The knowledge gained from dental radiographs not only improves patient care, it increases client compliance with treatment recommendations. Most important, the information gained via these radiographs speeds dental procedures and decreases complications.

This article is the first in a 3-part series on dental radiology, which will discuss:

• The importance of dental radiography
• Dental radiography techniques
• Interpretation of dental radiography images.

This article reviews indications for dental radiographs based on clinical presentation, demonstrating that radiographs are often critical for proper diagnosis and treatment of oral disease. These conditions are present in many patients and, therefore, are seen on an almost daily basis.

**PERIODONTAL DISEASE**

Periodontal disease is by far the most common problem in small animal veterinary medicine.\(^1,2\) By the age of 2, 70% of cats and 80% of dogs have some form of periodontal disease.\(^3\)

Periodontal probing is a critical first step in the evaluation of periodontal disease.\(^4,5\) However, there are 2 reasons dental radiographs are required for a complete evaluation:\(^6\)

1. **Periodontal pockets can easily be missed** due to narrow pocket width, a tight interproximal space (Figure 1A), or ledge of calculus.\(^7\) Tight interproximal spaces are normal in the molar teeth, especially in small and toy breed dogs,\(^8\) and dental radiographs should elucidate these pathologic pockets (Figure 1B).

2. **Radiographs are absolutely critical** in cases of periodontal disease of the mandible of small and toy breed dogs (especially in the area of the canine and first molar teeth). In these patients, periodontal disease can cause marked weakening of the mandible, creating risk for a pathologic fracture.\(^9,10\) In small breed dogs, the teeth, especially the mandibular first molar, extend across a much larger percentage of the bone of the mandible than in other breeds (Figure 2).\(^11\)

The periodontal aspect of these pathologic fractures is often missed on skull films, but...
can seriously complicate healing (Figure 3). Therefore, dental radiographs are important in assessing mandibular fractures.12 In addition, this weakening significantly increases the possibility of iatrogenic fracture during extraction attempts (Figure 4, page 20). Preoperative dental radiographs can help practitioners avoid this complication.

**FELINE TOOTH RESORPTION**

Dental radiographs are absolutely critical for proper dental care in feline patients due to the potential for resorptive lesions, which are very common in cats.7,13 Intraoral dental radiographs are required for proper diagnosis and treatment.6,14

**Types of Resorption**

There are 3 recognized types of tooth resorption:13,15

- **Type 1 lesions** do not undergo replacement resorption.13,15 These teeth typically retain sufficient normal root and pulp structure such that, because the roots are retained, pain and infection result. If dental radiographs reveal intact root structure (Figure 5, page 20) or worse, an active infection, complete root extraction is required.6,13,14

- **Type 2 lesions** demonstrate replacement resorption of the roots. The lost tooth structure is replaced by bone, which makes extraction very difficult (Figure 6, page 20).15 The resorption in these patients often continues until no recognizable
tooth structure remains (ghost roots) (Figure 7). In these cases, endodontic infection does not occur. This finding has resulted in the accepted therapy of crown amputation for treating these teeth.

- **Type 3 lesions** are seen in teeth that have evidence of Type 1 in one root and Type 2 in the other.

Dental radiographs save the practitioner time and frustration by directing his or her efforts appropriately. Premolar teeth in cats without ankylosis can typically be extracted closed (without a flap).

In patients with ankylosis, a surgical approach with buccal bone removal is often necessary.

Teeth with advanced replacement resorption can be crown amputated, rather than delving after retained/ankylosed roots. Crown amputation is indicated only if there is significant ankylosis and root resorption, with no evidence of periodontal ligaments, the endodontic system, or infection (endodontic or periodontal) (Figure 6). Patients with caudal stomatitis should not be treated by crown amputation.

**FIGURE 4.** Intraoral dental radiograph of right mandibular first molar in a 5-pound dog with advanced periodontal bone loss (blue arrows). Only 0.3 mm of ventral cortex remains (yellow arrow), which greatly predisposes the area to a pathologic mandibular fracture, especially during an extraction attempt. Note that the third premolar is only held in place by a calculus bridge (red arrow).

**FIGURE 5.** Type 1 tooth resorption on left mandible of a cat, with significant resorptive lesions in the crowns of the teeth (blue arrows). However, intact endodontic systems and periodontal ligaments are present (red arrows), mandating complete extraction.

**FIGURE 6.** Type 2 tooth resorption in maxillary left canine of a cat, with significant replacement resorption (dentoalveolar ankylosis) evidenced by lack of a radiographically identifiable periodontal ligament (red arrows). This condition makes extraction by standard elevation difficult to impossible.

