Eye Anatomy and Physiology

Part I of a series on equine eye care

By Tracy Williams

The Southeastern United States is considered the worst area for equine eyes in the country – partially attributed to heat, humidity and an abundance of microorganisms that thrive in these conditions. Irrespective of location, the equine eye is prone to problems because of its large surface area and decreased immunity to disease. Every eye injury has the potential to blind the horse; thus they are to be regarded with utmost care by the horse-owner. In order to identify abnormal eyes, you must be comfortable with their normal appearance and function. Thus, to combat eye disease, you must first arm yourself with the basics of anatomy and physiology.

Basic Anatomy

1. Orbit

The orbit is a bony socket that contains the entire eyeball plus the nerves, blood vessels, muscle, fat and connective tissue.

2. Eyelids

The eyelids are divided into three basic components: the skin, a powerful blinking muscle and an inner lining of conjunctiva, which helps to protect the eye and produce tears when needed. In addition, horses have a third eyelid, called the nictitans, which closes horizontally from the inside corner of the eye outwards, protecting the cornea and providing nutrition, vitamins and enzymes to keep the cornea healthy. It is also lined with conjunctiva.

3. Cornea

The cornea consists of four layers. The first layer is outer epithelium, which provides a strong barrier to microorganisms to keep them from entering the deeper eye tissues. The second layer is the stroma, composed mostly of collagen and making up 90 percent of the corneal thickness. The third layer is the Descemet's membrane, a narrow layer (only three red blood cells in thickness) secreted by the endothelium, the fourth layer of the cornea. The endothelium contains a pump which promotes corneal clarity by removing excess water.

4. Anterior Chamber

The anterior chamber, located between the cornea and the iris, is filled with aqueous humor, a clear fluid derived from the blood to help corneal

health.

5. Uvea: a. Iris b. Ciliary Body c. Choroid
The uvea is involved in the production and removal of aqueous humor – the fluid that fills the anterior chamber. It also provides nutrition for the eye and aids the eye's immune response to disease. The uvea consists of three parts: the iris, the ciliary body and the choroid. The iris is the colored portion of the eye, although in horses it is almost always dark-colored. It contracts or dilates the pupil (a hole in the iris) to constrict or heighten the amount of light that is allowed to enter the eye. The ciliary body produces the aqueous humor, and the choroid is the primary blood supply to the retina.

6. Lens
This transparent, gelatinous structure is held in place directly behind the iris by ligaments. By relaxation or contraction, the lens changes its size and thickness to focus on near or faraway objects. The lens focuses the incoming light and projects it to the retina.

7. Vitreous chamber
This large chamber between the lens and retina is filled with a clear, jellylike fluid.

8. Retina
The retina is composed of layers of rods and cones that convert chemical signals to electric signals that are carried to the brain via the optic nerve. Rods are responsible for sight in darkness or dim light, and cones produce color effects. The retina also contains many ganglion cells which allow horses to detect motion from great distances.

The Path of Light

Vision is based on light. Light is reflected off an object, enters the eye and hits the cornea, which helps to focus it. Then the light passes through the aqueous humor and the iris. Depending on the amount, the iris may contract or dilate the pupil to limit or increase the amount of light allowed to enter further into the eye. Once it travels through the pupil, it hits the lens, which changes shape to concentrate on near or faraway objects, and the focused light then beams through the center of the eye, through the vitreous chamber to the retina – its final destination. The light is projected onto the flat, smooth retinal surface – much like an image onto a screen. The chemical light energy is then converted to electric signals by the photoreceptors that layer the retina. The photoreceptors then send the electric signals along nerve fibers to the optic nerve, which transmits them to the brain. The brain receives and interprets the signals, resulting in

vision.

Equine Vision Peculiarities

Because their eyes are uniquely positioned on their heads, horses have a distinctive view of the world. First, they have both monocular and binocular vision. Monocular vision means horses can use one eye independently of the other because their eyes are located on the sides of their heads. This can explain why horses will spook at objects they have seen before if they approach them from another direction; the object, while familiar to the one eye, is a brand new sight for the other eye. Horses also do use binocular vision (both eyes) for objects directly in front of them.

In addition, horses can see almost 360 degrees around them except for one blind spot directly in front of their muzzles and another about six feet directly behind their tail. Thus, it is better to approach a horse from the side rather than directly in front or behind, lest you cause a fit of flightiness.

Thirdly, horses have limited color perception but excellent night vision due to a unique balance of retinal rods and cones. They possess only two types of cones, making them responsive to blue and green light but not to red. However, their well-developed rods allow for excellent vision in the darkness.

In addition, horses have slightly decreased visual acuity, which means they view the world much like a nearsighted person, relying on patterns of behavior and movement rather than details to recognize objects.

Now that you are well-versed in the basics of form and function, you are ready to handle the deviations from normal. Next in our series, we will discuss your mode of action when faced with an equine eye injury.

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