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Equine Dental Radiography

Robert M. Baratt, DVM, MS, FAVD

Author’s address: Salem Valley Veterinary Clinic, 12 Center Street, Salem, CT 06420; e-mail: rbaratt1dvm@gmail.com.

Indications

The indications for dental radiography include, but are not limited to:

- Maxillofacial trauma
- Assessment and staging of periodontal disease
- Malocclusion assessment and orthodontic treatment planning
- Exodontia
- Abnormal tooth numbers
  - Persistent deciduous teeth
  - Supernumerary teeth
- Facial swelling, draining tracts, nasal discharge
- Tooth fracture

Equipment

The equipment used for equine extraoral dental radiology is generally the same that is used for radiographic examination of the horse for lameness: a portable x-ray generator is adequate. While standard film systems can be used, portable digital systems have distinct benefits for ambulatory practitioners:

- Multiple views and retakes can be anticipated in dental imaging; if processing in the field is not possible, the horse should be referred to a clinic where immediate processing can be performed.
- Similarly, intra- and postoperative images are often needed; without the ability to process the images in the field, the patient should be moved to a facility where this can be done at the time of the procedure.

Radiographic imaging systems presently available fall into 3 groups:

- Conventional film/rare earth cassettes and wet film processing.
-Computed radiography (CR) utilizing phosphor plates that are processed in a scanning device that generates a digital image.
- Direct radiography (DR) digital sensors that immediately generate a digital image.

The main disadvantage of traditional film is the inability to process the films in the field. For a clinic-based practice this is not a factor, and vinyl intraoral cassettes with rare earth screens can be purchased so that intraoral views of the maxillary cheek teeth can be obtained. The CR systems are portable, less than half the costs of the DR systems, but the image acquisition time is slower than the DR systems and they are more technique sensitive. In addition to the high cost, intraoral imaging of the cheek teeth is not possible with the DR sensors that are presently available.
Comparison of the 3 Systems

<table>
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<tr>
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<th>Conventional Film</th>
<th>Computed Radiography</th>
<th>Digital Radiography</th>
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<tbody>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High</td>
<td>Very High</td>
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<tr>
<td>Intraoral Imaging</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Image Quality</td>
<td>Good</td>
<td>Very Good</td>
<td>Very Good</td>
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Radiographic Views/Positioning

Conventions and Labeling

The convention for presenting radiographic images of the dentition is somewhat different from that used by veterinary radiologists. As in human and small animal veterinary dentistry, the radiographs are presented as if a panoramic view of the dental arcades were being obtained. This standardized presentation eliminates the need for placing radiographic markers. However, since the digital imaging software may display the image incorrectly, requiring the clinician to rotate the image, an electronic label should be permanently imbedded in the DICOM image.

Incisors

The incisors are best viewed using intraoral placement of the cassette or digital sensor. Since the cassette/sensor is not parallel to the long axis of the incisor teeth, the bisecting angle technique is used to obtain an image of the teeth that minimizes foreshortening or lengthening of the image. Intraoral radiography in the horse requires sufficient sedation to eliminate chewing when the imaging cassette/sensor is placed in the mouth.

When the imaging plate cannot be placed parallel to the target tooth, the optimal image is obtained when the x-ray beam is directed 90° to the plane that bisects the angle between the target tooth and the plate (Fig. 1). In geriatric patients the inclination of the incisors diminishes, so that the bisecting angle decreases, and the x-ray beam approaches a perpendicular orientation to the plate.

Figure 1. The x-ray beam (red arrow) is directed perpendicular to the plane that bisects the angle formed by the target tooth and the imaging plate.
Standard views of the maxillary incisors are the intraoral straight and oblique occlusal views, with the beam centered on target incisor(s) (Figs. 2 & 3).

**Figure 2.** Intraoral views of the maxillary incisors of a 5-year-old horse: straight occlusal (far left) and oblique occlusal (middle and far right) views.

**Figure 3.** Intraoral views of the mandibular incisors (5-year-old horse): straight occlusal (far left) and oblique occlusal views (middle and far right).

