Dental radiography is an essential component in the delivery of high-quality dental care for dogs and cats. During the 1980s veterinarians began taking radiographs of teeth using standard radiographic units; however, these units made patient positioning difficult and often resulted in suboptimal films. In the 1990s dental radiographic units became a more common part of the veterinary dental diagnostic workup, and by the year 2000 many state-of-the-art veterinary practices were switching over to digital dental radiography. This session focuses on the value of taking dental radiographs, how to take digital dental radiographs, special features available with digital dental radiographic units, advantages and disadvantages of digital dental radiography, indications for taking dental radiographs, positioning for optimal dental radiographs, critiquing dental radiographs, and the importance of recognizing dental radiographic lesions.

The diagnostic value of full-mouth dental radiography in dogs and cats has been previously reported.1, 2 It was found that the diagnostic yield of full-mouth radiographs in feline and canine patients is high, and routine full-mouth radiography is justified. These studies found that if disease existed, radiographs were clinically useful in 86.1% of the cases in the study (Tables 1 and 2).1–3

<table>
<thead>
<tr>
<th>VALUE OF RADIOGRAPHS WHEN NO CLINICAL FINDINGS PRESENT</th>
<th>Dogs</th>
<th>Cats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidental radiographic findings</td>
<td>41.7%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Clinically important findings</td>
<td>27.8%</td>
<td>41.7%</td>
</tr>
<tr>
<td>Radiographs of no value</td>
<td>30.5%</td>
<td>53.6%</td>
</tr>
</tbody>
</table>

Table 1

<table>
<thead>
<tr>
<th>VALUE OF RADIOGRAPHS WHEN CLINICAL FINDINGS PRESENT</th>
<th>Dogs</th>
<th>Cats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation only</td>
<td>24.3%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Additional findings</td>
<td>50.0%</td>
<td>53.9%</td>
</tr>
<tr>
<td>Clinically essential findings</td>
<td>22.6%</td>
<td>32.2%</td>
</tr>
<tr>
<td>Radiographs of no value</td>
<td>3.1%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 2

How to Take Digital Dental Radiographs and Special Features Available
There are 2 methods of acquiring digital dental radiographs, DR (Digital Radiography) and CR (Computer Radiography). DR images are acquired by placing a sensor into the mouth in the same position as a film and exposing the sensor with a greatly reduced dose of radiation. The image is transferred within seconds for viewing on a computer. These images are then electronically stored and manipulated as needed for radiographic evaluation of a wide variety of dental lesions. CR images are an indirect way of acquiring digital dental radiographs. With this technology a reusable Phosphor Storage Plate (PSP) is exposed to X-rays, and the PSP is then processed and converted to a digital image on a computer. The Scan X®, a digital radiography system, produces a digital image by scanning PSPs of various sizes (0, 2, 3, and 4), which have been exposed to X-rays. The Scan X® allows computer storage, processing, retrieval, and display of the computed radiographic images utilizing a user-supplied software package. The Scan X® also has an in-line plate eraser function that removes the latest image from the plate immediately after scanning, providing an efficient, one-step scanning and erasing process leaving the PSP ready for collecting the next radiographic image.

Digital dental radiographs can be manipulated for better visualization. The mouse can be used to adjust the contrast and brightness; a particular area of a tooth can be highlighted, magnified, labeled, flipped, rotated, and measured; or explanatory notes can be added.

The advantages and disadvantages of digital dental radiography have been previously reported.3, 4
Advantages of Digital Dental Radiography

- There is a 50–90% reduction in radiation needed to expose an image.
- DR images are displayed on the computer within seconds, eliminating processing chemicals and reducing anesthetic time.
- CR images are displayed after being inserted in the Scan X® within approximately 30 seconds; CR images come in various sizes (0, 2, 3, and 4), providing flexibility in imaging.
- Phosphor Storage Plates (PSP) are very thin and flexible, providing easy placement in confined spaces.
- Errors in positioning and exposure can be corrected immediately, without waiting for film processing.
- Computer storage makes retrieval and storage of the image easier than for conventional film and allows easy electronic transfer of radiographs to the patient file, consultant, or referring veterinarian.
- Images can be adjusted for better visualization; the image can be enlarged, rotated, the contrast and brightness can be changed, and the image can be inverted or rotated.
- Provides extremely efficient progress evaluation during endodontic and oral surgery procedures.

