JUNE 2 - 4th, 2024

56TH ANNUAL CONFERENCE

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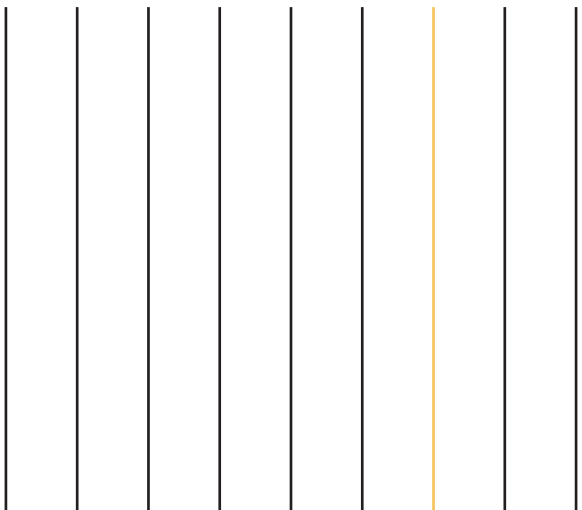

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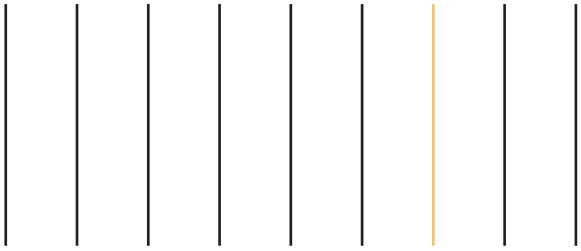
CONFERENCE EVALUATION

Thank you for joining us!

SEEING DIFFERENTLY: ANATOMY & PHYSIOLOGY OF THE EQUINE EYE

ANN DWYER
DVM



EQUINE

1. **SEEING DIFFERENTLY: EQUINE EYE EXAMINATION**

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Understanding the Anatomy of the Equine Eye

1. **The three layers and other items inside the globe can be thought of like a sandwich**
   - Outer layer is connective tissue: sclera and cornea (Think of this tunic as the "Bread")
   - Middle layer is vascular uvea: composed of iris, ciliary body and choroid (Think of this tunic as the "Tomato")
     - Uvea is derived from the Latin term for grape—pigmented, juicy!
   - Inner layer is sensory: retina and optic nerve—the business layer (Think of this tunic as the "Meat")
   - Lens splits the eye into anterior and posterior segments. (Think of as "Lettuce" inside sandwich)
   - Ocular media are wet sources of nourishment and transparent fluid volume that maintains ocular pressure.
2. **There is normally a blood ocular barrier. The interior of the eye is immune privileged.**
   - Lens proteins are not recognized as "self". If discovered by immune surveillance, intense inflammation results
   - Similarly many proteins in the retina are regarded as "foreign" and will incite an immune reaction if accessed by immune monitoring elements
   - Some proteins found in nature (f.g. leptospiral bacterial proteins) mimic molecules found in the eye (f.g. corneal or retinal proteins). If the immune system mounts a reaction to a foreign protein encountered outside the eye, it will "remember" and react to any similar proteins inside the eye if the blood ocular barrier is compromised.
3. **Chambers inside the eye normally hold clear media that are in liquid or gel form.**
   - Every clear substance that light passes through has a refractile influence. Light passes through the tear film, cornea, aqueous humor, lens, and vitreous to reach the retina.
   - The volume of the aqueous is about 3 ml and is normally a clear liquid that is an ultrafiltrate of plasma. The volume of the vitreous is about 26 ml and is normally a clear gel but often liquefies in aging horses or in disease conditions**.**
   - Disruption of blood ocular barrier lets components into these media that do not belong in the eye: ensuing altered clarity of ocular media, or obvious accumulation of cells in the chambers of the eye is proof of a compromised barrier. Manifestations include hyphema (accumulation of RBC), flare, hypopyon (accumulations of WBC), fibrin clots in the anterior chamber, and vitritis or hyalitis (accumulation of cells and debris in the posterior segment).
4. **Cornea:**
   - The equine cornea is the transparent oval window of the outer tunic of the eye. It measures approximately 33-35 mm in horizontal width and 25-28 mm in vertical height.
   - Cross section of the cornea includes the **precorneal tear film** plus several tissue layers: **Epithelium, basement membrane (Bowman's), stroma, basement membrane (Descemet's), endothelium**. All layers add up to a little less than one mm of cross sectional thickness in the non-inflamed eye.
     - The epithelium is thin with only 8-15 layers of cells. It comprises about 15% of the entire thickness of the cornea. The stroma makes up the bulk of the cross-sectional

area, a bit more than 80% of the corneal thickness. The combined thickness of Descemet's membrane and the monolayer of endothelium is very thin, less than 60 microns, or less than 5% of the corneal diameter. Clinicians must judge both the depth of corneal ulcers and the layers affected.

- Healing of non-infected epithelial defects can be *very fast*. The whole corneal epithelium normally turns over in about one week in a healthy eye.
- Healing of stromal defects can be *very slow*. Deep stromal defects may get covered with epithelium but persist as "facets" (depressions) until fibrosis and remodeling is complete. Normally the stroma is made of layers of connective tissue arranged in regular geometric planes that are transparent. Fibrotic areas will have irregular geometry and be opaque. Areas where inflammatory cells or infectious elements have infiltrated within the layers will be opaque.
- The endothelium is responsible for normal cornea transparency, as activity of the Na+/ K+ ATPase pump across this deep boundary layer of cells keeps the corneal stroma relatively dehydrated by pulling water out of the cornea and into the aqueous. This action can be likened to that of the defroster of a car windshield. If the endothelium decompensates or is damaged, the cornea will "steam up" in the compromised area. Endothelial cell density in this monolayer decreases with age, so geriatric animals are more susceptible to developing endotheliitis or endothelial dysfunction.
- A normal cornea is avascular but contains many nerve fibers that trigger pain if exposed. Nerve fibers are most abundant in the upper stromal layers and near the limbus. Corneas undergoing inflammatory processes often become vascularized with new vessels growing in towards the axis from the limbus. Vessel pattern geography gives a clue as to the location of the insult that triggered angiogenesis.

5. **Uvea: Iris**
    - The iris has no epithelium on the anterior face—heavily pigmented stroma and abundant blood vessels are readily visible. The posterior iris has TWO layers of epithelium.
    - The walls of uveal blood vessels are normally sealed by tight junctions between component cells. In addition there are active mechanisms that "police" vessel boundary activity to maintain the blood ocular barrier. With inflammation (uveitis) the uveal blood vessels become congested and the tight junctions are compromised. The vessels become LEAKY. Red blood cells, white blood cells inflammatory cytokines and other plasma components then enter the ocular tissues and media.
    - An inflamed iris is a "sticky" tissue. Iridal tissue can adhere to other parts of the eye like a weld. Most commonly the tissue sticks in a posterior direction to form posterior synechia between the posterior iris epithelium and the lens. Occasionally iris tissue migrates forward and forms anterior synechia between the iris stroma and the corneal endothelium.
        - When used to treat inflammation, atropine not only pulls the iris out of harm's way by dilating the pupil but also reduces the "leakiness" of the blood ocular barrier, and lessens ocular pain by blocking ciliary spasm.
    - If iris tissue prolapses out a hole in the cornea it looks like focal granulation tissue—more red than brown. In some cases this may effectively seal a leaking globe, but in other cases it is part of a complete endophthalmitis that will necessitate enucleation or globe compromise that will require advanced surgery.
6. **Uvea: Ciliary Body**
    - The ciliary body (CB) is one of the biggest multitaskers in the body!
        - It actively produces aqueous humor and filters plasma from circulating plasma, acting as a continuous "soaker hose" to inflate the anterior chamber

    - It is bordered anteriorly by the ciliary cleft and trabecular meshwork, and thus is adjacent to the region that is responsible for the outflow drainage of aqueous out of the eye
    - If inflamed, it acts as a regional immune surveillance site, harboring clusters of infiltrating lymphocytes that organize into a follicular pattern
    - It suspends the lens with zonular fibers arranged like the springs in a trampoline
    - The CB musculature pulls on the zonular fibers in response to visual stimuli, altering the lens curvature and resultant refractile properties. This process is called accommodation. It is more pronounced in primates and many carnivores than in horses.
- When the CB is inflamed all these functions are affected
    - Aqueous production decreases
    - Infiltrating lymphocytes form organized clusters that function as regional "nodes" for expansion of inflammatory activity
    - The lens may subluxate or fall down completely
    - Altered CB function can result in a globe that has too little fluid (hypotony from reduced production) or too much fluid (glaucoma from a drainage angle that is clogged with inflammatory debris, blocking aqueous outflow)
- In end stage ocular disease the CB stops functioning. The eye then deflates and becomes atrophied and scarred, a condition called "phthisis bulbi".

7. Uvea: Choroid

- A tremendous blood flow occurs through the network of choroidal vessels. The layer of wide choroidal vessels that appose the sclera (visible as red diagonal stripes on the fundus of a globe with sparse pigment in the non-tapetal region) is adjacent to an inner complex of capillary sized vessels, the choriocapillaris.
- The choroid in the horse is responsible for supplying nutrition to the entire retina, except the immediate peripapillary area. Disruption of the blood ocular barrier can result in exposure of retinal antigens to immune surveillance and leakage of blood between the choroid and the retina.
- When the blood ocular barrier is compromised, infiltrating WBC gain access to resident intraocular antigens. Some of the most reactive antigens are found within the retinal pigmented epithelium (RPE), the retinal layer adjacent to the choroid

8. Lens

- Normally the lens is a clear disc that is oriented in a vertical plane and held up by the zonular fibers, like a trampoline that is resting on its edge.
    - The lens can also be compared to a disc shaped candy (M & M or Junior Mint). The outer coating is similar to the lens capsule and the inner sweet is analogous to the cortex.
- The lens is nourished by the aqueous humor. The lens is transparent because it is maintained in a dehydrated state by the metabolic activity of the lens epithelial cells.
    - If enzymatic activity or lens metabolism is altered, a cataract ensues and the lens loses transparency.
- A lens that is diseased manifests as one or two problems: loss of position (luxation) or loss of transparency (cataract).
    - Intraocular inflammation can cause both conditions as the supporting zonular fibers fail if the ciliary body is compromised, and the metabolic and enzymatic activity of the epithelial cells of the lens is affected by inflammatory activity in the aqueous.

- Lens cortical proteins are autoantigens that cause intense immune reaction and may further cause cataractogenesis if exposed to intraocular WBC.

9. Neurosensory retina

- The retina is adherent to the outer layers of the eye in only two places: a boundary ring around the margin of the optic disc and a boundary ring "behind" the ciliary body.
  - Disruption of the blood ocular barrier can result in leakage of fluid between the loose plane that separates the choroid and the retina, causing retinal detachment and vision loss.
- The retinal layer called the retinal pigmented epithelium (RPE) contains abundant quantities of autoantigens, notably such molecules as IRBP, S antigen and CRALBP.
  - Lymphocytes that are found inside the eye of horses with uveitis mount intense responses to these antigens. This activity contributes to retinal degeneration and vision loss in ERU.
  - Retinal detachments are a common blinding sequellae of end stage uveitis. The RPE is the "cleavage layer" for detachment.
- Visual signals from the retinal photoreceptor cells are relayed towards the brain by a large population of retinal ganglion cells that comprise the nerve fiber layer of the retina.
  - Increased IOP in glaucoma causes interruption of axoplasmic flow in the optic nerve. This interruption eventually causes RGC death and vision loss. ERU is the primary risk factor for development of glaucoma.

Instrumentation to examine the equine eye

A direct ophthalmoscope can be used in general practice to examine the equine eye. The 3.5V coaxial direct ophthalmoscope head made by Welch Allyn is the most common model. A 3.5 V Halogen fiber-optic Finnoff transilluminator is recommended as a bright light source. It costs less than $150 from Welch Allyn. It can be ordered with a removable cobalt blue filter. The transilluminator attaches to the handle of the direct ophthalmoscope and is used to illuminate the periocular region and corneal surface as well as the interior of the eye. The transilluminator is very useful for quickly accessing a magnified view of the fundus of the eye that is similar to that seen with the direct scope head. Another handy item is an Optivisor®, a simple headband magnifying head loupe that provides reasonable magnification of ocular detail; available through online distributors for about $50. A tonometer is a handheld instrument used to measure intraocular pressure. Two models are available: the Tonopen (made by reichart.com) and the Tonovet (sold through icare.com) The Tonopen measures IOP through applanation, the force required to flatten the ocular surface as the instrument is hand-tapped on the ocular surface. The Tonovet measures rebound force when a disposable sterile probe is gently propelled on and off the corneal surface; this instrument requires no topical anesthetic and is the most practical choice for field exams. Each of these instruments costs around $4000. Practitioners with a special interest in ophthalmology will want to invest in a hand held portable slit lamp. Hand held slit lamps provide excellent magnification of surface and intraocular detail.

Ocular examination process

An ocular examination starts with an unsedated general assessment of the whole animal, with particular care paid to body condition, general "bloom", neurologic status, skin lesions and any clues of systemic disease that might accompany or influence ocular issues. The examination then moves to the head and periorbit. Skull symmetry, sinus anatomy, ocular position, and gaze of both eyes are assessed. A basic assessment of cranial nerve function is performed. Pupils are inspected and compared, and a bright light source is used to test dazzle and papillary light responses. Mildly threatening hand motions are used to assess menace responses of both eyes. The skin around the eyes is inspected closely for masses,

alopecia, swelling or inflammation. Blepharitis, tearing and excessive nasal discharge is noted. The angle of the lashes on both upper eyelids is compared, as a drooping of one side may indicate ocular pain. The conjunctiva and third eyelids are inspected for color, masses and inflammation.

The examination then moves to the globe. Many horses need no sedation, but some must be sedated for thorough globe inspection, and may require regional anesthesia of the auriculopalpebral nerve to block blepharospasm. This author uses xylazine as a sedative for ocular examination of nervous patients. Detomidine is used if the horse is extremely painful or requires deep corneal debridement and/or insertion of an SPL system. Thorough globe examination is aided by pupil dilation. This is achieved by instilling 0.5 ml of tropicamide drops onto the ocular surface. A normal pupil takes about 20 minutes to dilate; this time delay should be factored into the examination plan. The pupil function will return within a few hours.

The globe examination begins with a bright light source (transilluminator or slit lamp set on "spotlight" setting at one of the lowest illumination levels). All elements of the three-dimensional globe should be examined in a logical and systematic fashion with the operator consciously thinking about the anatomic region (i.e. "cornea", "anterior chamber", "iris", "lens") in sequence. When an abnormal finding is noted, the operator should localize it in terms of its geography on the anatomical region (f.g. "axial", "paralimbal", "equatorial", etc) and its depth on the parent structure (f.g. "anterior", "subepithelial", "subcapsular", "posterior", "mid stromal", etc) and be prepared to record the pertinent findings in a similar fashion in the medical record, taking care to include a thorough description of the character and size of the lesion(s). If a slit lamp is available, a narrow beam of light is used to systematically scan "slices" of the anterior segment, looking for cellular infiltrates in the tissue or ocular media, and assessing tissue areas that are swollen, thin or edematous, characterizing any abnormal infiltrates or masses from a three- dimensional perspective. The surface of the iris is inspected, as is the drainage angle behind the limbus. The lens is illuminated to look for cataracts or displacement.

An assessment of the posterior segment follows. Many practitioners will use a direct ophthalmoscope or transilluminator held close to their cheekbone for this purpose. The video setting on a cell phone camera can also be used to evaluate the posterior segment if the flash is dimmed by placing a small piece of elasticon tape over the light to dim the intense illumination of the light source. The bulk of observable pathology is located in the peripapillary region, and all these methods are acceptable techniques for field purposes. Some clinicians also incorporate indirect ophthalmoscopy using a Finnhoff transilluminator and handheld lens to expand the observable geography of the interior of the eye. Specialists may inspect the fundus using a hand lens that is illuminated by an indirect ophthalmoscope mounted on a headband.

Measurement of intraocular pressure with a hand held tonometer can be done before or after the ocular examination. Horses that present with ocular surface abnormalities or signs of ocular pain also undergo other diagnostic tests such as staining the tear film with fluorescein dye.

References/Suggested Reading

1. Brooks, D. *Ophthalmology for the Equine Practitioner, 2nd ed*. Jackson, Wyoming, Teton NewMedia, 2009.
2. Cutler T. Ophthalmic findings in the geriatric horse. *Vet Clin N Am Equine Pract* 2002: 18 (3): 545-574.

3. Czerwinski SL, Brooks DE. How to diagnose and treat common ophthalmic diseases in the neonatal foal. *Am Assoc Eq Pract Proc* 2014; 60: 26-31.
4. Dwyer, AE. Ophthalmology in equine practice. *Vet Clin N Am Equine Pract* 2011; 28 (1): 155-174.
5. Dwyer, AE. How to take digital photographs of equine eyes in practice. *Proceedings* Am Assoc Equine Pract 2010;56: 228-237.
6. Gilger, BC (ed.) *Equine Ophthalmology*, 4th Ed. Hoboken, NJ, Wiley Blackwell, 2022.
7. Seruca, C and Lowe, R. Equine Ophthalmic Examination: Routine Diagnostic Techniques. Equine Veterinary Education 2016;28:8: 455-468.

EQUINE OPHTHALMOLOGY FOR ROAD WARRIORS

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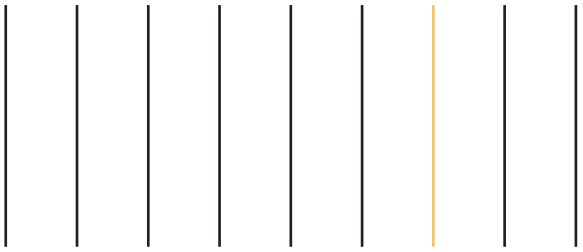

EQUINE

2. ROAD WARRIOR OPHTHALMOLOGY PRACTICE TIPS

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A. **Stallside Diagnostic Tests** may include tonometry, Schirmer tear testing (STT), fluorescein and rose Bengal ocular surface dye tests, corneal culture and cytology. In some cases, blood may be drawn for serologic or other analysis.

Tonometry is used to measure intraocular pressure. The author uses a rebound tonometer (Tonovet-Plus, https://tonovet.com/products/icare-vet/ cost @$4000). Although the soft tapping pressure of the instrument tip on the cornea is tolerated without topical anesthesia, most horses are not very cooperative about having a piece of equipment the size of a small hammer very close to their globes. The normal IOP of a mature horse ranges between 10-30mm Hg. This author prefers to perform tonometry on patients who have been given light sedation (150-200 mg of xylazine, IV). Results are most consistent when the horse head is supported on a bale table in a normal resting position, and the upper eyelid motion is stopped by the use of an auriculopalpebral eyelid block.

Schirmer Tear Testing is used to quantify the volume of tear production. Fold the paper strip at the notch and then insert the notched end over the lower eyelid. Record how fast the strip is wet at 15, 30 and 60 seconds by the capillary wicking action of the paper strip, which has a metric ruler calibrated in millimeters. Normal tear production in horses is copious. Healthy horses have been reported to have a range of >30 mm of wetting in one minute and 15-20 mm in 30 seconds.

Fluorescein Dye testing is used to assess integrity of the corneal epithelium, find defects that expose Descemet's membrane, check for leakage of aqueous humor from the anterior chamber, test the patency of the nasolacrimal system, and assess tear film breakup time. Any area of the cornea that is devoid of epithelium will stain bright green as dye adheres to exposed stroma. Any corneal defect that is deep enough to expose Descemet's membrane will appear dark as dye does not adhere to this acellular membrane. Subtle lesions are best viewed through a cobalt filter blue light. Welch Allyn makes a cobalt blue filter that slips over the halogen lamp of a Finnoff transilluminator. (Part # 41102). https://www.welchallyn.com/en/products/categories/physical-exam/nose-and-throat-exam/illuminators/3-5-v-halogen-fiber-optic-transilluminators/parts-and-accessories.html

The orange end of the paper fluorescein dye strip can be applied to the bulbar conjunctiva as this will allow dye to merge with the tear film where it will turn green. Alternatively the orange end of the strip can be torn off, and put inside a 3 ml syringe and mixed with a small volume of sterile saline. The dyed saline is then sprayed on the ocular surface through the hub of a broken off 25-gauge needle.

Rose Bengal Dye testing is used to assess the mucin layer of the tear film. The red RB dye is irritating, so the paper strip should be torn off, put inside a 3 ml syringe and mixed with a few mls of sterile saline. The dyed saline is then sprayed on the ocular surface through the hub of a broken off needle attached to the syringe. Areas with abnormal tear film will stain a rosy pink pattern, which is often stippled or irregular. Corneas that have positive RB staining characteristics are suspect for keratoconjunctivitis sicca or for surface fungal colonization, but it should be noted that faint RB staining can be seen in many normal horses, particularly if they have just had a windy trailer ride or exercise session.

Cultures of corneal ulcers should be taken prior to cytology sampling. It is best to sample a cornea that has not been treated with topical anesthetic, but sometimes this is not possible due to patient

resistance. Calcium alginate swabs are preferable to other sampling devices. http://www.capitolscientific.com/Puritan-25-801-A-50-Pur-Wraps-Calgiswab-Sterile-Calcium-Alginate-Tipped-Urethro-Genital-Applicato The swab can be submitted to a diagnostic laboratory for analysis. Alternatively, a sample for in house analysis can be taken by scraping a small portion of diseased/disrupted cornea with the sterile blunt end of a scalpel blade. The blade can then either (a) be used to directly apply the contents to bacterial culture plates by making a series of small "C" shaped carvings into the growth agar, or (b) be dropped in sterile fashion into a tube of thioglycollate broth and placed in an incubator at 38 degrees C. If the broth becomes turbulent, the resultant growth can be plated out onto agar plates for identification and antimicrobial sensitivity analysis.

Corneal cytology is a recommended diagnostic test for all significant corneal ulcers and also for suspect neoplastic lesions. The sampling procedure is a simple skill that all equine practitioners should master. The horse should be sedated, and the mandible should be supported by a bale table. If the horse has severe blepharospasm or is uncooperative, an auriculopalpebral nerve block should be performed. About 0.5 ml of topical anesthetic (Proparicaine® or Tetracaine®) is applied to the corneal surface through the hub of a broken off 25-gauge needle attached to a small syringe. The blunt end of a scalpel blade (any standard size except #22 as the width of this size blade is not optimal) is applied at a 45 degree angle to the target lesion, with the operator using the foil wrapper of the scalpel blade to hold the blade in a sterile fashion and cover the sharp end. A firm scraping motion is used to dislodge cellular material from the corneal surface. The material is transferred from the blade edge to the dry surface of two glass microscope slides. The scraping process is repeated several times and the slides are inspected to make sure that several areas of visible material that is at least 0.5-1 mm in diameter is observed. The slides are placed in a slotted plastic slide box http://www.heathrowscientific.com/catalog/product?deptId=MICROSCOPY+SUPPLIES&prodId=15982 and allowed to air dry. After the slides are dried one is stained with DIFF-QUIK stain. If analysis of the Diff-Quik stain reveals an abundant population of bacteria, the other slide is gram stained to see if the bacteria are gram negative or gram positive. Clinicians are urged to gain comfort with interpretation of corneal cytology—the skills needed for most cases are simple and rapid access to this diagnostic information will provide key information for effective therapeutic decision-making. A sample from a normal cornea should contain nothing but epithelial cells, easily recognizable by their resemblance to fried eggs, and mosaic arrangement. Cytology analysis of a sample from an inflamed or ulcerated cornea should ask three questions:

(1) Are inflammatory cells present? If so, what kind of cells are there neutrophils, bands, eosinophils, or mast cells on the slide?
(2) Are infectious agents (bacteria or fungi) present? If so, what are the staining and morphologic features?
(3) Are there any foreign bodies or other non-cellular elements present? (plant material, crystals of calcium, parasites, etc.)

B. Subpalpebral Lavage systems (SPLs)

SPLs are commercial devices for delivery of topical liquid medication to the ocular surface in patients who have serious ocular disease or severe pain. These devices can be placed on horses at their home stable or in the clinic, and medication can be administered as often as needed by the owner or a hospital technician. SPL placement requires heavy sedation, topical and local anesthesia of the eyelid where the trochar is placed, and an auriculopalpebral block to induce short term paralysis of the upper eyelid. The system tubing is fixed to the face with one or more sewn on patches of tape, then woven through the patient's braided mane to a site close to the withers. An injection port is fashioned from a male catheter cap, tongue depressor, and adhesive tape and secured to a braid of mane. Medications are administered as needed through the catheter cap. Some clinicians administer medications "one at a time", injecting 01.-0.2 ml of drug into the cap, then flushing the drug onto the ocular surface with a

small bolus of air. Others have had success "stacking" medications in the tube, loading the tubing from exterior port to interior eyelid discharge opening with sequential medication in dose and type that reflect the prescribed treatment schedule. Clinicians who use the latter "stacking" method then achieve topical distribution of the medications onto the ocular surface with timed administration of small boluses of air to dispel the series of drugs that are adjacent to the cornea in small quantities, allowing a few minutes for each medication to mix with the tear film before applying the next bolus of air.

SPL systems can be used to treat an ocular problem for a month or more. If the tubing develops a leak or a break, it can easily be repaired by cutting the tubing near the damaged section so it has a clean lumen, then threading a 20 G, 1 ¼ inch catheter into each end of the open tubing, and securing the repaired tubing ends with adhesive tape. SPL systems are easily removed by trimming the tubing close to the face and pushing the tubing that penetrates the eyelid skin into the conjunctival sac using the cut end. The small remnant can then easily be retrieved from the inner eyelid region with a gloved finger. Specific instructions for insertion, management, repair, and removal of SPL systems are in reference #5 below.

C. Stallside Ocular Imaging for Road Warriors

Ultrasound of the globe, orbit and periorbit can be performed with standard machines that ambulatory clinicians use for reproductive or musculoskeletal evaluation. Ultrasound is appropriate for cases where the clinician is trying to check for orbital fractures, assess tissue density in a swollen eyelid to check for abscesses, or assess globe size in cases of exophthalmos or suspected orbital tumors. It is also useful for inspecting the anatomy inside the globe to look for evidence of cataract, lens luxation, intraocular masses, or retinal detachment. The author favors the use of a 7.5 mHz curvilinear probe for most ocular imaging, but also uses a 5.0 mHz linear probe for assessment of tissue behind the globe. A transpalpebral approach is suitable for most ambulatory cases. The author always performs ocular ultrasound with the horse's head supported by a bale table as this practice simplifies restraint. Images can be captured on a jump drive, photographed directly from the machine screen, or saved on the machine internal software. Clinicians should be aware that many referral institutions have access to **high frequency ultrasound machines** that can obtain very high detail of ocular structures. Certain cases may benefit from referral for this procedure.

D. Digital photography.

The advent of high quality, inexpensive compact digital cameras has brought the capability of high quality field imaging within the range of all practitioners. A few tips for great ocular photography:

- The most important concept is an understanding of the **autofocus system**. If the camera is set on the PROGRAM (P = automatic) setting with the MACRO option (flower icon) selected, the autofocus will be optimized for taking pictures of objects that are 12-20 cm away from the lens. This autofocus system is engaged when the shutter button of the camera is pushed half way down. This action causes an infrared beam to be emitted from the camera. This beam bounces off of the object that is in the center of the camera viewfinder and is "read" by a computer inside the camera. The processor then adjusts the lenses and the light aperture for optimum imaging of the object in the center of the viewfinder. It signals the operator that it is focusing on the area of interest by projecting a bracketed outline on the viewfinder. <u>If the camera shutter is depressed fully after the autofocus is engaged, and the distance from the camera lens to the eye has not changed at all, the image will be in sharp focus.</u>
    - Experimentation with a given camera model will demonstrate the optimum focal distance for imaging the eye. The autofocus will NOT engage if the camera is held too

close to the eye. The operator will know this because the bracket will not appear on the viewfinder.

- Horses become restless if too much time is spent "setting up" an image, so the best practice is to take several images in rapid sequence, making sure the autofocus is operating for each one. The operator can then review the images on the viewfinder and decide if the quality is acceptable. If necessary, shots can be repeated, or slightly different angles can be taken to image the area of interest.
- Photographs will be of the highest quality if they are taken indoors in a dark area with a flash. The operator must be aware of background and foreground detail that may impair quality—the corneal surface is glossy and reflective and it will pick up windows or other reflections that are present behind the operator.

The digital zoom feature should NOT be used when the picture is taken. However, the digital zoom feature is very useful to use AFTER the image is obtained to demonstrate lesions to the owner on the camera LED screen. The clinician can use the camera "review" feature to scroll through the images on the screen on the back of the camera, selecting the best ones. Then the digital zoom and positional buttons can be used to center and enlarge the area of interest to fill up the screen. Owners can then look at the lesions in a magnified view. Showing the problem to the owner on the camera LED screen (or cellphone screen) is a VERY important part of the treatment plan. It is hard for most owners to "see" lesions on the live horse, but it is easy for them to appreciate pathology on a camera screen. Treatment compliance and acceptance of the expense and effort involved in handling a tough problem will be enhanced by the stallside review of images.

Images obtained in the field should be downloaded to a viewing computer at the end of the day. The images will have superfluous detail of the animal's head that will need to be cropped with editing software. This task is easily performed with a variety of software programs (Apple iPhoto, Aperture, Microsoft Photo Editor, Adobe Photoshop). The detailed, magnified images can then be transferred to the medical record and/or emailed to the owner.

Modern smartphones have evolved to contain high quality cameras. These devices have great features that allow the fundus to be photographed through a dilated pupil; the procedure is well described in the reference by Dr. Dennis Brooks at the end of this paper, and further tips for cell phone fundic photography can be found at this website: https://www.facebook.com/equineeyeclinic/

Patience is required to master this technique but it can be very rewarding to capture images of fundic abnormalities.

In some situations, cell phones can also be used to take good photos of the ocular surface or anterior segment. However, the author has found that the images that are acquired with a digital camera are usually superior to those from a cell phone because one hand of the operator can be used to steady the digital camera and operate the shutter while the other hand holds the eyelids of the horse open. This sequence, which is not practical with the cell phone shutter operation, tends to produce superior images that are in very sharp focus. Moreover, the "autofocus" feature of cell phones may select the level of the tapetum inside the eye as a focal point rather than the ocular surface, and if this happens the image of the external globe will be out of focus.

Progressive photography of lesions that are being treated or followed is important. Assessing progress (or worsening) of a lesion is difficult when the operator is relying on memory for judgment, but is straightforward when sequential images are compared side by side.

E. Medical Record of Equine Eye Examinations

An examination is never complete without a **medical record:** findings that detail various regions of the cornea and globe should be recorded. Many clinicians use pre-made outline drawings of the cornea, iris/pupil, lens and fundus as templates on which to depict findings. Drawing can be supplemented with written detail. Reviewing ocular photographs will aid the description process for complicated findings A few tips:

- A STT strip makes a handy ruler to measure findings
- For reference, the average width of the equine palpebral fissure is about 40 mm and the width of the cornea is about 32-35 mm from 9:00 to 3:00. The height of the cornea is about 25-27 mm from 6:00 to 12:00.
- Any ocular region that is circular or ovoid (iris, cornea, optic disc, observable fundus) can be related to a clock face where findings can be compared to their "clock hour" position. Findings can also be related to a point of reference like the optic disc (f.g."the fundic lesion is located ½ disc diameter away from the 4:00 border of the optic nerve and occupies a region that is ¼ disc diameter in width") .
- A few vocabulary words reflect common anatomic descriptions: "**Axial**" describes a line bisecting the center of the cornea and the rear of the globe. "**Limbal**" describes the intersection between the cornea and sclera. "**Temporal**" describes the "outside" of the eye (what might be thought of as "lateral"). "**Nasal**" describes the "inside" (often also called "medial") . Although many clinicians refer to the "top" of the eye as dorsal and the bottom as "ventral", the most correct terms are **"Superior**" and "**Inferior**". The lens has a "**capsule**" that acts an outer skin and a "**cortex**" (everything inside the capsule, but thought of in terms of anterior and posterior regions). It also has an "**equator**" which is a term that describes the outer thin edge of the vertical disc shaped structure which is usually covered by iris.
- Terminology for areas of altered color or appearance on the cornea, lens or fundus may be quite descriptive. Examples of words used to describe the shape of ocular findings include: geographic, **floriform, stellate, focal, pinpoint, speck like, vermiform, serpiginous, dendritiform, staghorn, geographic, elliptic** and **corraliform**. Examples of terms that may be used to describe the character of an ocular opacity found within a normally transparent structure include **lacy, steamy, stippled, smokelike, opalescent**. Ophthalmic medical record detail will bring out your inner creative writer!

a. Conditions common to various equine lifestages:

Practitioners should be alert to detecting the following conditions as they examine horses through the stages of their lives:

Neonatal congenital conditions: present at birth

- Microphthalmos
- Lacrimal puncta agenesis or duct atresia
- Congenital strabismus
- Dermoids
- Aniridia
- PPMs (persistant papillary membrances)
- Anterior segment dysgenesis (may not be noticed till maturity)
- Congenital cataracts
- Coloboma
- Persistant hyaloid artery
- Congenital glaucoma or retinal detachment (rare)

Neonatal acquired conditions: follow birth process or develop in the first few days of life

- Entropion (be vigilant for this in sick foals)
- Subconjunctival hemorrhage
- Retinal hemorrhage
- Uveitis secondary to septicemia
- Jaundice secondary to neonatal isoerythrolysis (scleral icterus)
- Various manifestations of HIE (hypoxic ischemic encephalopathy)
- Ulcers: Uncomplicated, melting, infected, or persistent erosions
- Secondary manifestations of adenovirus, botulism

Pediatric conditions that are found in sucklings or weanlings

- Blunt head trauma—concussive during pasture roughhousing or training accidents—can cause acute blindness
- Blunt globe trauma—as above
- Sharp facial or lid trauma
- Uveitis secondary to R. Equi or strangles
- Corneal ulcers
- Vitiligo

Mature horse conditions that commonly occur during adulthood

- Trauma: blunt and sharp
- Corneal ulcers
- Uveitis
- Squamous cell carcinoma
- Sarcoid

Geriatric horses conditions often found in aged patients

- Sinus disease with ocular manifestations
- Periocular neoplasia
- Indolent ulcers
- Cataract
- Glaucoma
- Insidious uveitis
- Vitreal syneresis
- Asteroid hyalosis/synchesis scintillans
- Senile retinopathy
- Proliferative optic neuropathy

References/Suggested Reading

1. Barnett, KC et al. *Color Atlas and Text of Equine Ophthalmology, 2nd edition* London, Mosby-Wolfe, 2004.
2. Brooks, D. *Ophthalmology for the Equine Practitioner, 2nd ed*. Jackson, Wyoming, Teton NewMedia, 2009. Excellent reference for the ambulatory vehicle, "plasticized" pages and strong binding make it a rugged addition on the road. Acompanying CD with extra images and video.
3. Brooks, D. How to use a Smartphone Camera for Ocular Photography in the Horse. *Proceedings Am Assoc Equine Practitioners*; 60; 1-6. 2014.
4. Dwyer, AE. How to take digital photographs of equine eyes in practice. *Proceedings* Am Assoc Equine Practitioners; 56: 228-237, 2010.
5. Dwyer, AE. How to insert and manage a subpalpebral lavage tube. In *Proceedings Am Assoc Equine Pract* ;59: 164-173, 2013.

