there are no outward clinical signs, however the patient suffers regardless. In rare cases, the retained root may abscess, resulting in significant morbidity to the patient and possible legal action from the client. Dental radiographs must be exposed following all extractions. Regardless of the appearance of complete extraction, there is still a possibility of retained roots or other pathology. Therefore, post-operative radiographs are critical in all cases. In addition, they will serve as a legal document in cases of complications.