

Equine Ophthalmology Examination

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There are many components to the ophthalmic examination. Having a general understanding of the anatomy, examination process, and common diseases will make the process smooth and efficient. A general knowledge of ocular anatomy will enable description of ocular lesions and a better understanding of the examination process. Understanding the examination process and the diagnostics that accompany it is vital. Knowing what instruments are necessary for a basic examination is a starting point. As you become more experienced, determining which diagnostic procedures are necessary for individual cases will be possible. These procedures will help the clinician arrive at a diagnosis.

Taking client calls can be very time consuming. Having a basic understanding of common diseases and medications will help when trying to determine if a situation is urgent. This knowledge also helps when fielding questions that clients have after appointments regarding progress and medications.

Ocular Anatomy

The location and structure of the equine eye was designed to serve the horse as a grazer and prey animal. The orbits are laterally positioned to provide almost a completely panoramic view (340 degrees) with approximately 65 degrees being binocular vision. The only "blind spot" is a small area directly caudal to the horse's tail. The large equine globe (~44x48x48mm) sits inside a complete bony orbit. Movement of the globe is facilitated by a series of muscles innervated by cranial nerves 3, 4 and 6. The tear film is composed of secretions from the lacrimal gland, meibomian glands, and gland of the third eyelid. The exact contribution of the gland of the third eyelid is unknown, however, in one study it was shown that the quantity of tears produced in horses following third eyelid removal was not significantly different when compared to normal horses¹. The equine cornea has a horizontal diameter (30-34 mm) greater than the vertical diameter (21-27mm). The cornea is composed of epithelium, stroma, and endothelium. The epithelium and endothelium are lipophobic layers and help to maintain the normal hydration state of the stroma. Disruption in either the epithelium or endothelium can lead to significant corneal edema due to the stroma's naturally hydrophilic nature. The horizontally oval shape of the cornea allows visualization of the iridocorneal angle laterally and medially. A

prominent feature of the equine uvea is the corpora nigra, which are cystic extensions of the posterior iris epithelium along the dorsal pupil margin. The horse has a paurangiotic retinal vasculature pattern. This means that the choroid is responsible for supplying nutrition to the majority of the retina. The tapetum spans the dorsal half of the fundus and is typically a yellow-green color. In this area end-on choroidal capillaries can be seen and these are known as the Stars of Winslow.

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Examination

A proper ophthalmic examination starts with observation. Horses that have been previously examined or medicated can be sensitized to people near their head. For this reason, a more accurate interpretation of blepharospasm will be possible from a distance, preferably from outside of the stall. Observation from a closer distance will allow evaluation of facial and globe symmetry. Palpation can be used to investigate any asymmetry noted and to characterize the texture and sensitivity of the globe. Retropulsion is performed by pushing the globe back into the orbit through closed lids. It is important to note that this should not be performed if there is any threat of globe rupture. Resistance to retropulsion suggests the presence of a retrobulbar mass. Retropulsion of the contralateral eye can provide a baseline for the individual patient. This technique can be used to help distinguish between changes in globe size and globe position (e.g. exophthalmos which would be associated with abnormal retropulsion and buphthalmos which would be associated with normal retropulsion). Lastly, when retropulsion of the globe is performed the third eyelid is displaced within the orbit and therefore passively elevates to cover the globe. Retropulsion is an essential part of any examination to allow close examination of the third eyelid for abnormalities. This is especially true in horses with a lack of pigmentation around the eye. Lack of a third eyelid is important to note because it raises the suspicion of prior neoplasia. There are multiple published reports of squamous cell carcinoma metastasis months to years after third eyelid removal and therefore this is something that a potential buyer should be made aware of.