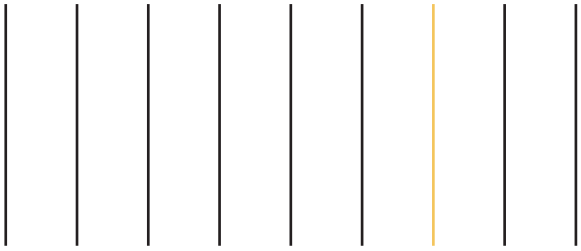
6. Dwyer, AE. Practical field ophthalmology. In: Gilger, B, (ed.) *Equine Ophthalmology, 3rd ed*. Ames, Wiley Blackwell, 72-111, 2017.
7. Dwyer, AE. Ophthalmology in equine ambulatory practice. p. 155-174. In: Ramey, D. and Baus, M. (ed.) *Ambulatory Practice.* Veterinary Clinics of North America, Equine Practice, 26, 1, Philadelphia, Elsevier, 2012.
8. Dwyer, AE. How to obtain and interpret corneal cytology samples. *Proceedings* Am Assoc Equine Practitioners; 63: 154-166, 2017.
9. Dwyer, AE and Henriksen, MDL. Equine ocular examination and treatment techniques. In Gilger, BC (ed.) *Equine Ophthalmology*, 4th Ed. Hoboken, NJ, Wiley Blackwell, 2022.
10. Henrikson, MDL. How to perform standing surgery of the equine periocular region in the field. *Proceedings* Am Assoc Equine Practitioners; 63: 139-153, 2017.
11. Seruca, C and Lowe, R. Equine Ophthalmic Examination: Routine Diagnostic Techniques. Equine Veterinary Education 2016;28:8: 455-468.

Resources for clinicians with a special interest in equine ophthalmology:

http://www.equineophtho.org/ Website for the International Equine Ophthalmology Consortium, an international professional organization that welcomes practitioner members. The group stages one meeting per year, early in June. The meeting alternates between a site in North America and a site in another continent.
http://www.wiley.com/WileyCDA/WileyTitle/productCd-VOP2.html Website for Veterinary Ophthalmology, the journal that is devoted to research on animal eye issues. The journal is now published online and a subscription purchase permits access to previous issues.
https://www.facebook.com/equineeyeclinic/ Facebook page with excellent, practical advice on ocular photography of equine eyes, including cell "Phoneoscopy" of the fundus.

EVERYTHING IS RELATIVE: THE EQUINE ORBIT & ADNEXA

ANN DWYER
DVM



EQUINE

3. EVERYTHING IS RELATIVE: PROBLEMS OF THE EQUINE ORBIT AND ADNEXA

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A. Orbit and Periorbit. The most common problems seen in the periorbital region involve trauma.

Chronic **facial deformity reflecting past trauma** is often encountered in mature horses in the form of dents or abnormal contour of the facial bones, especially in the sinus region. Practitioners must be alert to any acute facial deformity that could indicate recent fractures of the frontal, temporal or zygomatic bones, sequestra formation or local abscessation in the soft tissue, or the conchofrontal or caudal maxillary sinuses that border the orbit. Foreign body, abscess or fracture detection may require imaging with ultrasound, radiology, computed tomography or MRI. Occasionally sinus or orbital trauma will compress the extraocular muscles and other soft tissue structures around the globe, causing strabismus (deviant direction of gaze) and altered globe position/mobility.

Horses with acute **sinus fractures or sinus infections** secondary to trauma or dental disease are at risk for **orbital cellulitis.** Sinus fracture cases require aggressive antibiotic therapy for several weeks and/or sinus trephination and lavage. Horses with infections secondary to dental disease may require tooth extraction and/or sinus surgery. Horses with impaired eyelid function secondary to periorbital **oculomotor (CN VII) nerve trauma** are at risk for corneal ulceration secondary to exposure keratitis. They require frequent applications of topical lubricants and may need to have the corneal surface protected with a temporary tarsorrhaphy while nerve function is impaired. Horses that have sustained head trauma with **hyphema** where more than half of the anterior chamber is filled with blood have a guarded prognosis. If bleeding recurs the eye has a poor prognosis and may become phthisical. Horses that show any restriction or deviation in eye position or movement following blunt trauma are candidates for referral. Horses that have sustained enough trauma to the head to cause optic neuropathy may lose vision in the affected eye.

Horses may present with focal hard, non-painful enlargements of the skull in the periorbital region. Radiology will reveal that such masses develop along the suture lines where the facial bones knit together during development. This is a benign condition called **suture line periostitis** that requires no treatment, and the enlargements will usually reduce in size or disappear over a period of months.

Horses occasionally present with exophthalmos caused by **orbital tumors** or masses. Exophthalmos can be easily differentiated from buphthalmos by measuring globe diameter with transpalpebral ultrasound using a 5.0 or 7.5 MHz probe. Ultrasound of the orbit can also give an indication of the consistency and dimensions of any abnormal tissue behind the globe. The most common tumors that have been reported in the orbit are neuroendocrine tumors and extra-adrenal paraganglioma. Other neoplastic conditions that have been reported in the orbit include squamous cell carcinoma, anaplastic sarcoma, and lymphosarcoma. Rare reports of malignant rhabdoid neoplasia, fibroma, angiosarcoma, adenocarcinoma and juvenile neuroectodermal tumor exist. While some cases of orbital neoplasia are solitary, others can spread to, or originate from, other regions within the skull, including the sinuses, periorbital tissues and pharynx. Imaging of these areas with endoscopy and computed tomography is encouraged prior to surgery for prognostic reasons. Practitioners who attempt enucleation of horses with presumptive orbital tumors should be advised that hemorrhage during removal of orbital neoplasia

may be excessive, particularly if the tumor is an extra-adrenal paraganglioma. Patients undergoing enucleation of such a tumor are at risk of fatal intra-operative hemorrhage.

B. Eyelids and adnexa. The most common problems seen in the eyelid region involve trauma, allergy and neoplasia. Facial nerve paralysis, while uncommon, is a serious problem as it is associated with a loss of the capacity to blink.

Eyelid margin tears commonly occur when stabled horses rub their heads on prong like objects and avulse the eyelid margin. The incidence of eyelid trauma can be greatly reduced if owners tape up the J shaped bases of the handles of stall buckets. Repair of eyelid lacerations in the field will be facilitated if a "surgery table" is constructed for head support using stacked bales of hay or shavings. A bright LED headlight or tripod halogen light positioned near the patient will aid visualization. Practice tips for effective closure include cleansing the wound with liberal application of 2% Betadine solution, minimal sharp debridement with a small pair of Metzenbaum scissors, and closure of the subcutaneous tissues with knots that are buried and placed sparingly. Precise apposition of the torn tarsal margin is critical and should be achieved with careful placement of a figure of eight suture that does not penetrate the conjunctiva or have tags that rub on the cornea. The author obtains excellent cosmetic results with the use of 4-0 to 5-0 absorbable suture for all layers, placed using a 5 ½ inch Olsen-Hegar needle holder and a small pair of forceps. Repair of chronic lacerations that are several days old is often successful if done with great care for the preservation of anatomy.

Owners often call for emergency examinations of horses with very **swollen eyelids**. Many of these horses are suffering acute eyelid edema related to insect allergy or other seasonal irritant. If edema is the only problem, the pupil of the affected eye will be midrange and reactive, and the surface of the cornea will be transparent and show no fluorescein dye uptake. This problem responds quickly to topical corticosteroid application, but must be differentiated from chemosis accompanying a corneal ulcer or a deeper problem in the globe.

Neoplasia of the eyelid or periocular region is a difficult challenge for the practitioner. The most common tumors are **squamous cell carcinoma** and **sarcoid**, though melanoma, lymphoma, fibroma, mast cell tumors and other tumors may occur. Patients at risk for squamous cell carcinoma include draft horses (particularly Belgian Drafts), Haflingers and color dilute breeds like Paints, Pintos, Appaloosas and Hackney ponies that lack pigmentation in the lid region. Exposure to a high level of solar radiation is an additional risk factor. Field therapy for smaller eyelid tumors should include careful excision followed by local immunotherapy, cryotherapy or infiltration of the region with chemotherapeutic agents (cisplatin or 5-fluorocytourasil). However, many patients with periorbital neoplasia present when the tumors are advanced. Horses that present with lesions that occupy more than one third of an eyelid margin may be best served by prompt referral to a veterinary ophthalmologist that can perform excision with reconstruction and administer adjunctive therapies. Current adjunctive therapies include cryotherapy, hyperthermia, photodynamic therapy, brachytherapy and intralesional chemotherapy (cisplatin or carboplatin) either done as a standing local injection or using electrochemotherapy equipment which requires short term general anesthesia. Intralesional chemotherapy is usually administered over 3-4 sessions spaced a few weeks apart and involves the injection of cisplatin, carboplatin or other chemotherapeutic agents. Early referral gives the best chance of good long-term results.

Facial nerve paralysis affects the mobility of the face. Signs of unilateral dysfunction of the nerve include a droopy ear and an inability to blink on the ipsilateral side. The horse's nose will be pulled to

the contralateral side. Loss of eyelid mobility is associated with exposure keratitis which frequently leads to corneal ulceration.

Nictitans. The most common problems seen in the nictitans are trauma, neoplasia and burdock pappus bristle keratopathy. Minor tears of the nictitans may not cause a clinical problem. Lacerations that cause the nictitans to evert intermittently outside the eyelid margin may require excision or surgical revision of the leading edge of the third eyelid.

The most common neoplasia affecting the nictitans is **squamous cell carcinoma**. This tumor presents as a raised or ulcerated reddened region of abnormal mucosa. Most SCC of the nictitans originates on the leading edge of one third eyelid. The extent of the tumor may not be appreciated until the nictitans is everted with forceps for examination. Affected horses may show profuse mucopurulent discharge. Occasionally horses will present with bilateral SCC of the nictitans, particularly Belgian Drafts and Haflingers. A test is now available through UC Davis to test Haflinger and Belgian Draft horses for the genetic mutation that has been linked to both squamous cell carcinoma of the limbus and of the nictitans: https://www.vgl.ucdavis.edu/services/HaflingerSCC.php The test can be done on either hair or blood samples. Lymphoma, hemangiosarcoma and melanoma have also been reported as originating on the nictitans.

Treatment of tumors of the nictitans is either local excision of the mass (for small masses on the leading edge) or complete excision of the nictitans (for larger masses). Surgery may be performed as a standing procedure in the sedated horse. Practice tips for successful removal include supporting the horse's head on a table made of stacked bales, heavy sedation, doing the surgery within stocks, and judicious infiltration of the mucosa of the nictitans with local anesthetic, using a tuberculin syringe attached to a 25 G needle. The base of the nictitans is attached to a large pad of orbital fat which will be pulled out of the fornix during the surgery. Complications from orbital fat prolapse are rare if the fat pad that is attached to the gland is amputated along with the nictitans.

Burdock pappus bristle keratopathy is often seen in the fall in horses that live in temperate climates like the Northeast where burdock is a common pasture weed. The tiny bristles of the mature plant can become embedded in the mucosa of the nictitans that apposes the cornea or in the cornea itself. A hallmark of this condition is a cobblestone appearance of the inner mucosa of the nictitans, and adjacent scarring and ulceration of the opposing nasoventral corneal epithelium. Treatment involves topical anesthesia of all affected surfaces, eversion of the nictitans and debridement of both the nictitans mucosa and the affected cornea. Cytology samples should be taken to check for associated infection. Practice tips for successful resolution include using the open jaw of a small hemostat as a scraping instrument for the mucosa, and following hemostat debridement with judicious rubbing of the mucosa with a bit of gauze stretched over a gloved finger.

C. Nasolacrimal system and Conjunctiva

Dacryocystitis is a common problem in the field. Retrograde flushing of the system can be performed using a variety of thin tubes that attach to a syringe containing wash fluid including plastic teat cannulas, IV catheters, tomcat catheters and intranasal vaccine applicators. Stubborn blockages can benefit from passing a small 5 Fr nasogastric feeding tube (Mila International, NG522S, 5Fr x 55 cm) as far up the duct as it will pass. Practice tips for smooth flushing include the use of an LED headband light for illumination of the nasal puncta, application of a small dab of local anesthetic gel onto the nasal mucosa around the puncta and inclusion of a small amount of local anesthetic in the first volume of sterile wash that is

flushed into the duct. Cases that present seasonally with a lot of mucopurulent discharge may benefit from the topical application of an ocular preparation containing 1% hydrocortisone or 1% dexamethasone that will medicate the mucosa as tears drain down the duct.

Conjunctivitis is another common field problem. Practitioners must understand that conjunctivitis is rarely a primary diagnosis—it is usually a secondary symptom of more widespread ocular inflammation. Practitioners should look for allergic, infectious, immune mediated, neoplastic or parasitic disease elsewhere in the eye as the inciting cause.

Prolapse of orbital fat is a condition that is occasionally seen following trauma or surgery and may occur spontaneously. Weakened episcleral fascia allows fat to herniate under the bulbar conjunctiva or the conjunctiva of the nictitans, forming a fluctuant mass that may be mistaken for a tumor. The character of prolapsed fat is soft and pillow like, much like a marshmallow. Cytology on material aspirated from the fluctuant region of conjunctiva will differentiate this benign condition from neoplasia. The prolapsed fat is not harmful but will have an undesirable cosmetic appearance; a surgeon with ophthalmic expertise may be able resect the prolapsed fat and suture the underlying fascia to restore good cosmesis.

D. Orbital Imaging

General practitioners can use **ultrasonography** to assess periorbital masses, eyelid swelling or abscess, orbital fractures and look for foreign bodies. Machines commonly used for reproductive and orthopedic imaging have probes that are adequate for field examination of these problems. A transpalpebral examination will delineate the extent of fluid or soft tissue periorbital enlargements or abscesses and is useful to identify any breaks in bone continuity. Comparison of the depth measurements of both globes is indicated if one globe is more prominent than the other—if both globes have a similar axial diameter, a space occupying mass is probably present in the retrobulbar space.

Referral options for orbital imaging have advanced considerably in the last few decades; today many universities and specialty hospitals have machines that produce excellent three dimensional images of this complex region. **Computed tomography** produces the lifelike reconstructions of the orbit, providing excellent detail when there is a need to image the periorbital sinuses, an orbital mass or orbital fracture. Practitioners should offer patients with these problems the option of referral to a university for computed tomography but the owners should be aware that the procedure is fairly expensive. Recently many referral centers have invested “standing CT units”. When imaging of the equine head is indicated, referral to a site that has a standing CT unit is recommended over a unit that requires general anesthesia due to the risks and costs of anesthesia.

E. Surgery of the Orbit

Many equine practitioners offer **enucleation surgery** as an option for their patients. In recent years, many clinics have been performing enucleation as a standing surgery, restraining the horse in stocks and providing deep anesthesia through either a CRI infusion of sedation, or intermittent boluses of sedatives. The author has performed over 80 enucleations in standing patients with good results. Several reports have been published that detail practical techniques for this procedure.

In addition to advanced imaging, referral hospitals offer options for certain types of **orbital surgery**, including orbital exploration, repair of orbital fractures and enucleation, including exenteration (removal

of all orbital contents). A few horses have undergone orbital implantation where a cosmetic conformer (artificial corneal scleral prosthetic) is fitted to an orbital implant that is made of hydroxyapatite.

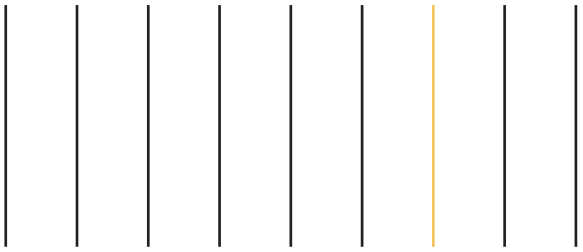
References/Suggested Reading

1. Barnett, KC et al. *Color Atlas and Text of Equine Ophthalmology, 2nd edition* London, Mosby-Wolfe, 2004.
2. Brooks, D. *Ophthalmology for the Equine Practitioner*. Jackson, Wyoming, Teton NewMedia, 2002.
3. Dwyer, AE. How to take digital photographs of equine eyes in practice. *Proceedings* Am Assoc Equine Pract 56: 228-237. 2010.
4. Dwyer, AE. Repair of torn eyelids in horses. The Practitioner (publication of the Florida Association of Equine Practitioners), Issue 2: 10-16, 2021.
5. Dwyer, AE. Ophthalmic Emergencies in the Field. In *Vet Clin N Am, Equine Practice, Management of Emergency Cases in the Field*. 37: 2, 441-460, 2021.
6. Ledbetter EC and Porter IR. Advanced ophthalmic Imaging in the horse. In Gilger, B (ed.) *Equine Ophthalmology*, 4th Ed. p.90-132. Wiley Blackwell, Hoboken, NJ, 2022.
7. Hartley C and Grundon RA. Diseases and surgery of the globe and orbit. In Gilger, B (ed.) *Equine Ophthalmology*, 4th Ed. p.133-186. Wiley Blackwell, Hoboken, NJ, 2022.
8. Hewes CA, Keoghan GC, Gutierrez-Nibero S. Standing enucleation in the horse: a report of 5 cases. *Can Vet J*; 48: 512-514, 2007.
9. Pollock PJ, Russell T, Hughes TK et al. Transpalpebral eye enucleation in 40 standing horses. *Vet Surg*; 37: 306-309, 2008.
10. Townsend, WM. How to perform a standing enucleation. *Proceedings Am Assoc Equine Pract* 59: 187-190, 2013.

Genetic testing information for periocular tumors in Haflingers and Belgians:
https://www.vgl.ucdavis.edu/services/HaflingerSCC.php

EVALUATION OF THE SOFT TISSUES OF THE EQUINE STIFLE USING MAGNETIC RESONANCE IMAGING

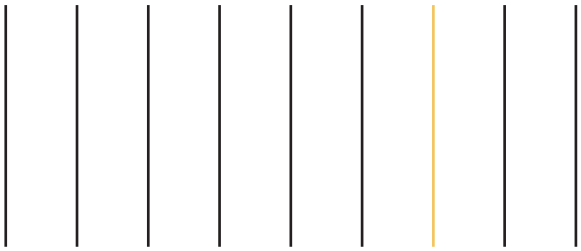
JOCELYN STEDMAN
DVM



EQUINE

TRACKS OF MY TEARS: ULCERATIVE KERATITIS

ANN DWYER
DVM



EQUINE

4. TRACKS OF MY TEARS: PROBLEMS OF THE EQUINE CORNEA

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A. Anatomy review.

The cornea is an oval structure measuring @28x35mm. It consists of several layers of tissue with an average total thickness of about 1 mm; the center or axial region is the thinnest portion.

The **corneal epithelium** is the relatively impermeable outer layer which is richly innervated and very thin (@0.14 mm and 8-15 cell layers thick) with an underlying basement membrane. The epithelium is covered by the **precorneal tear film** which many anatomists consider an additional layer of the cornea. Healing of non-infected superficial epithelial defects is rapid, involving "sliding leap frog" motion of adjacent cells to cover the wound followed by basal cell mitosis and migration.

The **corneal stroma** is about 0.8mm thick, making up 80% of the cross-sectional diameter. Stroma is primarily composed of Type I collagen fibrils that are arranged in a parallel lamellar lattice pattern. Disruption of the lattice causes opacity that is apparent as a corneal scar. The majority of the stroma is acellular but individual stromal keratocytes can be found interspersed sparsely between the layered lattice of collagen fibrils. Healing of stromal defects involves a balance of resorptive remodeling facilitated by proteinases that are released from bacteria, corneal cells and infiltrating PMNs, and restorative repair where fibroblasts lay down collagen to fill in the defect. Successful healing of defects begins with re-epithelialization and is followed by several months of new collagen production and lamellar remodeling that may return the tissue to its original transparency. In deep lesions, or lesions where healing is delayed, collagen is laid down in a random fashion, resulting in an opaque scar. In severe cases, proteinase activity is excessive, resulting in keratomalacia (melting), which can lead to perforation.

Descemet's membrane (DM) is the next layer of the cornea. DM is a thin, elastic, acellular basement membrane. It sits on top of the **endothelium** which has just a single layer of cells that form the inner boundary of the cornea. Endothelial cell membranes contain a NA+-K+ activated, ATP-ase dependent electrolyte pump that works constantly to keep the corneal stroma relatively dehydrated. Disruption of normal pump activity results in edema of the overlying stroma that can be permanent. The endothelium has poor regenerative capacity.

Veterinarians are frequently called out to examine and treat horses with corneal disease. A normal cornea is transparent and covered with smooth epithelium and a healthy tear film. Abnormal findings may include disruption of the normally smooth ocular surface (ulceration), and/or opacification of the normally transparent corneal layers.

B. Ulcerative corneal problems common in horses

Superficial corneal erosions are defects that involve only the outer few layers of epithelium. Non infected erosions usually heal quickly without visible scars. Topical mydriasis and antibiotic therapy is indicated.

Superficial keratitis may present as punctate areas of stain uptake, as focal vascularization, as pigment deposition, or as focal superficial opacities. **Punctate keratitis** may have a herpetic, fungal or an

idiopathic etiology. The lesions may be painful or comfortable. Epithelium shows fluorescein stain uptake in a dot like pattern that is scattered over the corneal surface. A trial of topical idoxyuridine may improve the condition. Topical NSAID products, especially 0.1% diclofenac, may be very helpful. Some forms of keratitis will respond to topical NSAIDs or antivirals, while others respond to topical antibiotics.

Non healing (indolent) ulcers: Shallow epithelial defects may fail to heal in older horses if the adjacent epithelium does not generate a normal basement membrane. These cases may be helped by debridement with a swab or blunt blade, or a temporary tarsorrhaphy. If a non-infected ulcer does not heal in two weeks, diamond burr debridement (DBD) with an AlgerBrush II® equipped with a 3.5 mm medium grit burr may stimulate healing. This debridement creates small defects in the superficial stroma providing a platform for adherence of new epithelial cells. In the past, many clinicians performed linear or punctate grid keratotomies on ulcers suspected to be indolent. The DBD procedure is simpler and less risky to perform and is rapidly replacing the former "grid" debridement technique. It is important to perform cytology on any non-healing lesion to rule out infection before attempting a DBD.

Ulcerative keratitis refers to defects that extend through the corneal epithelial layers and underlying basement membrane into the stroma. Healing of such defects is a balancing act: ideally, tear film proteinases remodel the stromal defect, and native fibroblasts restore stromal integrity. Bacterial or fungal infections, as well as various host factors, may tip the balance towards excessive resorption, resulting in melting of stromal collagen or even perforation of the globe. Ulcerative keratitis is very painful and accompanied by secondary uveitis, so the syndrome is complicated by patient objection to topical therapy. Adjunctive surgical therapy may involve debridement or keratectomy. Complex cases may need conjunctival grafts, amniotic membrane grafts, or tarsorrhaphy and thus may best be handled as referral cases. Very serious cases may require corneal transplantation.

Bacterial ulcerative keratitis is diagnosed by culture and cytology. Initial therapy choices are dictated by the type of bacteria seen on slides, and later may be adjusted according to clinical response and results of lesion culture/sensitivity. Therapy is intense, usually 4-6 x per day. Antibiotics are combined with mydriatics and topical antiproteinases. Systemic NSAIDs help control pain. Subconjunctival injection may be used to supplement topical therapy. Treatment of cooperative patients without obvious keratomalacia may be accomplished via topical ointments administered at home, and resolution may be straightforward. Treatment of fractious patients, or patients with deep defects is best via liquid medications administered through an SPL tube at home or at a referral hospital. Frequent monitoring will be necessary until it is clear that healing is occurring. The most common antibiotic drugs used on bacterial keratitis are fluoroquinolones (ciprofloxacin, ofloxacin, moxifloxacin), chloramphenicol, cefazolin, tobramycin, gentamicin, and amikacin. Atropine application should be to effect. Topical antiproteinase therapy using serum application is routine and may include a combination of other MMP inhibitors such as EDTA or acetylcysteine. Debridement should be judicious but may need to be repeated weekly.

Fungal ulcerative keratitis is common in humid southern climates, but reports of fungal keratitis in northern areas and desert climates have increased in recent years. Cytology of a scraping of the corneal lesion is essential to make this diagnosis. The presence of septate branching hyphae with parallel walls on a corneal cytology sample is diagnostic, but sequential cytology samples may be needed to discover fungal elements. Treatment is often begun empirically if the index of suspicion for fungus is high. Antifungal sensitivities vary from one region to the next, so it is helpful to know what medications have been most effective in a specific geographic area. Fungal infections are very painful and the host inflammatory reaction is extreme. Fungi have the ability to tunnel down to Descemet's membrane

where topical drug activity may be limited. Prognosis is always guarded; early surgical intervention may be necessary for resolution. Surgical treatment involves keratectomy with conjunctival grafting or corneal transplantation. Topical antifungal therapy may involve the use of voriconazole, miconazole, natamycin, itraconazole, or silver sulfadiazine. Systemic antifungal therapy may be instituted. Intrastromal injection of 1% voriconazole may optimize outcome.

Melting ulcers are stromal defects where host proteinase activity is severe enough to cause corneal "melting" that threatens globe integrity. In some cases, corneal melting may be related to bacterial infections particularly those caused by *beta hemolytic Streptococcus* spp or *Pseudomonas aeruginosa*. Melting ulcers are expensive and time consuming to treat and therapy must be immediate and aggressive. Outcome may be optimized if the horse is sent to a referral center where anti-infective and antiproteinase therapy (serum, EDTA, acetylcysteine, ilomastat) is administered every 1-2 hours around the clock.

Eosinophilic keratoconjunctivitis (EK) is a condition of immune mediated etiology where horse presents with limbal granulation tissue, chemosis, mucoid discharge, and/or limbal, axial or paraxial corneal ulcers that may have a rubbery or waxy texture, or may have white or yellow raised plaques with gritty chalk like material embedded along the margins. Cytology reveals an abundance of intact eosinophils and loose eosinophilic granules and may show scattered mast cells. Therapy includes debridement/debulking of the plaques using an AlgerBrush II® battery powered tool equipped with a 3.5 mm pterygium burr of medium grit (DBD). The corneal surface is then treated with atropine, and anti-infectives. In selected cases where the cornea is only mildly affected, topical steroids may be tried, but must be monitored closely, as therapy carries a risk of fungal keratitis. Cases of EK that present with extensive ulceration should not be treated with topical steroids, but a tapering does of systemic steroids in addition to systemic NSAIDs is beneficial. A sample dose regimen for a 450 kg horse would be one initial dose of 40 mg of dexamethasone (0.1 mg/kg) given IV or IM, followed by a few days oral or injectable dexamethasone at 0.04 mg/kg, then dropping the dose every 3 days by 0.01 mg/kg until reaching a dose of 0.01 to 0.02 mg/kg, then continuing on an every other day dose regimen until the condition is resolved. Recent reports on the addition of a systemic oral human antihistamine (ceterizine or Zyrtec®, 0.4mg/kg PO BID, administered for several weeks) have been encouraging. The condition has been noted to recur in the warm season and is most frequently seen on premises that are near water (wetlands or creeks) and woods. The etiology of EK is not well understood but it may be related to insect activity around the face. Constant use of a fly mask may prevent recurrence.

Calcific band keratopathy may occur as a complication of chronic uveitis or keratitis. It involves mineralization of the cornea with deposits of calcium and may be related to repeated topical steroid application. Gritty plaques of Ca+ are deposited in the corneal epithelium and upper stroma in the axial region where the lid aperture exposes the central band of corneal surface. Often the plaques protrude through the epithelium and are associated with erosions and ulceration. Removal of the irritating deposits may require diamond burr debridement, superficial keratectomy, and/or chelation with topical 1-2% EDTA. Recurrence is common.

Corneal foreign bodies embedded in the stroma or epithelium are occasionally discovered in horses. Superficial foreign bodies can often be flushed out with a pressure lavage of saline pushed through a broken off hub of a 25G needle, or "wicked" out with a sterile dry cotton bud, or "scooped" by careful undermining with the bevel of a 20G needle or small 2 mm biopsy punch. The remaining ulcer bed should be swabbed and lavaged with 2% povidone iodine/saline solution and treated medically. Very deep or penetrating foreign bodies must be referred for surgery and supportive care.

Burdock pappus bristle keratopathy: Horses that live in regions where burdock is a common pasture weed often present in the fall with tiny pappus bristles embedded in the cornea or nictitans. Large burdock thistles are commonly found tangled in the tail and mane. Affected horses present with signs of corneal ulceration or erosion, particularly in the medial canthus under the nictitans. The tiny burdock bristles are not visible in field conditions, but in chronic cases there may be vessel patterns on the nictitans conjunctiva or on the cornea that "point" to their location. All suspect areas should be debrided. Nictitans debridement is facilitated by everting the whole membrane with a small towel clamp or hemostat, and gently scraping the conjunctiva with the serrated edge of a sterile hemostat until it bleeds. Resolution is prompt if the bristles have been completely removed. Treatment involves topical atropine and antibiotics, plus systemic NSAIDs.

C. **Nonulcerative problems of the equine cornea** (Covered more extensively in talk #5 in this series)

Stromal abscesses (SA) are seen as single, or occasionally multiple, non-staining focal fluffy yellow to tan-white densities which reflect microabscesses located deep within the corneal stroma. These focal lesions are very painful and are usually accompanied by an intense ingrowth of deep vessels from the closest region of the limbus. Many of these lesions contain fungal hyphae so aggressive antifungal therapy is advised in addition to antibacterial and mydriatic treatment, and systemic NSAIDs. Recently, a technique of intrastromal injection of 1% voriconazole or other antifungal medication into the stroma surrounding a SA has been described. The technique requires expertise, a delicate touch and heavy sedation/regional anesthesia, but has resulted in successful resolution of many SA. While many superficial SAs respond to intense topical therapy or intrastromal injection, very deep SAs are sometimes completely refractive to medical therapy, intrastromal injections or debridement. Surgical options for SAs include several different types of corneal transplantation procedures. Outcome is improved if referral is made is early in the course of disease, and if the referral institution has broad experience in treating equine patients. Some patients with SAs end up requiring enucleation if they are not treated surgically at a specialty hospital.

Immune mediated keratitis/keratopathies (IMMK) are a group of conditions where corneal transparency is reduced. IMMK represents a spectrum of disease, and is poorly understood. IMMK tends to be chronic and tend to wax and wane in severity, often with periodic "flares". The variants described by the term IMMK demonstrate focal or diffuse regions of corneal opacity limited to the stroma or endothelium that retain an intact epithelium and thus do not take up ophthalmic stains. Spectral-domain confocal microscopy of opaque regions usually reveals an infiltrate of lymphocytes and plasma cells within the affected stroma and an absence of infectious elements. Although IMMK can be bilateral, most cases are unilateral and a careful history may reveal a previous episode of trauma in the affected eye. The observed opacity may reflect a cellular immune reaction to antigens expressed within the stroma. The intensity and regional pattern of observed opacification often varies over time. Areas that were previously opaque may clear only to have other geographical regions of the cornea lose transparency. Often there is vascularization of the opaque areas that will also change pattern over time. Pain is variable—some horses never exhibit pain while others may have episodes of severe pain that accompany increasing opacity. Topical treatment involves application of drugs that modulate the immune response (cyclosporine, tacrolimus, corticosteroids). Response to treatment is variable; severe cases may respond to superficial keratectomy.

Corneal tumors: Neoplasia of the ocular surface is seen less often than on the adnexa, but when it occurs, squamous cell carcinoma is the most common corneal or corneal limbal tumor, especially in

Haflinger, Appaloosa, Paint or draft breeds. Certain lines of the Haflinger and Belgian breeds have a genetic based risk for both corneal limbal and adnexal squamous cell carcinoma. Prompt referral for surgery, with added adjunctive therapy like beta irradiation, cryotherapy, photodynamic therapy or laser ablation is advised. Enucleation may be the best treatment for some cases.

D. Diagnosis, treatment and prognosis of equine corneal problems

Clinical skills required for equine practitioners to diagnose corneal problems include application and interpretation of ocular surface stains and Schirmer tear tests, collection and interpretation of corneal cytology samples, sample submission for corneal culture and sensitivity, and administration of topical and regional anesthesia. Photography should be used to document findings and assess progress.

Treatment of corneal ulcers ranges from simple application of mydriatic and anti-infective ointment a few times per day to hourly application of antiproteinases coupled with intense topical therapy with antibacterial and antifungal medication and application of atropine several times per day to effect mydriasis. The intensity of the therapy schedule is dependent on the depth of the lesion, degree of melting, the infectious agent(s), patient pain and cooperation, and owner resources.

Skills required for treating equine corneal disease include experience with insertion and management of subpalpebral lavage systems, administration of subconjunctival injections, as well as expertise in corneal debridement with cotton buds and blunt sterile metal blades. Practitioners with special interest in ophthalmology may pursue training in intrastromal injection of antimicrobials and in use of the Alger brush instrument for diamond burr debridement, but caution is advised as these two procedures are not without risk. Most serious ulcerative problems require insertion of a subpalpebral lavage system. Treating these conditions will involve extensive client communication, as well as owner dedication to home treatment and frequent veterinary recheck examinations.

Corneal problems range from simple traumas that resolve uneventfully, to progressive, painful conditions that are among the most complicated and expensive that horses experience. Prompt assessment and intense, evidence-based therapy is key for treating most conditions; choice of anti-infective therapy should be based on cytologic evidence of infectious agents. Administration of mydriatic therapy (atropine) is critical as prompt dilation of the pupil reduces ciliary spasm and thus blocks pain, decreases the leakiness of iridal blood vessels, and helps prevent posterior synechiae. Frequent administration of anti-collagenase therapy is essential to prevent melting in severe ulcers, and systemic anti-inflammatory agents are usually needed to decrease pain and inflammation. Practitioners should commit to seeing painful eyes on the date of occurrence and must perform appropriate diagnostic tests to make rational treatment choices. Owner resources for home treatment are often critical; if treatment options are limited, early referral to a specialist may result in the best outcome. The prognosis for fungal keratitis, stromal abscesses, desmetoceles and melting ulcers is guarded. Successful resolution of these complex corneal conditions often requires intense treatment and surgical intervention so referral is encouraged.

References/Suggested Reading

1. Barnett, KC et al. *Color Atlas and Text of Equine Ophthalmology, 2nd edition* London, Mosby-Wolfe, 2004.
2. Brooks, DE. *Ophthalmology for the Equine Practitioner, 2nd ed*. Jackson, Wyoming, Teton NewMedia, 2009.

