How to Take Digital Photographs of Equine Eyes in Practice

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1. Introduction
Equine practitioners are well-versed in the use of radiographic and ultrasonic imaging in the evaluation of the axial skeleton and reproductive and internal organs of their patients. However, imaging of ophthalmic problems has not been widely implemented in equine practice. Digital photography of the adnexa and anterior segment of the equine eye is an invaluable tool in documenting and following a variety of equine ophthalmic problems.

In the last decade, a variety of inexpensive, compact point and shoot digital cameras has come to market, and most practices have invested in digital cameras for field use. Many practitioners who have tried to use their cameras for ocular photography have become frustrated when the resultant images are blurred or of non-diagnostic quality. The objective of this paper is to explain techniques of operating compact cameras that will produce excellent diagnostic images of the equine eye. The paper will also describe how the camera can be used as a stall-side client-education device and discuss archiving the images for the medical record.

2. Materials and Methods
General Information
Good technique in using simple digital cameras to obtain useful ophthalmic images is dependent on understanding some basic principles of digital photography and camera operation.

Digital cameras use a series of lenses to focus light onto a semiconductor device. The device records the light electronically, and a small computer in the camera translates each bit of electrical data into digital data called a pixel. The summation of pixel data becomes the image. The camera software then displays the image on the liquid crystal display (LCD) screen on the back of the camera (Fig. 1A). The digital-zoom feature of the camera can be used to magnify the image on the LCD (Fig. 1B).

Digital imaging of equine eyes requires an understanding of the autofocus system present in cameras equipped with an electrical viewfinder (EVF). Cameras with an autofocus system have a shutter button that has a two-stage release system. Depressing the shutter release halfway activates the EVF and causes an infrared signal to be emitted from a tiny window on the face of the camera (Fig. 2). The infrared signal bounces off objects in the field of view.
of the camera lens and is reflected back and received by an automatic microprocessor. When the camera is in the automatic capture (camera icon) or program capture (P icon) mode of operation, the microprocessor receives information from both the reflected infrared signal and the internal light meter in the camera. The EVF microprocessor then activates motors that adjust the lenses and camera aperture for sharp focus and appropriate lighting. In most cameras, a noise will sound, and green brackets will appear on the LCD when the EVF has successfully focused the camera. Full depression of the shutter button will then capture the image. Sharp focus will result as long as the object of interest is stationary and the camera is not moved.

The EVF system can be set to focus on close objects (like an eye) by selecting the macro mode. The macro mode is represented by a flower icon on the camera menu and can be accessed by pressing a button or turning a dial on the digital camera body. Other choices include the landscape mode (the symbol is two triangles representing mountains, and the setting is used for distance photography) and manual focus mode (symbol is the initials MF, and setting is used by photographers who set the focus themselves). When the camera is in macro mode, the EVF will set the camera focus on the closest object detected by the infrared beam that is in the range of the autofocus system and near the center of the viewfinder. It will also increase the size of the aperture of the camera lens and reduce the depth of field. This means that elements of the image that are farther away than the focus plane will not be in sharp focus.

It is important to understand that the lens of a digital camera set on the macro setting has a limited range of possible focal distances. Ocular photographs are often blurred, because the camera has been positioned too close to the globe. User manuals should be consulted to determine the macro focal range of the particular model: for many models, the optimal range is 12–70 cm (5–27 in). Novice photographers should look at the LCD screen when staging a close-up photograph. The LCD on most models will show green framing brackets when the central object (globe) is in sharp focus, and the cam-
era may emit a chime. If the camera is positioned too close to the globe, the brackets will not appear and a red signal will be displayed, indicating that the autofocus is not operating (Fig. 3A). If this happens, the camera should be repositioned a little farther away from the globe. After the camera is positioned within the macro focal range, the LCD and the camera chime will signal when the EVF has successfully secured a sharp focus (Fig. 3B). Image will be in sharp focus as long as the operator and horse do not move.

