Dental Radiology Series

TECHNIQUES FOR INTRAORAL RADIOLOGY

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Exposing diagnostic dental images can be frustrating for the novice; however, with a small amount of training and practice, it can be mastered. This article is a brief introduction to exposure techniques for intraoral radiology. Further training via hands-on laboratories is an excellent investment and can greatly improve the learning curve.

**STEP 1. PATIENT POSITIONING**

Position the patient so that the area of the mouth being imaged is closest to the radiographic beam.

- **Mandibular canines/incisors:** Place the patient in dorsal recumbency (**Figure 1**)
- **Mandibular cheek teeth:** Leave patient in dorsal recumbency or place in lateral recumbency
- **Maxillary teeth:** Positioning for these teeth is controversial; some veterinary dentists recommend sternal recumbency, while others prefer lateral recumbency.

While sternal recumbency makes it easier to visualize angles, possibly making exposure of initial survey films more efficient, rolling patients into this position for intra- and/or postoperative images is somewhat arduous and time consuming, often displaces the monitoring leads, and can be traumatic to spines and hips of older pets and large breed dogs. Therefore, in our practice, virtually all maxillary radiographs are exposed in lateral recumbency (**Figure 2**).

**STEP 2. FILM PLACEMENT WITHIN THE PATIENT’S MOUTH**

For **direct digital radiography** (DR, or DDR) sensors, the digital sensor is placed in the mouth so that the cord exits through the front of the mouth (**Figure 3**, page 60).

**FIGURE 1.** Feline patient in dorsal recumbency in preparation for exposing a radiograph of the mandibular incisors and canines.

**FIGURE 2.** Canine patient in dorsal recumbency, but with head rotated into lateral recumbency in preparation for a radiograph of the right maxillary canine (104).
For photostimulable phosphor (PSP) plates, or indirect digital radiography, the side with writing (Figure 4) is placed toward the back of the mouth, while the blank side faces toward the tube head.

Place the sensor/plate as near as possible to (generally touching) the teeth and oral tissues in order to minimize distortion (Figure 5). If possible, position the sensor/plate within the mouth so that the entire tooth is covered; in general, the roots are twice as long as the crown. If coverage of the entire tooth is not possible with a size 2 sensor, which is commonly the case in large breed dogs:
1. Position the sensor apically enough to expose the apex of the tooth and 3 mm beyond. This technique “cuts off” the crown, but often radiographs of the crown do not provide critical information.

2. Expose 2 images (one of the root and one of the crown).

**STEP 3. POSITIONING THE TUBE HEAD**

There are 2 major techniques for positioning the tube head, both of which are required for complete imaging of veterinary patients.

**Parallel Technique**

The film is placed parallel to the object being radiographed, and the beam positioned perpendicular to both the sensor/plate and the tooth/root (Figure 6). This technique results in the most accurate image, but is only useful for the caudal mandibular cheek teeth because:

- Dogs and cats do not have an arched palate and, therefore, the maxillary teeth cannot be imaged with this technique
- The mandibular symphysis interferes with placement of the sensor/plate parallel to the tooth roots of the mandibular canines and incisors as well as the rostral mandibular premolars.

**Bisecting Angle Technique**

This technique is based on the theory of equilateral triangles, and creates an image that accurately represents the tooth and roots (Figure 7).

- The sensor/plate is placed as parallel as possible to the tooth roots.
- The angle between the tooth root and sensor/plate is measured or estimated.
- Then the angle is cut in half (bisected) and the beam placed perpendicular to this bisecting line.

If the angle between the sensor/plate and the beam is incorrect, the radiographic image will be distorted because the beam will create an image that is longer or shorter than the object imaged.

When the angle of the beam to the sensor/plate is:

- Too small, the object will appear longer on the image than its actual length, known as elongation (Figure 8).
- Too great, the object will appear shorter on the image than its actual length, known as foreshortening (Figure 9, page 62).

The bisecting angle technique is the most commonly used technique in veterinary patients because it is the most scientifically correct way to take veterinary dental images and provides the most accurate representation of the root.

However, since it is time consuming, a modified, or “simplified” technique has been developed.

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**Dental Radiology Terms**

**Digital radiography:** Conversion of transmitted x-rays into a digital image using either solid-state detectors, such as amorphous selenium or silicon; or photostimulable phosphor (PSP) plates (which are then scanned). Following image acquisition, computer processing is performed and the image displayed.