3. Brooks, DE and Plummer CE. Diseases of the equine cornea. In: Gilger, B, (ed.) *Equine Ophthalmology, 4th ed*. Ames, Wiley Blackwell, p. 253-440, 2022.
4. Dwyer, AE. How to take digital photographs of equine eyes in practice. p. 52-92. *Proceedings* Am Assoc Equine Pract; 56, p. 228-237, 2010.
5. Dwyer, AE. Ophthalmology in equine ambulatory practice. p. 155-174 In: Ramey, D. and Baus, M. (ed.) *Ambulatory Practice.* Veterinary Clinics of North America, Equine Practice, 26, 1, Philadelphia, Elsevier, 2012.
6. Dwyer, AE. How to insert and manage a subpalpebral lavage tube. In *Proceedings Am Assoc Equine Pract* ;59: 164-173, 2013.
7. Dwyer, AE. Ophthalmic Emergencies in the field. In Veterinary Clinics of North America, Equine Practice, 37,2,441-460, 2021.
8. Nunnery, C. How to select appropriate treatment for corneal ulcers. *Proceedings* Am Assoc Equine Pract; 63, p. 167-178, 2017.

CRY ME A RIVER: NON-ULCERATIVE KERATITIS AND COMMON INTRAOCULAR CONDITIONS

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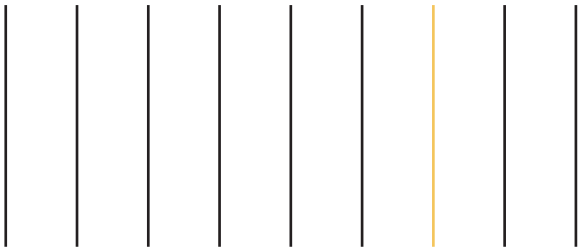

EQUINE

5. Cry Me a River: Non-ulcerative corneal disease and Common Intraocular Conditions

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A. Non-ulcerative corneal disease

Stromal abscesses: One of the most serious corneal conditions that presents without ulceration of the epithelium is a **stromal abscess** (SA). Stromal abscesses are seen as single or multiple non-staining focal fluffy yellow to tan-white densities which reflect microabscesses located deep within the corneal stroma. These focal lesions are very painful and are usually accompanied by an intense ingrowth of deep vessels from the closest region of the limbus. Many of these lesions have been found to contain fungal hyphae so aggressive antifungal therapy is advised in addition to antibacterial and mydriatic treatment, and systemic NSAIDs. Superficial SAs may respond to intense topical therapy, but deeper SAs may be completely refractive to medical therapy or debridement, and many patients with SAs end up requiring enucleation if they are not treated surgically at a specialty hospital. Surgical options for SAs include several different types of corneal transplantation procedures including penetrating keratoplasty (PK), penetrating lamellar keratoplasty (PLK), or deep anterior lamellar keratoplasty (DALK). Outcome is improved if referral is made is early in the course of disease, and if the referral institution has broad experience in treating equine patients.

Immune mediated keratitis" (IMMK): Less serious but still problematic transparency changes are seen in the group of conditions known as the **immune mediated keratopathies**. This group of diseases is poorly understood. The variants termed IMMK demonstrate focal or diffuse regions of opacity limited to the stroma or endothelium that retain an intact epithelium and thus do not take up ophthalmic stains. Many of these conditions are recurrent. Confocal microscopy of opaque regions usually reveals an infiltrate of lymphocytes and plasma cells within the affected stroma and an absence of infectious elements. Although some cases are bilateral, most are unilateral and a careful history may reveal a previous episode of trauma in the affected eye. The observed opacity may reflect a cellular immune reaction to antigens expressed within the stroma. The intensity and regional pattern of observed opacification often varies over time. Areas that were previously opaque may clear only to have other geographical regions of the cornea lose transparency. Often there is vascularization of the opaque areas that will also change pattern over time. Pain is variable—some horses never exhibit pain while others may have episodes of severe pain that accompany increasing opacity.

Management of IMMK cases requires lifelong monitoring. Treatment may involves systemic NSAIDs and topical anti-inflammatory therapy for horses that present with pain or increasing areas of opacity. Some horses will respond well to topical NSAIDs (diclofenac); others may be helped by topical immunomodulators (compounded cyclosporine (2%) or tacrolimus). Topical steroids (prednisolone acetate or dexamethasone) help some cases but the use of these agents requires close monitoring, as the presence of an undetected infectious agent deep in the stroma can never be fully ruled out, and topical steroids can exacerbate a flare up of infectious keratitis.

Endotheliitis: Occasionally the cornea can develop white to light blue regions of edema that appear foggy, particularly in older horses. The opacities often begin as triangular shaped patches that border the limbus and usually extend over at least 25% of the cornea. This condition is called **endotheliitis**. It occurs when the single layer of endothelial cells fails to perform its normal physiologic function of

removing water from the corneal stroma. Severe cases progress to **bullous keratopathy** where the entire cornea becomes opaque and swollen, and may develop small blisters on the epithelial surface. Endotheliitis is poorly understood and often refractory to treatment. The condition may be related to a loss of endothelial cell density, endothelial cell dysfunction, or rupture of Descemet's membrane. There may also be an immune mediated component.

B. Intraocular conditions.

Anterior Chamber

The anterior chamber normally contains about 3 ml of aqueous humor, a clear fluid that is a blend of plasma ultrafiltrate and actively processed fluid that circulates into the uvea. Aqueous is produced by the ciliary body, then it flows over and around the lens capsule, through the pupil, and inflates the anterior chamber. Intraocular inflammation can result in visible masses of cells or inflammatory components in the chamber manifesting as flare, hypopyon, hyphema, clouds of fibrin or a combination of all these things. Rarely the anterior chamber can contain foreign bodies (secondary to trauma), nematode parasites, or a lens that has luxated anteriorly.

Iris

Variations in the normal observed anatomy of the anterior uvea are frequently observed in practice, and include **uveal cysts, iris hypoplasia, heterochromic irises, persistent pupillary membranes, iris colobomas** and **hyperplastic granula iridica**. Neoplasia is rare but cases of **melanoma, medulloepithelioma** and **lymphoma** have been reported in the iris and other uveal tissues. Inflammation secondary to uveitis frequently deforms or damages the iris, causing atrophy of the margin of the pupil, "extra" pupils (colobomas), and synechia. Posterior synechia (iris adherent to the lens) are much more common than anterior synechia (iris adherent to the corneal endothelium); synechia are usually a sequellae of uveitis, but may occasionally occur after trauma.

Horses with silver dapple coat colors as well as many miniature horses are often found to have developmental abnormalities of their globes. This condition used to be called anterior segment dysgenesis but is now termed **multiple congenital ocular anomaly (MCOA**). MCOA is a syndrome that ranges in severity from minor variants like ciliary body cysts that do not cause clinical problems to small abnormally shaped pupils that fail to show a strong PLR, abnormal drainage angles, cataracts, glaucoma and blindness. A genetic test for MCOA is available through University of California at Davis; analytics can be performed on a hair sample, and the test is recommended for horses with silver dapple coloring.

Lens

Lens abnormalities commonly encountered in the field include cataracts and lens luxations. Both these conditions are common complications of uveitis but may also occur for other reasons.

Cataract evaluation is aided by short term mydriasis. Dilation is induced 15 – 20 minutes after 0.3 to 0.5 ml of tropicamide (Mydriacil) is applied to the corneal surface. Digital photography of cataracts is advised to document the extent of opacity, provide a baseline image for assessing progression and demonstrate the lesion to the owner. Lens opacities should be described using the classification system proposed by Matthews (see references below) which specifies the anatomic location (capsulolenticular, lenticular; zonal, anterior capsule, axial, sutural, perinuclear, equatorial, and complete), physical appearance (diffuse, crystalline, vacuolated, floriform, elliptic) and etiology (acquired or developmental) of the lesion.

Extracapsular phacoemulsification dissection and aspiration surgery is advisable for foals under 6 months of age that present with congenital cataracts. Phacoemulsification surgery may also be

appropriate for a some affected adult horses but case selection is important as post operative complications for of adult horses undergoing cataract surgery are common. Owners of horses that suffer severe blunt trauma should be cautioned that cataract formation often occurs several months after the trauma due to autoimmune reaction to lens proteins normally sequestered from the immune system.

Lens luxation is common in Appaloosa horses that suffer insidious uveitis and may be seen in other horses with uveitis or in horses that sustain blunt trauma. Posterior lens luxation is much more common than anterior luxation in the horse. Most posterior luxations are asymptomatic, but anterior luxations often cause severe pain. Intracapsular cataract surgery for removal of a luxated lens is associated with poor results in the horse.

Vitreous (Posterior Segment)

The vitreous is a clear, gel like substance that fills the posterior segment. The average volume of vitreous in the horse is about 26 ml. The most common abnormal field findings include the presence of optically refractile elements within the vitreous, liquefaction of the vitreous gel and inflammatory changes (vitritis).

Optically refractile elements in the vitreous are best appreciated by retroillumination against the tapetal reflection. They can appear as small dust like opacities, as thread like filaments, as focal highly refractile crystals or as tangled clumps of material. Larger densities may or may not be attached to the posterior lens capsule. Small focal densities are common and usually of no clinical significance.

Liquefaction of the vitreous is most commonly observed as a function of aging but may also accompany uveitis. Liquified vitreous is best appreciated when the horse's head is moved enough to cause ocular saccades (globe movements). Small densities present within a liquefied vitreous can be seen to swirl within the globe as if they are suspended in oil.

The most common causes of **vitritis** are posterior uveitis and ocular trauma. Following the influx of inflammatory proteins and blood cells into the posterior segment, the normally transparent vitreous assumes a yellow to orange hue and appears cloudy. The observable fundic image then appears hazy and the optic disc appears orange tinted when seen through the filter of the inflamed vitreous. In sequential examinations, resumption of a sharp fundic image of normal color is a sign that vitritis has subsided, while persistence of a hazy orange tinged disc image and blurred fundic detail indicates continued inflammation.

Fundus

Many equine practitioners use direct ophthalmoscopy or inspection of the fundus with a Finnhof transilluminator to perform fundic examinations in the field. Recently some practitioners have started using cell phone cameras that have been modified to facilitate fundoscopy. The video smartphone function, coupled with illumination from a phone camera flash lens that has been reduced by applying a small piece of elasticon tape over the lens creates an excellent imaging system that can also be used to record findings of significance. Assessment will be most complete if the examination is done in the dark and the pupils are dilated with topical application of 0.3 ml of tropicamide/eye (Mydriacil). Induction of dilation takes 15-20 minutes so the timing of the examination must be planned accordingly.

Identification of the major structures that can be seen on fundic examination (tapetal and non-tapetal portions of the fundus, optic nerve head, retinal vasculature and choroidal vasculature) is relatively easy as these structures can be seen just ventral to the axis, and each is distinct in shape, color and position. The major challenge that practitioners face is recognizing the wide variation in "normal" clinical findings that occur, and discriminating these from true pathology. Most aberrations and common pathologic changes are visible within one to two disc diameters of the optic disc border and thus are readily observable.

Skills in fundic examination will be enhanced by studying photographs of normal and abnormal fundic images in textbooks (See references at the end of proceedings: Barnett, Gilger, Brooks, Gelatt) and by performing a large number of fundic exams on horses of various ages, colors, breeds and sizes. Observable **pigment patterns** of the tapetal fundus and non-tapetal fundus are highly variable and often correlated with coat color. The degree to which the **choroidal vasculature** can be seen is dependent on the intensity of the pigment expressed. Slight variations in the observable shape of the **optic disc**, the contour of its border, and the pattern of vessels that cross the disc surface are common. Practitioners must be able to recognize these normal papillary variants and also identify findings such as **circumpapillary pigment variants , ectopic myelination of ganglion cell axons, persistent hyaloid artery remnants, tapetal pigment variations, partial albinism, tapetal naevi** and certain small **colobomas** of the fundus as variants of the peripapillary region.

Practitioners must also learn to recognize the footprints of previous or chronic disease in the fundus. The most common lesions observed are pigmentary retinopathies. The most common of these are **focal chorioretinitis** (also termed "bullet hole lesions"), **peripapillary chorioretinitis** (sometimes called "butterfly lesions") and **senile retinopathy**. While lesions of focal or peripapillary chorioretinitis are probably acquired presumably from previous inflammation or blunt trauma, the determination of their clinical significance in an individual horse can be difficult. These lesions can be problematic in the prepurchase examination. Senile retinopathy is a common bilateral finding in horses over the age of fifteen years.

Other fundic pathology may be observed, and the practitioner should study texts to interpret the significance of observed lesions. **Focal proliferative optic neuropathy** is not uncommon in older horses and must be distinguished from optic neuritis, neoplasia or traumatic neuropathy. Practitioners must also be able to discern signs of **retinitis**, **retinal** or **optic nerve atrophy** and **retinal detachment**. Horses that present with weakness and weight loss should undergo a fundic examination as this may reveal evidence of Equine Motor Neuron Disease (EMND). The non-tapetum of an EMND horse will have a bizarre mosaic appearance that looks like a "gaudy granite countertop". The mosaic pattern of dark and light tissue represents the deposition of ceroid lipofuscin within the choroidal tissue. Such a finding should prompt testing for blood levels of Vitamin E/Selenium as EMND is related to very low blood levels of Vitamin E.

References/Suggested Reading

1. Barnett, KC et al. *Color Atlas and Text of Equine Ophthalmology, 2nd edition* London, Mosby-Wolfe, 2004.
2. Brooks, D. *Ophthalmology for the Equine Practitioner, 2nd ed*. Jackson, Wyoming, Teton NewMedia, 2009. Excellent reference for the ambulatory vehicle, "plasticized" pages and strong binding make it a rugged addition on the road. Acompanying CD with extra images and video.
3. Dwyer, AE. Ophthalmic Emergencies in the field. In Veterinary Clinics of North America, Equine Practice, 37,2,441-460, 2021.
4. Gilger, B (ed.) *Equine Ophthalmology*, 4th Ed. Hoboken, NJ, Wiley Blackwell, 2022.
5. Matthews AG. Lens opacities in the horse: a clinical classification. *Vet Ophthalmol* 2000; 3: 65-71
6. Matthews AG. Multiple congenital ocular anomalies and the silver dapple gene. *Equine Vet Educ* 2013:25 (11) 556-557
7. Matthews AG. The lens and cataracts. *Vet Clin N Am Equine Practice* 2004; 20: 393-415.

BONUS NOTES: THE MANY FACES OF UVEITIS

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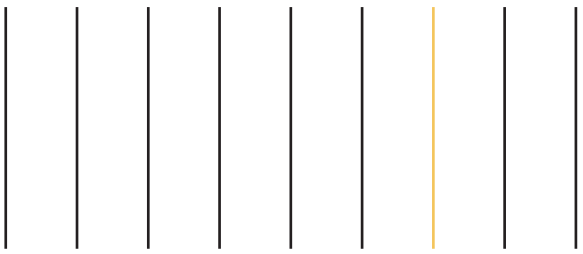

EQUINE

6. BONUS NOTES: THE MANY FACES OF UVEITIS

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FOR KANSAS STATE 2024 Conference attendees: *The 2024 lecture series was scheduled for five talks, and those covered 1. anatomy and physiology, 2. examination and treatment practice tips, 3. orbit and adnexal problems, 4. ulcerative keratitis and 5. non-ulcerative keratitis and intraocular problems. One major equine ocular disease complex that was not covered is uveitis, also known as ERU (equine recurrent uveitis) or moon blindness. This topic is a complex one that needs its own lecture, but time limitations did not allow scheduling of this subject. These notes are offered as "bonus" material for attendees.*

By definition, **uveitis** is inflammation of the uvea of the eye (iris, ciliary body and choroid). The complex of diseases known as "Equine Recurrent Uveitis (ERU) refers to intraocular inflammation that recurs or persists causing various degrees of inflammation, scarring, degeneration and dysfunction of multiple components of the eye.

A. Diagnosis, pathophysiology and etiology of uveitis

Diagnosis of uveitis is simplified by understanding that a horse may present anywhere along the spectrum from acute to end stage, and as either a recurrent or insidious case. Horses that present with three or more signs of intraocular inflammation and a history that is suggestive of either recurrent disease or breed-associated insidious disease can be given a presumptive diagnosis of ERU or persistent uveitis. Examination of these horses may reveal a combination of signs reflecting acute or recent inflammation and other signs that reflect chronic ocular damage from previous episodes. Inflammation is always present on a cellular basis in both quiescent and insidious cases, so sequential examination may discover progressive ocular deterioration in horses that have seemed "normal" to their owners.

Pathophysiology: Normal horses have a blood ocular barrier that functions to keep the aqueous and vitreous ocular media clear. Tight fenestrations between ocular capillary cell walls prevent circulating cells and large molecules from passing through the blood vessels of the iris, ciliary body and choroid into the surrounding stroma. The blood ocular barrier also serves to isolate intraocular structures from the normal cellular immune surveillance traffic, making the tissue of the inside of the eye an immune privileged site. Uveitis begins with *compromise of the blood ocular barrier*. The blood vessels in the iris, ciliary body and choroid thicken and become congested. Soon these vessels become "leaky", allowing cells and inflammatory mediators to cross the compromised blood ocular barrier and enter the inside of the eye.

Most cells that first cross the barrier are neutrophils. The invading cells may be seen grossly as hypopyon, aqueous flare, and vitreous haze. Neutrophils that enter the eye are soon replaced by large numbers of lymphocytes, some of which infiltrate the connective tissues of the ciliary body and iris, forming spherical organized follicles within the stroma of various regions of the uvea. The lymphocytes produce antibodies and inflammatory cytokines that are detectable in the ocular media and within ocular tissues. These substances react with host and (in some cases) infective factors to contribute to ongoing pathologic changes. Numerous heavy exudates appear on intraocular tissue surfaces, most notably on the epithelium of the iris and ciliary body, on the capsule of the lens, and in the layer

between the retinal pigmented epithelium (RPE) and the photoreceptors of the retina. The exudates interfere with the function of adjacent ocular tissue. Cytokine activity mediates additional tissue destruction. With repeated or persistent inflammation chronic changes occur within the ocular tissues, affecting, variably, the cornea, uvea, lens and retina. Vision loss results when dense cataract and synechiae obscure acuity, when the retina detaches or degenerates and no longer can transmit processed light signals to the brain, or when glaucoma causes ischemic damage and degeneration of the axonal processes of the retinal ganglion cells and optic nerve.

Etiology: Recurrent uveitis is an immune mediated disease. However some external conditions, as well as host genetic risk factors have been associated as triggering events for the syndrome. These factors include bacterial, viral and parasitic infections as well as host conditions like septicemia or severe trauma.

Of all infectious triggers, leptospirosis is the most significant worldwide. Leptospiral associated ERU cases account for at least 60% of the cases seen in the Genesee River Valley where the author practices. This temperate river valley is in western New York, directly south of Toronto, Canada. The most significant serovars associated with disease are *L. interrogans* serovar *Pomona* (seen often in the USA) and *L. interrogans* serovar *Grippotyphosa* (seen often in Germany and central Europe, but also in some regions of North America). Factors that increase the risk of leptospirosis in horses include pasture access to wildlife, cows or pigs, close proximity to streams or ponds, rat infestation in the stable and a rainy season with persistent ground water. Horses become infected when they drink water contaminated by the urine of a carrier animal (often a cow, deer, raccoon, pig or rat). The spirochete gains access to the horse's bloodstream by mechanical penetration of mucous membranes. Bacteremia results in clinical illness, manifested by anemia, fever and flu like symptoms. Acute clinical disease is mild and self-limiting, thus rarely diagnosed. Resolution of signs occurs in a few days to a few weeks. However, the spirochetes colonize the kidneys of the horse during the acute phase, and may persist for a few months, being shed in the urine. *L. pomona* has also been associated with late term abortion in mares, as well as placentitis, stillbirth and neonatal illness.

Ocular signs of leptospiral associated uveitis (LAU) do not occur during the acute infection; they begin months later. The ocular inflammation observed during the initial episode of LAU is variable but often severe. Inflammation usually subsides with or without therapy but then may recur at unpredictable intervals. Subsequent episodes of ocular inflammation may be more or less severe than the initial one. Inflammation and damage to ocular tissues associated with repeat episodes eventually compounds and creates visual deficits. Blindness is a common final outcome.

Although systemic infection with pathogenic strains of leptospirosis is clearly a common trigger for vision threatening ERU, the genetic makeup of an affected horse, specifically the genes that determine the MHC complex and ELA (equine lymphocyte antigen) profile of that individual, probably play a major role in determining both susceptibility to leptospirosis as an inciting trigger, and severity of subsequent inflammatory episodes.

Testing horses for exposure to leptospirosis: The author routinely submits serum from horses diagnosed with uveitis to the diagnostic laboratory at Cornell University for MAT analysis against a panel of leptospiral serovars (https://ahdc.vet.cornell.edu/). Many non-uveitic horses will show low titers to the bratislava, autumnalis, hardjo or canicola serovars; these findings are judged to be insignificant in the author's practice geography. Titers above 1:400 to *L. interrogans* serovar *Pomona* or *L. interrogans*, serovar *Grippotyphosa* are judged to be significant in horses with ERU and are a likely indicator of

leptospiral associated etiology. Seroreactivity to *L. interrogans* serovar *Icterohemmorhagica* is often paired with reactivity to *L. interrogans* serovar *Pomona,* The titer levels to the Icterohemmorhagica serovar are consistently much lower than those reported for serovar *Pomona.*

Research has shown that horses with uveitis can be seronegative for antibodies to leptospira and still have leptospiral DNA or live organisms that can be cultured from the eye. A negative leptospira titer thus does not fully rule out leptospirosis as an etiologic factor. However a positive titer to either serovar *L. Pomona or L*. *Grippotyphosa* is a strong cause for concern. The "gold standard" for diagnosing LAU is a positive "C value", that is, an aqueous to serum leptospiral MAT ratio that is greater than 3 or 4. Determining a C value requires an anterior chamber tap to sample aqueous humor. This is an invasive procedure not often performed in the field. However the author has performed C value testing on several eyes from enucleated or deceased horses with ERU where previous serologic testing has suggested LAU. In every case to date, the testing has confirmed LAU (C value higher than 4).

Breed and Uveitis: Recent work has also shown that certain breeds are at risk for uveitis, most notably Appaloosas, European warmbloods and draft horses. A survey done by the author found the Appaloosa breed to be 8.3x more at risk than other breeds for uveitis. Appaloosas that have insidious disease often have overall roan or light coat colors rather than dark coats with a rump blanket. The skin around the lids of affected Appaloosas is often mottled or pink in pigmentation. Mane and tail hair may be sparse. Recent studies performed at the University of California Davis and at the University of Saskatchewan have found that affected individuals have a genetic proclivity to uveitis due to aberrations in the MHC (major histocompatibility complex, specifically in their ELA or equine lymphocyte antigen subtype. Recent research from Germany has supported this concept in German warmbloods susceptible to disease. Substantial research in this subject is ongoing in many universities, and genetic testing for mutations associated with uveitis may be available in the future.

Unilateral vs Bilateral disease: Recurrent uveitis can be a unilateral or bilateral disease. In a study of 160 cases reviewed by the author:

- 50% of horses seropositive for a pathogenic strain of leptospira had unilateral disease and 50% had bilateral disease
- Over 80% of the Appaloosas had bilateral disease
- 62% of the non-Appaloosa horses that were seronegative for pathogenic strains of leptospira had unilateral disease

Uveitis may begin in one eye and later occur in the fellow eye. However, if a case is unilateral and no attacks are seen in the other eye for two years after the initial attack, it is uncommon for uveitis to occur in the contralateral eye.

B. Therapy of uveitis

Mydriasis is essential therapy for all cases of acute uveitis. Initial application of atropine should be BID until pupil is fully dilated, then reduced to SID with frequent monitoring to assure that the pupil stays dilated. Severe cases may show poor response to the action of mydriatics.

Topical corticosteroids and systemic NSAIDS are the core elements of anti-inflammatory field therapy for acute attacks. Therapy should be intense for about two weeks and may be tapered over another two to four weeks depending on response. Subconjunctival and/or systemic corticosteroids are indicated in severe cases.

Intravitreal injection of gentamycin: Recently many horses with ERU have shown fewer flares and a reduction in intraocular inflammation after intravitreal injection of 4 mg of preservative free gentamycin sulfate. This is a delicate procedure usually administered by specialists as it carries some risks.

Surgical options: Suprachoroidal cyclosporine implant surgery may reduce the frequency and/or severity of ERU and persistent insidious uveitis. The best candidates for this referral procedure are early ERU cases that have only experienced a few "attacks" who show little or no permanent ocular scarring. Pars plana vitrectomy is frequently performed on ERU horses in central Europe with reported good results but is frequently complicated by the development of post surgical cataracts. The procedure is not often performed in the United States.

C. Common challenges

Insidious, persistent uveitis is a challenging condition that is common in Appaloosas, some draft horses and many Warmbloods. Therapy does little to alter the progression of disease in affected horses, and many cases progress to blindness.

Secondary glaucoma is a complication seen in many of horses who suffer from uveitis, particularly Appaloosas. Glaucoma therapy is often unrewarding in the long term, but topical timolol maleate, dorzolamide or a combination of these two drugs may be tried. Judicious topical steroids and/or mydriatic therapy may help as well.

Calcific band keratopathy may be a complication of topical corticosteroid therapy especially in horses with leptospiral associated uveitis. The troublesome calcium deposits should be treated with diamond burr debridement followed by EDTA chelation.

Secondary corneal ulcers are diagnosed in 25% of horses with ERU or persistent uveitis at some point in their disease course (statistics compiled by author). This fact is not surprising given the pain associated with uveitis and the propensity of horses to suffer self-trauma. Corticosteroids are contraindicated in these cases. Practitioners must warn owners that they should refrain from applying topical steroids to an inflamed painful eye without a full veterinary exam, as signs thought to be a "flare" of ERU may instead be secondary to a corneal ulcer.

D. Prognosis of uveitis

Visual prognosis for horses suffering from multiple acute attacks of uveitis or insidious chronic disease is always guarded. Data on the statistical incidence of blindness in uveitic horses is lacking, but it is clear that uveitis is the leading cause of blindness in horses worldwide.

The author has observed ocular inflammation serious enough to threaten vision in at least 1-2% of her practice population. Analysis of the visual outcome of 160 cases followed over 11 years revealed the following trends:

- 56% of the case series ((89/160) lost vision in one or both eyes.
- 20% of the cases (32/160) became completely blind
- 36% (57/160) lost vision in one eye

Breaking the cases down further into those that were seropositive or seronegative to *L. interrogans* serovar *Pomona,* and those that were Appaloosas or "non-Appaloosas", the following trends were seen:

- Appaloosa horses seropositive to *L. pomona* had a very poor visual prognosis: 100% lost vision in at least one eye and 50% went completely blind (n=14).

- Appaloosa horses that were seronegative had substantial occurrence of blindness: 72% lost vision in at least one eye and 29% went completely blind. (n=28)
- Other breeds of horses that were seropositive to *L. pomona* had a slightly lower rate of blindness, but 50% still lost vision in at least one eye and 17% went completely blind (n=86)
- Seronegative non-Appaloosa horses had the best visual prognosis: 34% lost vision in at least one eye, and just 6% went completely blind. (n=32)

Secondary complications and degeneration of ocular tissues are common sequellae; the following findings are frequently seen in insidious cases that are longstanding or in cases where several flares have occurred:

- **Cornea**: Focal scars, folds, calcium deposits and other corneal opacities are common. LAU cases are noted to experience a high rate of calcific band keratopathy. Striae and dense corneal folds are common in Appaloosas and highly correlated with blindness.
- **Iris:** Iris atrophy and color change are common, especially in Appaloosas and LAU horses. Anterior synechiae are rare unless phthisis bulbi is present, but posterior synechia occur in a large % of affected horses.
- **Lens**: Diffuse cataract(s) develop in a high % of all cases, and affect nearly 75% of the Appaloosas. These cataracts are a common cause of blindness. Lens luxation is common in Appaloosas.
- **Posterior segment**: Severe vitritis is often observed. Peripapillary scarring (focal or alar) occurs in some horses. Cataracts and synechiae often obstruct posterior segment evaluation, so inflammatory changes in such changes may not be detected.
- **Glaucoma and phthisis bulbi:** Appaloosas have a high rate of glaucoma. Phthisis bulbi is a frequent end stage finding in uveitic horses that become blind.

Many horses with ERU, particularly those with glaucoma or calcific keratopathy, experience chronic pain even after vision is lost. These patients benefit from enucleation and may show a dramatic positive change in temperament after the offending globe is removed.

E. Blindness

Recurrent or insidious uveitis is the leading cause of blindness in horses. It is a challenging disease to treat and manage, and it affects large portions of the horse industry worldwide. Every year many thousand horses suffer vision loss as a consequence of intraocular inflammation. In some cases, horses with vision loss are euthanized. However many owners are motivated to manage blind horses in their home situations. Successful management of a blind horse is highly dependent on temperament and owner dedication. Owners can be referred to this website which links to reference #4** below: www.blindhorses.org

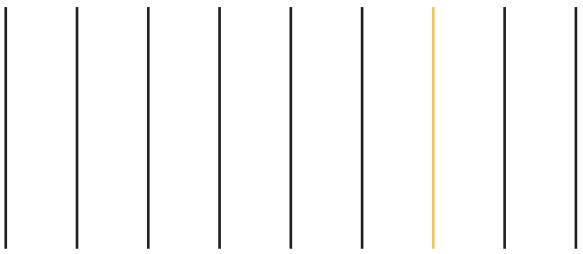
References/Suggested Reading

1. Deeg CA. Ocular immunology in equine recurrent uveitis. Vet Ophthalmol 11 (Suppl 1): 61-65, 2008.
2. Dick AD. Understanding uveitis through the eyes of a horse: relevance of models of ocular inflammation to human disease. *Ocul Immunol Inflamm*; 6:211-214, 1998.
3. Dwyer, AE et al. Association of leptospiral seroreactivity and breed with uveitis and blindness in horses: 372 cases (1986-1993). *JAVMA,* 207 (10): 1327-1331, 1995

4. Dwyer AE. Management of blind horses. In Gilger, B, (ed.) *Equine Ophthalmology*, 4th Ed. Hoboken, NJ, Wiley Blackwell: 798-820, 2022**
5. Gilger, BG and Hollingsworth K. Equine recurrent uveitis: new methods of management. in *Veterinary Clinics of North America, Equine Practice 20 (2) Updates in Equine Ophthalmology.* Philadelphia, Saunders: 417-428, 2004.
6. Gilger, B, Degroot R and Deeg C. Diseases of the uvea, uveitis and recurrent uveitis. In Gilger, B, (ed.) *Equine Ophthalmology*, 4th Ed. Hoboken, NJ, Wiley Blackwell: 441-498, 2022.
7. Gelatt, KN, Spiess, B and Gilger, B. Vitreoretinal Surgery. In Gelatt KN and Gelatt JP, *Veterinary Ophthalmic Surgery*. Philadelphia, Elsevier; 369-370, 2011.
8. Roberts SR, York C, Robinson J. An outbreak of leptospirosis in horses on a small farm. *J Am Vet Med Assoc*;121:237-242, 1952.

EQUINE INTRAVENOUS REGIONAL LIMB PERFUSION

JARROD TROY
DVM, DACVS-LS, CERP



EQUINE

Equine Regional Limb Perfusion

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1

Conflict of Interest Disclosure:

I have no financial interest, arrangement, or affiliation with any company or organization.