Disadvantages of Digital Dental Radiography

- Sensors are initially expensive; however, over time they are less expensive than film-based radiology; digital dental imaging system cost $6,000–$15,000 in addition to the dental radiography unit.
- At this time sensors are supplied only in periapical film size (number 2); since occlusal size (number 4) sensors are not currently available, multiple exposures with smaller sensors are required, and sensors are rigid and thicker than standard dental film or PSPs, making acquisition of images in confined spaces difficult.
- There is possibility of sensor damage, necessitating costly replacement.
- Requires a computer in the dental operatory and extra time needed for computer patient input.

Indications for Taking Dental Radiographs

Ideally full-mouth radiographs should be taken on every patient; however, this may not be possible because of cost constraints or concerns for time under anesthesia in critically ill patients. Digital radiographs can help alleviate these concerns because of the decrease in time needed to acquire digital radiographs. If full-mouth radiographs are not taken, there are several indications in which teeth should be radiographed. Dental radiography is recommended in the evaluation of odontoclastic resorptive lesions, the evaluation of periodontal disease including animals with nasal discharge, the evaluation of endodontic disease including discolored teeth and facial swelling, retained roots, missing teeth, abnormally located teeth, malformed teeth, osteomyelitis, boney lysis secondary to neoplasia, metabolic bone disease, localization of dentigerous cysts, and evaluation of traumatic injuries. Dental radiography is indispensable in the development of an appropriate treatment plan.

Positioning for Optimal Dental Radiographs

Numerous publications describe appropriate positioning for optimal dental radiographs. There are 2 specific intraoral radiographic dental techniques: the parallel technique and the bisecting angle technique. The ideal dental radiograph is produced by utilizing the parallel technique. When using the parallel technique, the plane of the radiographic film is parallel to the long axis of the tooth and perpendicular to the plane of the radiographic beam. The parallel technique in dogs and cats can only be achieved with the mandibular premolars and molars. The flat shallow palate and the shallow caudally extending mandibular symphysis in dogs and cats prevent utilization of the parallel technique when radiographing the maxillary premolars and molars and the incisor and canine teeth. In these teeth the bisecting angle technique can be utilized. The film is placed parallel as possible to the teeth being radiographed. An imaginary line that bisects the angle between the long axis of the tooth and the film is the bisecting angle line. The X-ray beam should be directed perpendicular to the bisecting angle line. Improper utilization of the bisecting angle technique will result in an elongated, a foreshortened, or an overlapped radiographic dental image.

A basic dental radiographic survey consists of 6 views: the rostral maxillary and mandibular projections, the right and left maxillary projections, and the right and left mandibular projections. Additional radiographs may be necessary depending on the size of the patient. The upper fourth premolar requires additional radiographs to permit adequate visualization of all 3 roots. A 30-degree rostral oblique projection needs to be added to the bisecting angle technique to permit adequate visualization of the mesiobuccal and palatal roots.
Critiquing Dental Radiographs

Various organizations, including the American Veterinary Dental College and the Academy of Veterinary Dentistry, require dental radiographs for evaluation. Striving to follow these established guidelines will produce meaningful diagnostic films. These guidelines, which have been previously published, can be used as a guide to assist in self-evaluation of radiographs.3

- All teeth to be evaluated are clearly visible.
- Radiographs are well positioned.
- The maxillary cheek teeth should have the roots facing upward and the crowns downward.
- The mandibular cheek teeth have the crowns facing upward and the roots downward.
- Maxillary incisors have the roots facing upward and the crowns downward.
- Mandibular incisors have the roots facing downward and crowns upward.
- When viewing the right side of the mouth, the anterior teeth are on the right side.
- When viewing the left side of the mouth, the anterior teeth are on the left side of the radiograph.
- Proper angulation has been used.
- There is no foreshortening or elongation.
- Visualization of all roots and apices is adequate.
- Exposure and developing technique are adequate.
- No artifacts appear on the film.
- Contrast and density of the radiograph are correct.

Importance of Recognizing Dental Radiographic Lesions

Proper evaluation of feline teeth with odontoclastic resorptive lesions can help determine the appropriate treatment option, including either routine extraction or crown amputation with intentional root retention. When retained roots are identified with dental radiography, a decision to retrieve or retain these roots must be made. If the retained roots are an incidental finding in a patient that is asymptomatic, there is no evidence of periapical or apical lysis around the retained root tip, and the root is covered by normal gingiva that is epithelized, then no treatment is recommended. However, if the patient is symptomatic, there is an area of granulation tissue over the retained root tip, or radiographically there is evidence of periapical or apical lysis, then removal of the root is recommended.