Epiphora or ocular discharge may not be active so it is important to look for evidence of previous discharge such as facial staining. Reflexes and responses should be evaluated after the initial observation. The menace response is commonly used in vision evaluation, however, it is important to keep in mind that vision and the menace responses are not directly related. If there is a question regarding an animal's vision a maze test can be performed. This involves obstacles that the horse is encouraged to walk through or guide around. Completion of the menace response requires an intact visual and motor cortex, including cranial nerves II (optic nerve) and VII (facial nerve)¹. Keep in mind that this is a protective response that is learned and may not be present in animals less than 2 weeks. To perform this test the veterinarian should touch the periocular area once or twice to first stimulate the palpebral reflex. This should be followed by

movements that create visible motion without creating stimulation of aural or tactile senses. The menace response should be evaluated throughout the horse's monocular visual field. For the horse this extends approximately 150 degrees (starting directly behind the horse) leaving a small section perpendicular to the forehead that requires binocular vision. The dazzle reflex is a very simple test that, similar to the menace response, evaluates the function of the retina, CN II, and CN VII. When a focal light source is directed towards the eye the horse should respond by blinking. After vision is fully assessed the focal light source is used to evaluate pupil size and pupillary light reflexes. Pupil symmetry can be evaluated by standing approximately six feet in front of the horse with a focal light directed at the center of the horse's head to visualize both tapetal reflexes simultaneously. The normal horse pupil is round when dilated and oval shaped when constricted with the horizontal axis being longer than the vertical axis. After pupil symmetry is evaluated pupillary light reflexes should be evaluated individually. This is done by directing the focal light into each eye from approximately 2-3 centimeters. When the light is directed into one eye both pupils should constrict (direct/indirect response). It is normal for the equine pupil to respond slowly with vertical movement being more noticeable than horizontal movement. The palpebral reflex is stimulated when the medial or lateral canthus is touched. A normal response is complete closure of the eyelids. Failure of this reflex occurs if there is damage to either the trigeminal (CN V) or facial nerve (CN VII) or if the eyelids are unable to close properly (Ex: trauma). Incomplete lid closure for any reason can lead to predispose the horse to exposure keratopathy and other related consequences.

Following evaluation of the ocular reflexes and responses, examination of the globe is performed. A dark area of the barn is ideal for this stage of the examination; towels can be used to cover windows. If a barn is unavailable, the examination can be performed in the evening to provide a better examination environment. The compliant patient is usually achieved after some amount of sedation; rarely a patient allows complete examination without chemical restraint. Horses with ocular pain are generally less willing to be examined. The most common drugs used are alpha 2 agonists (xylazine, detomidine). Xylazine has a shorter duration of action but it is generally sufficient for ophthalmic examination. In addition an auriculopalpebral nerve block can be performed to further facilitate examination. This blocks motor innervation to the upper lid (a branch of the facial nerve) and allows the lid to be opened with ease.

Generally examination is easiest if started on the less painful eye. There is no strict order of examination, however, the order should be consistent for each individual examiner so as to not miss important abnormalities. Most frequently the examination begins with the adnexa. This is best done with a direct focal light. Common abnormalities are tumors (sarcoids, squamous cell carcinoma) and tarsal margin irregularities.

Purkinje-Sanson reflections can be used to examine the cornea, anterior chamber, iris, and lens. Reflections can be used to examine the clarity and location of any abnormalities. Opacities can be further investigated with the use of slit lamp biomicroscopy. Transillumination can be used to evaluate the anterior chamber by directing a focal beam at a 45 degree angle to the corneal surface. This method of

observation will allow for evaluation of cells within the anterior chamber (aqueous flare). Corpora nigra cysts are seen frequently in horses but their clinical significance is very difficult to determine. Corpora nigra atrophy is generally associated with uveitis episodes, but is rarely the only uveitis change. Iris hyperpigmentation is another change generally associated with uveitis episodes. Persistent pupillary membranes are a common finding in horses and have no known clinical significance. To evaluate the entire lens pharmacological dilation is necessary. 1% tropicamide is most commonly used because it is effective in 20-30 minutes and has a shorter duration (~4-8 hours) than atropine². All cataracts have the possibility of progression; cataract characteristics can help determine the likelihood of progression. Cataracts can be classified according to etiology (primary, secondary), age of onset (developmental, senile), stage of maturity (incipient, immature, mature, hypermature), and location. Age of onset and etiology may be difficult to determine without a complete history. Developmental cataracts are the result of abnormal growth during embryogenesis and are commonly non-progressive or very slowly progressive cataracts. Common developmental cataracts are seen at the anterior/posterior suture line and within the nucleus. The nucleus is the first part of lens to form in utero and therefore these cataracts are generally congenital. Senile cataracts are a form of nuclear cataracts generally seen in horses greater than 20 years old; it is important to differentiate these from nuclear sclerosis. Nuclear sclerosis does not cause vision loss or interference with the tapetal reflection. The equator is the most metabolically active portion of the lens so cataracts in this location tend to be progressive, especially if vacuolation is also seen.