2

Objectives

- Discuss clinical use of intravenous regional limb perfusion (IVRLP) in horses
- Perform IVRLP in horses
- Discuss variations in IVRLP technique in horses

3

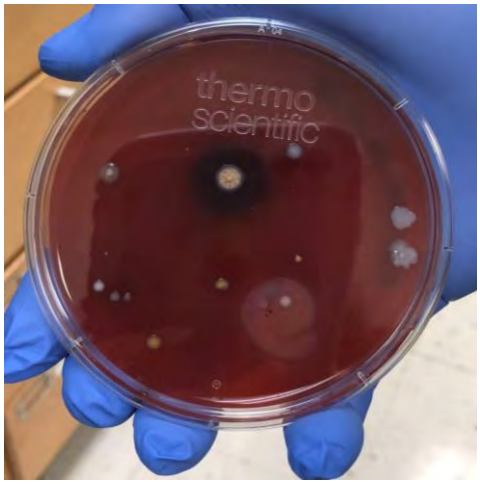
Outline

- IVRLP indications and clinical use
- Performing a traditional IVRLP
- IVRLP technique variations

4

IVRLP

- Generates locally high antimicrobial concentrations
- Concentrations to 91 times higher than bacterial MIC



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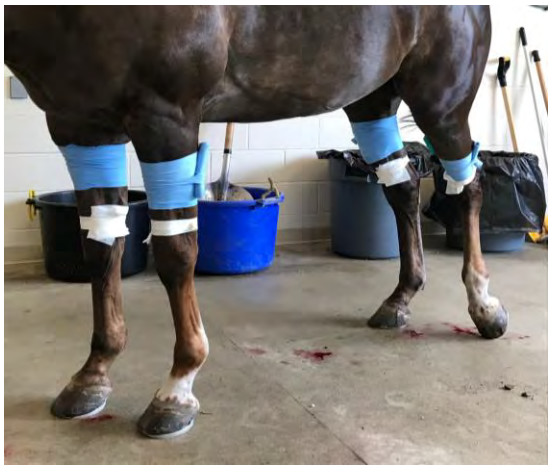
IVRLP

- Intravenous antimicrobial administration
- Administered in isolated vasculature
- Tourniquet placed proximal for isolated



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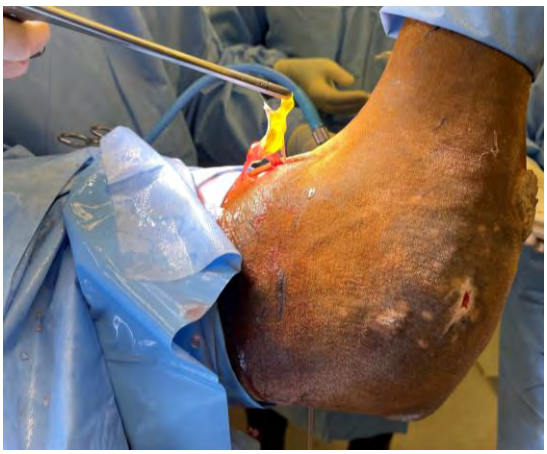
IVRLP Indications

- Orthopedic infections
- Synovial sepsis
- Cellulitis
- Penetrating wounds



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IVRLP Indications

- Three reports on clinical IVRLP

Indwelling Cephalic or Saphenous Vein Catheter Use for Regional Limb Perfusion in 44 Horses with Synovial Injury Involving the Distal Aspect of the Limb

Gal Kelmer[1], DVM, MS, Diplomate ACVS & ECVS, Amos Tatz[1], DVM, and Tali Bdolah-Abram[2], Msc

Meropenem Administered via Intravenous Regional Limb Perfusion for Orthopedic Sepsis in Horses: A Clinical Retrospective Study

Allison P. Mosichuk[1], Joseph S. Smith[2,3], Dane M. Tatarniuk[4], Jarrod R. Troy[4] and Amanda J. Kreuder[5]*

Clinical use of antimicrobial regional limb perfusion in horses: 174 cases (1999–2009)

Luis M. Rubio-Martínez, DVM, PhD, DACVS; Colette R. Elmas, DVM; Belinda Black, BVMS; Gabrielle Monteith, BS

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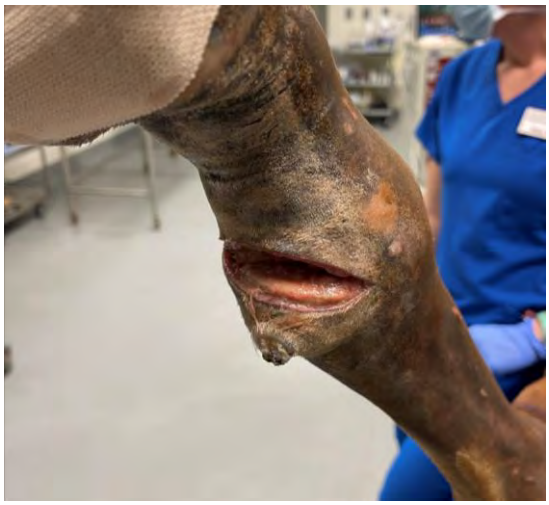
IVRLP Indications

- Synovial sepsis – 71-87% survival
- Return to exercise – 61-80%
- Further clinical study needed



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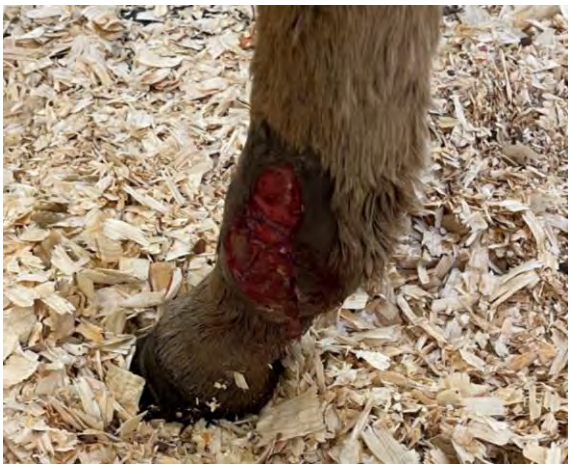
IVRLP Indications

- Retrospective study 2010-2020 from Iowa State (unpublished data)
- Evaluated IVRLP treatments
  - Septic synovitis
  - Penetrating synovial wounds

10

Septic Synovitis Qualifiers

- Positive bacterial culture
- Bacteria on cytology
- ≥3 of cytology criteria



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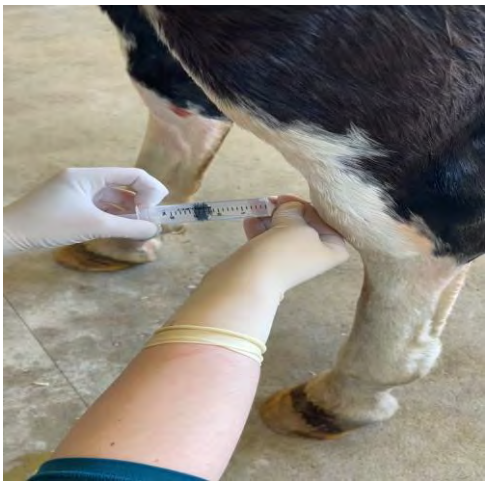
Septic Synovitis Qualifiers

- WBC > 30,000 cells/uL
- >90% PMN or degenerative PMN
- Total protein >4 g/dL
- Fibrin present in synovial space



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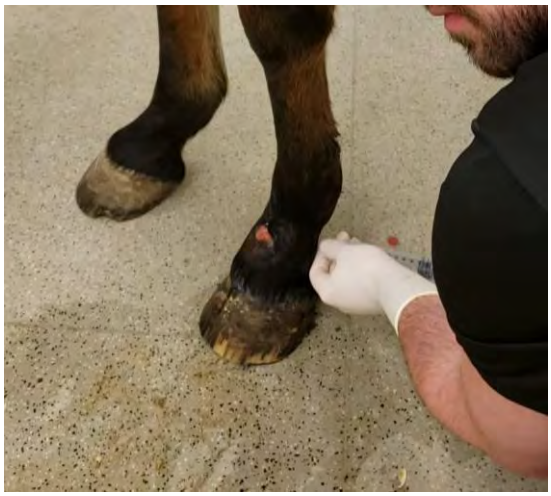
Penetrating Wound Qualifiers

- Wounds involving distal limb synovial structures
- Fluid observed exiting wound during distension
- 1-3 septic synovitis qualifiers



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IVRLP Indications

- 163 cases
- All cases treated with IVRLP
- Gentamicin the most common antimicrobial used

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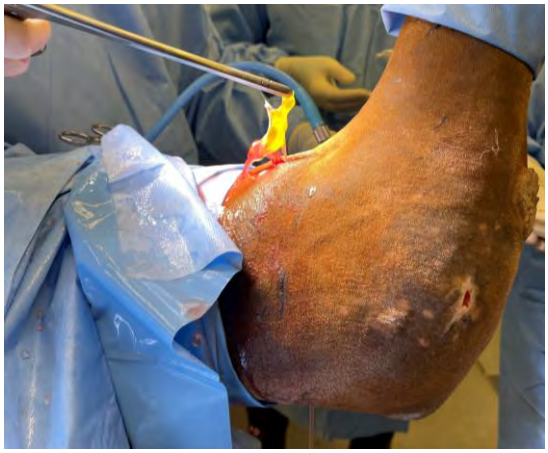
Septic Synovitis

- 63 cases
- Septic synovitis survival to discharge – 88% (56/63)
- Survival >1 year – 61% (25/41)



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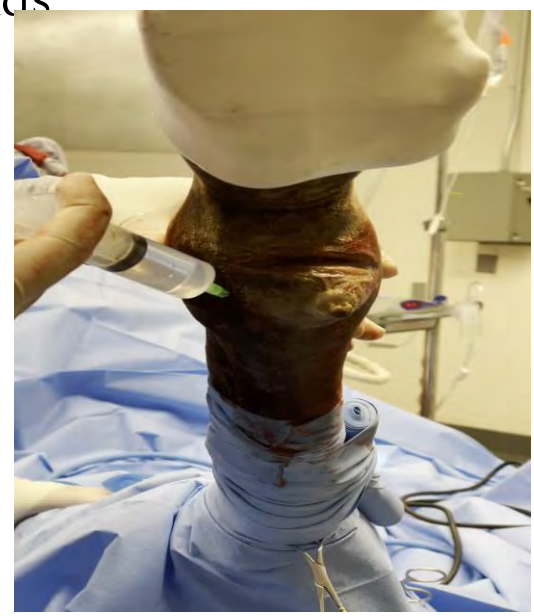
Penetrating Synovial Wounds

- 100 cases
- Penetrating wound survival to discharge – 99% (99/100)
- Survival >1 year – 84% (46/55)



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IVRLP Indications

- Clinical reports – IVRLP overall helpful
- Clinical reports – few

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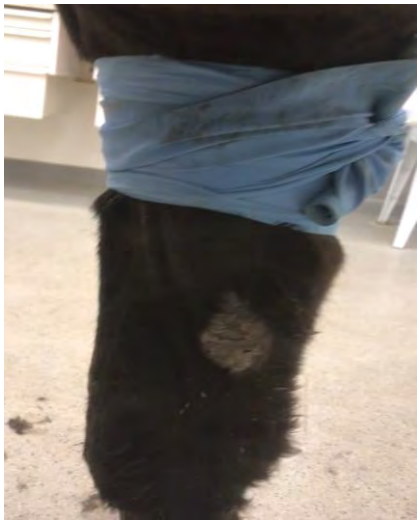
Outline

- IVRLP indications and clinical use
- Performing a traditional IVRLP
- IVRLP technique variations

18

Performing IVRLP

- Supplies
- Sedation
- Traditional technique



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IVRLP Supplies

- Antimicrobial (1/3 systemic dose)
- Wide rubber (Esmarch) tourniquet
- Butterfly (over the needle) catheter 19-25 g (21 g author)

20

IVRLP Supplies

- 5 cm (2”) gauze roll
- Local anesthetic (mepivacaine 2%)
- Isotonic IV fluid solution
- Syringes large enough to hold entire perfusate volume

21

IVRLP Supplies

- Sedation
- Adhesive tape with 1-2 gauze 4x4 sponges
- Chlorhexidine scrub & 70% isopropyl alcohol

22

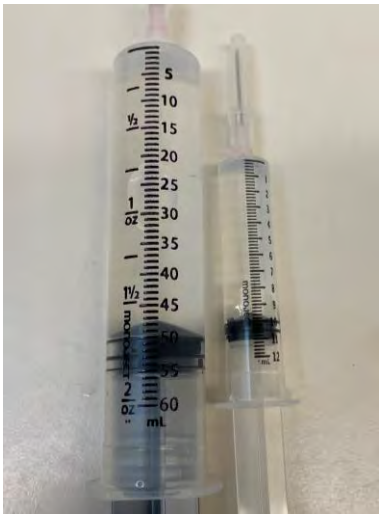
IVRLP Perfusate

- Create before sedation when possible
- Total perfusate volume – 60 mL
- Antimicrobial 1/3 systemic dose volume
- Remaining volume with isotonic fluid

23

IVRLP Perfusate

- 1 or 2 syringes
- 2 syringes – antibiotic & isotonic solution
- Antibiotic first in case vein develops hematoma/inflammation



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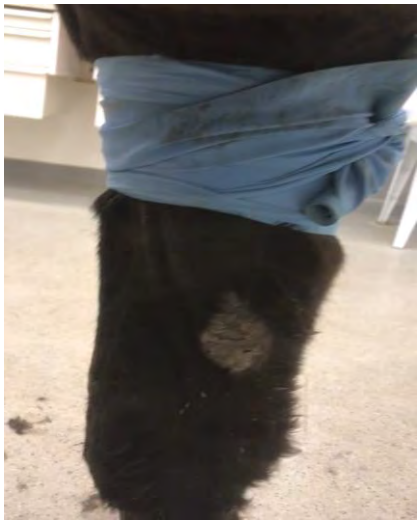
Performing IVRLP

- Supplies
- Sedation
- Traditional technique



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IVRLP Sedation

- Very important to minimize patient movement
- Limb movement increases release into systemic circulation
- Over sedation causes stumbling & limb movement

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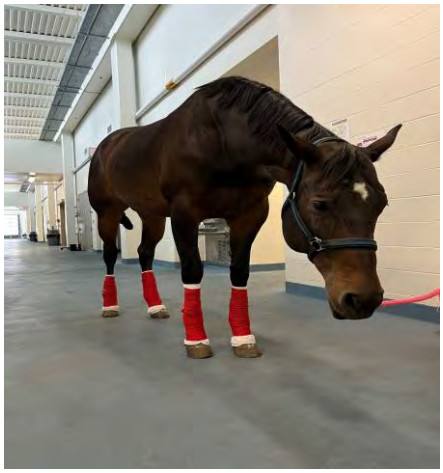
IVRLP Sedation

- Detomidine (0.01 mg/kg) IV
- Butorphanol (0.01 mg/kg) IV
- Xylazine (0.02 mg/kg) IV – often used as re-dose to limit movement



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IVRLP Sedation

- Horse should remain standing & still for 30 minutes after IVRLP
- Re-dosing of sedation during IVRLP is common
- Perineural anesthesia can aid in movement reduction

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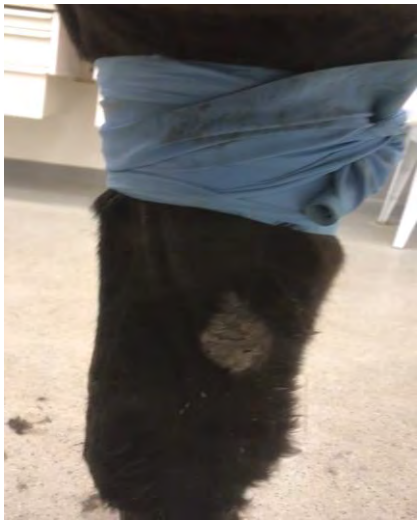
Performing IVRLP

- Supplies
- Sedation
- Traditional technique



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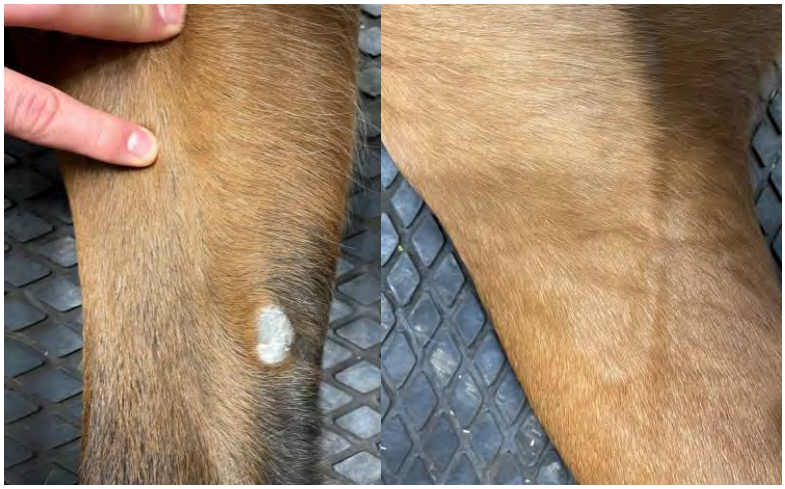
Traditional IVRLP

- Preparation
- Administration
- Post-administration

30

IVRLP Preparation

- Identify target vein
- Cephalic
- Saphenous
- Digital veins



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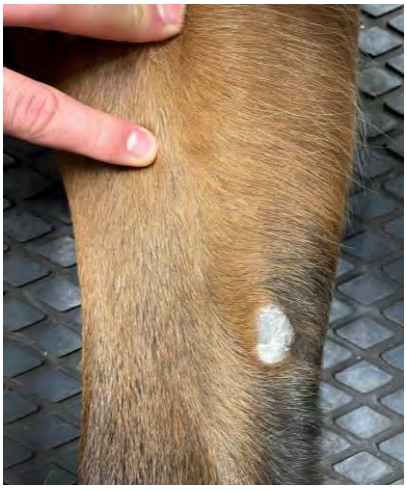
IVRLP Preparation

- Aseptically prepare target vein
- Peripheral nerve blocks
- Ensure can visualize or palpate target vein
- ± Perform before sedation



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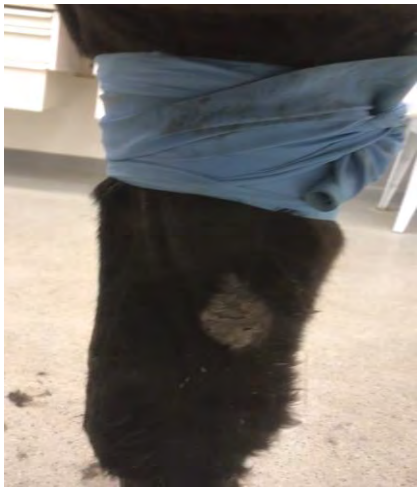
Traditional IVRLP

- Preparation
- Administration
- Post-administration

33

IVRLP Administration

- Tourniquet placed at least 10cm proximal to target site when possible
- 5cm (2”) gauze roll placed over target vein with tourniquet wrapped over top



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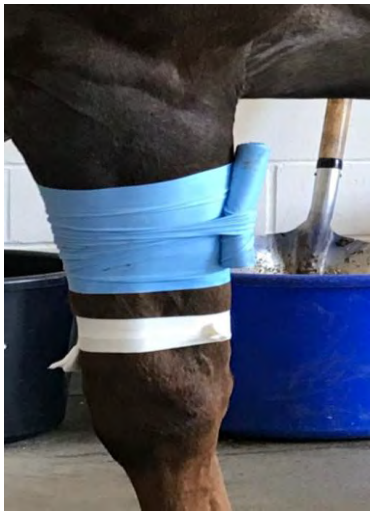
IVRLP Administration

- Tourniquet should be wrapped as tightly as possible without breaking
- Secure tourniquet so does not unravel before 30 minutes



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IVRLP Administration

- Butterfly catheter can be placed in target vein as proximal as possible
- Distal vein can be used in case of phlebitis
- Allow blood to prime the line

36

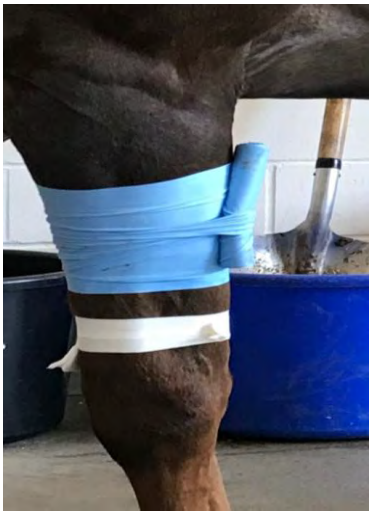
IVRLP Administration

- Whenever possible aim for single venipuncture to reduce leakage
- Do not pullout previous catheters if hit vein but not working – reduce leakage
- Pull later and wrap with bandage

37

IVRLP Administration

- Whenever possible aim for single venipuncture to reduce leakage
- Do not pullout previous catheters if hit vein but not working – reduce leakage
- Pull later and wrap with bandage



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IVRLP Administration

- Administer perfusate slowly over 1-3 minutes
- Check to ensure blood returning into catheter line
- Once completed remove catheter and place bandage

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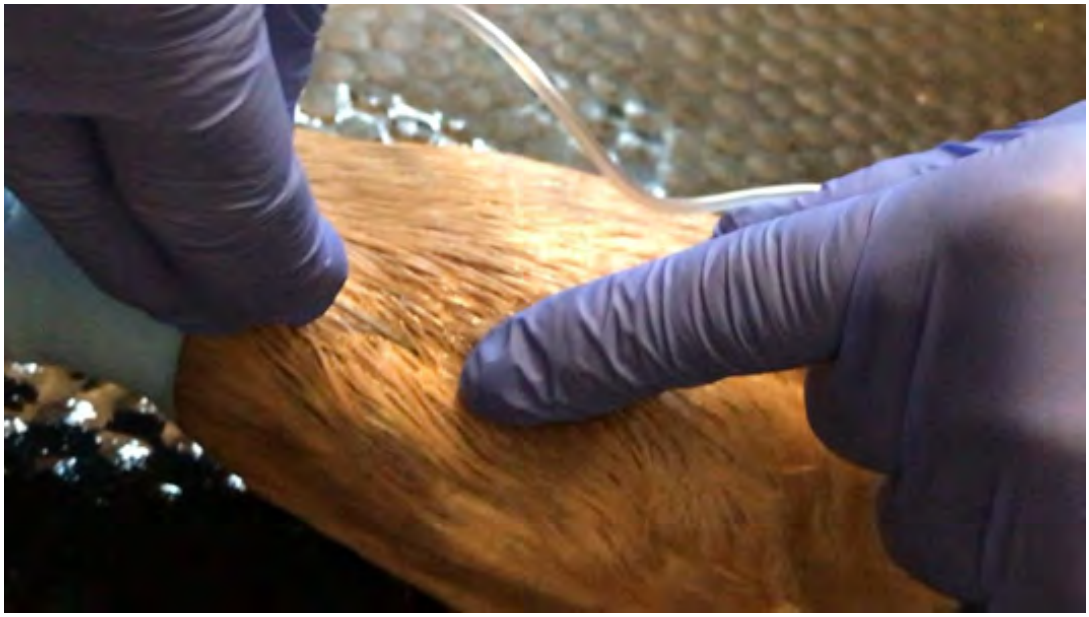

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IVRLP Administration

- If swelling (phlebitis) occurs…
- Continue if blood returning to catheter and swelling not large
- Try more distal with a second line
- Place compression bandage over site

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Traditional IVRLP

- Preparation
- Administration
- Post-administration

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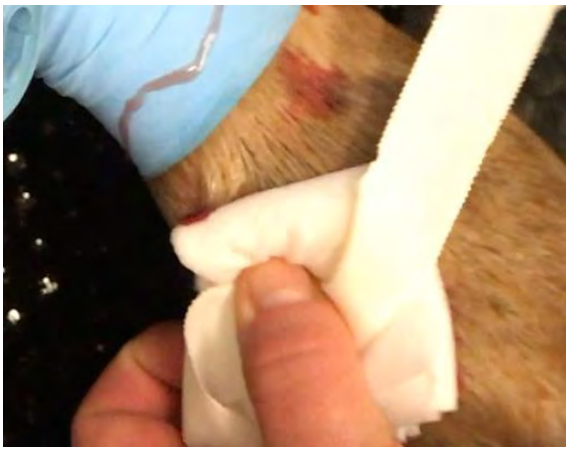
IVRLP Post-administration

- Tourniquet remains in place for 30 minutes with no limb movement
- **Ensure** tourniquet removal after 30 minutes



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IVRLP Post-administration

- Re-dose every 24 hours for 3 days when using aminoglycoside antibiotics
- Break after 3 days to reduce chance of phlebitis & re-assess
- Can continue for another 3 days

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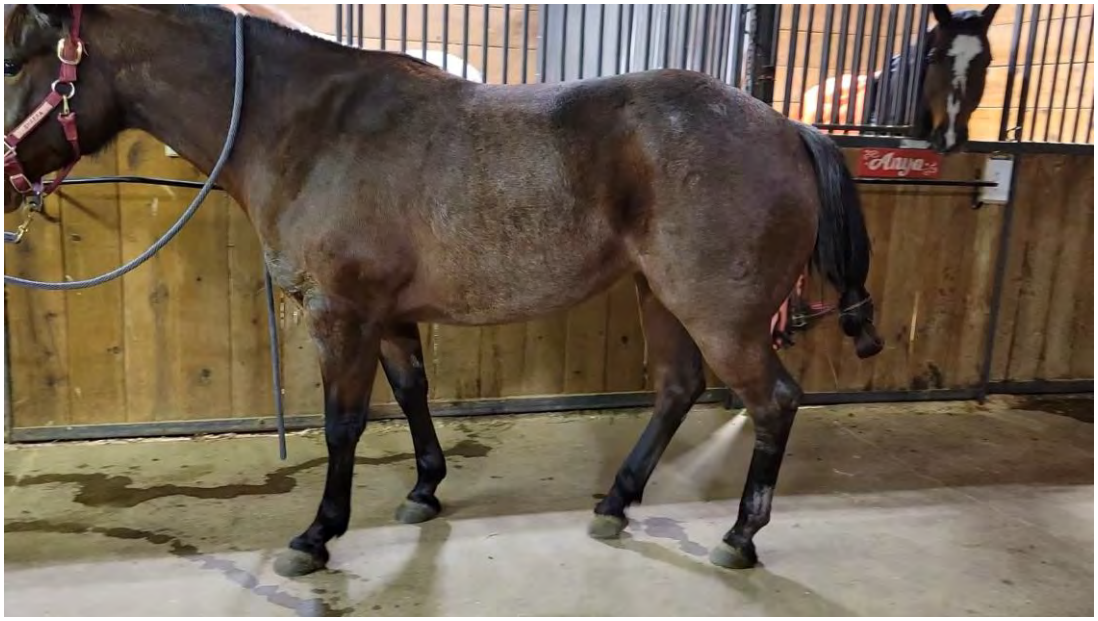

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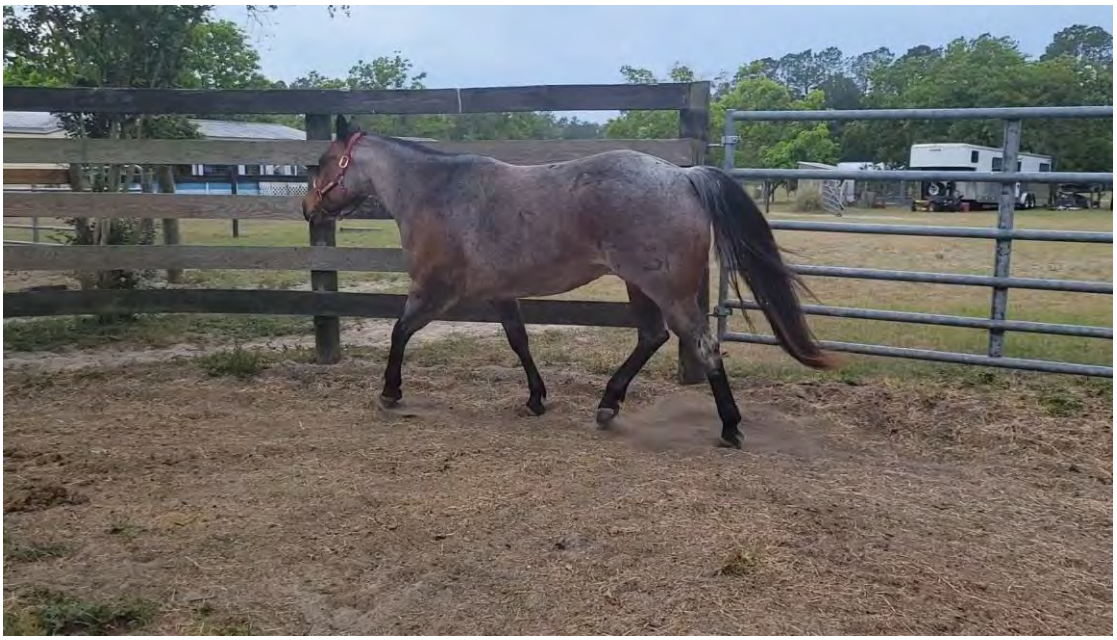


48

Outline

- IVRLP indications and clinical use
- Performing a traditional IVRLP
- IVRLP technique variations

49

IVRLP Modifications

- IVRLP performed often in equine veterinary medicine
- Few clinical reports assessing IVRLP treatment
- Numerous scientific IVRLP concentration & technique studies

50

IVRLP Modification Studies

- Local anesthetic perfusate
- Antimicrobial choice
- Perfusate volume
- Tourniquet duration

51

Local anesthetic perfusate

- Peripheral nerve blocks to reduce motion
- Mepivacaine 2% - 25 mL added to the perfusate reduced sensation

The Effects of Mepivacaine Hydrochloride on Antimicrobial Activity and Mechanical Nociceptive Threshold During Amikacin Sulfate Regional Limb Perfusion in the Horse

Aimée C. Colbath[1], Luke A. Wittenburg[2], Jenifer R. Gold[3], C. Wayne McIlwraith[1], and Valerie J. Moorman[1]

52

Local anesthetic perfusate

- Mepivacaine added to the perfusate reduces additional needles for blocks and wait time
- No change in amikacin synovial concentration

53

Local anesthetic perfusate

- Either option seems to be effective anecdotally
- No difference at ISU (unpublished data) in survival
- Maybe horse dependent

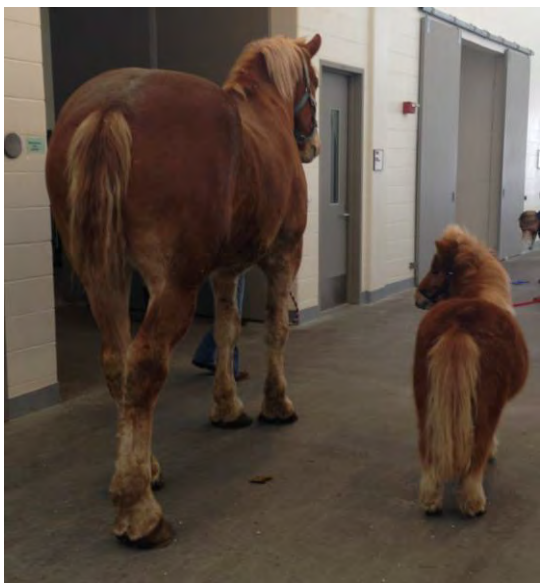


Photo courtesy of Dr. Stephanie Caston

54

IVRLP Modification Studies

- Local anesthetic perfusate
- Antimicrobial choice
- Perfusate volume
- Tourniquet duration

55

Antimicrobial choice

- Aminoglycosides traditionally
- Dosing every 24 hours
- 1/3 systemic dose
- Full systemic dosing or 2/3s?

https://www.jefferspet.com/rx-amikacin-1gm-4ml-injection-10-x-4ml-vials/p

https://pipevet.com/gentamicin-sulfate

56

Antimicrobial choice

- Beta-lactams
- Enrofloxacin
- Meropenem
- ±Dosing schedule changes

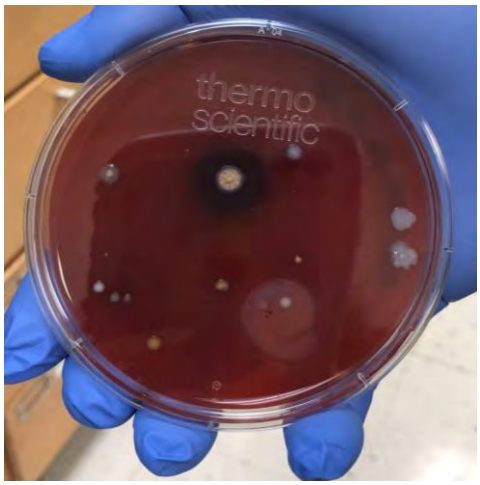
https://www.jefferspet.com/rx-amikacin-1gm-4ml-injection-10-x-4ml-vials/p

https://pipevet.com/gentamicin-sulfate

57

Antimicrobial choice

- Bacterial culture is important
- Treating empirically – reach out to local lab that does the cultures
- ISU gentamicin commonly effective



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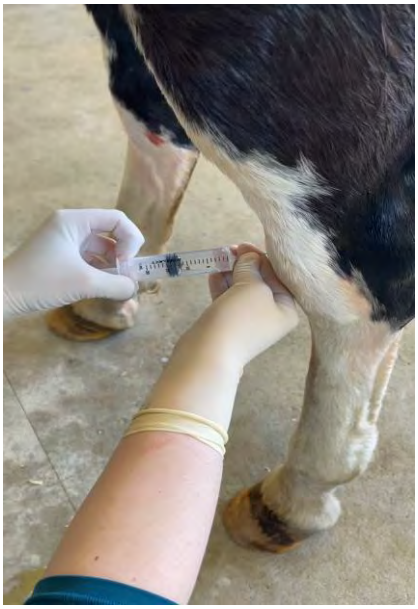
Antimicrobial choice

- Intrasynovial antimicrobial injection
- No data on concentrations reached when doing intrasynovial & IVRLP administration



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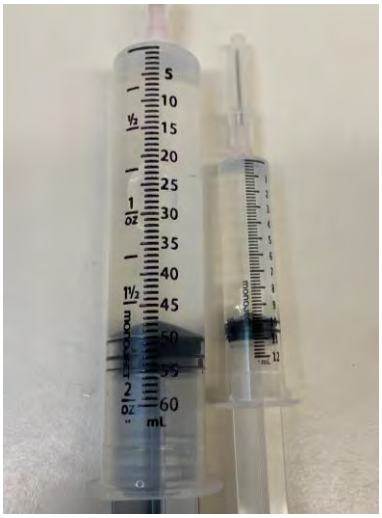
IVRLP Modification Studies

- Local anesthetic perfusate
- Antimicrobial choice
- Perfusate volume
- Tourniquet duration

60

Perfusate Volume

- IVRLP mechanism of action unclear
- Perfusate volumes ranging from 10 – 1000 mL
- Optimum volume is unknown



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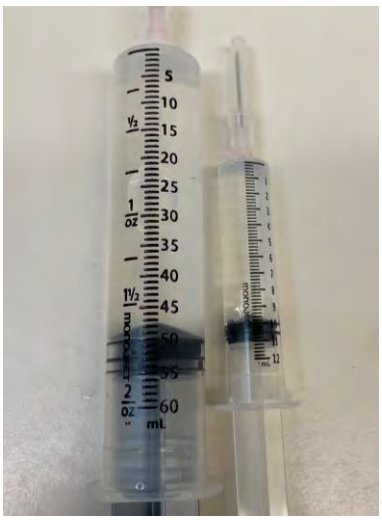
Perfusate Volume

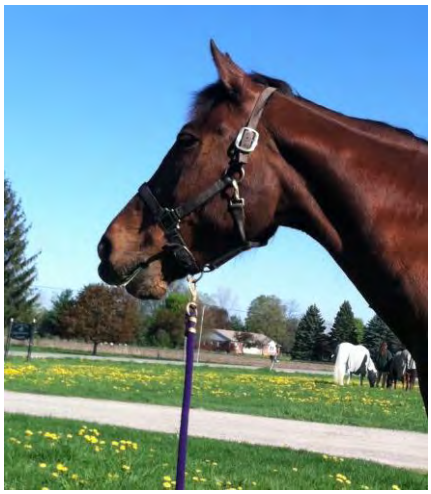
- Clinically 60 mL & 100 mL perfusate volumes have been reported
- Experimentally these different volume ranges can produce clinically high antimicrobial concentrations



62

Perfusate Volume

- Optimum perfusate volume is unknown
- Unpublished data no difference in survival to discharge from perfusate volume – most volumes were 20 or 60 mL



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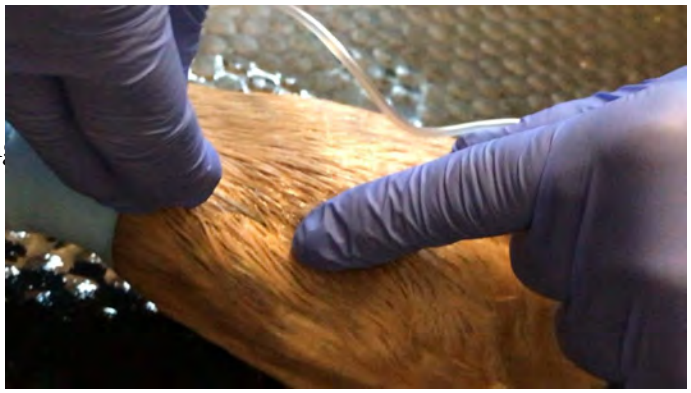
IVRLP Modification Studies

- Local anesthetic perfusate
- Antimicrobial choice
- Perfusate volume
- Tourniquet duration

64

Tourniquet Duration

- 30 minutes can feel a lot longer
- 20 minutes has been evaluated showing no difference when using amikacin



65

Tourniquet Duration

- Further studies are needed to identify optimum tourniquet time
- Ensure tourniquet removal at end of procedure

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Outline

- IVRLP indications and clinical use
- Performing a traditional IVRLP
- IVRLP technique variations

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Summary

- IVRLP is a useful technique for distal limb orthopedic infections, cellulitis, or septic physitis in horses
- Appears to be clinically effective
- Still much more to learn regarding optimum IVRLP use in horses

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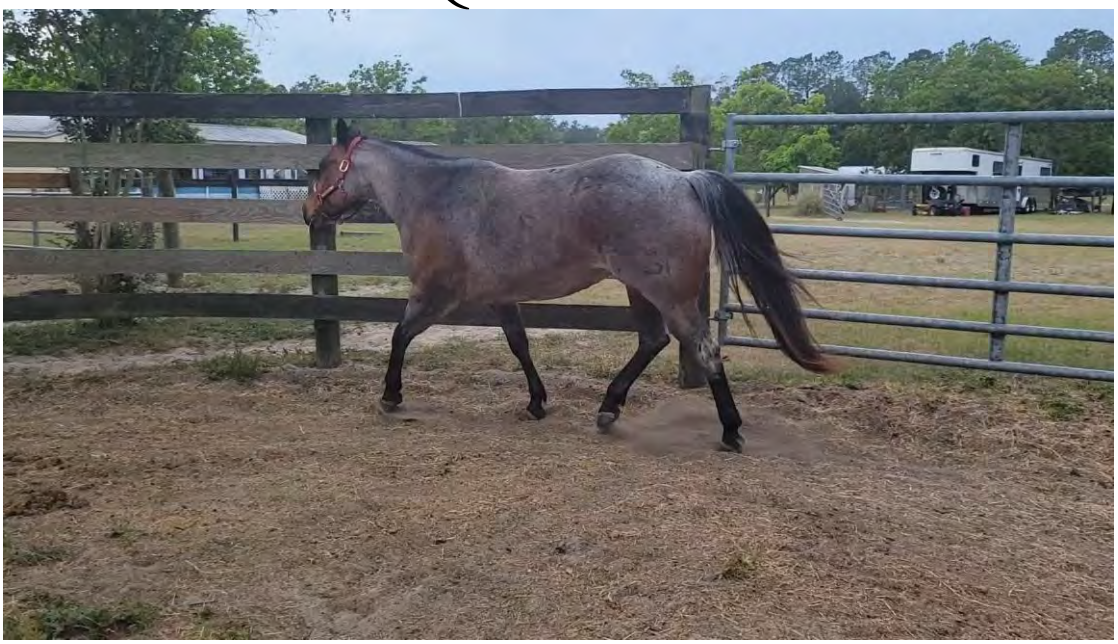
Questions?