**FIGURE 7.** Advanced Type 2 tooth resorption in left mandibular third premolar (307) in a cat, with no radiographically identifiable root canal or periodontal ligament (red arrow). In addition, no radiographic evidence of periodontal or endodontic infection is present. This tooth is a candidate for crown amputation provided that the patient is not being treated for caudal stomatitis.

**FIGURE 8.** Intraoral image of a patient with an uncomplicated crown fracture of left maxillary fourth premolar (208). In this case, the dentin is exposed, but not the root canal system directly. In most hospitals, these teeth are not evaluated further.

**FIGURE 9.** Intraoral dental radiograph of the tooth in Figure 8 that reveals periapical rarefaction of all 3 roots (red arrows), which indicates the tooth is nonvital and significantly infected (similar to a tooth with direct pulp exposure). Root canal therapy or extraction is required to relieve the infection.
ENDODONTIC DISEASE

Even in cases of obvious endodontic disease, such as a complicated crown fracture or discolored (nonvital) tooth, radiographs may convince clients to consent to the recommended treatment. However, dental radiographs are even more critical in cases where endodontic disease has either subtle or no clinical signs.

Uncomplicated Crown Fractures
The most common cases of camouflaged endodontic disease are uncomplicated crown fractures. These teeth have dentinal, but not direct pulp, exposure (Figure 8). Most of these teeth are vital; however, there is a possibility that the endodontic system has been infected through the dentinal tubules, which can result in tooth nonvitality and infection/abscessation, similar to a tooth with direct pulp exposure.13,19,20

This painful endodontic infection generally cannot be diagnosed without dental radiographs, as clinical abscessation is very rare. Therefore, every tooth with direct dentin exposure should be radiographed to rule out endodontic disease.20,21 Further therapy is always indicated, depending on the results of the dental radiograph. If the dental radiographs reveal no signs of endodontic disease, the tooth should be treated with a bonded sealant, and the patient should have dental radiographs repeated in 9 months to ensure the tooth is/was not subclinically infected.13,20–22

If there is evidence of tooth death (wide root canals or periapical lucency) (Figure 9), root canal therapy or extraction is mandated.7,19,22

Worn Teeth
Another scenario in which teeth appear healthy but may be endodontically abnormal is worn teeth.7,13

If a tooth has been worn to the point of direct pulp exposure, either root canal therapy or extraction is required. If there is adequate reparative (tertiary) dentin (Figure 10A), the majority of these teeth remain vital and pain free.23

However, teeth can become nonvital and infected despite visibly sufficient reparative dentin, and can only be elucidated by dental radiographs.23 If radiographic evidence of endodontic disease is present (ie, wide root canals or periapical lucency) (Figure 10B), root canal therapy or extraction is indicated.7,20,23

FIGURE 10. Intraoral image of a canine patient with moderate attrition of mandibular incisors (A). Adequate tertiary dentin is present; therefore, direct pulp exposure should not be a concern. Intraoral radiograph of these teeth reveals 3 nonvital and infected incisors (B); infection is evidenced by widened endodontic spaces (blue arrows) and periapical rarefaction (red arrows).

FIGURE 11. Intraoral dental radiograph of retained deciduous left maxillary canine (604). The vast majority of the root is normal (blue arrows), which means that, in all likelihood, the tooth will not resorb, indicating the necessity of complete extraction. However, resorption—caused by pressure from an erupting adult tooth—is present in the cervical region of the tooth (red arrow), which greatly increases the risk of fracturing the tooth during extraction. Therefore, careful elevation apical to this point allows for complete extraction of the tooth; a surgical approach may be advised. Reprinted from Importance of Dental Radiographs client educational poster.
Teeth with Hidden Infection
The final scenario of camouflaged endodontic disease is clinically normal teeth that are actually infected. These teeth, like all endodontically infected teeth, rarely have clinical signs, and the infection can only be diagnosed on radiographs.

Persistently Deciduous Teeth
Extraction of persistent deciduous teeth is a common procedure; however, without dental radiographs, this can be a challenging and frustrating endeavor.

Incomplete Resorption
In some cases, the root and attachment of the deciduous tooth are normal, and extraction—if performed correctly—is straightforward, without root fracture occurring. In most cases, however, the deciduous teeth have undergone some to significant resorption due to the pressure applied by the erupting permanent dentition. Resorption and secondary ankylosis make extraction very difficult, commonly resulting in a fractured root. In these cases, as in resorptive lesions, beginning with a surgical approach may be advised. Regardless, if an identifiable root canal or signs of infection are present, these roots require complete extraction to avoid inflammation and infection.