The horse's fundus can be imaged using either direct or indirect ophthalmoscopy and ideally should be examined with both techniques. Indirect ophthalmoscopy requires a focal light source and handheld lens. This technique provides a wide field of view, however, the image visualized is upside down and backwards. Conversely, direct ophthalmoscopy (diopter wheel set at 0 to -3) provides an upright with a very magnified view (approximately 15 times that of indirect ophthalmoscopy). Either technique can recognize important abnormalities such as retinal detachment, optic nerve atrophy, or chorioretinitis. The nontapetal fundus is often overlooked but is more often affected than the tapetal fundus with lesions such as chorioretinitis and chorioretinal scarring.³ Two common patterns of chorioretinal scarring are peripapillary (butterfly lesions) and multifocal (bullet hole lesions). Sedation is important and often necessary to lower the horse's head so that the nontapetal fundus can be visualized in its entirety.

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Diagnostics

There are a few tests that are done routinely during an initial ocular examination. The Schirmer tear test measures the amount of tears produced in one minute. Normal is generally accepted as >15 mm/min, however, horses frequently have results that are off the strip within seconds (>30 mm)¹. It is important to note that just because the quantity of tears is normal it does not mean that the quality of tears is normal.

Fluorescein stain is another diagnostic that is commonly performed. This can be used to diagnose corneal ulcers or corneal perforation, assess nasolacrimal duct patency, and determine tear film break up time. Fluorescein dye is lipophobic and hydrophilic. These characteristics prevent adherence to intact epithelium; however, breaks in the epithelium will result in stain adherence to the exposed stroma. It is called Seidel's test when stain is applied to a suspected corneal perforation. If aqueous fluid is leaking the stain becomes diluted and often rivulets can be seen. Application of stain to the cornea will also assess nasolacrimal duct patency and this is referred to as the Jones test. It generally takes 5-20 minutes for stain placed on the cornea to travel through the lacrimal puncta into the nasolacrimal duct and be visualized at the external meatus. The external meatus can be easily seen in the horse at the mucocutaneous junction on the nasal floor. The final test that is commonly performed with Fluorescein dye is the tear film break up time. To perform this test, stain is applied to the cornea and then the eyelids are blinked twice. The eyelids are then held open and the stain should start to evaporate at ~9 seconds². If the stain starts to evaporate prior to that time, instability of the mucin layer is suspected.

Diagnostics that are frequently used but less available in the field include rose bengal stain, corneal touch threshold, and tonometry. If 1% rose bengal stain is used it should be done at the beginning of the examination because simple steps such as placement of a Schirmer tear strip can cause damage to the tear film. Uptake of rose Bengal stain will be seen when there are devitalized corneal and conjunctival cells not covered by an adequate tear film. Corneal touch threshold (CTT) is determined using an aesthesiometer. The filament was first applied at its maximal length; the length was decreased in 5 mm increments once it was determined that blink response at that particular length was not present. A positive response is 3 consecutive blinks. The average CTT for adult horses is 48mm³. Older horses and horses with Cushing's disease tend to have decreased corneal sensitivity which can predispose them to corneal ulceration. In many cases tonometry is a vital diagnostic tool. There are two common tools used in veterinary medicine to measure intraocular pressure (IOP). The Tono-Pen measures IOP via applanation tonometry, which converts the force required to flatten the cornea into mmHg⁴. The TonoVet measures IOP via rebound tonometry, which analyzes motion parameters of the probe after collision with the cornea⁵. Normal intraocular pressure for horses is 15-25 mmHg. Decreased intraocular pressure is often due to inflammation. Glaucoma is defined by increased intraocular pressure and should be treated immediately to prevent complications such as retinal detachment.