Dental radiographs can be used to assess bone loss secondary to periodontal disease and help determine the most appropriate treatment plan. In cases in which there is greater than either 50–75% attachment loss, or bone loss to the apex of a single root of a multi-rooted tooth is revealed on the dental radiographs, extraction is generally recommended.

Dental radiography can be used to evaluate for the presence of endodontic disease. Abnormal radiographic findings associated with endodontic disease include periapical lysis, apical lysis, large endodontic systems secondary to failure in normal development or resorption, radiographic loss of tooth structure to the pulp canal, and secondary destruction of the periodontium. Periapical lysis appears as a dark halo around the apex of the roots, caused by lysis of the bone around the apex of the tooth associated with endodontic disease. Apical lysis is lysis of the apex or tip of the root itself. Apical lysis is associated with chronic endodontic disease. It is important to recognize the presence of apical lysis, since apical lysis precludes the performance of conventional root canal therapy alone and necessitates the performance of surgical endodontic therapy in combination with conventional endodontic therapy or exodontia. Large or asymmetrical endodontic systems may be secondary to failure in normal development from early pulpal death from endodontic disease or may be secondary to internal resorption from pulp damage. The canals of affected teeth may be larger than the contralateral canals or larger than the canals of adjacent teeth or may be asymmetrical within a solitary affected tooth. Chronic endodontic disease can result in secondary destruction of periodontal structures along the root of a tooth with pulpal necrosis.

Dental radiography is recommended in the evaluation of missing teeth. In puppies with missing deciduous teeth, a dental radiograph may be taken to determine if a permanent tooth bud is present. Early determination of the absence of a permanent tooth bud will help breeders determine if a dog is either show or pet quality. Dental radiography can also reveal the location of teeth that have been misplaced following trauma.
Teeth that appear malformed require dental radiographs to help determine the presence of endodontic disease. Developmental abnormalities such as dens-in-dente, in which the enamel is enfolded, may result in secondary endodontic disease. This condition appears to most frequently affect the lower first molar in the dog and often occurs bilaterally. These teeth appear to have an increased radiodensity in the crown, convergence of the roots, large pulp canals, and presence of periapical lysis.

Osteomyelitis may be detected radiographically. Osteomyelitis may be secondary to severe periodontal disease, endodontic disease, or trauma. Osteomyelitis may appear as an increased bony density with loss of detail and periosteal reaction. Osteomyelitis should be treated by removal of diseased teeth and bony sequestra and appropriate long-term antibiotic therapy.

Radiographs should be taken in animals with multiple loose teeth in one region of the oral cavity. Severe boney lysis and displacement of teeth is suggestive of a malignant tumor. Biopsy of these lesions is required for a definitive diagnosis and for appropriate treatment planning.

Metabolic bone diseases, such as renal secondary hyperparathyroidism, can be evaluated with dental radiographs. The initial radiographic finding associated with hyperparathyroidism is loss of the lamina dura, which is the cortical plate of the alveolus that surrounds the tooth roots. As the disease progresses, there is a loss of density of trabecular and cortical bone.

Dental radiographs are essential in the diagnosis of dentigerous cysts. When oral examination of dental patients reveals a soft, fluid filled gingival swelling in the region of a missing tooth, a dental radiograph is recommended. Radiographs may reveal the presence of a dentigerous cyst, which appears as a smooth-bordered radiolucent cavity typically adjacent to the cementoenamel junction of the unerupted, misplaced tooth.

Dental radiographs are important in the perioperative management of jaw fractures. Preoperative radiographs will assist in the evaluation of the fracture site, determine the location of tooth roots in and around the fracture site, and assist in the selection of appropriate treatment options. Dental radiographs are also essential in the postoperative evaluation of fracture fixation and reduction and assessment of proper healing of jaw fractures.

Summary
Dental radiography is an essential component in the daily delivery of high-quality dental care for dogs and cats. Recently many state-of-the-art veterinary practices have switched over to digital dental radiography because of the speed and ease with which these images can be produced and evaluated. The real value in taking digital dental radiographs is improved patient care while at the same time providing a profit center for the hospital. The advantages of digital dental radiography far outweigh the disadvantages of this new technology. With proper orientation and training in the use of digital dental radiographic units, this new technology can become an integral part of small animal veterinary. Following an appropriate training period, veterinarians and veterinary technicians will be able to obtain high-quality dental images, resulting in the recognition of more lesions, which can then be appropriately treated.

References