Key Points:

- The use of a rigid endoscope for intraoral examination can identify pathology that cannot be seen with only a mirror.
- The vast majority of equine dental cases can be diagnosed with a good oral examination and dental radiographs.
- Multiplanar views and thin slice thickness is critical for maximizing the diagnostic value of a CT scan.

Diagnostic imaging is a critical tool for complete evaluation of oral health and disease in the horse. Even the most advanced oral exam using endoscopic techniques will not be able to determine the health of adjacent hard and soft tissue structures, the reserve crown, and the roots located within the alveolus. Some equine teeth that appear normal on examination of the clinical crown can be the cause of regional sinusitis, impressive apical pathology, and fistula formation. Diagnostic imaging can help identify the tooth/teeth responsible for current clinical signs as well as provide additional information regarding the health of otherwise clinically normal teeth. Many times incidental pathology can be identified during imaging studies allowing the veterinarian to diagnose the current problem and to warn the owner of developing pathology.

The first step in evaluating any horse for dental pathology should be a complete oral examination. Over the past decades, advances in intraoral imaging have made the exam more fruitful. The introduction and emphasis on using a mirror to evaluate teeth intraorally was followed by suggestions for the use of an intraoral camera. Rigid endoscopes have proved most useful, and there are currently a handful of models to choose from on the market. A rigid endoscope detects subtle lesions on the tooth surface and in adjacent soft tissue that was previously invisible to the practitioner. It is also a valuable teaching tool for students and clients as they are able to view the pathology in real time for the veterinarian to point out lesions. This tool is highly recommended for any veterinarian commonly performing equine oral examinations.

Radiology is widely used, and the combination of view variety (extraoral and intraoral) and improved imaging systems has led to a renaissance in the practitioner’s ability to diagnose pathology with this modality. With the appropriate tools, adequate views, and experienced eyes, the majority of dental cases can be diagnosed with a complete oral examination and dental radiography. When radiography is not enough, four additional modalities can be utilized to provide additional information. Ultrasound, nuclear scintigraphy, magnetic resonance imaging (MRI), and computed tomography (CT) have all been used as ancillary techniques to either confirm or complete a diagnosis. CT has proven to be the most valuable of these four modalities to identify maxillofacial pathology providing accurate images in cross sectional and multiplanar views. Both soft and hard tissue algorithms with or without contrast provide ample information. Three-dimensional reconstructions are particularly useful for maxillary and mandibular fracture repair. The equipment and facility expense for nuclear scintigraphy, CT, and MRI programs usually restrict clinics, hospitals, and universities to providing one or two out of the three aforementioned modalities. Therefore, these facilities have become quite good at using the
imaging system(s) available to identify pathology. With that said a handful of clinics and universities are using larger Tesla magnet MR systems adapted to handle equine limbs and heads. As a result, a new frontier of equine maxillofacial and mandibular imaging is being explored.

Ultrasound is an excellent modality for imaging soft tissue structures. Its use is limited in dental applications due to regional bone overlying the tissues of interest. When bone destruction is extensive or masses lie superficial to the flat bones of the skull and jaw ultrasound can be used to help describe and determine the nature of these swellings. It can also be used to determine the nature of soft tissue swellings of the cheek, tongue, orbit, and salivary gland.

Nuclear scintigraphy is unique among the imaging modalities because it allows for visualization of an active biologic process rather than a snap shot of structural anatomy. The third edition of Easley, Dixon, and Schumacher’s *Equine Dentistry* does a nice job of summarizing the use of nuclear scintigraphy in the horse for imaging of the head, specifically the teeth and sinuses. In short, an intravenous injection of a gamma ray-emitting radioisotope, $^{99m}$Tc-MDP, is used to detect regions of increased bone mineral turnover. Regions of increased radioisotope uptake appear darker on the scintigram and indicate active bone remodeling. Nuclear scintigraphy can image some bony pathology prior to its appearance in radiographic images as bone mineral turnover precedes structural change. Findings on the scintigram should always be evaluated with patient history, physical exam, and oral exam in mind as bone remodeling can be normal in certain circumstances such as growth, fracture repair, and alveolar remodeling post-extraction. If used to investigate pathology of dental origin, nuclear scintigraphy will readily identify regions of periapical disease and sinusitis. Various forms of neoplasia can also be imaged with this modality. Diagnosing additional dental pathology from a scintigram and/or determining a primary sinusitis from a tooth related sinusitis is often challenging and unrewarding. Therefore, nuclear scintigraphy is not usually the primary advanced imaging modality used for dental cases.