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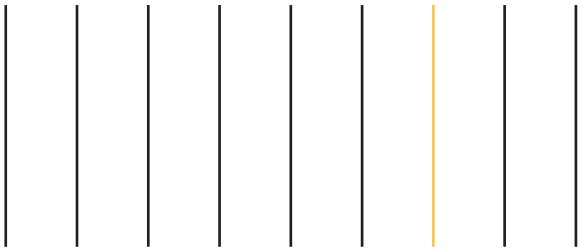
EQUINE EMERGENCY SURGERIES IN THE FIELD

JARROD TROY
DVM, DACVS-LS, CERP



EQUINE

Equine Emergency Surgeries in the Field

Jarrod Troy DVM; DACVS-LA; CERP
Assistant Professor
Iowa State University Veterinary Clinical Sciences

1

Conflict of Interest Disclosure:

I have no financial interest, arrangement, or affiliation with any company or organization.

2

Objectives

- Identify and manage penetrating wounds
- Utilize additional options or tips regarding wound repair
- Perform and utilize additional tips for tracheostomy
- Identify the need and perform a perineal urethrotomy (PU)

3

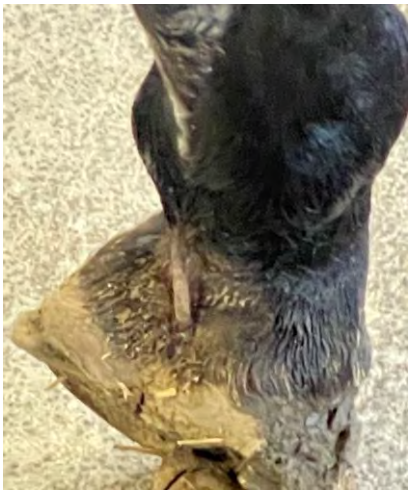
Outline

- Laceration/wound repair
- Tracheostomy
- Perineal urethrotomy (PU)

4

Wounds

- Penetrating
- Non-penetrating



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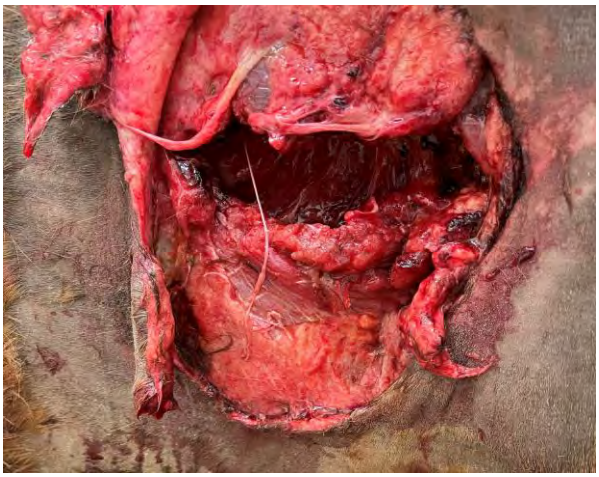
Penetrating Wounds

- Thoracic cavity
- Peritoneal cavity
- Synovial structures

6

Thoracic Penetrating Wounds

- Pneumothorax diagnosis
- Pneumothorax treatment



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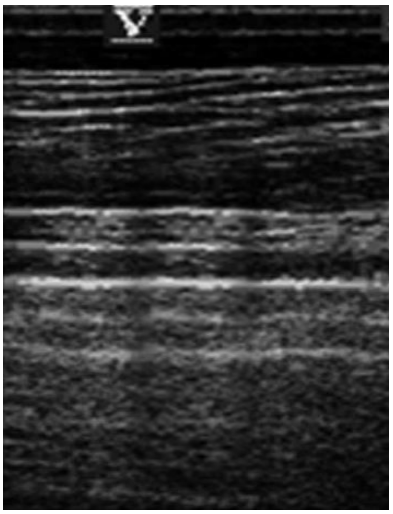
Pneumothorax diagnosis

- Tachypnea/dyspnea/cyanosis
- Reduced lung sounds dorsally
- Ultrasound – no glide sign
- ± Radiographs
- Decreased PaO_2



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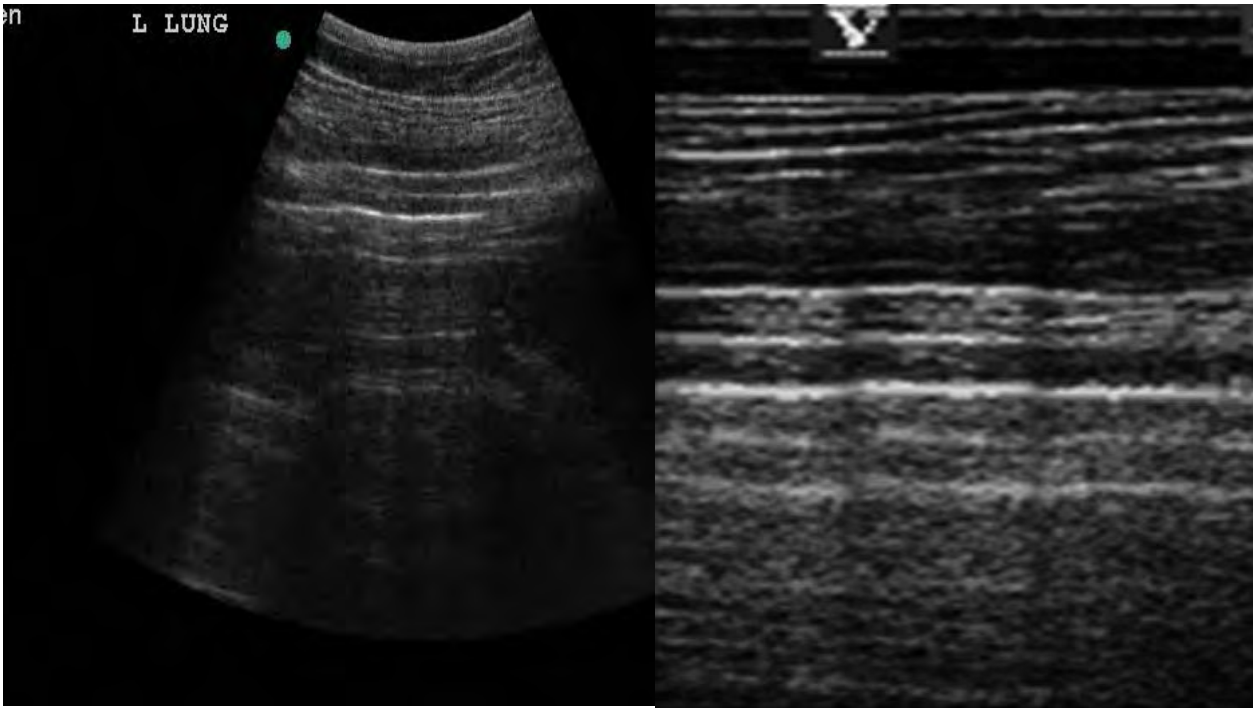

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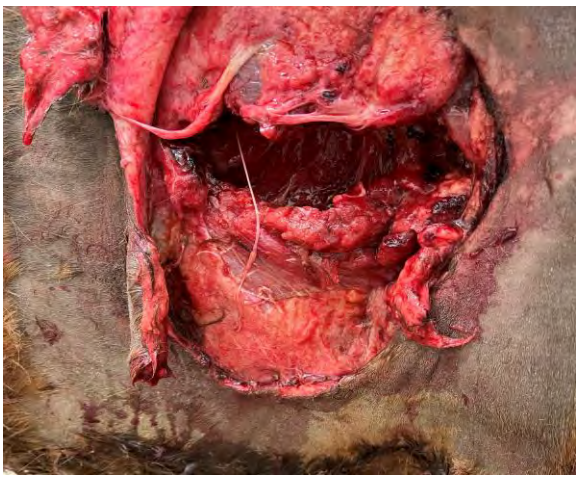
Thoracic Penetrating Wounds

- Pneumothorax diagnosis
- Pneumothorax treatment



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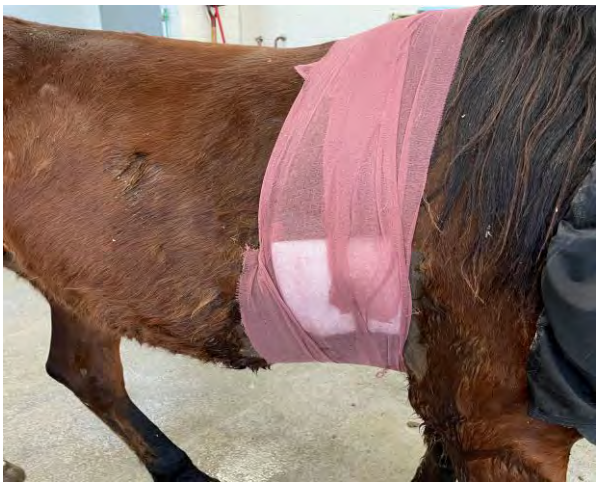
Pneumothorax treatment

- Seal with sterile bandage
- Plastic wrap/tie over bandage/bandage material
- Thoracocentesis
- Thoracostomy drain



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Thoracocentesis

- Rib space 12-15 below epaxial muscles
- 14 g IV catheter/teat cannula/thoracostomy tube
- 60 mL syringe + 3-way stopcock remove air slowly
- >3-4 times in 24 hours – need thoracostomy tube

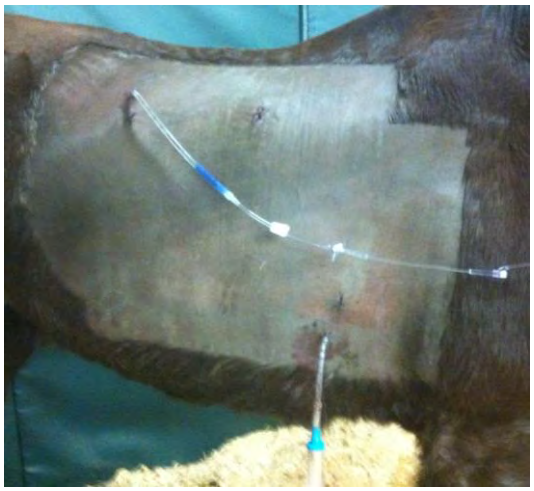
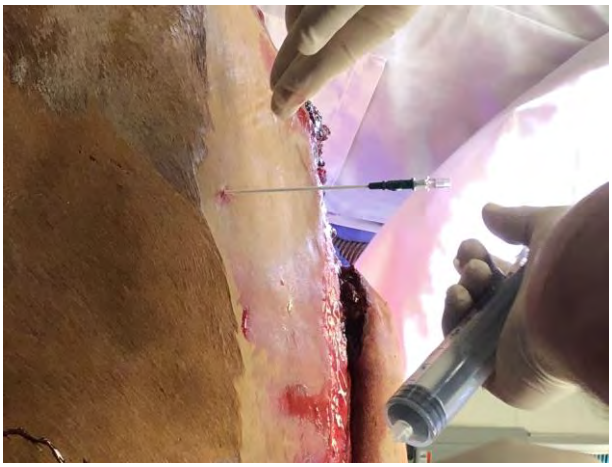


Photo courtesy of Dr. Jamie Kopper

12

Thoracic Penetrating Wounds

- Pneumothorax diagnosis
- Pneumothorax treatment
- After pneumothorax treated manage wound as non-penetrating wound



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Penetrating Wounds

- Thoracic cavity
- Peritoneal cavity

14

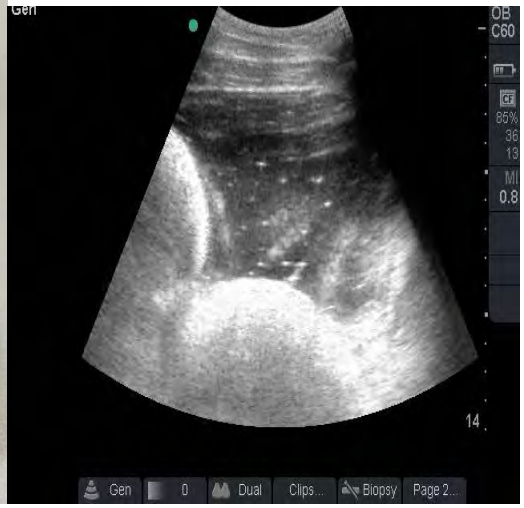
Peritoneal penetrating wound

- Diagnosis
- Treatment

15

Peritoneal penetrating diagnosis

- Abdominocentesis
- Ultrasonography
- Palpation



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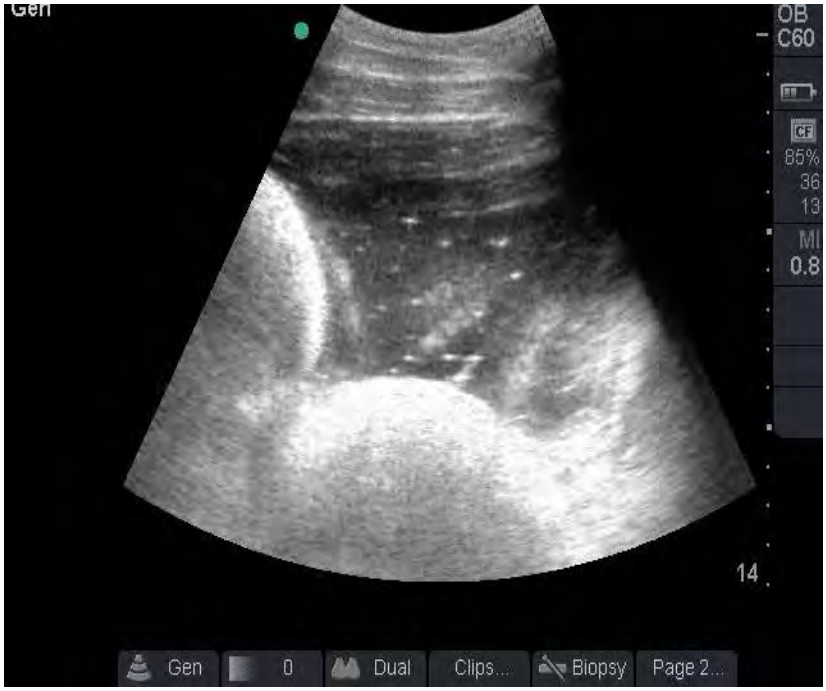

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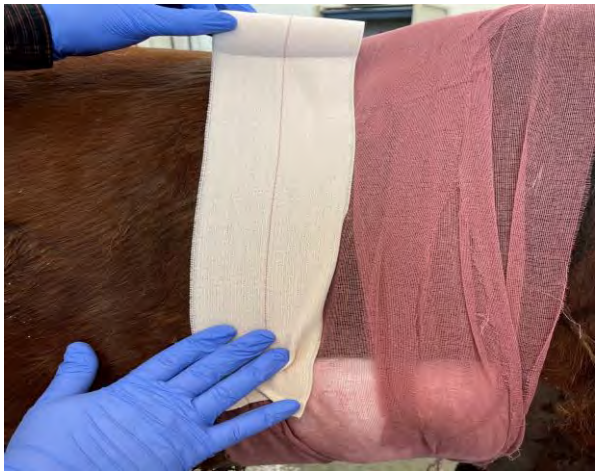
Peritoneal penetrating wound

- Diagnosis
- Treatment

18

Peritoneal penetrating wound Treatment

- Seal wound with plastic wrap or sterile bandage that will not fall into peritoneum
- Surgical repair
- Wound management



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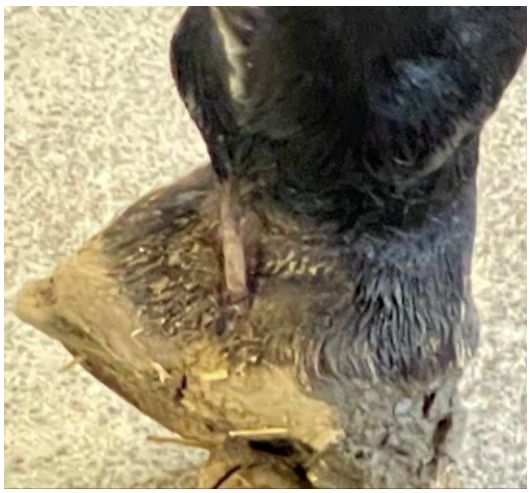
Penetrating Wounds

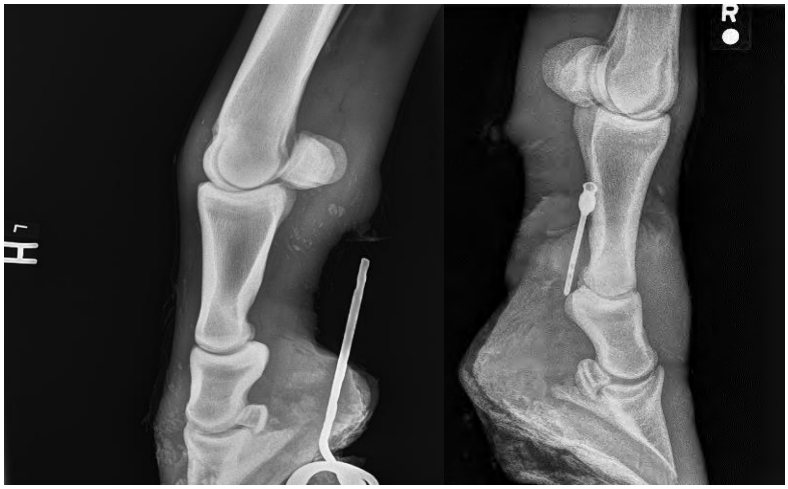
- Thoracic cavity
- Peritoneal cavity
- Synovial structures



20

Synovial structures

- Diagnosis
- Treatment



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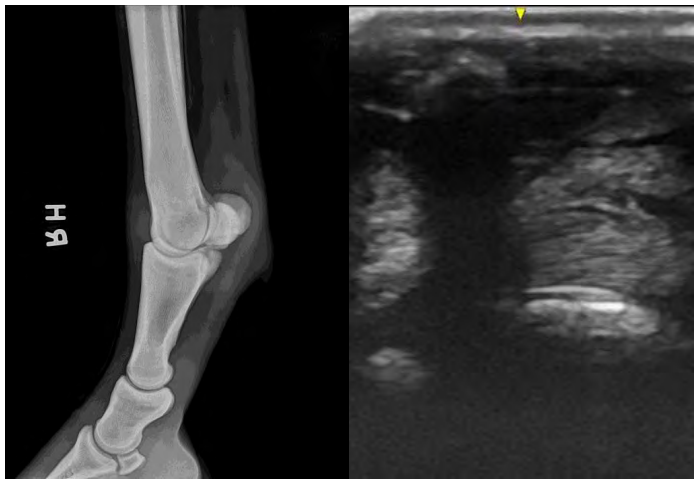
Synovial structures Diagnosis

- Radiographs – 2 or more orthogonal views ± contrast
- Ultrasonography – especially with wood foreign bodies
- Synoviocentesis & analysis



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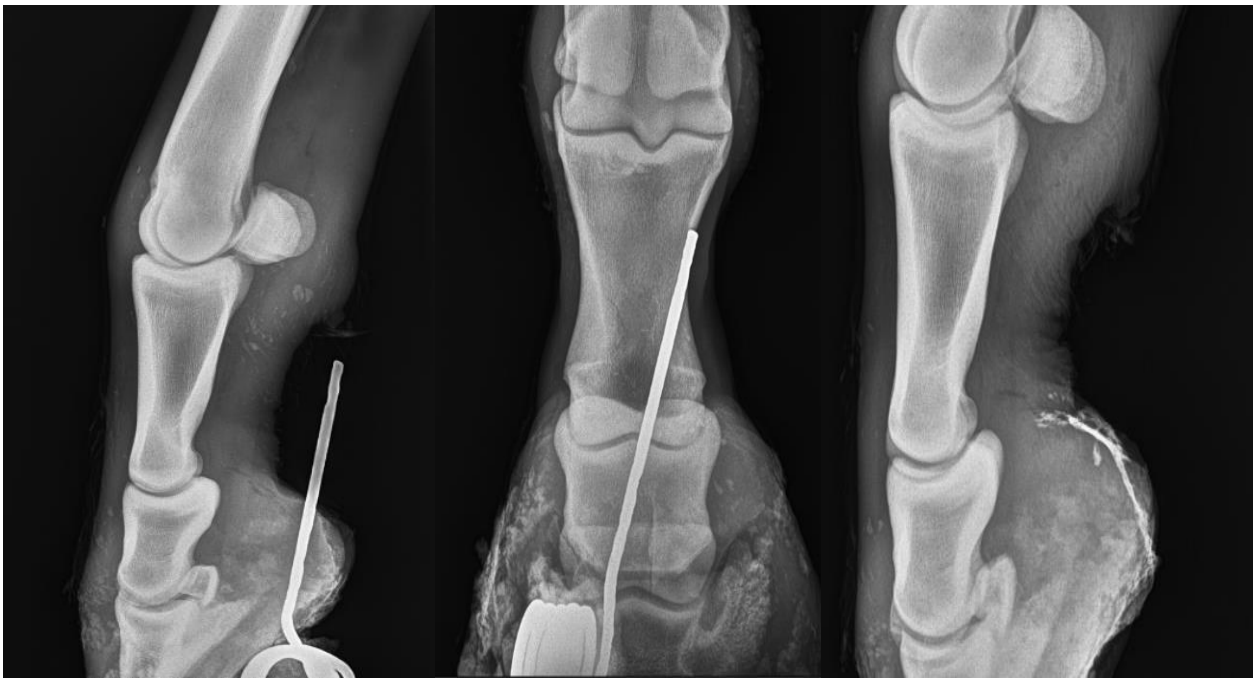

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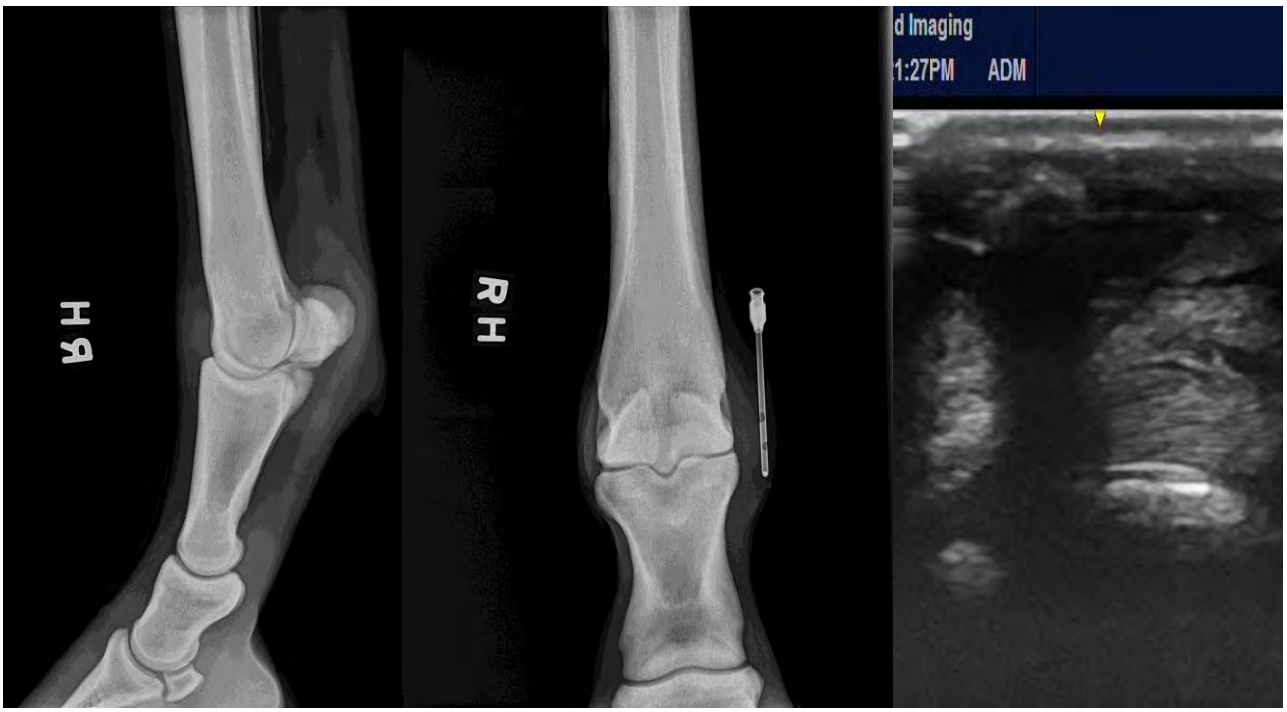

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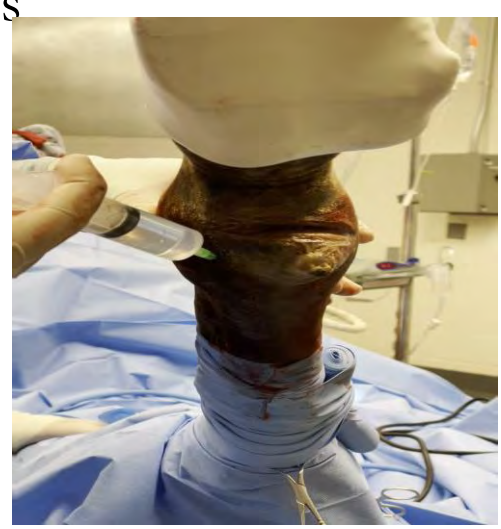
Synoviocentesis & Analysis

- Fluid analysis & culture
- Structure distension looking for communication
- PPG mixture for easier visualization



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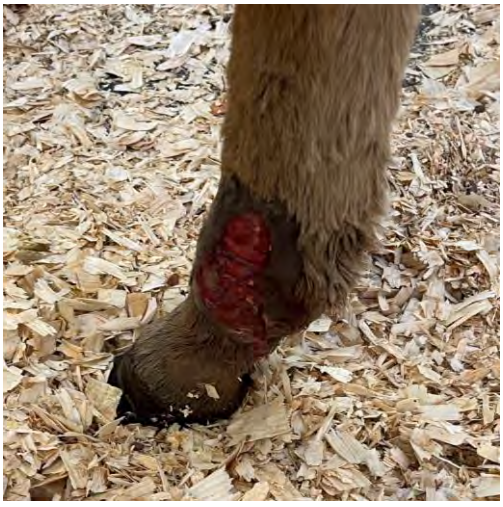
Analysis synovial sepsis

- WBC >20,000 /μL
- TS ≥ 3.5 g/dL
- Degenerate neutrophils >90%
- Bacteria seen or positive culture



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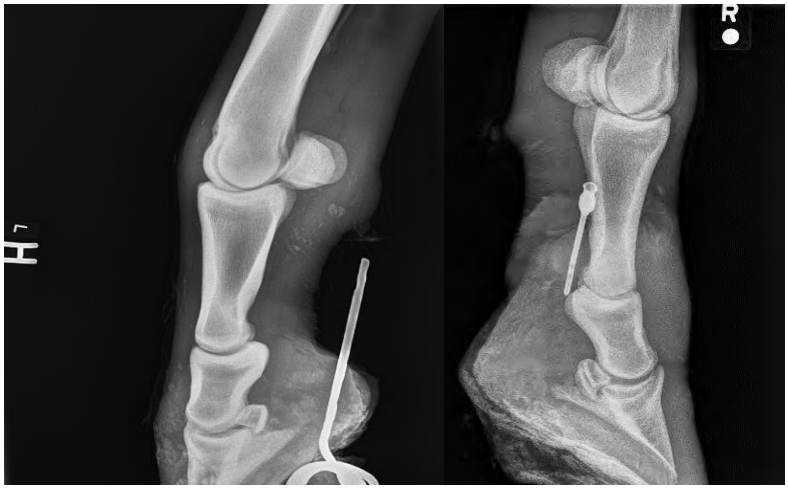
Synovial structures

- Diagnosis
- Treatment



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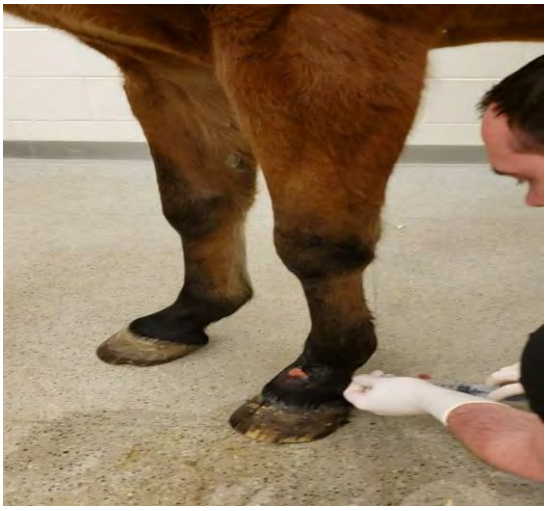
Synovial structures Treatment

- Needle through needle lavage or arthroscopy
- Intrasynovial antibiotics
- Intravenous regional limb perfusion



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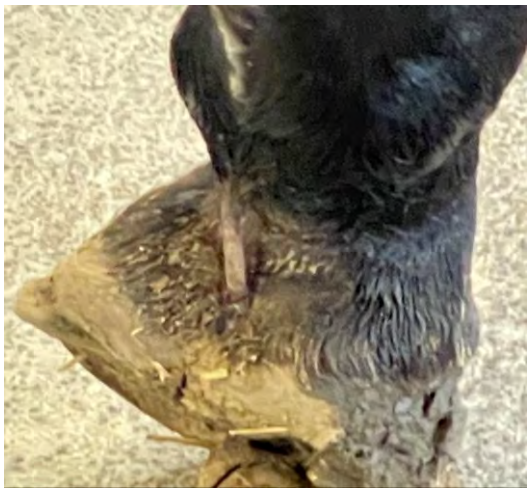
Penetrating Wounds

- Thoracic cavity
- Peritoneal cavity
- Synovial structures



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Wounds

- Penetrating
- Non-penetrating

30

Non-penetrating Wounds

- Standing sedation – patient response
- Local anesthesia
- Wound debridement & repair
- Drains & bandaging

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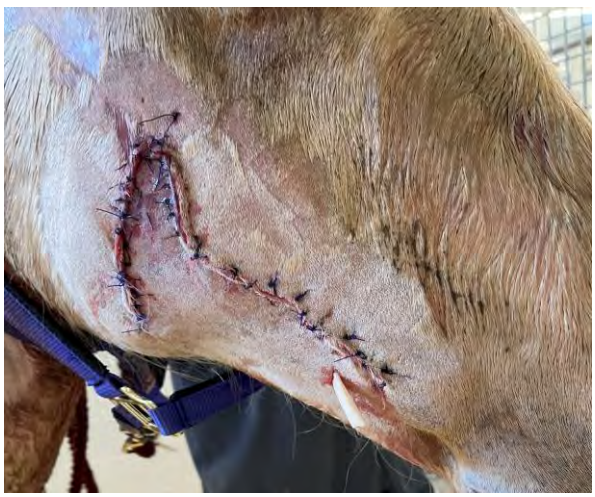
Wound debridement & repair

- Leave skin flaps if possible
- Sharp debridement & lavage
- Mattress sutures
- Near-far-far-Near sutures



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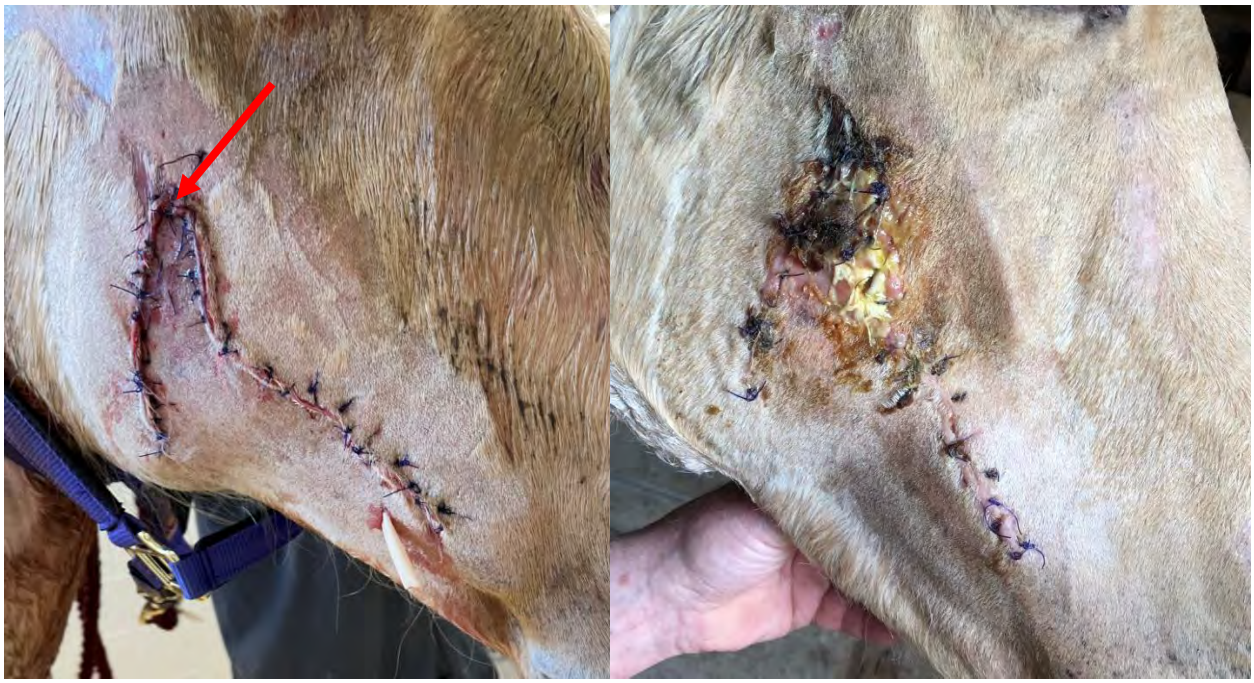