Camera Choice for Ocular Imaging

High-cost cameras are not necessary to obtain useful images of equine eyes. There is no advantage in purchasing a camera with a high megapixel resolution or advanced digital or optical zoom, because these features do not improve the image quality of photographs taken at close range. Basic features that are recommended include:

- at least 4 megapixels of resolution
- automatic flash
- active autofocus system that is fast and easy to use
- fast click to capture speed (<0.3 s)
- macro focus setting
- large LCD screen for staging and reviewing images
- digital zoom that will facilitate reviewing images on the LCD
- no features that startle the horse (noises or light flashes)

Many brands of cameras produce excellent ocular images if the photographer knows how to set the controls and practices good positioning of the horse. However, some models produce inferior results or are difficult to operate. It is a good idea to try before you buy. The search can be narrowed by choosing a few rugged, full-featured camera models that have large LCD screens, simple controls, good autofocus capabilities, and fast click to capture speed. The final choice should be made after the models are tried, making sure that the camera is easy to use in a barn setting.

Particular attention should be paid to the ease and speed of the autofocus system and the quality of the image on the LCD screen. Test images from the models being considered for purchase should be downloaded to a viewing computer and compared for sharpness, color, focus, and contrast. The steps that would typically be taken to edit and archive the images should be followed, and the results should be compared between models. Battery life and ease of recharge are other factors to consider. A camera model that takes detailed ocular images is also a good tool for general field use and will produce useful images of other clinical entities with slight alterations of focus settings.

The author has obtained thousands of very good eye images with a digital camera that has an autofocus mode that produces a soft audible chime when the EVF focus is engaged. This brand of camera has a docking system that easily transfers images to the viewing computer and doubles as a battery recharging stage. The LCD screen is 2.5-in wide, making it a good tool for client instruction. Newer models in this camera series have replaced the dock-
ing stage with a battery compartment that accepts disposable or rechargeable batteries.

Regardless of model or brand chosen, practitioners are also advised to invest in a padded camera case, an extra battery, and additional storage media (SD, SDHC, or MMC card).

Camera Settings for Novice Photographers

1. Set the camera capture mode to **program (P)**. The P option allows full access to menu options, but the camera will set the shutter speed and aperture based on available lighting.
2. Set the focus mode to **macro** (flower icon).
3. Enable the **autoflash** or **flash fill** option to assure that the flash will operate.
4. If applicable, set the autofocus EVF to **spot** or **center** to assure that the camera focuses on the object in the center of the LCD (not needed in every camera).
5. Check that the zoom button is in the default **wide-angle mode**.

Stall-Side Considerations in Ocular Imaging

The horse should be placed in a relatively dark area, and the handler should stand on the opposite side of the eye to be photographed, holding the horse with a lead rope attached to the halter. The practitioner must remember that the equine cornea is a glossy surface that will reflect objects like a fish-eye mirror. No windows, doors, or bright objects should be present in back of the horse's head or behind the photographer, because these will produce troublesome reflections (Fig. 4). Red or white clothing produces reflections on the corneal surface, and therefore, the photographer should wear dark clothes.

Mild sedation may be appropriate, especially if the horse is experiencing pain in the eye being imaged. Auriculopalpebral and frontal (supraorbital) nerve blocks will deter blepharospasm and optimize the imaging of painful, swollen eyes. Dirt, tears, and ocular discharge should be removed before imaging.

Horses become restless if the operator spends too much time setting up a photograph, and subsequent head movements can impair image quality. The best results will occur if the photographer learns to stage photographs quickly and takes the image as soon as the camera is in focus. An external light source, such as a Finnoff transilluminator or bright flashlight, is useful if held lateral to the globe, because it will acclimatize the horse to the pending flash stimulus.

Ideally, an assistant should lift the upper lid to maximize exposure of the cornea. When an assistant is not present, the photographer may need to use their dominant hand to spread the lids and the other hand to operate the camera, but this practice may produce a reflection of the operator's palm and digit on the corneal surface.

Positioning the horse's head on a homemade table constructed of 4–5 stacked bales of shavings, hay, or straw may be helpful in some instances. Exposing the sclera and limbus will be aided by rotating the horse's head and taking advantage of the resultant oculovestibular motion: rotating the poll region away from the photographer will aid exposure of the dorsal region of the globe, and rotating the poll toward the photographer will aid exposure of the ventral region of the globe (Fig. 5).