**Direct digital radiography:** Uses an x-ray photoconductor, such as amorphous selenium, that directly converts x-ray photons into an electric charge. With this type of digital radiography, the sensor is typically connected by a cord to an analog-to-digital converter box (or card), which is connected to the computer. Images are produced within seconds of sensor exposure—the primary advantage of direct sensor systems.

**Indirect digital radiography:** Requires a 2-step process for x-ray detection: the scintillator converts the x-ray beams into visible light, which is then converted into an electric charge by photodetectors, such as amorphous silicon photodiodes. This system uses PSP and, after exposure, these plates must be scanned in order for an image to be obtained.

**Position indicating device:** The lead-lined cone or cylinder that directs the x-ray beam during radiographic exposure. This device improves and standardizes dental radiographic imaging and reduces the patient’s and operator’s risk of radiation exposure.
Simplified Technique

The simplified technique\(^{2,11}\) does not require direct measurement of any angle, but instead relies on the approximate angle between the position indicating device (PID) and sensor/plate to create diagnostic images. There are only 3 angles used for all radiographs in this system: 45, 70, and 90 degrees.

- **Mandibular premolars/molars:** Exposed at a 90-degree angle; the film is parallel, while the beam is perpendicular (parallel technique, Figure 6).

- **Maxillary premolars/molars:** These roots are typically straight and parallel with the visible crown, and the sensor/plate lies essentially flat across the palate, creating an approximate 90-degree angle that, when bisected, indicates that all maxillary premolars and molars be imaged at a 45-degree angle (Figure 10).

- **Canines/incisors:** These teeth curve caudally at an approximate 40-degree angle to the palate/body of the mandible; therefore, they are imaged with a 70-degree angle rostrocaudal (bisecting the 40-degree angle equals 20; when 20 is subtracted from 90, it indicates that the angle should be 70 degrees from perpendicular to the sensor/plate) (Figure 11).

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**FIGURE 9.** Foreshortening: The bisecting angle for the maxillary premolars and molars is 45 degrees to the sensor. In this photo, the PID has been set up at approximately 65 degrees (A). The resulting image (B) demonstrates foreshortening of the tooth roots. To fix this error, rotate the tube head to a more parallel position to the sensor.

**FIGURE 10.** Proper bisecting angle for the maxillary premolars and molars of a dog: The PID is set 45 degrees to the sensor, which provides an excellent image of all premolars and molars (A). Note that, when using a size 2 sensor, multiple images are often necessary. In this patient, the first and second premolars (B) and fourth premolar (C) are in separate images. The mesial roots of the maxillary fourth premolar are overlapped (red arrows). In order to visualize these roots separately, the mesial or distal tube shift is required (Figures 15 and 16, page 66).
To initiate a radiograph with this technique:

- **Mandibular premolars/molars**: Place the sensor/plate in the mouth and set the PID perpendicular to the sensor/plate.
- **Maxillary premolars/molars**: Rotate the beam laterally to a 45-degree angle.
- **Canines/incisors**: Rotate the beam rostrally 20 degrees.

**Exceptions**

There are only 4 conditions in which these techniques may not produce a diagnostic image:

1. **Maxillary canines**: Because the maxillary canine roots lie directly dorsal to the maxillary first and second premolars in dogs and the second and, occasionally, third premolars in cats, a maxillary occlusal image produces overlap with these structures (Figure 12A, page 64). Therefore, in addition to the 20-degree rotation rostrally, rotate the PID 20 degrees laterally to image the root over the nasal cavity and avoid this superimposition (Figures 12B and 12C, page 64).²¹²¹³

2. **Rostral mandibular premolars** (first and second in dogs; third in cats): The apices of these teeth are often “cut off” on images exposed with the parallel technique due to the symphysis interfering with placement of the sensor/plate sufficiently ventral to capture the apices, therefore,

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**FIGURE 11.** Proper imaging of the incisors and mandibular canines: Due to the caudal curve of these teeth, the bisecting angle for the roots—70 degrees to the sensor—is very different than the angle for the crown. Demonstrated are the proper positioning (A) and resulting image (B) for mandibular incisors and canines in a cat, and the proper positioning (C) and resulting image (D) for maxillary incisors in a dog. Note that Figure 11C demonstrates lateral recumbency, which is this author’s recommended technique, although sternal recumbency is also acceptable.
the bisecting angle technique is used. The sensor/plate is placed in the same position as for the mandibular canines, with the tube head positioned 45 degrees laterally (Figure 13).2,7,9

3. Feline maxillary cheek teeth: When using the standard intraoral bisecting angle technique, the zygomatic arch impedes visualization of the maxillary third and fourth premolars as well as the first molar. While this author feels this does not significantly affect interpretation, if the practitioner wishes to view these teeth without interference, the extra-oral technique can be utilized.