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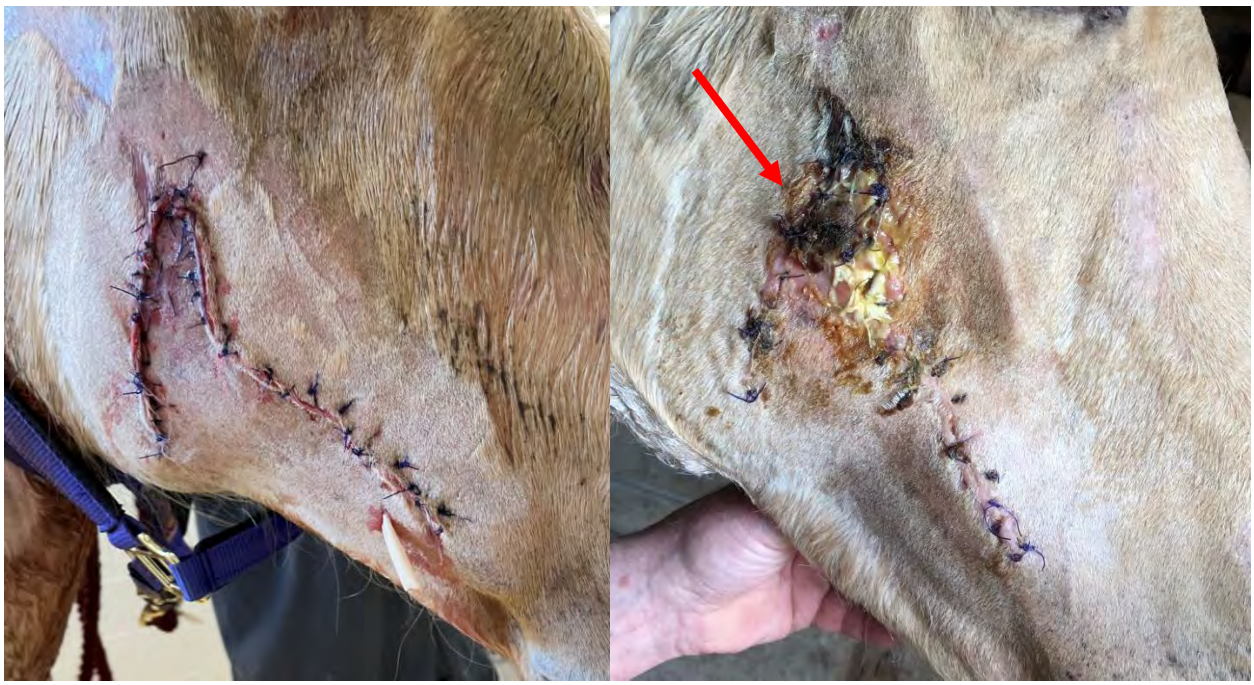

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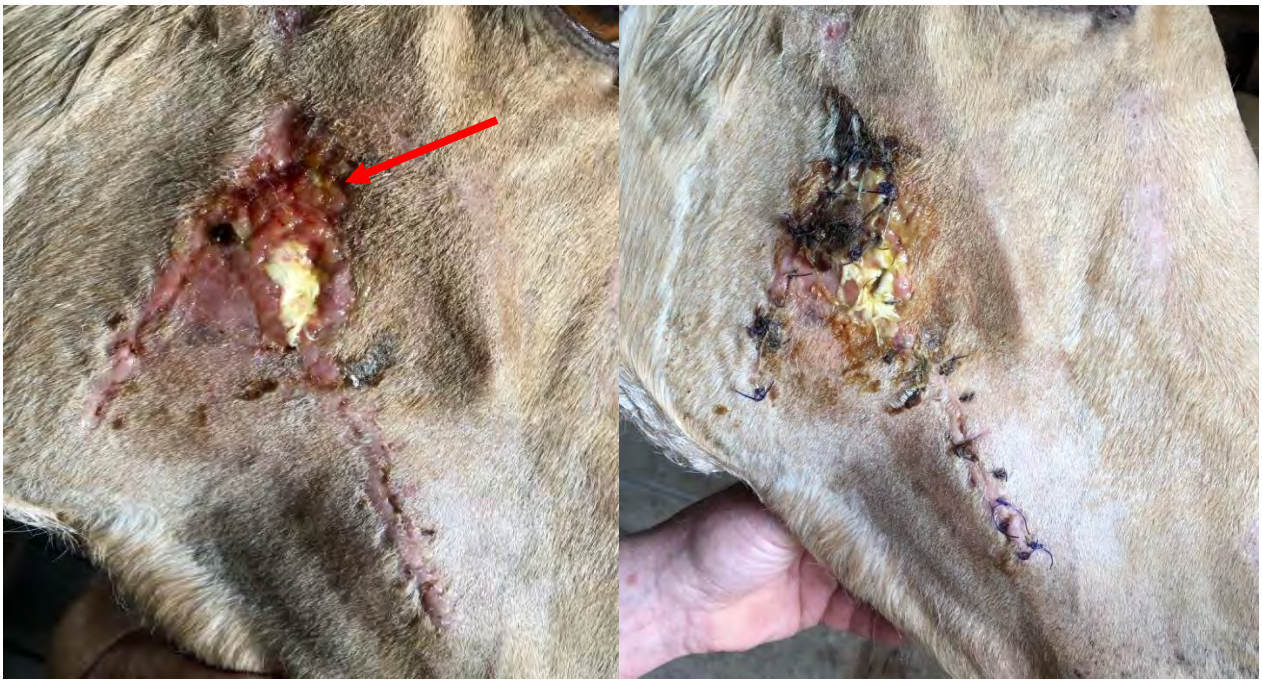

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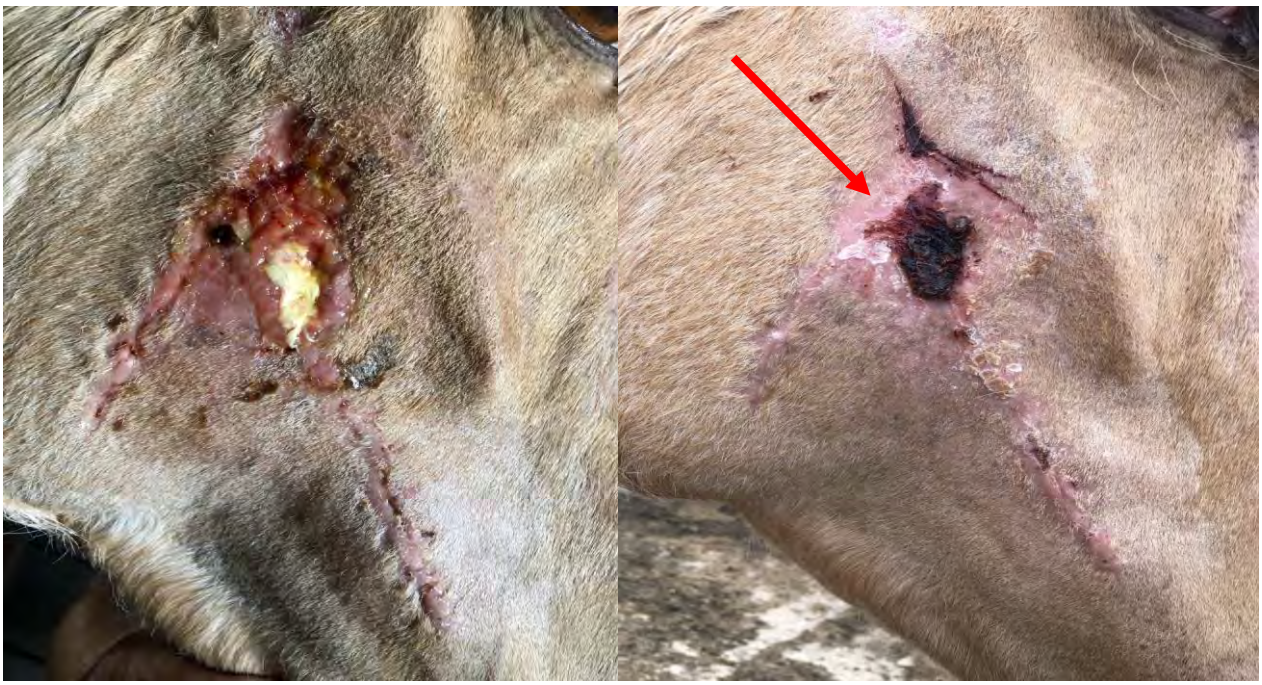

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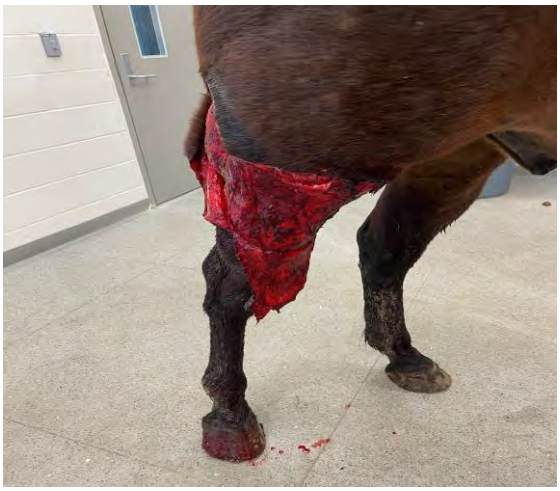
Drains & bandaging

- Large or deep defects
- Penrose drains
- Tie over bandages
- Petroleum jelly & cayenne pepper



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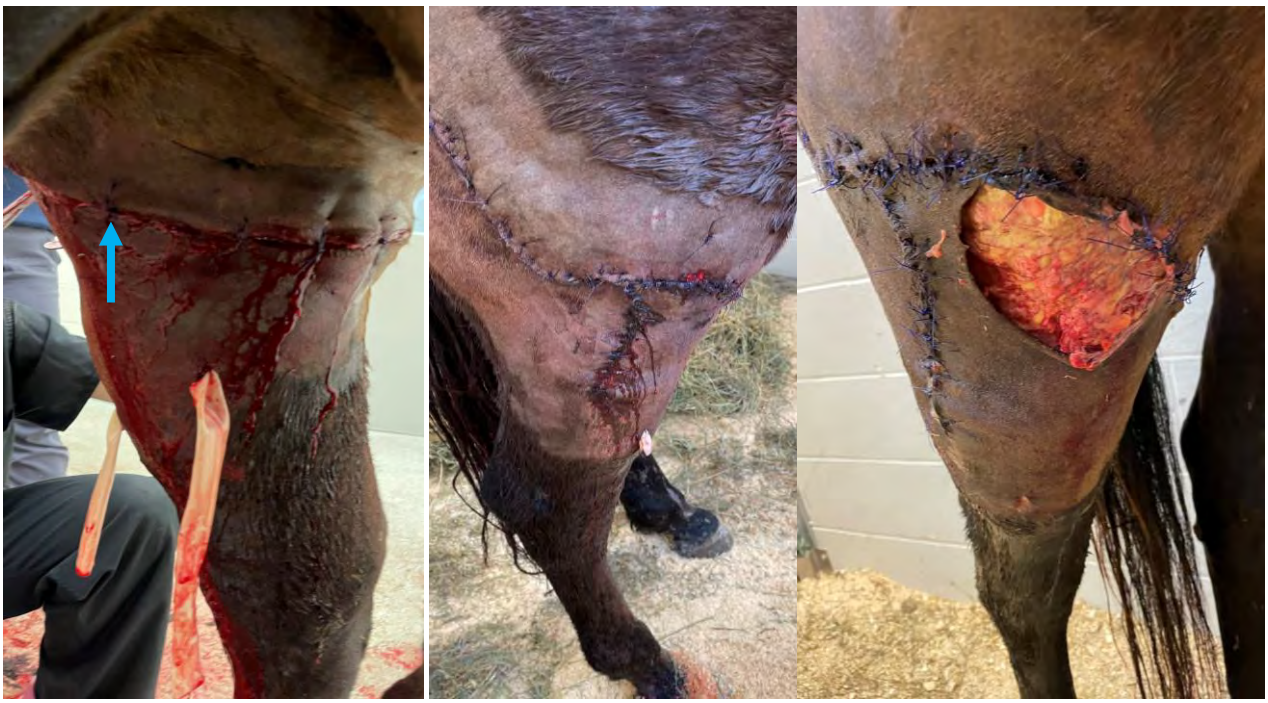

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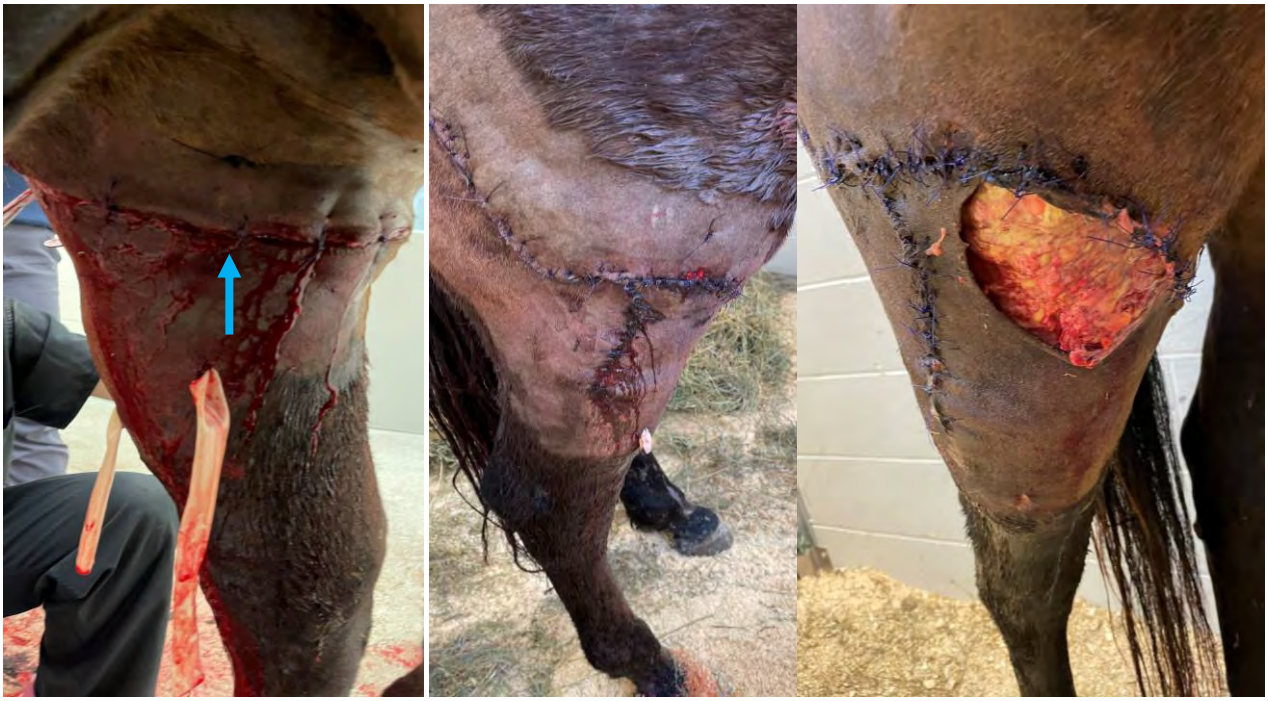

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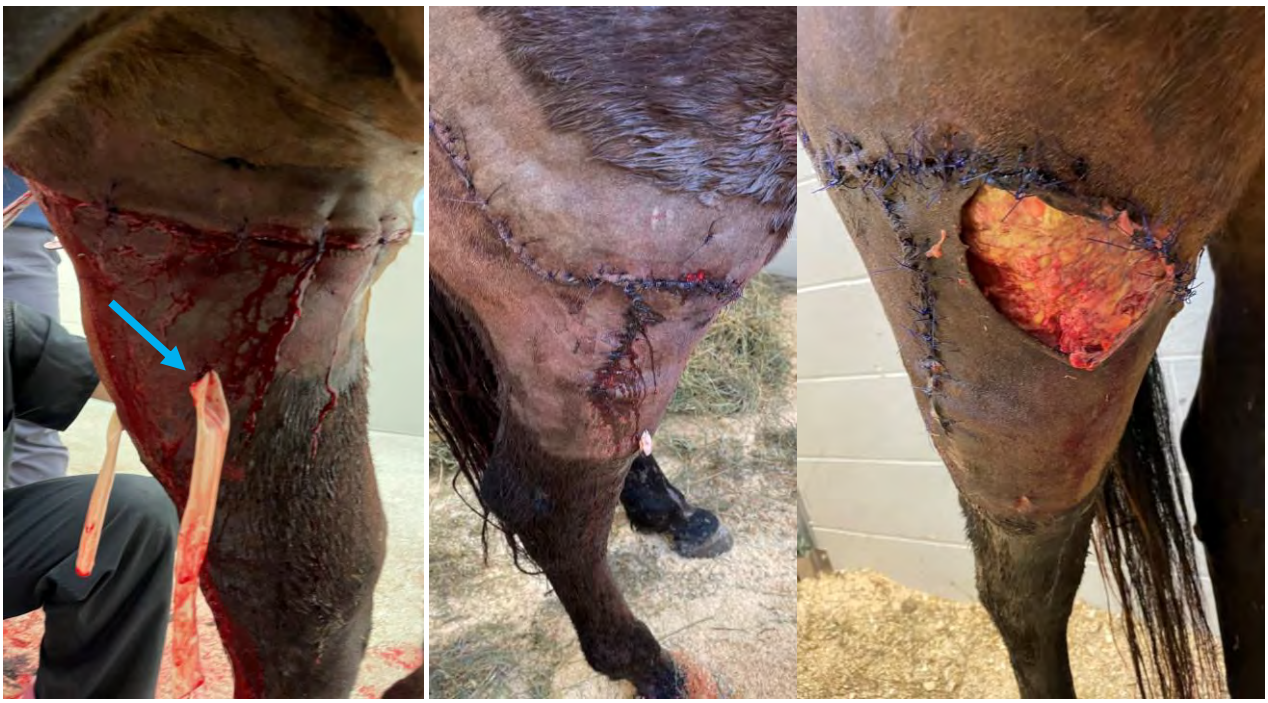

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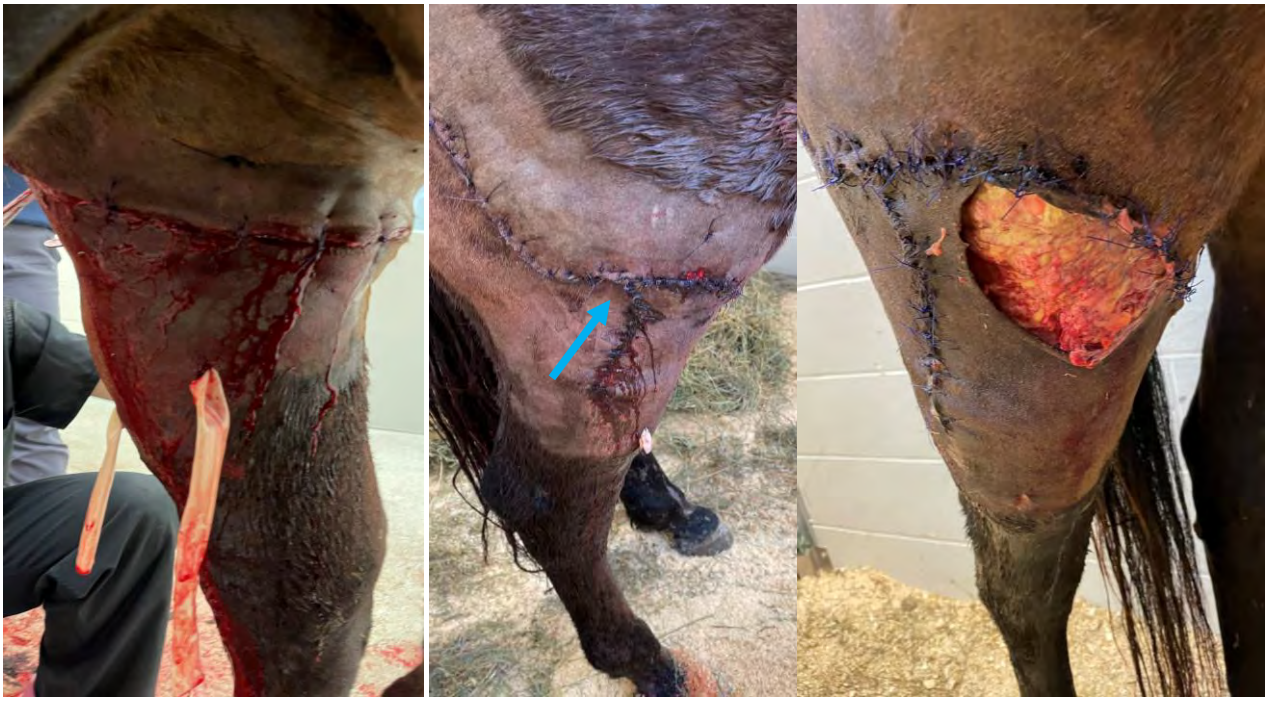

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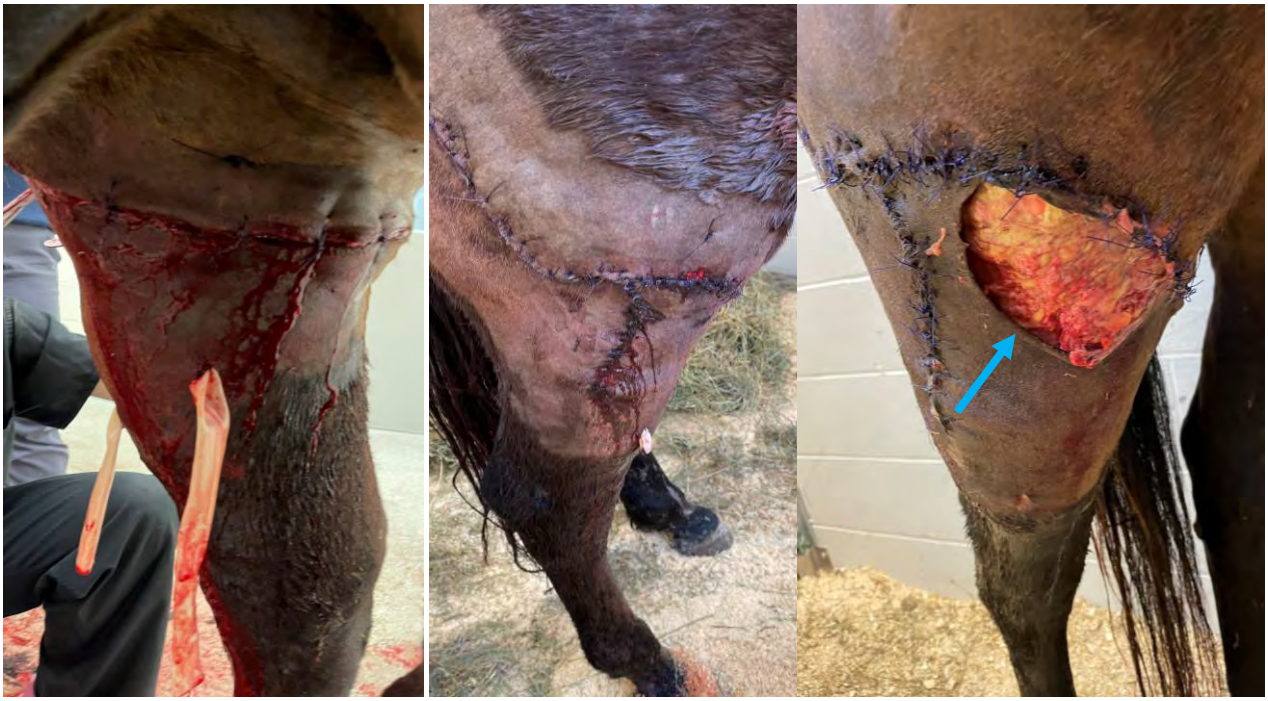

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Wounds

- Penetrating
- Non-penetrating

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Outline

- Laceration/wound repair
- Tracheostomy
- Perineal urethrotomy (PU)

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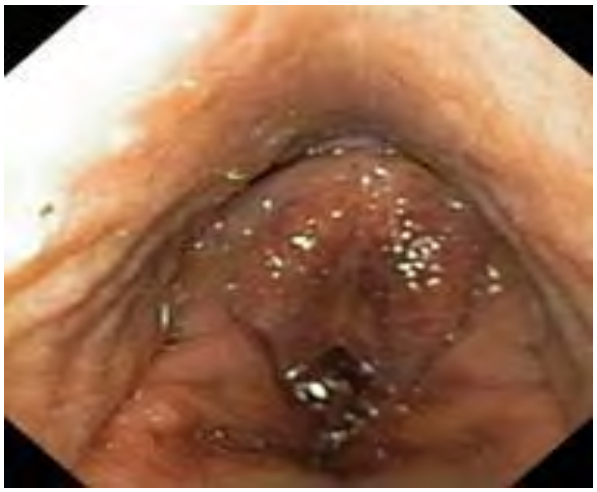
Tracheostomy

- Upper airway distress
- Lower airway distress



45

Upper airway distress

- Clinical signs
- Tracheostomy
- Tips & Tricks

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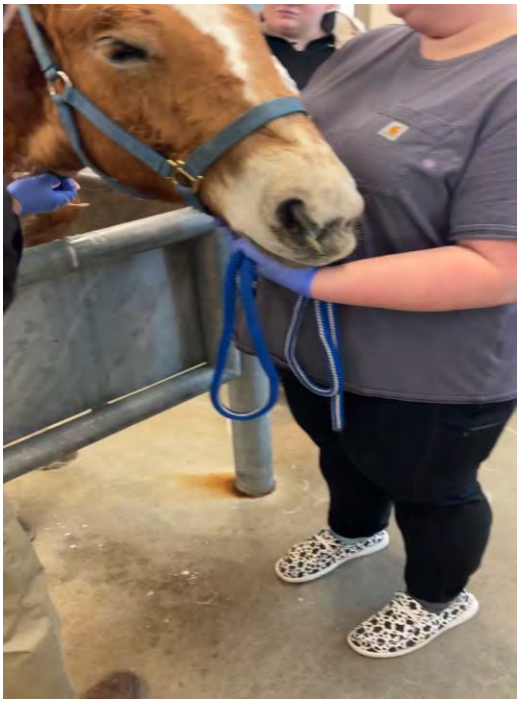
Clinical signs

- Increased **inspiratory** effort
- Nostril airflow absent or decreased
- Fractious or anxious
- Recumbency – time critical



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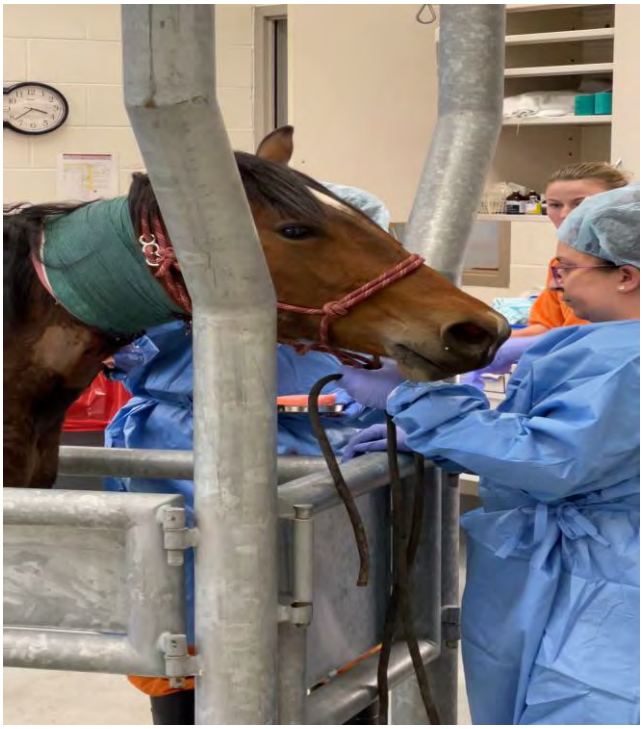


48

Upper airway distress

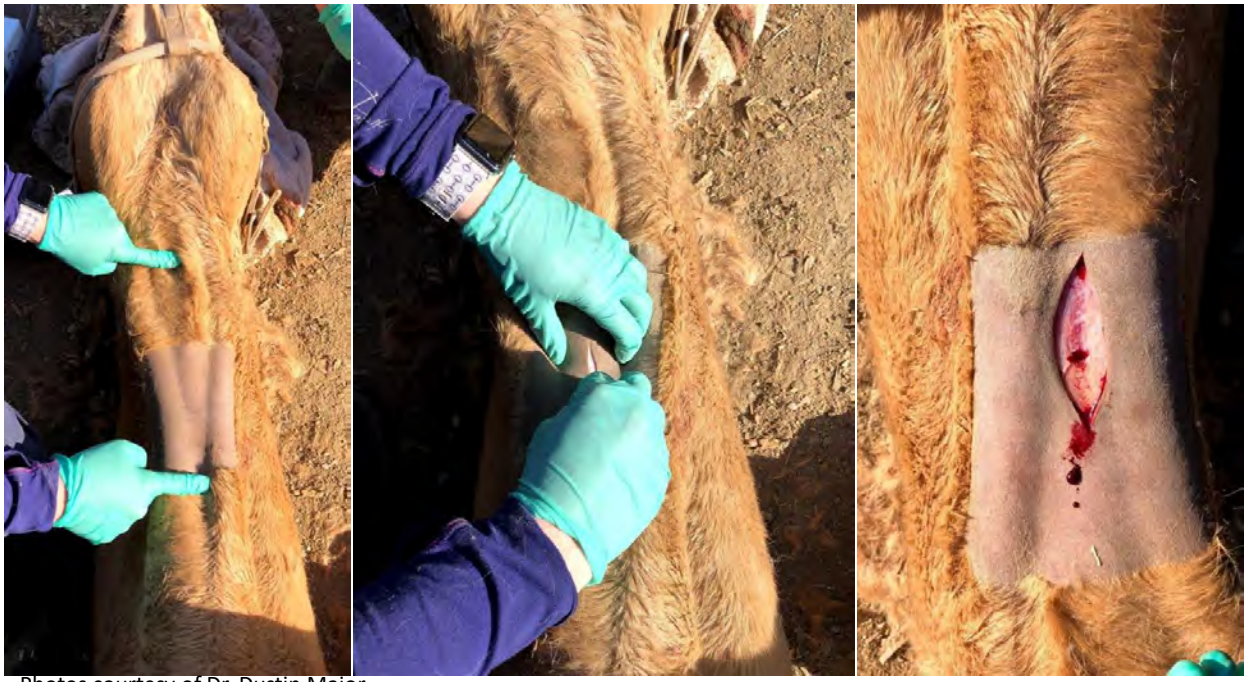
- Clinical signs
- Tracheostomy
- Tips & Tricks

49

Tracheostomy – materials

- Tracheostomy kit
- #10 scalpel blade
- Lidocaine, needles, & syringes
- Tracheostomy tube

50



Photos courtesy of Dr. Dustin Major

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Photos courtesy of Dr. Dustin Major

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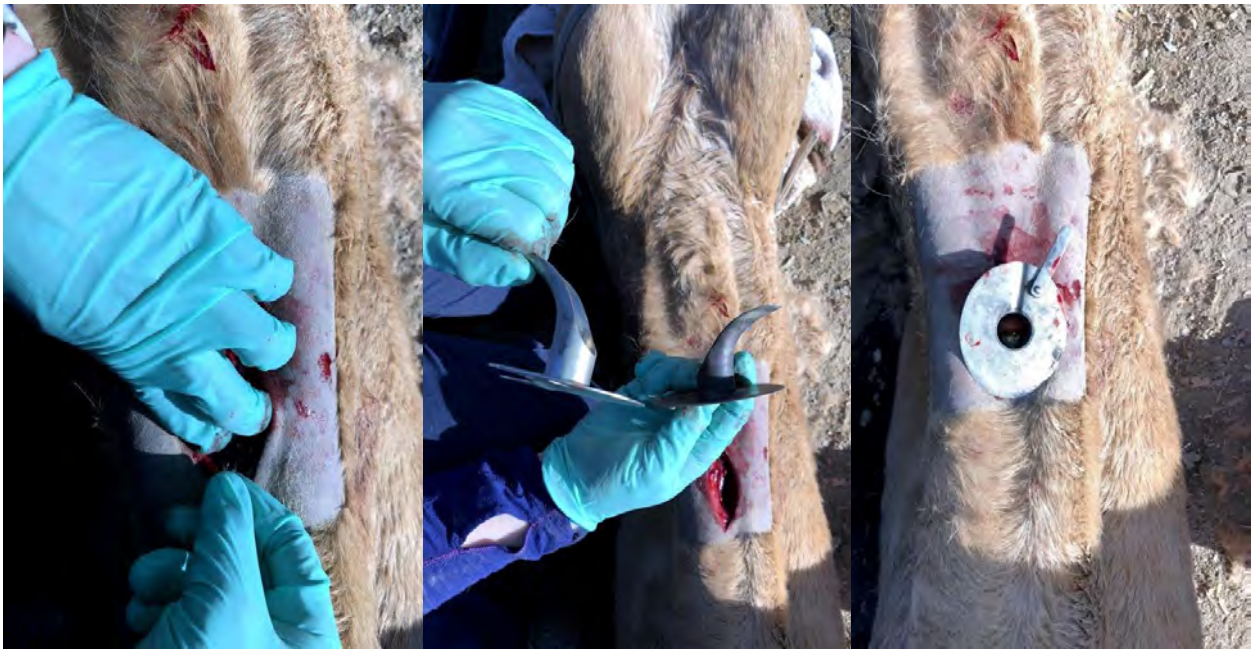

