Advanced Imaging of the Equine Eye

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KEYWORDS

• Equine • Eye • Imaging • Ultrasound • Computed tomography • MRI
• Optical coherence tomography • Confocal microscopy

KEY POINTS

- Advanced imaging is becoming more important and feasible for use in the diagnosis of equine ocular disease.
- Ultrasound imaging of the eye and periocular structures is the most common modality used and is indicated whenever there are cloudy ocular structures preventing direct examination of ocular structures.
- Optical coherence tomography and in vivo confocal microscopy are very promising techniques, especially for detailed examination of the cornea.
- Computed tomography with or without use of MRI are the most useful imaging modalities to thoroughly evaluate the equine orbit and periorbital structures.

INTRODUCTION

Advanced ocular imaging has revolutionized human ophthalmology with new technologies such as optical coherence tomography (OCT), which has developed into the primary method for the diagnosis of retinal diseases such as macular degeneration in humans.[1,2] Although there is a considerable need for better imaging techniques beyond ophthalmoscopy in equine ophthalmology, the routine use of advanced imaging has been relatively slow in acceptance. This is most likely due to several factors, including the high cost and lack of portability of the instruments and the inability to image the equine eye using human-designed equipment given the differences in anatomy and ocular size of the horse eye compared with the human eye. Furthermore, the need for general anesthesia to conduct many imaging techniques, such as computed tomography (CT) or MRI, limit their routine use in equine practice. However, improved instruments and advanced techniques such as the standing CT scanner have made these technologies more readily available, more feasible, and in some cases, such as ultrasound, quite practical to image the equine eye.

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This article is organized by anatomic structure of the eye and diseases associated with each structure. Indications for imaging, suitable modalities, techniques, and interpretation of images of specific areas of the eye, such as the adnexa, cornea, anterior chamber, lens, vitreous, retina, and orbit, are reviewed. With this organization, the reader will be able to easily identify ways to image a specific disease entity or anatomic location, making this article a valuable reference source. Furthermore, although there are many advanced imaging modalities described for the eye in the human and research literature, this article concentrates on those techniques that have been reported in normal or diseased equine eyes. At first mention of the imaging modality, a brief description of the procedural steps for the modality is included in an adjacent text box. This article does not describe routine clinical imaging and examination techniques of the equine eye, such as slit lamp biomicroscopy, tonometry, color surface and retinal photography, and electroretinography, which have been described well recently.[3]

This article reviews the literature for studies describing advanced imaging of the equine eye to serve as a reference for practitioners to assist in choosing image modalities, be a reference for the procedural technique, and to help with interpretation of the image results. For the ocular adnexa (eyelids), we review studies describing the use of ultrasound imaging. For corneal imaging, we will review ultrasound imaging, high-frequency ultrasound imaging (ultrasound biomicroscopy [UBM]), OCT, and in vivo confocal microscopy. For nasolacrimal duct (NLD) assessment, we review studies using CT and endoscopy. For the anterior segment and lens, we review ultrasound imaging, infrared (IR) photography, and anterior segment angiography. For the vitreous, retina, and optic nerve, we review ultrasound imaging, posterior segment angiography, and OCT. For the orbit, periocular structures, and to assess blindness, we review studies using CT and MRI. Finally, we describe several other diagnostic methods using advanced imaging, such as ultrasound-guided aspirations and injections.

IMAGING OF THE OCULAR ADNEXA

Indications for Imaging

The most common reason that imaging, other than routine ocular examination, is needed for eyelids or periocular tissue is when trauma has occurred and the eyelids are very swollen or when there is a suspected abscess or foreign body in the eyelid (ie, draining tract).

Advanced Imaging Modalities Described

In nearly all cases, ultrasound is used to image the eyelid or anterior orbit. Ultrasonography is a safe and painless method to examine intraocular and retrobulbar structures in awake animals (**Box 1**). Depth of sound beam penetration is proportional to wave length of the ultrasound probe. A low-frequency transducer (5 MHz) gives greater tissue penetration but poor near-field axial resolution and a high-frequency transducer (10 MHz) gives lower tissue penetration, but high near-field axial resolution. Therefore, for the eye, the higher frequency transducer gives better resolution and is preferred. Ideally, a 10- to 20-MHz frequency transducer is used for ocular ultrasound. See this recent publication for more information on ultrasound imaging of the equine eye.[3]

Ultrasonic imaging of the lacrimal gland (either abscess or adenitis) was described in horses presenting with acute onset severe upper eyelid swellings.[4,5] On ultrasound imaging, approximately one-half of the eyelids with acute swelling had an enlarged lacrimal