**Canine Teeth**

The best images of the canine teeth are also obtained with intraoral placement of the film/plate/sensor. To image the maxillary canine tooth, the xray beam is centered on the canine tooth from the lateral aspect (perpendicular to the long axis of the head) and the at a 45 degree angle to the intraoral plate (Figs. 4 & 5).
Maxillary Cheek Teeth

The intraoral views of the maxillary cheek teeth are usually obtained with a full mouth speculum in place and a 4x8 inch vinyl cassette (film/intensifying screen or phosphor plate) placed across the palate and the occlusal surface of the cheek teeth. If the horse’s tongue is quiet, this cassette will stay in place. More often, it is necessary to keep the cassette from falling out by holding it with a long handled forceps or a notched 24 inch length of ½ inch PVC plumbing pipe (Fig. 6). The bisecting angle technique is also used when obtaining the intraoral views of the maxillary cheek teeth (Fig. 7). Since the long axis of the maxillary cheek tooth is almost 90° to the plate, the bisecting angle is about 45° to the imaging plate, with the beam centered on the target cheek tooth (or the rostral end of the facial crest, which marks the center of the arcade).

Figure 4. Intraoral oblique views of the maxillary canine teeth of a 5-year-old horse.

Figure 5. Intraoral oblique views of the mandibular canines of a geriatric horse.

Figure 6. Slotted PVC pipe used to hold the cassette for the intraoral views of the maxillary cheek teeth.
While the entire cheek tooth arcade is occasionally imaged with the intraoral technique, the 1st and 6th cheek teeth are often incompletely imaged or elongated (Fig. 8). The most informative radiograph is generally obtained when the x-ray beam is centered on the target tooth (Fig. 9).

Figure 7. Demonstration of the bisecting angle technique for the maxillary cheek teeth.

Figure 8. Intraoral radiograph of the right maxillary cheek teeth in a geriatric horse.

Figure 9. Intraoral radiograph of the left maxillary premolars of a 6-year-old. The x-ray beam is centered on the 3rd premolar (207).
Figure 10. Right maxillary cheek teeth of a 3-year-old. The image is foreshortened to include the apices of the long premolars. Note the absence of formed roots in the premolars. It is not possible to identify pulp horns and infundibulae due to the enamel infolding.

In a young horse, using the bisecting angle will frequently fail to image the apical region of these long teeth. In these horses it will be necessary to purposefully foreshorten the image (Fig. 10). It is often beneficial to obtain slightly off-angle views of the rostral or caudal cheek teeth in an effort to aim the beam through the interproximal space (Fig. 11). As the positioning is changed to optimize the image of individual maxillary cheek teeth, other teeth in the arcade will necessarily be distorted in the radiograph.

Figure 11. Demonstration of the change in rostro-caudal angle of the interproximal spaces of the maxillary cheek teeth.
The dorsoventral intraoral view, centered on the head at the level of the rostral end of the facial crest is useful for imaging the nasal passages, incisive, vomar and palatine bones (Fig. 12).

Extraoral views of the maxillary cheek teeth and associated sinuses are obtained with the imaging plate placed next to the target arcade. The straight lateral view will magnify the arcade closer to the x-ray generator, so any detailed apical radiographic anatomy of the superimposed teeth will likely be of the these cheek teeth rather than the arcade closer to the plate (Fig. 13). By convention, if the plate was placed next to the right side of the head, then the image is oriented for viewing so that the nose is to the viewer’s right. The straight lateral view is primarily used to evaluate the sinuses, and the technique should be adjusted to avoid “burnout” of these delicate bony structures (Fig. 13).

Figure 12. Comparison of the intraoral DV (left) and the extraoral DV views in a geriatric horse.

Figure 13. Left lateral extraoral view in a geriatric horse. The straight lateral view is of limited use in the evaluation of the cheek teeth due to superimposition. 1 infraorbital canals, 2 frontal/dorsal conchal sinuses, 3 rostral maxillary/ventral conchal sinuses, 4 caudal maxillary sinuses.
The dorsoventral oblique view with the beam centered on the apical region of the central maxillary cheek teeth is the standard survey image (Fig. 14). In most horses this will include the entire arcade. The maxillary and conchal sinuses have considerable overlap in the lateral and lateral oblique projections. The use of radiographic markers containing lead beads is recommended, so that the orientation of the head can be identified and correlated to suspected fluid lines (Fig. 15).