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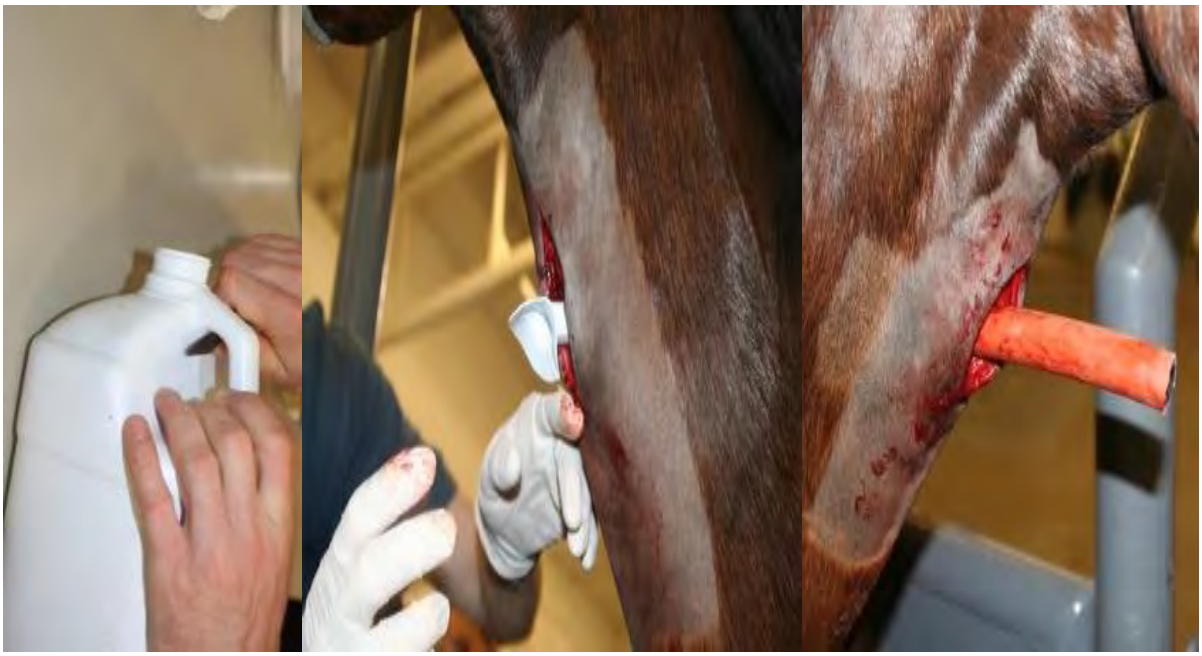

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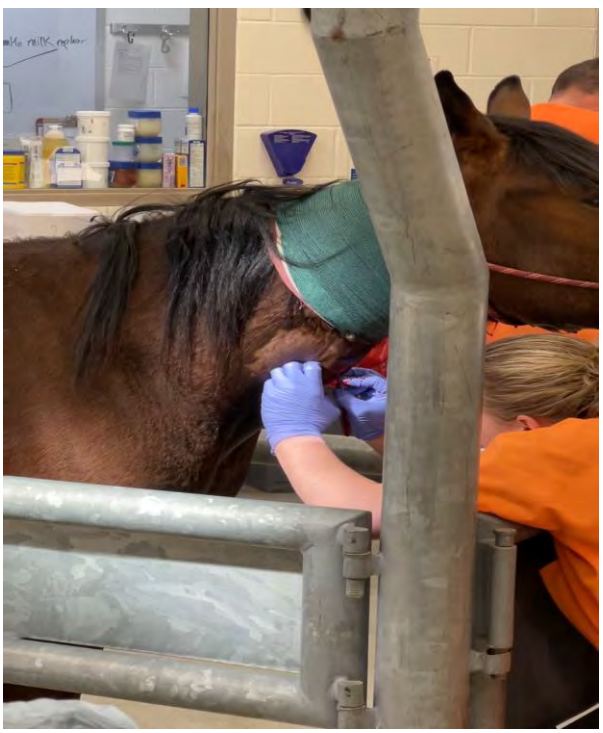
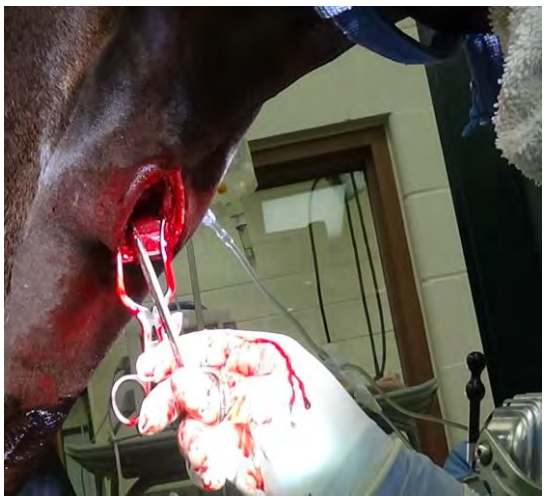


56

Tips & Tricks

- Lidocaine block – large "blebs" make incision more challenging
- Weitlaner retractors
- Occlusion trial prior to removing – should heal in 3-4 weeks



57

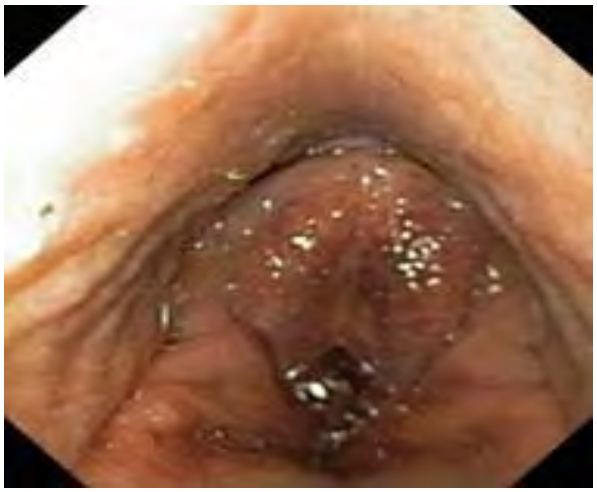
Upper airway distress

- Clinical signs
- Tracheostomy
- Tips & Tricks

58

Tracheostomy

- Upper airway distress
- Lower airway distress



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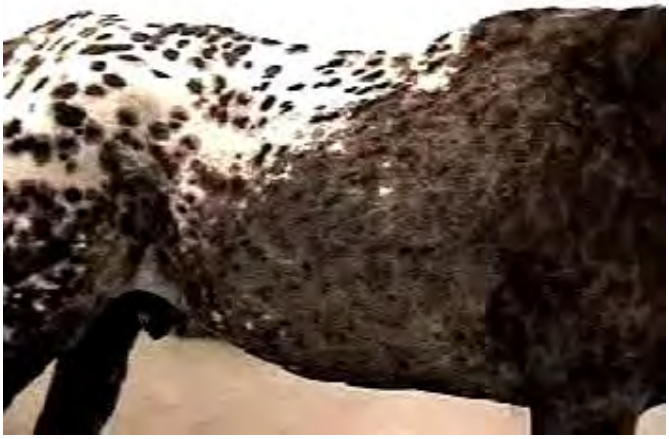
Lower airway distress

- Clinical signs
- Treatment

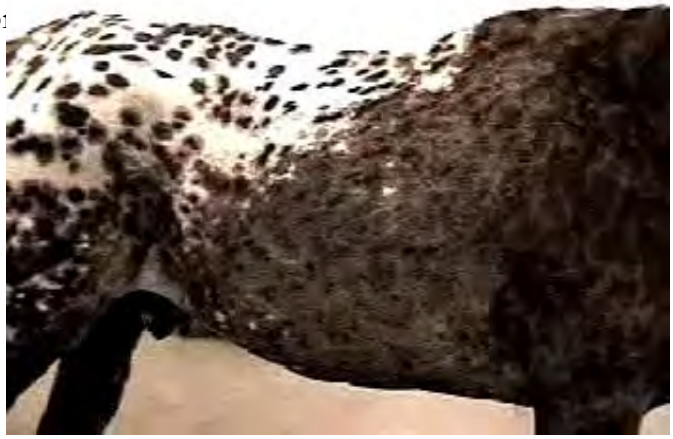


Photos courtesy of Dr. Jamie Kopper

60

Clinical signs

- Increased **EXPIRATORY** effo
- Auscultation for fluid, crackles/wheezes, or decreased lung sounds



Photos courtesy of Dr. Jamie Kopper

61

Clinical signs

- Increased **EXPIRATORY** effort
- Auscultation for fluid, crackles/wheezes, or decreased lung sounds

Photos courtesy of Dr. Jamie Kopper

62

Treatment

- Pleural pneumonia or pneumothorax – thoracocentesis

- Equine asthma
  - N-butyscopolammonium bromide
  - Atropine
  - Systemic steroids
  - Nebulization

Photos courtesy of Dr. Jamie Kopper

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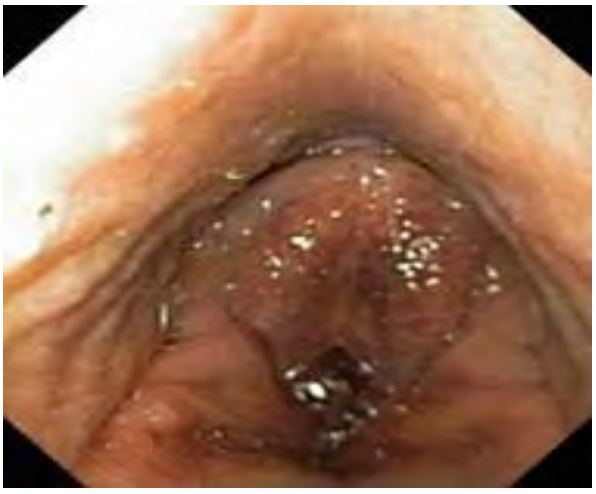
Tracheostomy

- Upper airway distress

- Lower airway distress



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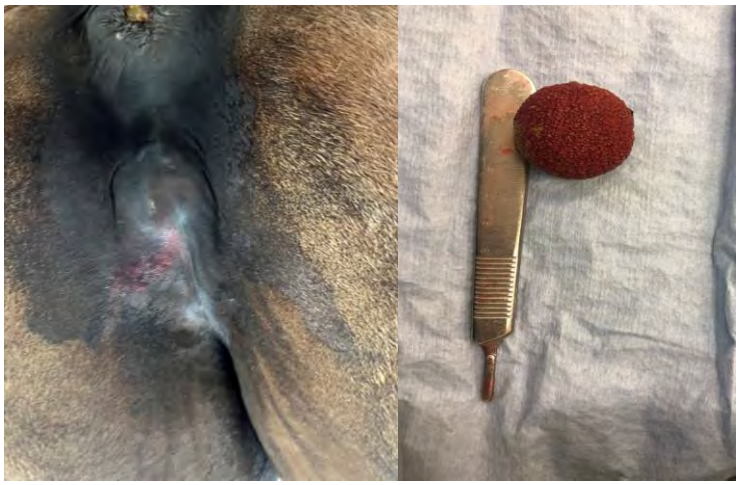
Outline

- Laceration/wound repair
- Tracheostomy
- Perineal urethrotomy (PU)

65

Perineal urethrotomy (PU)

- Urethral obstruction
- Clinical signs
- Surgical procedure



66

Clinical signs

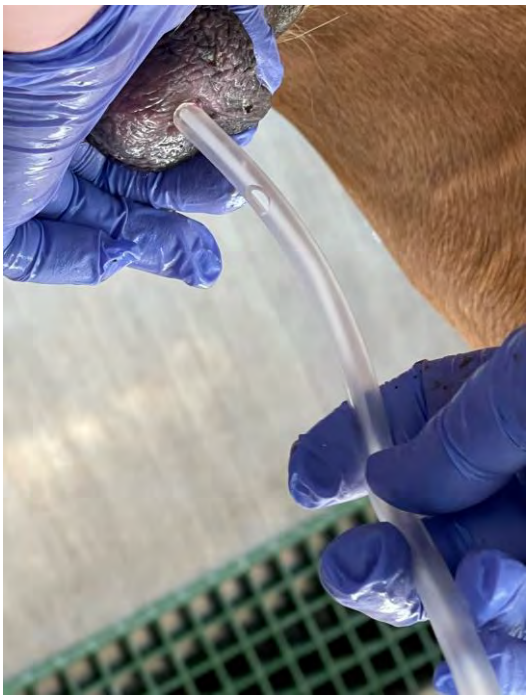
- Straining to urinate
- Colic
- Urethra pulsation
- Urolith palpation

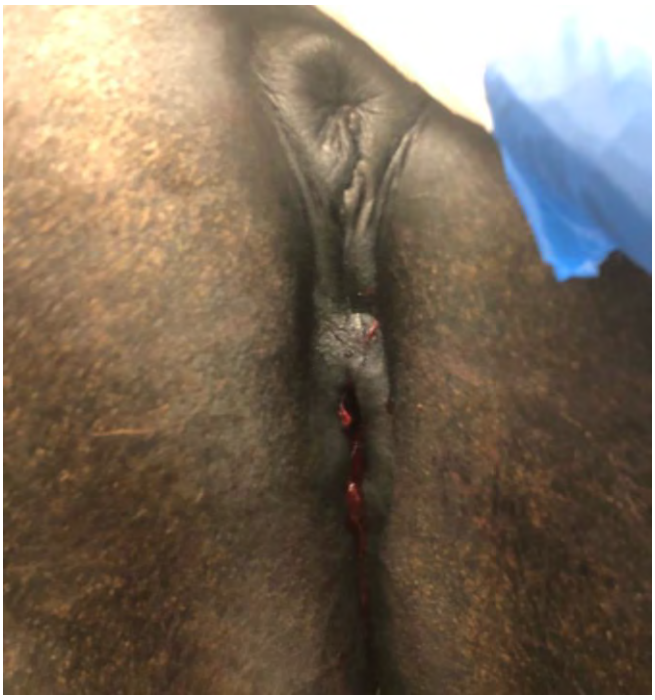
67

Procedure

- Pass urinary catheter to obstruction site
- Epidural or local incision block
- 6-8cm midline incision into urethra starting ~4-6 cm ventral to anus

68

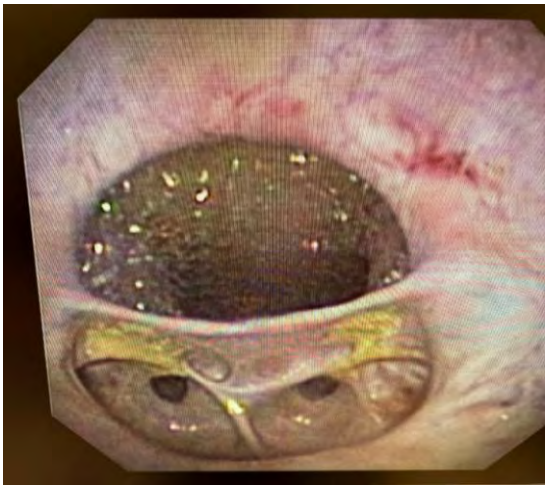




69

PU Tips & Tricks

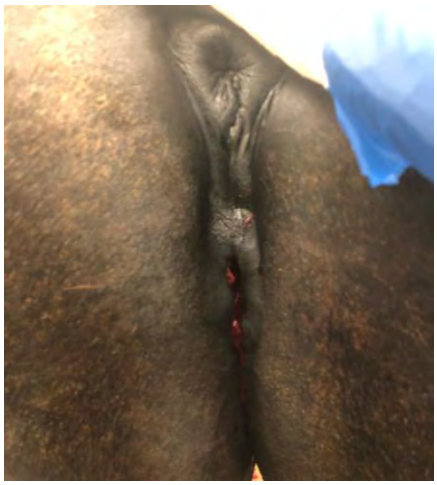
- Watch lidocaine bleb size
- Allis tissue forceps to remove stone
- Endoscopy for urinary bladder damage
- Abdominocentesis if worried about bladder rupture



70

Perineal urethrotomy (PU)

- Hematuria from PU for 24-48 hours
- Should not be profusely hemorrhaging
- Heals in 3-4 weeks – preventatively treat for urine scald



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Outline

- Laceration/wound repair
- Tracheostomy
- Perineal urethrotomy (PU)

72

Summary

- Wound repair, tracheostomy, and perineal urethrotomy are common equine emergencies that can be managed surgically in the field and stabilize horses

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Questions?

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EQUINE FRACTURE FIRST AID IN THE FIELD

JARROD TROY
DVM, DACVS-LS, CERP

EQUINE

Equine Fracture First Aid & Transportation

Jarrod Troy DVM; DACVS-LA; CERP
Assistant Professor
Iowa State University Veterinary Clinical Sciences

1

Conflict of Interest Disclosure:

I have no financial interest, arrangement, or affiliation with any company or organization.

2

Objectives

- Assess and prepare a horse with a fracture for stabilization
- Utilize different stabilization techniques
- Triage and explain best transport practice for a horse following fracture first aid

3

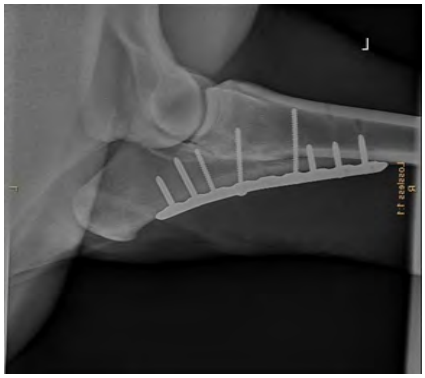
Outline

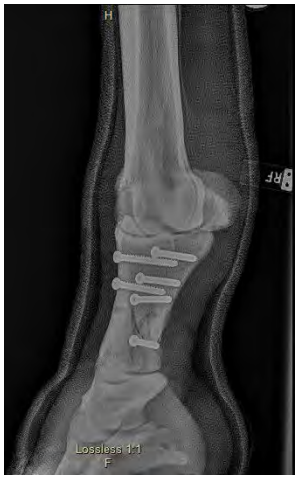
- Fracture first aid
- Fracture stabilization
- Fracture triage
- Transportation

4

Fracture First Aid

- Horse fractures happen
- Many fractures of the limb or skull can be repaired
- Appropriate first aid & transportation

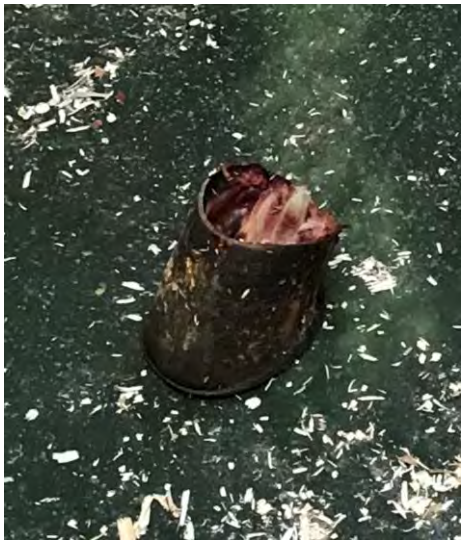




5

Fracture First Aid – Why Important?

- No or **inappropriate** first aid results in…
  - Increased soft tissue trauma → decreased healing
  - Simple fractures → complex fractures
  - Closed fractures → open fractures
  - Intact vasculature → disrupted vasculature → necrosis



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Fracture First Aid – Why Important?

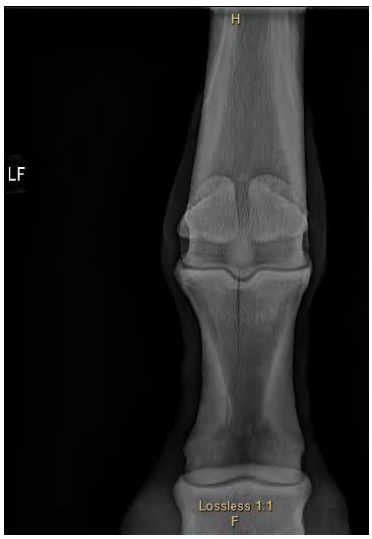
- Appropriate first aid results in…
  - Decreased pain/anxiety
  - Reduced injury and risk of fractures worsening
  - Best chance at a successful outcome

7

Fracture First Aid

- Physical assessment
- Sedation & analgesia
- Wound management
- Radiographs

Smith 2006



8

Fracture first aid – Physical assessment

- Anxious horse – sedate if needed
- Physical examination
- Stop severe hemorrhage
- Stabilization may come first

9

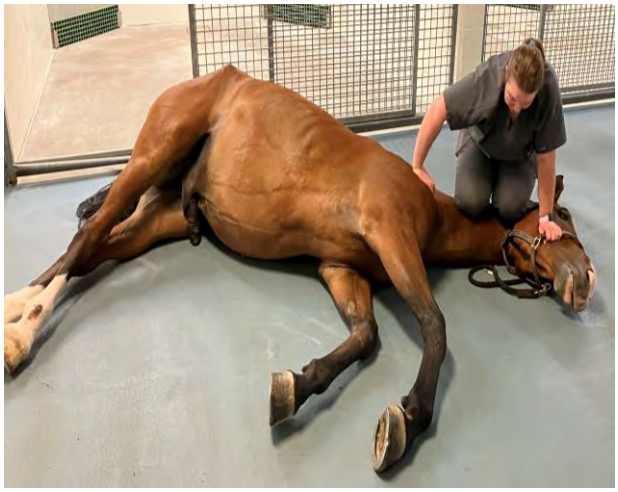
Fracture First Aid – Sedation & Analgesia

- Sedation – "Just enough"
  - **Xylazine** (0.3 – 0.8 mg/kg IV; **α_2-agonist**)
  - **Detomidine** (0.01-0.02 mg/kg IV; **α_2-agonist**)
  - **Butorphanol** (0.01-0.04 mg/kg IV; **opioid**)

10

Fracture First Aid – Sedation & Analgesia

- Sedation – "Just enough"
  - **Xylazine** (0.3 – 0.8 mg/kg IV; **α_2-agonist**)
  - **Detomidine** (0.01-0.02 mg/kg IV; **α_2-agonist**)
  - **Butorphanol** (0.01-0.04 mg/kg IV; **opioid**)
- Avoid Acepromazine



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Fracture First Aid – Fracture Assessment

- Localized swelling
- Pain on palpation
- Heat
- ± Wounds

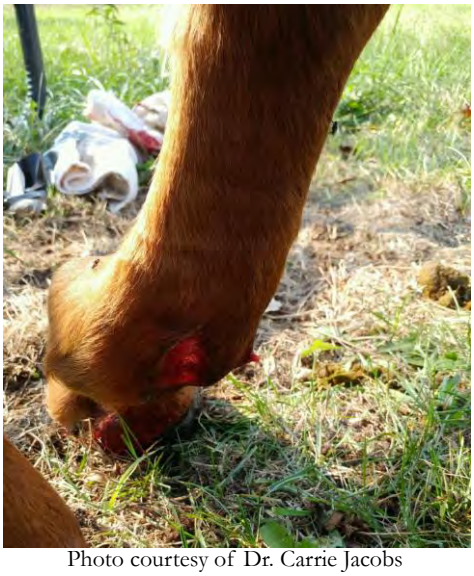

Photo courtesy of Dr. Carrie Jacobs

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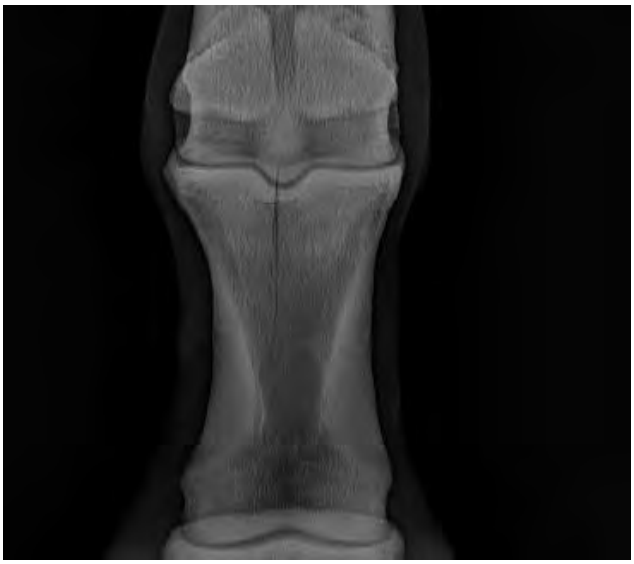
Fracture First Aid – Fracture Assessment

- ± Crepitus or instability
- ± Hemorrhage
- ± Synovial effusion

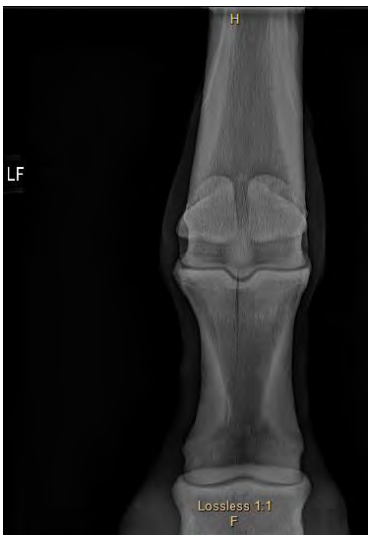


13

Fracture First Aid

- Physical assessment
- Sedation & analgesia
- Wound management
- Radiographs

Smith 2006



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Fracture First Aid – Wound Management

- Unstable fractures → stabilize fracture → wound management later
- Stable fractures

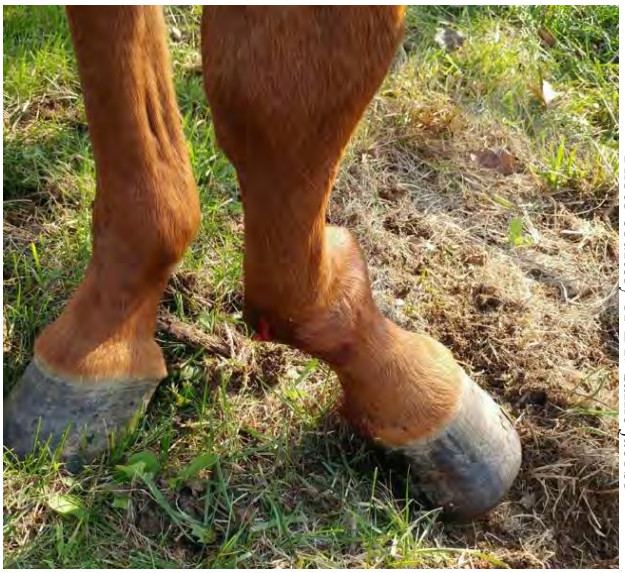

Photo courtesy of Dr. Carrie Jacobs

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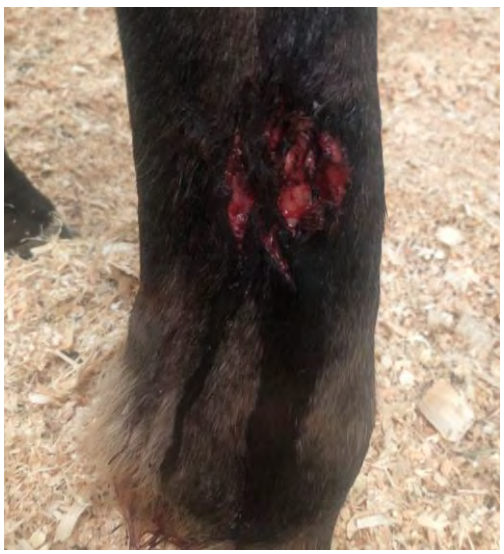
Fracture First Aid – Wound Management

- Stable fractures
  - Clean any gross contamination – isotonic solution
  - Open wounds – water soluble antimicrobial ointment
  - Wound should be included in the stabilization bandage
  - Closed wounds – clean unbroken skin



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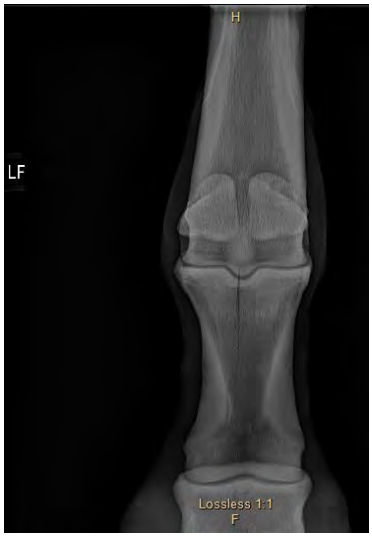
Fracture First Aid

- Physical assessment
- Sedation & analgesia
- Wound management
- Radiographs

Smith 2006



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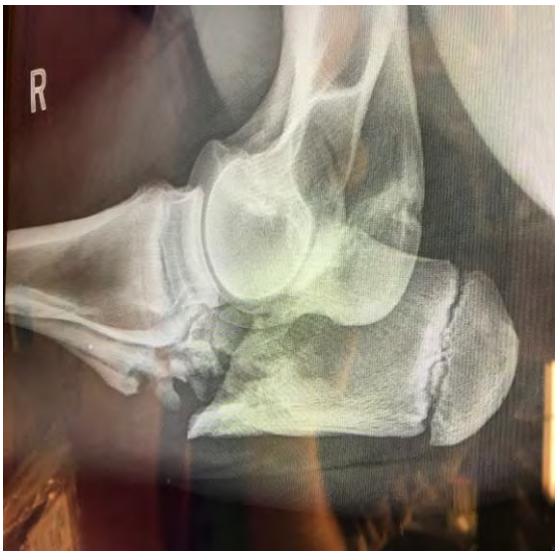
Fracture First Aid - Radiographs

- Unstable fractures → stabilize first
- PVC or Wood splints permit x-ray penetration
- Aluminum Kimzey splint or cast material permits x-ray penetration as well



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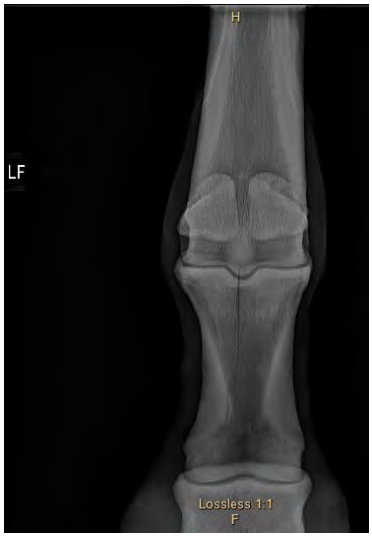
Fracture First Aid

- Physical assessment
- Sedation & analgesia
- Wound management
- Radiographs

Smith 2006



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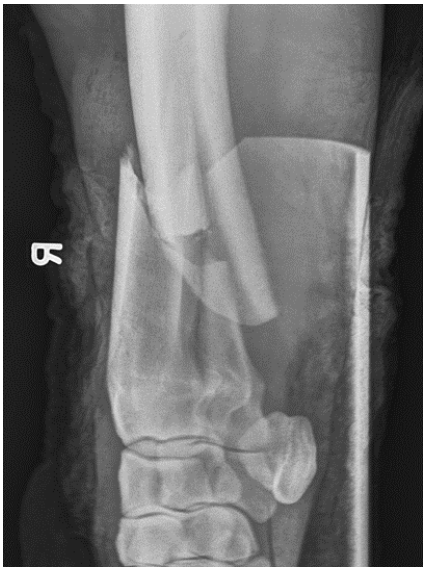
Outline

- Fracture first aid
- Fracture stabilization
- Fracture triage
- Transportation

20

Fracture First Aid – Fracture Stabilization

- Stabilization principles
- Stabilization types
- Stabilization methods and location



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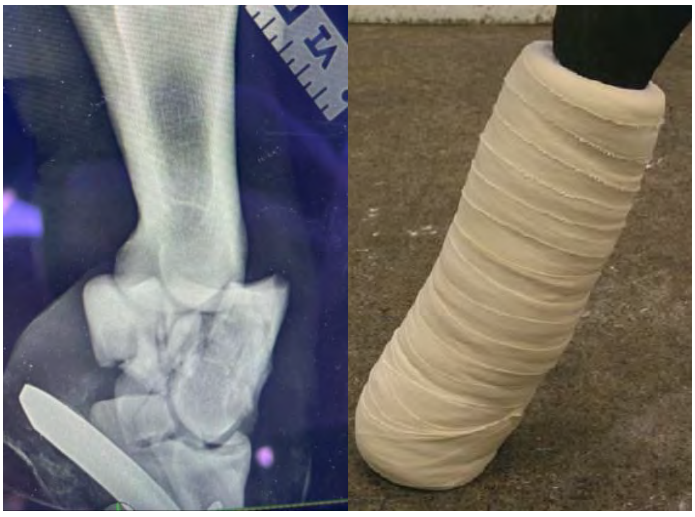
Fracture First Aid – Fracture Principles

- Unstable fractures → **need immediate appropriate stabilization**
- Wound management at hospital

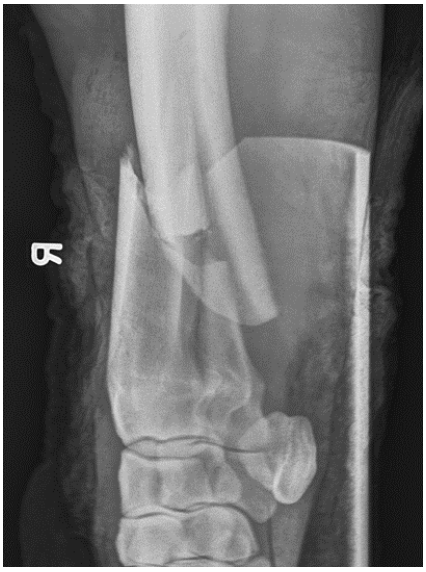


Wright 2016

22

Fracture First Aid – Fracture Principles

- Immobilizes the joint above & below the fracture
- Extends well beyond the fracture line
- Provides intact strut for weight bearing
- Neutralizes the forces on the fracture



23

Fracture First Aid – Fracture Principles

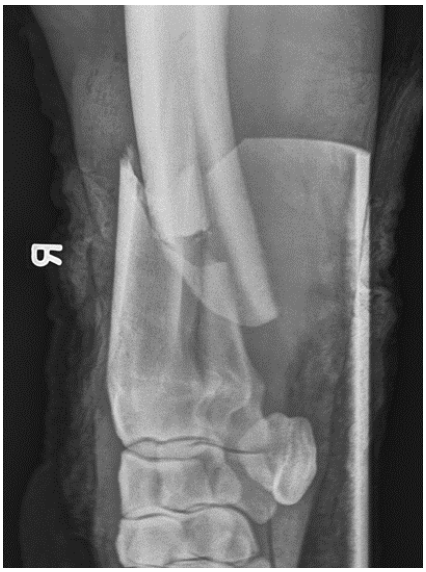
- Prevent further bone or soft tissue injury
- Assist with weight bearing
- Relieve anxiety
- Protect closed fractures from becoming open fractures or displacing