Even further diagnostics can be pursued depending on the presenting complaint. Corneal ulceration often warrants cytology and culture. Application of 0.5%

proparacaine can facilitate these diagnostics in a painful eye. Cytology can be performed with either a cotton swab or the blunt edge of a scalpel blade. The collected material is then smeared onto a slide and examined for infectious organisms. Ocular ultrasound is most commonly used prior to phacoemulsification to rule out retinal detachment. Another common use for ocular ultrasound in horses is evaluation of extraocular masses. Electroretinography (ERG) is another diagnostic used in evaluation prior to phacoemulsification. This objectively evaluates retinal function via a series of light flashes and the responses they elicit.

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Subpalpebral Lavage

Placement of a subpalpebral lavage (SPL) is often necessary to facilitate medical treatment for ocular disease in horses. This device is used in horses due to their large size and extraordinarily strong orbicularis oculi muscle. Currently there are commercially available SPLs through MILA International. The catheter systems consist of a 12-gauge trocar and a catheter with an attached footplate. The catheter comes in two sizes: 36 inch and 60 inch. For every subpalpebral lavage placement the eye is thoroughly prepared with dilute betadine solution. Soaked gauze is used to wipe around the eyelids. After the cornea is anesthetized with topical 0.5% proparacaine, dilute betadine is applied to the cornea and conjunctiva via a syringe with the needle broken off. The SPL can be placed in either the superiolateral eyelid or the inferiomedial eyelid. The position of the SPL determines the nerve blocks necessary. To place a superiolateral SPL an auriculopalpebral (motor) and a supraorbital (sensory) nerve block should be performed. To place an inferiomedial SPL an auriculopalpebral and local lower lid nerve block should be performed. The SPL is aseptically placed in the location of choice. After placement of the catheter it is important to check the position of the footplate to ensure that it is correctly placed and tight against the palpebral conjunctiva. The catheter is then sutured to the head making sure that the tubing is never severely bent, which can lead to micropuncture. It is also important that the word MILA (on the catheter tubing) can be seen just outside of the eyelid. This assures us that the position of the footplate has not changed and is especially important when the SPL is placed in the upper lid.

If the footplate slips out of position a corneal ulcer can occur. Another SPL complication is a lid abscess. This usually occurs within a few days of SPL placement. In a retrospective study of 101 horses with SPLs placed, 10% were diagnosed with either a corneal ulceration due to the SPL catheter or a lid abscess¹. The lid swelling associated with an SPL abscess can be quite severe but there is rarely discharge. Standard treatment includes administration of trimethoprim sulfamethoxazole (30 mg/kg PO BID) and application of Surpass cream to the eyelid. Complications associated with the SPL can often be avoided by correct placement of the catheter and proper management. The SPL needs to be thoroughly checked every time medications are given. The word "MILA" should always be easily read outside of the eyelid. The sutures should be intact and there should be no slack in the tubing on the horse's head. When injecting the medication it should flow easily and no leaks should be seen. The injection cap should be wiped with alcohol prior to every injection and the cap should be changed every 3 days to help maintain sterility of the tubing. Administration of medications can be done in two different ways. The first method is to give the medication and then follow the medication with a syringe of air. This method is effective, however, the air injection seems to cause corneal irritation and horses may become anxious about SPL treatment. The second method involves loading the line with a series of medications. After the loading process when a medication is injected into the tubing a different medication is pushed into the eye. This method has been shown to be effective in treating ocular disease² although it is very likely that the medications mix within the tubing.

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Common Diseases

Due to its large size, the equine cornea is especially at risk for corneal ulceration. A standard corneal ulceration should heal within 5-7 days. If healing is prolonged, it is important to determine why the corneal ulcer is not healing in an appropriate time frame. The most common reasons are infection and indolence. Common bacteria associated with corneal infection are Streptococcus and Staphylococcus. Most fungal species, as well as Pseudomonas spp., are known for causing severe corneal malacia in a short period of time. Common fungal organisms responsible for corneal infection are Aspergillus and Fusarium. The rate of fungal infection of corneal ulcers in horses is significantly increased compared to any other species. The equine environment (straw stall, poor ventilation) may be the reason for this. An indolent ulcer can occur in any horse, but has been associated with increased age and Equine Cushing's disease. In this disease process the proteins that normally bind the epithelium to the stroma are absent. Aggressive debridement (diamond burr keratectomy) can help to establish clean epithelial margins and stimulate proper healing. Placement of a contact lens provides comfort as well as encourages normal epithelial-stromal attachments.