Cataracts and lens-position abnormalities can best be imaged with the pupil fully dilated (Fig. 6). Short-term (4–8 h) mydriasis can be accomplished by the application of topical tropicamide. A tuberculin syringe attached to a 25-gauge needle is used to draw 0.3–0.5 ml of drug out of the dropper bottle. The needle is then broken off, and the medication is sprayed onto the corneal surface through the remaining hub. Full dilation will occur 15–20 min after application.

Although standard images are taken from a directly lateral viewpoint, supplemental views are often beneficial, especially when directed toward the nasal or temporal angle of the globe (Fig. 7, A and B). A flash should always be used when imaging the eye. Flash artifacts on the cornea are unavoidable. If an artifact obscures essential detail, additional images should be taken from different angles to move the flash artifact to a less important region of the globe. Sterile cotton-tipped swabs can be inserted into the fornix or under the eyelid to retro-pulse, expose, or evert areas of interest (Fig. 8). A Schirmer tear test strip or scalpel handle with
measuring marks can be included in the photograph as a measuring reference.

Procedure for Imaging

1. Aim the camera at the globe from a distance of 12–25 cm (consult the camera owner’s manual for range specifications of the macro setting). Experience will dictate the optimum distance for the camera model; Fig. 3B).

2. Activate the autofocus system by pushing the shutter halfway down. Listen for the sound that indicates that the EVF has engaged prop-
erly. Look at the LCD screen to make sure the focus brackets are centered on the globe.
3. Depress the shutter as soon as the focus system is ready, without moving the camera.
4. Take several photos at the desired angle in rapid succession, repeating the autofocus process for each photo.
5. In some cases, it may be prudent to photograph the fellow eye for comparison or documentation of the baseline status of that globe. Steps 1–4 should be repeated if the second eye is imaged.
6. Review the images on the LCD screen, deleting any that are out of sharp focus. Repeat steps 1–5 if useful images have not been obtained.

3. Results
After the images have been captured in the camera, they should be reviewed in the presence of the owner. The images that best show the issue of concern should be centered and magnified on the LCD screen to explain the findings to the client. The procedure to do this is as follows:

1. Press the review button on the camera to scroll through the series of captured images on the LCD.
2. Select the image(s) that best display the issue of concern.
3. Using the arrow buttons, move the image on the LCD to center the desired region.
4. Press the zoom button to activate digital-zoom processing of the image on the screen. Increase the magnification until the area of interest is easily viewed.

The stall-side review process is a critical step in owner education. It is difficult for most lay people to appreciate ocular lesions just by looking at the animal’s globe. However, many problems can be easily explained with the aid of a magnified, still image on the camera screen (Fig. 9). Compliance with intensive treatment protocols as well as acceptance of the expense required to treat serious ocular problems will be increased if the clinician takes a few minutes to show the owner exactly what the problem is. Follow-up can include electronic transmission of selected images to the owner through e-mail.

The best images of the patient should be downloaded to a viewing computer at the end of the day. Transfer can be accomplished by a variety of methods, including cabling between the computer and camera or use of a memory-card reader device. The images should be downloaded to an archiving software program and edited for storage in the medical record. The editing process uses a digital zoom where the region of most interest is selected using the crop feature and the remainder of the image is

Fig. 8. Retropulsion or eversion of some eye lesions with a sterile swab will aid demonstration of detail. This photo shows the extent of growth of a squamous cell carcinoma on the nictitans.

Fig. 9. Stall-side review of ocular images is a powerful teaching tool. Clients understand eye problems much better if they can see the issue at hand on the screen. Follow-up can include e-mail transmission of the best images.

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discarded (Fig. 1, A and B). Often, as much as 85% of the original image is removed during editing, because many ocular images show optimal detail if the cropped image is limited to the cornea.

