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**Imaging of the Upper Airway**

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Imaging of the upper airway of the horse is a valuable adjunct to upper respiratory endoscopy. The major imaging modalities used in evaluating the upper airway are radiography, ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI). Conditions of the nasal passage, paranasal sinuses, pharynx and larynx, and guttural pouches can be assessed using various combinations of these techniques.

**Radiography**

**Preparation and Image Acquisition**

Radiographs of the equine head, in particular those of the paranasal sinus region, are notoriously challenging to interpret. However, they are inexpensive to produce, easy to obtain, and are widely available both in referral settings as well as in ambulatory practice.

Four projections (lateral-lateral, left and right obliques, and dorsoventral) are generally sufficient to examine the nasal cavity or paranasal sinuses and a lateral-lateral view is adequate to examine the laryngeal/pharyngeal region. Depending upon the size of the horse and x-ray detector, a rostral and a caudal image may need to be acquired to completely examine the entire nasal cavity and sinus region.

**Interpretation**

Abnormalities involving the paranasal sinuses often manifest as abnormal soft tissue or fluid opacities involving either part or all of a sinus region. A fluid line may be present. Lesions as diverse as primary or secondary sinusitis, paranasal sinus cyst, ethmoid hematoma will appear similar on radiographic images. The tooth roots can be evaluated for signs of tooth root abscess. In cases of trauma, fractures as well as paranasal sinus fluid accumulation may be identified, but interpretation can be challenging. 1-3

In the laryngeal-pharyngeal region, the anatomic positions of the palate, the palatopharyngeal arch, hyoid apparatus, and larynx can be assessed. 4 Abnormal accumulation of fluid within the guttural pouches, air in the esophagus, and foreign bodies may be appreciated.

**Ultrasonography**

**Preparation and Image Acquisition**

Although ultrasonography yields little information about the interior of the paranasal sinuses, it is a very useful technique to image the abaxial aspects of the laryngeal region. It is inexpensive and does not require general anesthesia. While sedation is not always necessary, it can facilitate patient cooperation and relaxation to allow extension of the head permitting access to the
laryngeal region. The hair can be clipped or soaked with alcohol. A 7-10 megahertz linear or microconvex transducer will provide good resolution and adequate penetration.

Lateral, oblique, and ventral windows can be used to image the larynx. The arytenoid cartilages, thyroid cartilage, cricoid cartilage, and cricoarytenoideus lateralis muscle are evaluated in longitudinal and transverse planes from a lateral window. In most horses, the lateral portion of the cricoarytenoideus dorsalis muscle may be imaged from an oblique window, as can the retropharyngeal area. From the ventral window, the basihyoid bone and lingual process, vocal folds, thyroid cartilage, and cricoid cartilage are imaged.

Interpretation

Ultrasonographic evaluation of the larynx is used to augment the findings of upper airway endoscopy in various laryngeal disorders. Increases in echogenicity of the cricoarytenoideus lateralis and cricoarytenoideus dorsalis muscles suggestive of denervation due to recurrent laryngeal neuropathy can be appreciated (Fig. 1). In cases of poor performance or abnormal upper airway noise with equivocal results of resting upper airway examination, ultrasonography of the cricoarytenoideus lateralis and cricoarytenoideus dorsalis muscles can provide additional information in recommending appropriate treatment. This is especially useful in cases where a high speed treadmill examination is not performed.

The extent of arytenoid chondritis can be more accurately determined and the disease process can be followed with serial ultrasound examinations. Ultrasonography allows evaluation of arytenoid thickness, identification of perilaryngeal abscessation, and impingement of the inflamed and enlarged arytenoid on surrounding structures.

In addition to assisting with the diagnosis of more common upper airway conditions, unusual congenital malformations can be more fully evaluated by imaging the abaxial aspect of the larynx. Retropharyngeal masses (abscesses, enlarged lymph nodes) can be readily identified in the cranial neck region. Ultrasound guidance can be valuable if masses require aspiration or surgical drainage.

Magnetic Resonance Imaging

Patient Preparation and Image Acquisition

When considering MRI of the upper airway, a bore large enough to accommodate the region of interest is required. Current standing magnet designs cannot accommodate the equine head, so general anesthesia is required. Magnetic resonance imaging examinations of the sinonasal or laryngeal regions can generally be completed in 60-90 minutes, depending upon the size of the area examined. Images may be acquired in any geometric plane. We have used intravenous gadolinium-based contrast media to more accurately characterize tooth root infection, vascular malformations, cyst-like structures, and abscessation.

Interpretation

Magnetic resonance imaging provides excellent information about soft tissue and bony structures in the head. The locations of fractures in cases of trauma and any associated soft tissue
damage can be determined with a much higher degree of certainty than with radiography. The extent of anatomic malformations or mass lesions can be appreciated. Abnormalities such as tooth root abscess (Fig. 2), oronasal fistula, ethmoid hematoma, and paranasal sinus cyst may appear similar on radiographic images, but can be differentiated from one another using MRI.

**Computed Tomography**

**Patient Preparation and Image Acquisition**

General anesthesia is usually required for this type of examination, but there are designs that will accommodate a standing, sedated horse. Like MRI, the limiting factor of CT examination in the horse is bore size. Unlike MRI, CT examinations have a rapid acquisition time. This is particularly advantageous when surgical intervention is anticipated, as the surgical procedure can often be completed during the same anesthetic episode. Intravenous contrast may be used as well. As images are obtained only perpendicular to the bore of the CT, precise patient positioning is imperative. The images may be reconstructed in any plane after acquisition, but the level of detail is not typically as high in reconstructions as in the original data set.

**Interpretation**

Computed tomography allows determination of the location and extent of paranasal sinus masses, paranasal sinusitis, tooth root abscesses, fractures, and congenital abnormalities.\textsuperscript{13-15} This modality has advantages over MRI for many types of pathology in the sinonasal region as the level of detail for bones is higher than that of MRI, thinner slices can be obtained in a short acquisition time, and excellent three dimensional reconstructions can be created. However, the level of soft tissue detail is generally not as great as that afforded by MRI.

![Figure 1: Ultrasound images obtained from a lateral window in a longitudinal orientation to the neck. Image a (left) is the left side of the larynx of a normal horse and image b (right) is the left side of the larynx of a horse with left laryngeal hemiplegia. Note the increased echogenicity of the cricoarytenoideus lateralis muscle in b. AC = arytenoid cartilage, CC = cricoid cartilage, TC = thyroid cartilage, CAL = cricoarytenoideus lateralis muscle. Cranial is to the left of the images, caudal is to the right, superficial (skin) is at the top of the images and deep (glottis) is to the bottom of the images.](image)
Figure 2: T2 weighted transverse images obtained at the level of the first molar. Image a is a normal horse and image b is a horse with a tooth root abscess of the right maxillary first molar with exudate of mixed signal intensity within the maxillary and ventral conchal sinuses. M1 = first molar.

References