Uveitis is inflammation of the uvea (iris, ciliary body, choroid) and can be caused by trauma, infection, or immune-mediated disease. Equine Recurrent Uveitis (ERU) is a disease complex that can have globe and vision threatening consequences (glaucoma, cataracts, retinal detachment). The pathogenesis of ERU has been shown to involve a T-cell-mediated response. This response may or may not be triggered by ocular inflammation, including bacterial infections. The presence of leptospiral organisms has been suggested as a cause of ERU in some areas (California¹, New York², Europe) but in other areas no correlation has been seen (midwestern and southeastern United States). In California horses with ERU had leptospira organisms detected in the aqueous fluid and in New York horses with ERU had increased seropositive horses in comparison to a control group. At the University of Zurich Leptospira organisms were detected in 79% of aqueous and/or vitreous samples from horses with ERU³. In Europe it is common to treat these cases with a pars plana vitrectomy to remove the organisms. In the previously mentioned group of horses, 73% of horses that underwent this procedure had no further episodes of uveitis. However, in the United States the pars plana vitrectomy has not proven to be as successful. One theory is that the disease process has various causes based on geographic location. In the United States, ERU is often treated medically with either topical steroids or topical nonsteroidal anti-inflammatories. In the past decade cyclosporine implants have been routinely used for control of ERU. Implantation of the device decreases the frequency and severity of episodes. A long-term retrospective showed increased uveitis episodes and vision loss after 48 months, suggesting that replacement of the cyclosporine implants at this time may be beneficial⁴.

Squamous cell carcinoma (SCC) is the most common ocular and adnexal neoplasm in horses. This tumor is typically locally invasive but can metastasize to the local lymph nodes. The most common locations are third eyelid, limbus, cornea, and adnexa. Horses with light coat color or areas of hypopigmentation have a higher prevalence of ocular SCC⁵. Limbal squamous cell carcinoma is overrepresented in the Haflinger⁶. Multiple studies have shown that success of treatment is based on size of the lesion. There are many treatment options including surgical excision, cryotherapy, immunotherapy, radiation⁵, chemotherapy^{7,8}, photodynamic therapy (PDT)⁹, and carbon dioxide laser ablation¹⁰. Surgical therapy combined with adjunctive therapy has been shown to lower the recurrence rate. The recurrence rates for surgical excision combined with radiation treatment, carbon dioxide ablation, photodynamic therapy, or Mitomycin C administration have all shown similar recurrence rates (12-22%)^{5,7-10}. Recurrence can be severely delayed so horses should be monitored very closely in the future¹¹.

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Common Medications

Topical medications are commonly used in many equine ocular diseases. There are a wide variety of drugs that are used so it is important to know the purpose of each medication and how each should be used. Ointments are used most frequently because they have a greater contact time than a solution so can be given less frequently. However, if a subpalpebral lavage system is in place then solutions must be used. Medications can also be given via a subconjunctival injection. This is performed when sustained, high concentrations of a medication are necessary. This injection is performed using a 25 or 27 gauge needle within the bulbar conjunctiva. To treat disease of the posterior segment, systemic medications are recommended. The blood-ocular barrier prevents medications from entering the eye, however, inflammation breaks down this barrier and allows penetration of medications. An intraocular injection provides direct delivery of medications into the globe. The consequence of this procedure is the inflammation that is created. An intraocular injection is most commonly performed in cases of an end-stage and painful globe (gentamicin) or the presence of fibrin within the anterior chamber (tissue plasminogen activator). Antimicrobials are probably the group of topical medications with the most variety. Broad-spectrum antimicrobials are most commonly prescribed. These include neomycin polymyxin bacitracin or gramicidin,

and chloramphenicol. Neomycin and polymyxin combinations are a good first line of defense choice for routine corneal ulcerations. Fluoroquinolones (ofloxacin, ciprofloxacin) are also broad spectrum but have weaker gram-positive coverage. For this reason, if gram-positive cocci are seen on cytology we will give cefazolin in addition to a fluoroquinolone. Cefazolin has great efficacy against gram positive cocci. Other medications that have a weaker spectrum but are good for possible Pseudomonas infection are tobramycin and gentamicin. Tetracyclines are used more commonly in large animal species where Chlamydia infections are the primary concern (goats, camelids).