Cameras with high megapixel resolution will produce large data files that exceed 1 MB per image. Large image files pose a storage problem with some medical record software programs and may be difficult to transmit electronically. The camera software menu can be set to lower the camera megapixel resolution and reduce the file size. File size can also be reduced on the storage computer using the compression features of the image-archiving program.

Many veterinary medical-record software programs allow digital images to be attached to the patient record. After the files are edited, selected images can be transferred to the patient record for future reference. Image attachment may require high compression. The resultant .jpg image is usually of adequate quality for review in the field.

Patients with ocular trauma, neoplasia, inflammation, or infection will require follow-up visits. Photographs taken at each visit will document the progress of the case (Fig. 10, A and B). Images can be shown to the owner to show improvement or decline of the particular condition. Follow-up images can be paired with previously archived images and emailed to the owner or an ophthalmic specialist for consultation.

Horses suffering corneal ulcers usually require ocular cytology as part of the diagnostic work up. Unusual cytology findings can be photographed with compact cameras through the microscope lens (Fig. 11A). The technique involves the operator focusing an area of interest on the cytology slide on the microscope stage and then, resting the camera lens right on the microscope eyepiece. The image is taken using the same settings described above (macro lens, automatic flash, and program capture mode). The tunnel of the microscope eyepiece creates a peephole effect, and therefore, only a small circular image will be captured. However, with practice, the image can be centered to record the desired clinical pathology region (Fig. 11B).

The author takes digital photographs of most ocular cases that she sees and also habitually photographs interesting variants discovered on routine physical examination. Approximately 200–250 horses are imaged each year, many of them multiple times. Each visit to evaluate a clinical problem typically generates 5–10 images. The best 2–3 images are saved in a digital library on the author’s computer after any out of focus or poor images are deleted. The best single image of the case is uploaded in compressed format to the patient medical record and labeled with the examination date. Sequential exams often generate additional images; if changes in the findings are present, additional images may be added to the patient record. Case progress can be followed by selecting images out of the digital library that correspond to various examinations and inserting the images into a folder or email so that they can be viewed sequentially by date.

A review of images taken on routine ambulatory calls by the author between March and May 2010 showed that 48 horses with significant ocular problems and an additional 8 horses with interesting ocular variants were photographed during that 3-mo
interval. During the review period, digital photography was used to image problems of the orbit and periorbit (one horse with an open sinus fracture causing palpebral fissure distortion, adnexa and conjunctiva (one upper eyelid tear, two eyelid tumors, one case of bilateral lid margin dysplasia, one case of bilateral atretic nasolacrimal ducts, one foal with bilateral entropion, and one horse with unilateral chemosis), cornea (multiple horses with corneal ulcers or scars, four horses with single or multiple Haab’s striae, five horses with non-ulcerative keratopathy, one foal with bilateral indolent ulcers, and two horses with corneal foreign bodies), lens (several horses with cataracts and a few horses with luxated lenses), and globe (several cases of uveitis, three horses with glaucoma, two horses with multiple congenital ocular anomaly syndrome, and two horses with phthisis bulbi). During the 3-mo review period, corneal cytology of eight cases was also photographed through the practice microscope. Photomicrographs in these cases documented presence or absence of a suppurative response as well as intracellular bacteria, fungal hyphae, and foreign bodies (vegetative material in one case and a fence splinter in another case). In addition, the digital camera was used to take video footage of three unilateral blind horses as they underwent visual maze testing.

This list of problems seen and imaged in a 3-mo period is representative of the typical volume seen in the author’s general practice. Specific examples within this case series where digital photography was particularly valuable in case management are given.

1. Multiple Congenital Ocular Anomaly in a Miniature Horse

   The horse was purchased without an eye exam and then noted to have visual deficits. The defects were severe. Photographs of the horse’s eyes were sent electronically to the seller along with a detailed report of the abnormal findings. The seller then allowed the buyer to return the horse.

2. Foal Born With Bilateral Corneal Ulcers and Entropion

   The ulcers were indolent, and the foal required several weeks of hospitalization. Sequential photographs were emailed to the owner weekly. This documentation helped the owner understand the problem and accept the significant expense of the foal’s care. The photographs were also used for consultation with university specialists and day to day progress assessment.