**Figure 14.** Open mouth DV oblique view of the right maxillary cheek teeth (geriatric horse). 1 Infraorbital canal, 2 caudal maxillary sinus/dorsal conchal sinus, 3 caudal maxillary sinus/ventral conchal sinus, 4 frontal sinus/dorsoconchal sinus, 5 rostral maxillary sinus.

**Figure 15.** The marker with metal beads (white arrow) identifies the orientation of the plate to the ground, and facilitates identification of the fluid line in the caudal maxillary sinus (black arrow).

The offset mandible DV is useful for imaging the maxillary arcade without the superimposition of the mandibular arcade. The horse must be adequately sedated so that when lead ropes are
placed in the mouth to draw the maxilla in the opposite direction from the mandible, chewing or head movement will not occur (Figs. 16 & 17).

Figure 16. Positioning for the DV offset mandible view of the right maxillary cheek teeth.

Figure 17. DV offset mandible view of the right maxillary cheek teeth (postoperative radiograph of 109 repulsion).

Figure 18. Intraoral views of the right mandibular cheek teeth of a 5-year-old (above) and the left mandibular cheek teeth of a geriatric horse (below).
**Mandibular Cheek Teeth**

The narrower space between the mandibular arcades and the thickness of the masseter muscles overlying the caudal mandible make imaging of the mandibular cheek teeth a challenging endeavor, especially with the CR systems. In most well-sedated horses, a 2.5x7 inch vinyl cassette can be inserted between the tongue and the mandible, adjacent to the lingual aspect of the mandible. This allows for a parallel technique, centered on the target tooth or mid-arcade. While this will not include the apical region of the mandibular cheek teeth in the young horse, it usually does include the clinical crown and most of the reserve crown and alveolar bone (Fig. 18). Although there will be some lengthening of the image, by changing the beam angle to a slightly VD oblique, an increased amount of reserve crown/root can be imaged.

The apical region of the mandibular cheek teeth can be imaged best with either a bisecting angle DV or a VD oblique view. For the DV view of the left mandibular arcade the plate is placed under the horse’s head as for a standard DV. However, since the long axis of the mandibular cheek tooth is about 90° to the plane of the plate, the beam is directed at about 45° to the imaging plate (perpendicular to the bisecting angle). Alternatively, the plate is placed parallel to the tooth, on the side of the horse’s head, and the beam is directed at a 60° VD oblique angle. (Fig. 19)

![Figure 19. The mandibular cheek teeth can be imaged by using a DV bisecting angle technique (left) or with a VD oblique view (right).](image-url)

The mandibular cheek teeth are difficult to image with current CR systems. The technique for the premolars often underexposes the molars. The thick soft tissue (masseter muscle) over the molars

59
often results in poor contrast of the caudal cheek teeth (Fig. 20). It is easier to obtain a diagnostic image of the mandibular cheek teeth with DR systems (Fig. 21).

**Mixed Dentition**

Up until the full eruption of all the permanent incisors at age 4.5 to 5 years, the horse has a mixed deciduous and permanent dentition. As in other species, the permanent incisor erupt lingual to the deciduous counterpart. Persistent deciduous incisors result in liguoversion of the permanent successional tooth. Prior to extraction of these persistent deciduous incisors, intraoral radiographs are helpful in determining the anatomy of the deciduous incisor root, and post extraction films can confirm extraction of the entire root.

The permanent tooth develops within the dental sac. This cystic structure can be recognized on standard intraoral views of the incisors in horses with mixed dentition (Fig. 22).

**Figure 20.** VD oblique view of the right mandibular cheek teeth in a 5-year-old horse.

**Figure 21.** The DR image (VD oblique) of the left mandibular cheek teeth. Fracture of the left mandibular 4th premolar (308).

The reserve crown, as determined by the presence of enamel, extends apically well below the gum line. The open apex of the young permanent incisor becomes a lateral foramen as the root, composed largely of cementum, develops. The number and location of apical foramina in the geriatric incisor is variable.