Antifungal medications are a very important group of drugs in our equine patients. The efficacy of each antifungal depends of the species of fungus present and also seems to be influenced by geographic location. The most commonly isolated fungal organisms are Aspergillus and Fusarium. In vitro susceptibility testing of isolates from northeastern United States had a low percentage (27.5%) of isolates susceptible to miconazole¹. However, in vitro susceptibility of isolates from horses with fungal keratomycosis in Florida had a high percentage (77-86%) of organisms susceptible to miconazole². In both studies the fungal isolates were most susceptible to natamycin. Voriconazole is a newer topical azole that has excellent corneal penetration with detectable aqueous concentrations in horses. A recent study of in vitro susceptibility patterns using fungal isolates from the Midwestern and southern United States revealed increased susceptibility of isolates (especially Aspergillus spp.) to voriconazole compared to natamycin³.

Topical steroid medications are ALWAYS contraindicated in the case of corneal ulceration. Administration of topical steroids in the face of ulceration can lead to disastrous complications such as infection. Dexamethasone is the most potent topical steroid and the most common choice in our equine patients. Prednisolone is approximately 6 times less potent and hydrocortisone is approximately 25 times less potent than dexamethasone.

Topical nonsteroidal anti-inflammatory medications are also contraindicated in cases of corneal ulceration. Topical NSAIDs impair epithelialization and can delay healing time. The most commonly used topical NSAIDs are diclofenac and flurbiprofen.

Mydriatic drugs are commonly used in many ophthalmic disease processes. They are used to relieve ciliary spasm, which can be extremely painful, and to prevent posterior synechiae in states of uveitis. Tropicamide has a quick onset (~20 minutes) and short duration of action (4-8 hours). For this reason it is good for diagnostic purposes but a poor choice for therapeutic purposes. Atropine has a longer onset (~1 hour), but a longer duration of action and for that reason it is a good therapeutic choice. In normal horses the effect can last for weeks, however, horses with ocular disease may not respond to twice daily administration. In horses there is a limited variety of medical treatment options for glaucoma. The most commonly used medication is Cosopt. This is a combination of timolol, a beta-blocker, and dorzolamide, a carbonic anhydrase inhibitor. Both of these medications decrease intraocular pressure by reducing the production of aqueous fluid.

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Taking Phone Calls

Fielding calls from owners and referring veterinarians is a vital part of any ophthalmology practice. The first and most important question should determine if the situation is emergent. If the situation is not an emergency a brief history can be taken. If they believe the situation is an emergency it is important to try to determine what the problem is. This sounds simple but can be quite difficult when speaking with an owner or a referring veterinarian with little ophthalmology experience. When talking to a referring veterinarian I usually keep the questions brief and make sure to hit the major points: problem, duration, treatment, and progress. When talking to an owner it can be more difficult to acquire the important information. If another veterinarian has seen their horse I will take their information and ask permission to call them as well. My usual line of questioning for owners is listed below:

1. How long has this particular problem been going on?
2. Has your horse had previous ocular problems that you know of?
3. When looking at your horse from the front, how open is the eye (percentage compared to the other eye)?
4. Is the horse's face wet or is there just some discharge at the corner of the eye?
5. If you can see the cornea can you see any color changes?
 - a. Red-vessels
 - b. Blue-edema
 - c. Yellow-infection
6. Is the horse trying to rub his face?
7. What medications (topically and systemically) have you used?
8. How often are you giving the medications?
9. Has there been any improvement/worsening?

Suggested Resources

Gilger BC, 2011. Equine Ophthalmology. 2nd Ed. Elsevier, Maryland Heights.

Maggs DJ, Miller PE, Ofri R, 2013. Slatter's Fundamentals of Veterinary Ophthalmology. 5th Ed. Elsevier, St. Louis.