3. Case of Chronic, Severe Fungal Keratitis That Required 8 Wk of Medical Therapy

   The condition was extremely painful for the horse, and the prognosis was uncertain. Enucleation was considered as a humane option. Review of sequential photographs showing slow but continuous vascularization of the fungal plaque was crucial in the
decision to continue treatment, which eventually resulted in a pain-free globe.

4. On Pre-Purchase Examination, a Horse Was Found to Have a Single Haab’s Stria on the Right Cornea
A Haab’s stria is a finding of uncertain significance, but it is permanent. Digital photographs of the stria were emailed to the buyer’s home veterinarian along with the full pre-purchase report. The home veterinarian was then able to give his client an opinion on the purchase of the horse.

5. An Off-the-Track Thoroughbred Was Diagnosed With Unilateral Blindness Related to a Mature Cataract
The next week, this horse presented with acute glaucoma in the same eye. Digital photographs of the mature cataract and clear cornea were available for comparison when the cornea became severely edematous with glaucoma. The owner was given two serious diagnoses within 1 mo; digital photography helped her understand the poor prognosis. Photographs were also useful for insurance documentation (Fig. 12, A and B).

4. Discussion
This paper has presented tips on the use of compact digital camera models for imaging the equine anterior segment in the conditions common to ambulatory practice. The camera settings and imaging process described take advantage of several automated features available in most modern digital cameras. Camera models that perform well using the methods described in this paper are inexpensive, rugged, and simple to use.

The imaging techniques described in this paper have been chosen with the novice photographer in mind. Ocular imaging should add no more than 1–2 min to the eye-examination process if the camera is carried into the barn with other diagnostic tools. Practitioners will rapidly learn the skills needed to obtain good images and will find that the educational benefits of a stall-side review of magnified images with the owner make ocular photography invaluable. Archived images provide useful baseline information for cases that change over time. Ocular imaging can also provide valuable documentation for some conditions of the anterior segment or adnexa that are discovered during pre-purchase examinations.

Veterinary ophthalmologists use digital single-lens reflex (DSLR) cameras with special macro lenses to image the horse eye. Both the flash and the lens can be varied in DSLR cameras, making them versatile instruments in a variety of ambient light conditions. Composition and metering can be done manually through the lens viewfinder. These cameras produce the finest detail and greatest depth of field and thus, they produce the highest quality images; however, they are more costly and fragile than compact cameras. DSLR cameras are beyond the scope of this paper, but practitioners with a special interest in photography may be interested in their use.

Infrared imaging of the equine eye is a specialized type of photography that is being used with increasing frequency in referral centers. Infrared photography yields superior images of abnormal masses or fluid in the anterior chamber as well as enhanced detail of corneal vascularization, iris-surface fea-

Fig. 12. (A) A 12-yr-old Thoroughbred presented with blindness in the right eye. A digital photograph of the globe with the pupil dilated recorded the mature cataract associated with the blindness. (B) The same horse presented a few weeks later with acute glaucoma of the same eye. The owner was given two serious diagnoses within 1 mo; digital photography helped her understand the poor prognosis. Photographs were also useful for insurance documentation.
tures, and cataractous changes of the lens. The long wavelengths of infrared light penetrate a cornea that is opaque as a result of edema or fibrosis much better than wavelengths in the visible spectrum. This property allows greater visualization of intraocular structures than is possible with traditional photography. Several companies provide infrared conversion services for most DSLR cameras and selected EVF (point and shoot) camera models.

References and Footnotes


Kodak EasyShare model Z712IS, Eastman Kodak Company, Rochester, NY. (This camera is no longer in production, but similar models in the current Kodak Z series produce comparable images and cost between $200 and $350. Useful images have also been obtained from the Kodak M series cameras, which retail between $130 and $200.)

Mydriacil, Alcon Laboratories, Inc., Fort Worth, TX 76134.

Apple Iphoto, Apple Aperture, Adobe Photoshop, Microsoft Photo editor.