The canine teeth are frequently absent or rudimentary in the mare. Unerupted deciduous canine teeth may occasionally be seen in radiographs. Permanent canines are almost brachydont in their anatomy. The canine teeth can be imaged by both intraoral and extraoral techniques; however, the intraoral techniques are usually more detailed.

The maxillary cheek teeth consist of deciduous premolars and permanent molars with no deciduous precursors. In the young horse (less than 5 years of age), the mixed dentition of the cheek teeth can be evaluated using the open mouth oblique views (Figs. 25 & 26) or intraoral views.
When abnormal development and eruption of either deciduous or permanent cheek teeth occurs, associated clinical signs are common: facial swelling, nasal discharge, dysphagia, and draining tracts are the most common. Radiographic examination is key to the diagnosis and management of these cases.

Apical abscessation in young horses is frequently associated with the 4th premolars, which are the last permanent cheek teeth to erupt. It has been postulated that the eruption of the permanent 4th premolars in the space between the permanent 3rd premolar and the 1st molar results in some degree of impaction which sets up the right conditions for anachorectic infection of the apical portion of the pulp. This usually results in a ventral draining tract if the mandibular 4th premolar is involved, and facial swelling with nasal discharge or a facial draining tract when the maxillary cheek teeth are affected. This should not be confused with the normal “eruption cyst” frequently observed in 3-6-year-old horses (Fig. 27).

Figure 27. VD oblique view of the right mandibular cheek teeth of a 4-year-old horse. Note the artifactual lengthening of the cheek teeth and the eruption cyst of the permanent right 4th mandibular premolar (408), arrows.

Further Examples of Dental Radiographic Pathology
Figures 28 – 43
Figure 28. Fracture-avulsion of the left maxillary deciduous 1st and 2nd incisors (602, 603). Normal dental sac (arrows) of 101. The left permanent incisors failed to develop in this colt after fracture repair (wires and acrylic).

Figure 29. Periapical bone lysis (arrow) blunting of the tooth apex, and widened root canal of a fractured left mandibular canine tooth with pulp necrosis.

Figure 30. This 3-year-old horse presented with right facial swelling and ocular discharge. Intraoral radiograph reveals abnormal development of the permanent right maxillary second premolar (106) with defects in the mesial reserve crown (black arrow) and apical bone lysis (white arrows).
Figure 31. Tooth resorption of the maxillary incisors (arrows). Also note the thickened and irregular periodontal ligament space around the maxillary 1st incisors (101, 201).

Figure 32. Right mandibular canine of a geriatric horse. There is marked resorption of the crown, arrow (left). Postoperative radiograph after surgical extraction (right).

Figure 33. Tooth resorption with marked hyper-cementosis in a geriatric horse.

Figure 34. Mule, 9-years-old. Crowded right mandibular incisors and rotated right 1st mandibular incisor.
Figure 35. Right lateral (above) and straight DV (below, left) and close up of the right DV oblique radiograph of a horse with right facial swelling. (Courtesy of Dr. Roy White).
Figure 36. Congenital absence of a right maxillary 3rd molar, with overgrowth of the right mandibular 3rd molar (arrow).

Figure 37. Thoroughbred mare, 15-years-old. Supernumerary left mandibular incisor.
Figure 38. Supernumerary 211. Stage 4 periodontal disease (attachment loss of >50%).

Figure 39. Large cystic structure associated with abnormal development of the right permanent maxillary 2nd premolar (106).
Figure 40. Fluid lines in the dorsal conchal (white arrow) and maxillary (black arrow) sinuses in a geriatric horse with left nasal discharge.

Figure 41. Ethmoidal hematoma (arrow) as seen in the left DV oblique view (left) and the intraoral DV (right).
Figure 42. Apical bone lysis and root resorption (arrow) of the mesial root of the left mandibular 1st molar (309). Grade 4 periodontal disease.

Figure 43. Stage 4 periodontal disease of the left maxillary 1st molar (209) in an 18-year-old horse. Periapical bone lysis, blunting of the tooth root and widening of the periodontal ligament space (arrows). Extraoral (above), and intraoral (below).