Complete Resorption
There are occasional cases in which the root structure of the deciduous tooth has been completely resorbed, with the crown only held by ankylosis at the alveolar crest. Proper therapy requires that only the crown and the very small retaining root segment be removed. With this knowledge from the start, the practitioner saves time by not:

- Searching for the root
- Worrying about a problem that does not exist
- Causing unnecessary trauma to the patient.

“Missing” Teeth
Incomplete dental arches are quite common in veterinary patients. In some cases, the tooth is truly missing; however, often the tooth/root is actually present and may be pathologic.

Possible etiologies for “missing” teeth include:

1. Congenitally missing teeth are common in small, toy, and brachycephalic breeds. The premolars, maxillary second and mandibular third molars, and incisors are typically absent. No specific therapy is necessary.
2. Previously extracted or exfoliated teeth, while rare in young patients, are quite common in mature animals. Tooth loss can occur secondary to trauma, but occurs most commonly due to periodontal disease or previous extraction. With extraction, radiographs usually reveal evidence of a healing alveolus. Again, no therapy is necessary.
3. Teeth fractured below the gum line (Figure 13) may be a result of trauma or an incomplete extraction attempt. Retained roots following extraction attempts are quite common: one study evaluating carnassial teeth in dogs and cats revealed that almost 90% of these teeth had retained roots. Dental radiographs confirm retained roots and, in most cases (57%), an infectious lesion. If the root appears relatively normal (i.e., not significantly resorbed), surgical extraction is generally the recommended course of action to alleviate pain and endodontic infection.
4. Impacted or embedded teeth (Figure 14) can be malformed or normal, but do not erupt into the dentition, often because they are blocked by a structure, such as bone, teeth, or, most commonly, an area of thick and firm gingiva called the operculum. While this condition is most common in the first and second premolars of brachycephalic breeds, any tooth can be embedded.

Dentigerous Cysts
The biggest concern with unerupted or impacted teeth is the development of dentigerous cysts, which arise from the enamel forming organ of the unerupted tooth. The incidence of dentigerous cysts is unknown in veterinary medicine, but anecdotally is estimated to be approximately 50% of all unerupted teeth. In addition, pathologic changes were noted in 32.9% of cases in one human study.29

As the cyst grows it causes bone loss by pressure, and these cysts can grow quite large in a short period of time, resulting in a significant bony defect (Figure 15). In addition, malignant transformation can occur and the cysts can become infected, creating significant swelling and pain.26

Therapeutic Approach
The recommended therapy for impacted teeth is
surgical extraction. If cyst formation has occurred, en bloc removal or extraction of the tooth and meticulous curettage of the lining should prove curative. Following curettage, a biopsy of the lining and bone augmentation is recommended. Referral to a veterinary dentist is recommended for larger lesions.

It is critical to note that 2 of the causes for “missing” teeth require no therapy, while the other 2 can lead to significant pathology. Therefore, all “missing” teeth should be radiographed to determine the correct cause and, therefore, the correct approach to management.

EXTRCTIONS
Pre- and postoperative dental radiographs should be exposed for all extraction procedures.18 Pre-extraction radiographs allow the practitioner to determine the amount of disease present as well as any root abnormalities, such as curved (Figure 16) or extra roots. Ten percent of maxillary third premolars in cats have a third root (Figure 17).30

One of the more important findings on preoperative dental radiographs is the presence and degree of ankylosis.7,19 In addition, the level of remaining bone is elucidated. In the case of a mandibular first molar or canine extraction, knowledge of the amount of remaining mandibular bone can be critical with regard to avoiding an iatrogenic pathologic fracture.5,10,18 Radiographs also serve as legal evidence, documenting the need for extraction. Postextraction dental radiographs are equally important. Despite the appearance of complete extraction, there is still a possibility of retained roots or other pathology. One study evaluating extraction of carnassial teeth in dogs and cats revealed that almost 90% of these teeth had retained roots.28 Therefore, postoperative radiographs are critical in all cases (Figure 18). In addition, radiographs serve as legal documents in cases with complications.

IN SUMMARY
The conditions and therapeutic options discussed in this article emphasize the value—especially the patient benefits—of full-mouth radiographs for all veterinary patients.29 Nearly every veterinary patient has some form of oral disease. Dental radiographs are a critical piece of information for the veterinarian for both diagnosing and treating oral disease.
References