Only a small handful of papers have been written evaluating or reviewing the use of MRI for evaluation of the equine head. Universities and equine hospitals using this modality for cranial and mandibular evaluations are also limited. Though MRI has been available to horses over the last decade the expense involved with equipment acquisition and facility preparation have hampered its popularity. In addition, MRI requires longer general anesthesia times than computed tomography limiting the surgeon’s ability to image and operate on the same day due to concerns over excessively long anesthetic events. Facilities with MRI capability are usually functioning with a 1.5 Tesla magnet or better to produce diagnostic image quality. T1-weighted transaxial MR images are usually best for imaging the soft tissues of the cranial and mandibular regions. Bone and teeth have longer signal intensity and appear as dark regions. Soft tissues have higher signal intensities and appear lighter. This allows for excellent imaging of nerve, vasculature, pulp, periodontal ligament, temporomandibular joint, and adjacent soft tissue structures. Pathologic teeth can be identified by increased soft tissue surrounding teeth, decreased soft or hard tissue adjacent to teeth, pulp quality, and the reaction of sinus epithelium. Comparing structures bilaterally is essential for proper evaluation. As more institutions use this modality for dental evaluation, the value and advantage behind performing such an imaging study will become clearer.

Computed tomography in the horse is currently the best advanced imaging modality for dental pathology. In the third edition of *Equine Dentistry*, Drs. Simhofer and Boehler have written a comprehensive review that details the technical principles of CT and the appearance of
normal and abnormal dental tissue. Please refer to this review for detailed information and images. The vast majority of dental cases can be diagnosed with a thorough oral exam and high quality dental radiographs. When exam and radiographs do not leave the practitioner confident about a diagnosis it is time for CT. CT provides excellent images of hard tissue and diagnostic images of soft tissue. The use of contrast, different algorithms, multiplanar views and three-dimensional reconstruction all work together to provide the practitioner with a diagnosis and confidence in treatment planning. Usually, pathology resulting in distinct clinical signs will be clearly evident on CT. Newer machines are producing images with such detail that the veterinarian and radiologist have to be cautious of over-interpreting minor abnormalities and focus on major pathology. Very little literature has been published describing the newer high detail, multiplanar images and questions still remain about normal versus abnormal findings in some cases. The minor findings become more of an issue in cases with vague clinical presentations (e.g. discomfort with biting, plays with mouth, shakes head, carries head inappropriately) and a normal oral exam.

CT delivers the images necessary to identify the exact locations of pathology and the tooth/teeth associated with it. This can be particularly important in chronic sinusitis cases when radiographs may be inconclusive on tooth involvement. After years of evaluating CTs in only the cross sectional plane, the addition of multiplanar views has been very exciting. Cross sections are two dimensionally limited, and three-dimensional reconstructions can be limited depending on the facility, technical acquisition of images, equipment limitations, and the radiologist processing the images. Multiplanar views have opened up a new world of three dimensional imaging and treatment planning for the surgeon. Borders of cysts, masses, thickened tissue, reactive bone, fracture placement, periodontal disease, diastema formation, infundibular carious lesions, apical pathology, and tooth fracture can all be triangulated with this capability. This enhances the veterinarian’s ability to diagnose abnormalities and plan for optimal treatments.

Most equine dental CT images are acquired first in a bone window with slice thickness ranging from 3mm to 4mm. This spacing results in roughly 3-4 cross-sections per tooth which is adequate for diagnosing major pathology, but sometimes will completely miss smaller lesions. Slice thickness ranging from 1 to 2mm provides more information per tooth (5-7 slices/tooth) and should be used to examine teeth in detail. To emphasize the importance of smaller slice thickness and multiplanar views imagine a 3-4mm wide periodontal defect in a diastema, a 2mm congenital malformation along the full length of the crown, or a 2-3mm diameter oronasal fistula. All can cause significant clinical signs and yet be invisible or near invisible on a routine 4mm slice thickness cross sectional view, but these defects can be easily identified on transverse and sagittal multiplanar views. Needless to say, the temporomandibular joint should always be evaluated with decreased slice thickness and multiplanar views.

Since words can never provide as much information as pictures when reviewing CT images, the majority of the presentation will focus on normal and abnormal findings and case presentations. Please see the references below for further images and reading.

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