Place the sensor/plate on the table and, with the patient in lateral recumbency, place the patient’s head on the sensor/plate with the arch to be imaged closest to the table (away from the beam). Insert a radiolucent mouth gag to gently hold the jaws apart. Angle the beam through the mouth to create a bisecting angle of approximately 30 degrees (Figure 14). Remember that this image was created extraorally and must be labelled accordingly.2,7,9

4. Mesial roots of the maxillary fourth premolar: The straight lateral 45-degree bisecting angle provides a good representation of the mesial roots but they will be superimposed (Figure 10).2,9

If the practitioner wishes to view these roots separately, an additional angle—the tube shift technique—is necessary. The tube head is angled in the horizontal plane, and the mesial roots of the maxillary fourth premolar are split. To perform this technique, position the tube head for a straight lateral image (ie, 45 degrees in the vertical plane). Then rotate it distally or mesially, approximately 30 degrees in the horizontal plane. However, once the roots are split, it is imperative to be able to identify each root (see Identifying Buccal & Palatal Roots).

Since the whole tooth cannot be effectively evaluated with the mesial tube shift technique, it is recommended that the caudal tube shift technique be used, creating a quality image of the entire tooth. If the distal root is imaged well, the palatal root is in the middle.

Identifying Buccal & Palatal Roots

The classic way to determine the buccal from palatal root is to use the same lingual/opposite buccal (SLOB) technique.3,10 The root that is more lingual (or palatal) is imaged in the same direction the tube is shifted, with the buccal root in the opposite direction. Therefore, with a distal tube shift, the palatal root will move caudally compared with the buccal root. With a mesial tube shift, the palatal root moves rostral in relation to the buccal root.

There is, however, a much simpler way to identify the roots. If the tube head has been shifted mesial, the distal root of the fourth premolar is often imaged over the first molar. In this case (Figure 15, page 66), the mesiobuccal root is in the middle. When the tube head is shifted distally, the distal root is well visualized, away from the first molar, with the palatal root in the middle (Figure 16, page 66).
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STEP 4. SETTING THE EXPOSURE
1, 2

If you are using a machine that requires manually setting the exposure, the correct setting needs to be determined.

- For cats, generally there is one setting for the maxilla and one for the mandible, which are easily determined. For dogs, approximately 5 settings are available for use.
- However, each system has its own unique settings and these settings are incredibly variable depending on whether a sensor, plate, or film is used. Adjustments will be necessary, but after imaging several patients, practitioners develop a good sense for the appropriate settings.

If you are using a computer controlled system, set the buttons for the species, film/digital system, and tooth to be imaged. These settings are not perfect, so minor adjustments may be necessary.

STEP 5. EXPOSING THE RADIOGRAPH
1, 2

If it is possible, leave the room prior to exposing the radiograph to avoid radiation exposure. If this is not possible, stand at least 6 feet from the tube head (this minimum distance creates little to no exposure to radiation) at a 90- to 130-degree angle to the primary beam to limit radiation exposure.

Dental radiology machines have “dead man’s” buttons: if you decrease pressure on the button during the exposure, it stops production of x-ray beams and the unit provides an error message. Make sure you hold the button down until the machine stops beeping before you start over.
FIGURE 15. Mesial tube shift technique: Obtaining this image is initiated by positioning the PID 45 degrees in the vertical plane (as in Figure 10); then rotating the tube head approximately 30 degrees mesially (pointing toward the back of the head) (A). The resulting image (B) splits the roots of the maxillary fourth premolar; however, the distal root is obscured by the maxillary first molar (red arrow). In this view, the mesiobuccal root (yellow arrow) is distal to the palatal root (blue arrow).

FIGURE 16. Distal tube shift technique: Obtaining this image is initiated by positioning the PID 45 degrees in the vertical plane (as in Figure 10); then rotating the tube head approximately 30 degrees distally (toward the nose) (A). The resulting image (B) splits the roots of the maxillary fourth premolar and provides an excellent view of the distal root (red arrow); for this reason, I recommend this projection. In this view, the mesiobuccal root (yellow arrow) is mesial to the palatal root (blue arrow).

DDR = direct digital radiography; DR = direct radiography; PID = position indicating device; PSP = photostimulable phosphor; SLOB = same lingual/opposite buccal

References