Wright 2016

24

Fracture First Aid – Fracture Stabilization

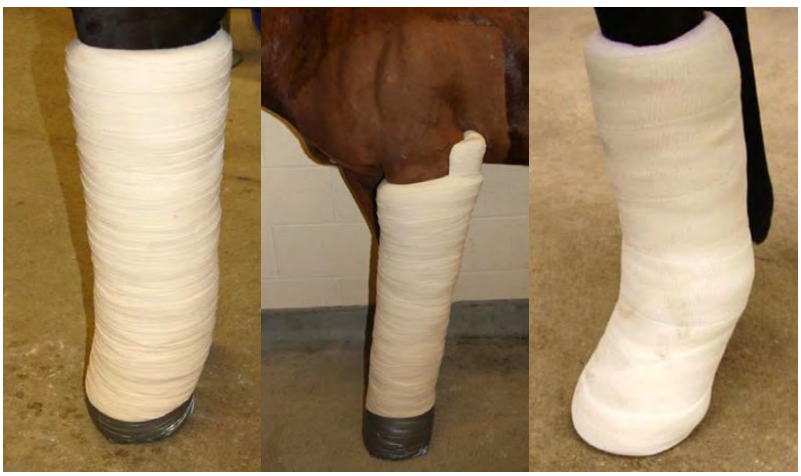
- Stabilization principles
- Stabilization types
- Stabilization methods and location



25

Fracture First Aid – Types of Stabilization

- Robert-Jones bandage
- Splints
- Casts



Wright 2016

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Fracture First Aid – Robert Jones Bandage

- Multiple layers of cotton
- Elastic gauze compressing each layer
- Bandage diameter = 3x the diameter of the limb
- Short term use – cannot stabilize a fracture long term

Wright 2016

27

Fracture First Aid – Splint

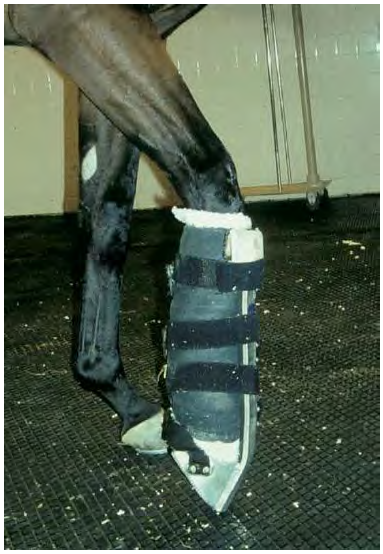
- Rigid & lightweight
- Easily applied under sedation
- Durable – does not break under horse's weight
- Splint must be secured to a bandage
- Splint must not slip out of place

Smith 2006

28

Fracture First Aid – Splint

- PVC (Polyvinyl chloride) pipe
- Wood boards, broomstick handles, etc.
- Leg Saver Splint or Kimzey Splint
  - Ensure top of splint does not end at fracture line
  - No lateral to medial stability
  - Cannot hold large feet

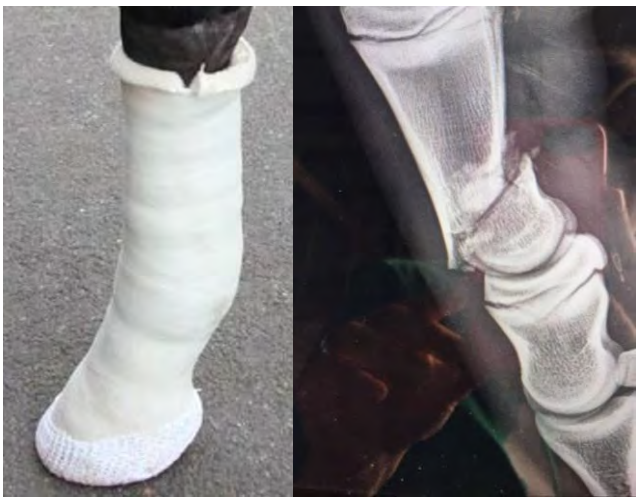


Smith 2006

29

Fracture First Aid - Casts

- Fiberglass casting tape
  - Full limb or half limb
- Cannot be effectively applied if…
  - Too much motion at fracture site
  - Patient is not sufficiently tractable
  - Include the foot when possible
  - Never end a cast at mid-diaphysis
- Bandage cast

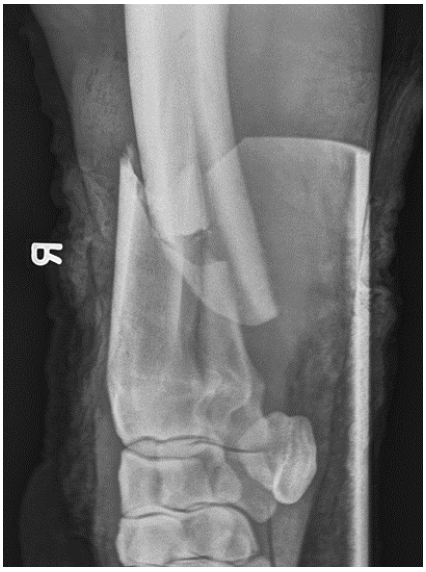


Wright 2016

30

Fracture First Aid – Fracture Stabilization

- Stabilization principles
- Stabilization types
- Stabilization methods and location



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Fracture First Aid – Stabilization Methods

- Developed technique based on the forces applied at different fracture locations
- Splinting horse limbs - Divided into 4 regions
- Each region has a method for appropriate fracture stabilization

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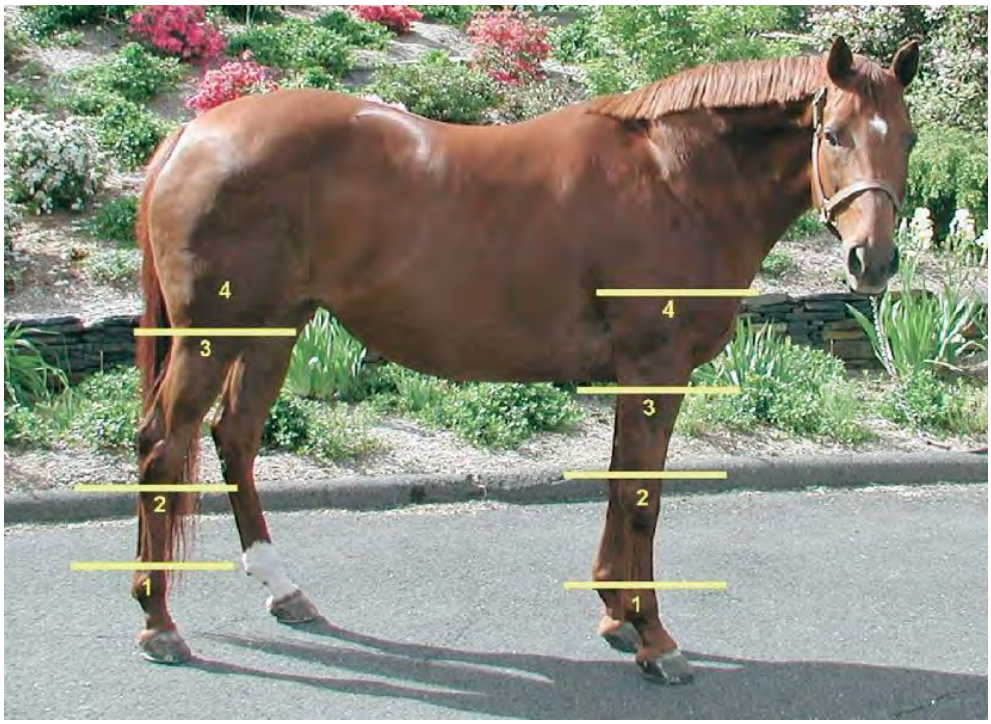


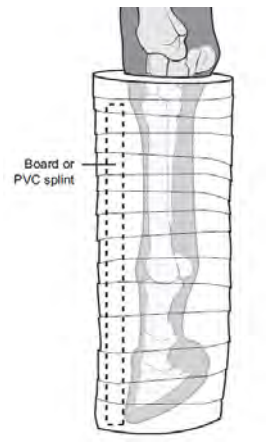
Smith 2006

33

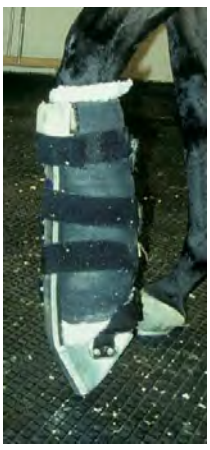
Fracture First Aid – Stabilization Regions

- Region 1 – Front limb
  - Phalanx 1; Phalanx 2
  - Sesamoid bones
  - Distal metacarpal 3

- Stabilization
  - Alignment of the dorsal cortices
    - Phalanges: P1, P2, P3
    - Cannon bone (Metacarpal 3)
    - Toe pointing towards the ground



Mudge & Bramlage 2007

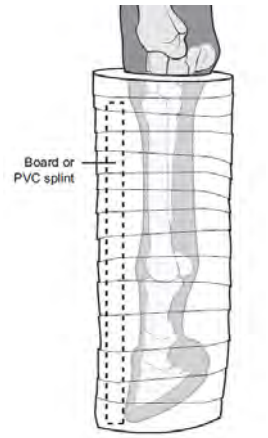


Smith 2006

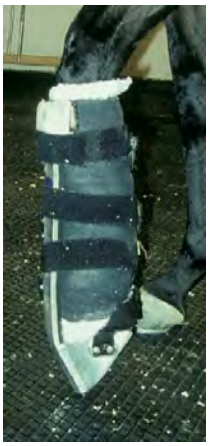
34

Fracture First Aid – Stabilization Regions

- Region 1 – Front limb
- Splint location
  - Dorsal aspect of limb
  - Extends from ground to just below carpus
- "Kimzey" Leg Saver Splint



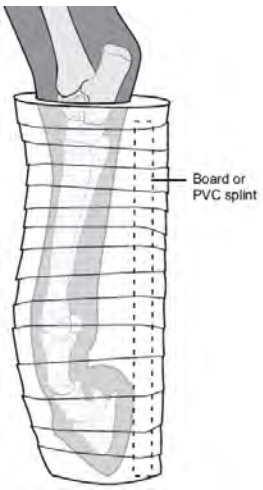
Mudge & Bramlage 2007


Smith 2006

35

Fracture First Aid – Stabilization Regions

- Region 1 – Hind limb
- Splint location
  - Plantar aspect of limb
  - Extends from ground to tarsus



Mudge & Bramlage 2007


Smith 2006

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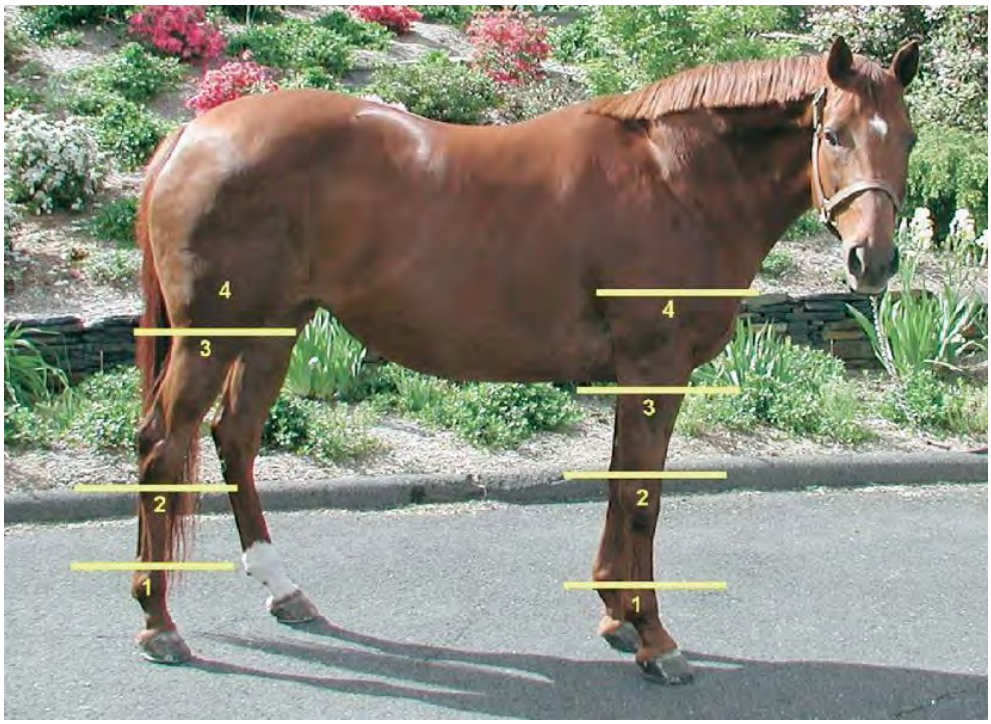


Smith 2006

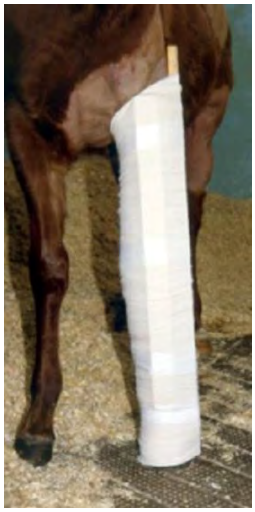
37

Fracture First Aid – Stabilization Regions

- Region 2 – Front limb
  - Mid – proximal metacarpus
  - Carpus
  - Distal radius

- Splint location
  - 2 splints – 90^0 angles from each other
    - 1 splint – caudal aspect
    - 1 splint – lateral aspect
  - Extend from elbow to ground

Smith 2006



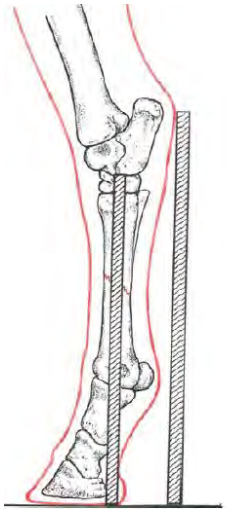
Wright 2016

38

Fracture First Aid – Stabilization Regions

- Region 2 – Hind limb
  - Mid – proximal metatarsus
  - Tarsus

- Splint location
  - 2 splints – 90^0 angles from each other
  - 1 caudal splint – Calcaneus to ground
  - 1 lateral splint –Proximal tarsus to ground
  - Stifle to ground – for proximal metatarsus fractures



Wright 2016

Smith 2006

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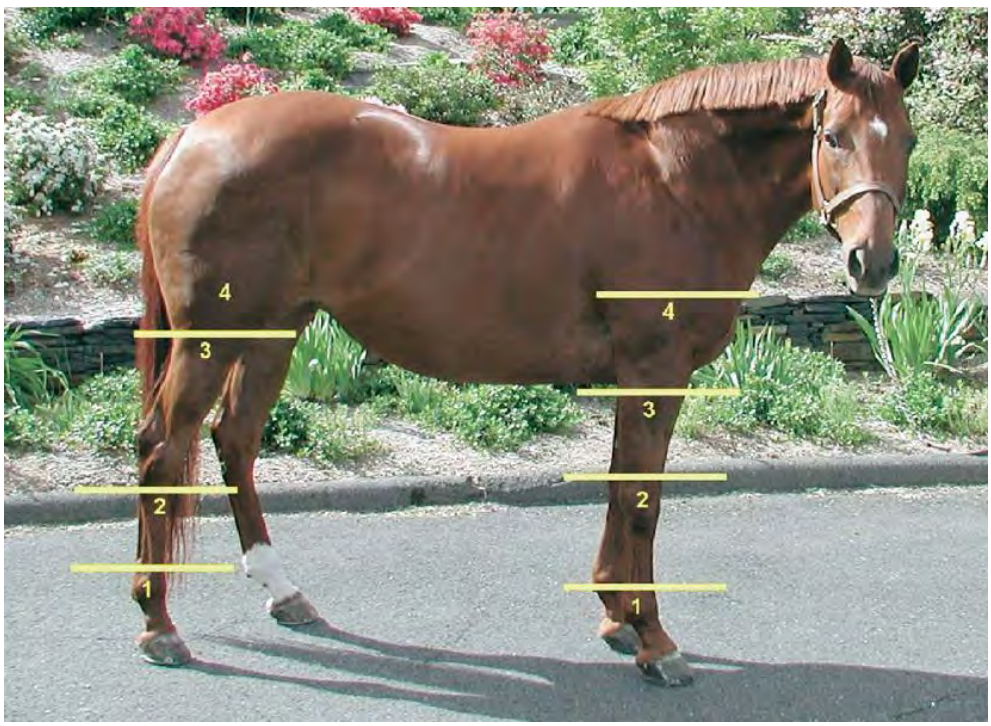
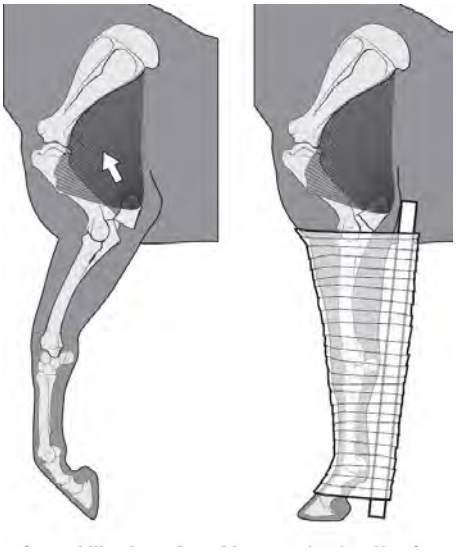


Smith 2006

40

Fracture First Aid – Stabilization Regions

- Region 3 – Front limb
  - Olecranon
- Splint location
  - Caudal splint that keeps the carpus in extension
  - Ground to top of olecranon
- Also useful for horses with radial nerve paralysis or humeral fractures



Mudge & Bramlage 2007

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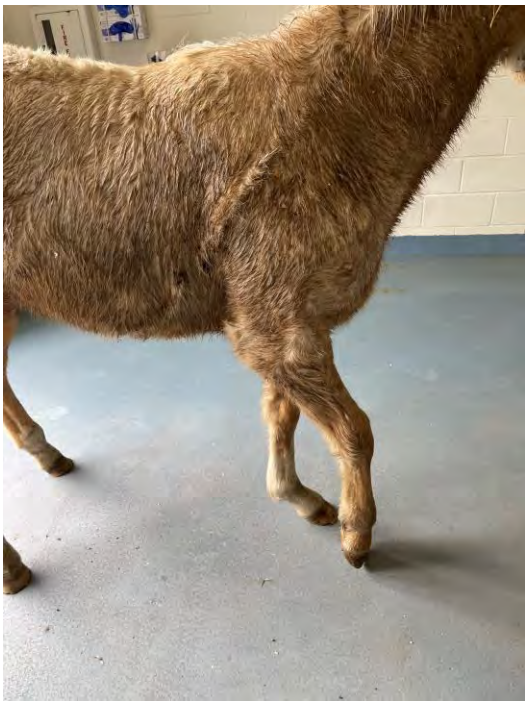
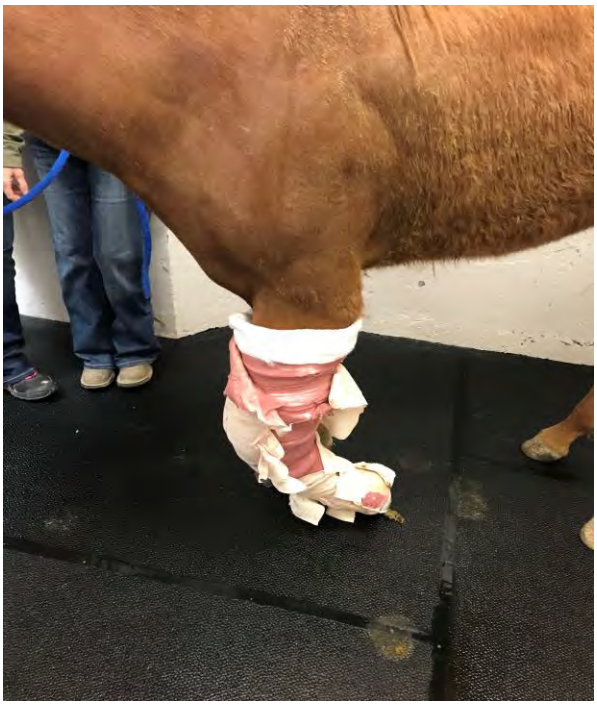
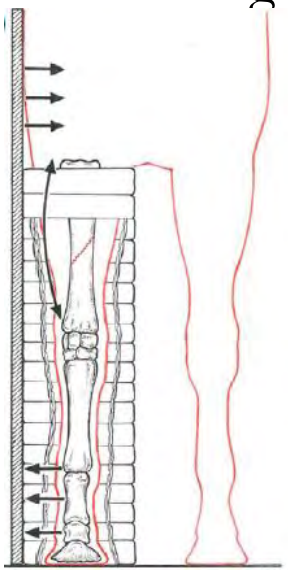




42

Fracture First Aid – Stabilization Regions

- Region 3 – Front limb
  - Mid – proximal radius
- Splint location
  - 2 splints – 90^0 to each other
  - Lateral splint – ground to shoulder
  - Caudal splint – ground to elbow
- Always look for medial wounds with these fractures



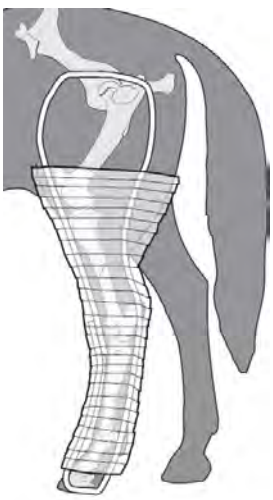
Wright 2016

43

Fracture First Aid – Stabilization Regions

- Region 3 – Hind limb
  - Tibia
- Splint location
  - Lateral splint – spans tarsus & stifle
  - Long and wide splint

Smith 2006



Mudge & Bramlage 2007

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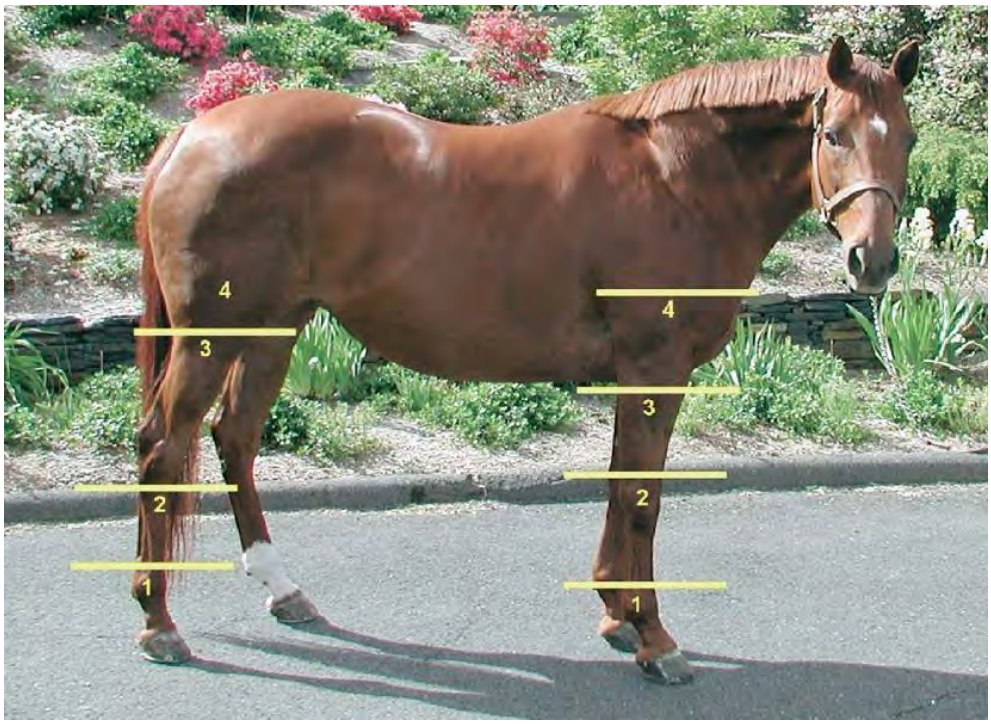

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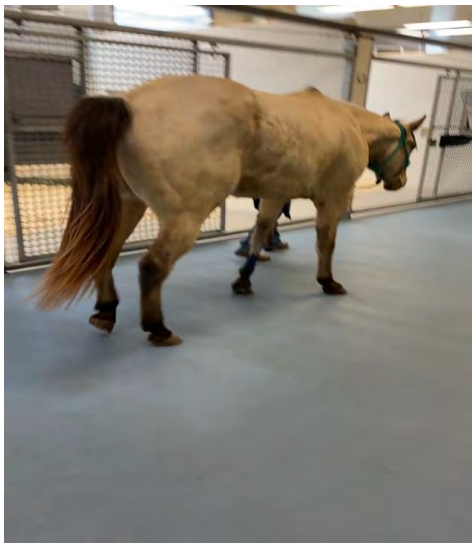
Fracture First Aid – Stabilization Regions

- Region 4 – Front & Hind limb
  - Humerus
  - Femur

- Stabilization – Not necessary
  - Humerus fractures with no triceps function → caudal splint to fix carpus in extension



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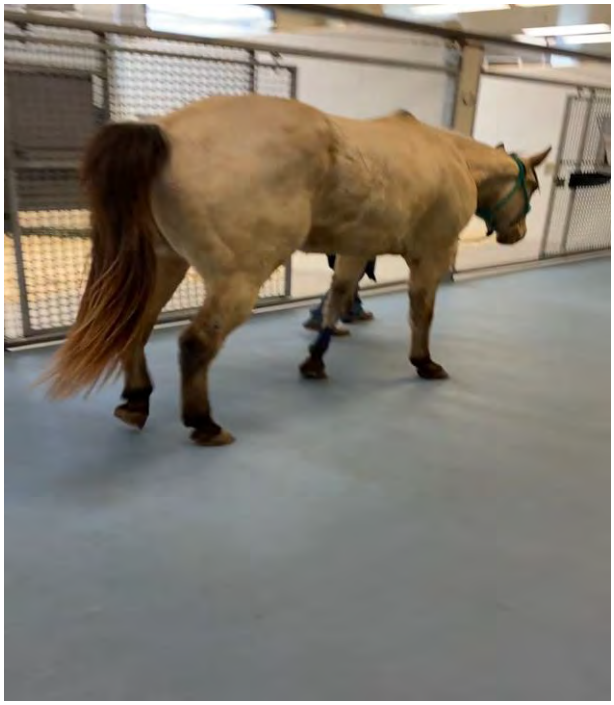

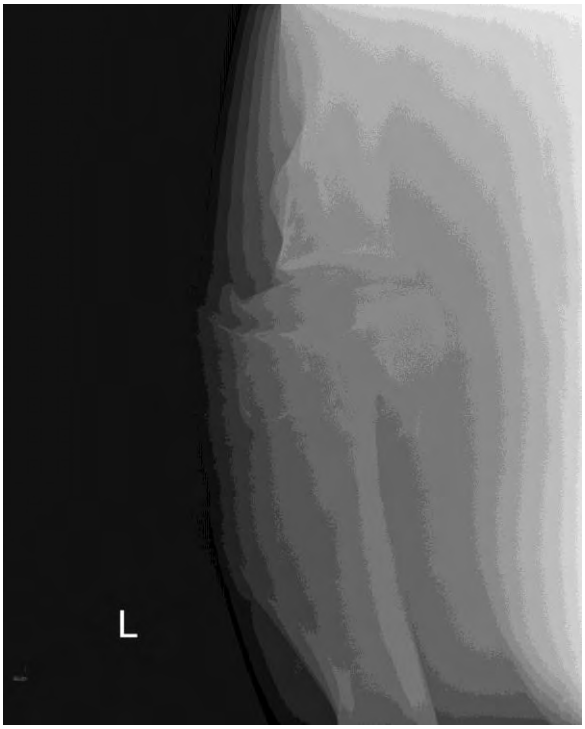

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Fracture First Aid – Skull Fractures

- First Aid
- Respiratory compromise
- Significant hemorrhage
- Neurologic deficits
- Ophthalmic evaluation

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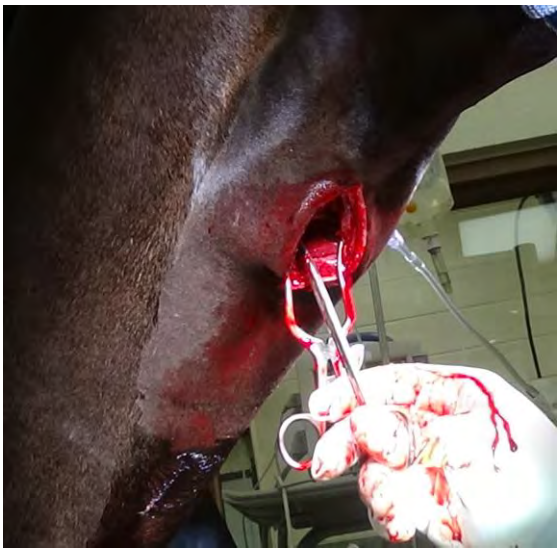
Fracture First Aid – Skull Fractures

- First Aid
- Respiratory compromise
- Tracheostomy



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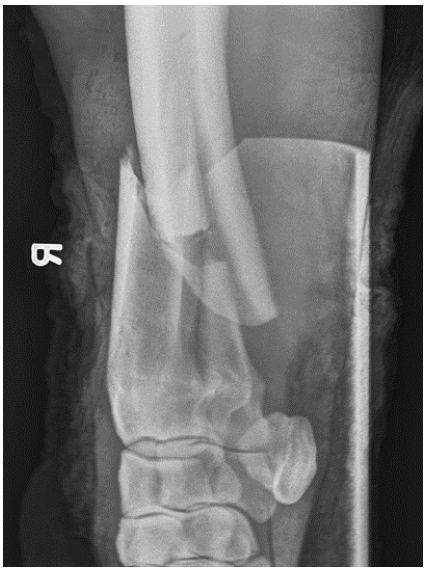
Fracture First Aid – Fracture Stabilization

- Stabilization principles
- Stabilization types
- Stabilization methods and location



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Outline

- Fracture first aid
- Fracture stabilization
- Fracture triage
- Transportation

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Fracture triage

- Fluid resuscitation
  - Administration of nephrotoxic drugs (NSAIDs or aminoglycosides)
  - Transportation time – minutes or hours
- Severe hemorrhage → need to control blood loss

52

Foal fluid therapy – Fracture triage

- Foals – limited fluid & energy reserves
  - Rapid dehydration & hypoglycemia
  - Hyperglycemia with potential rebound hypoglycemia
- Initial fluid therapy
  - 10-20 mL/kg bolus over 20 minutes of an isotonic electrolyte solution

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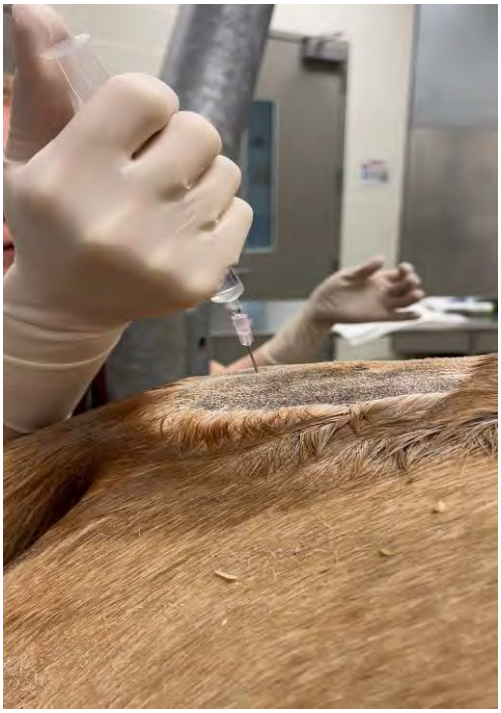
Fracture triage

- Non-steroidal anti-inflammatory drugs (NSAIDs)
- Systemic antibiotics – especially open fractures
- Tetanus toxoid vaccine
- No corticosteroids

54

Fracture triage

- Opioids – use cautiously
- Epidurals – very rarely
- Avoid sedation or analgesia that causes ataxia



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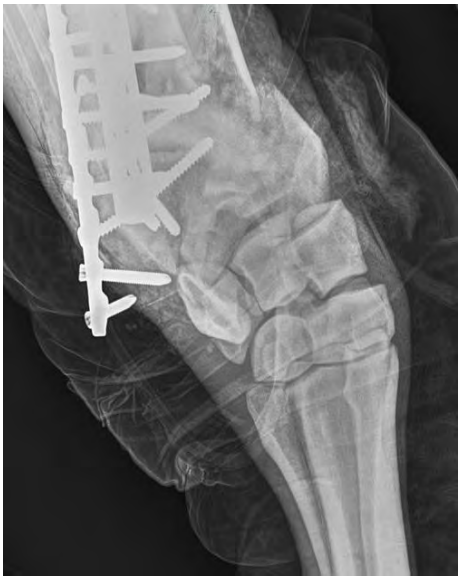
Fracture First Aid - Prognosis

- Significant advances in fracture repair
- Prognosis depends on type of fracture and horse
  - Stabilize the fracture and the horse
  - Contact your nearest ACVS large animal surgeon
- Horse temperament and size affect prognosis



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Outline

- Fracture first aid
- Fracture stabilization
- Fracture triage
- Transportation

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Fracture First Aid - Transportation

- Even with proper stabilization more damage can still occur
- Non-slip floors or extra shavings
- Leave partitions or butt bars in place
- Head free or loose

https://www.scotiscreation.com/New-Inventory-2019-Frontier-Trailers-Unknown-Fast-Track-2-Horse-Straight-Load-w-Side-Ramp-Manchester-6882323

58

Transportation – Horse Position

- Fracture limb towards back of trailer
- Straight load – fractured limb in back
- Slant load – fractured limb side in back
- Important but not worth hours of time

http://www.goretrailers.com/gooseneck19.html

59

Summary

- Decreased pain/anxiety
- Decreased soft tissue & bone damage
- Reduces infection risk
- Best chance at a successful outcome

- Always contact your nearest referral center if any questions

60

Outline

- Fracture first aid
- Fracture stabilization
- Fracture triage
- Transportation

61

References

- Mudge M & Bramlage L. Field fracture management. *Vet Clin Equine* 2007. 23: 117-133.
- Smith J. Emergency fracture stabilization. *Clin Tech in Equine Pract.* 2006. 5:154-160.
- Wright I.M. Racecourse fracture management. Part 1: Incidence and principles. *Eq Vet Ed.* 2017. 29 (7): 391-400
- Wright I.M. Racecourse fracture management. Part 2: Techniques . *Eq Vet Ed.* 2017. 29 (8): 440-451
- Wright I.M. Racecourse fracture management. Part 3: Emergency care of specific fractures. *Eq Vet Ed.* 2017. 29 (9): 500-515

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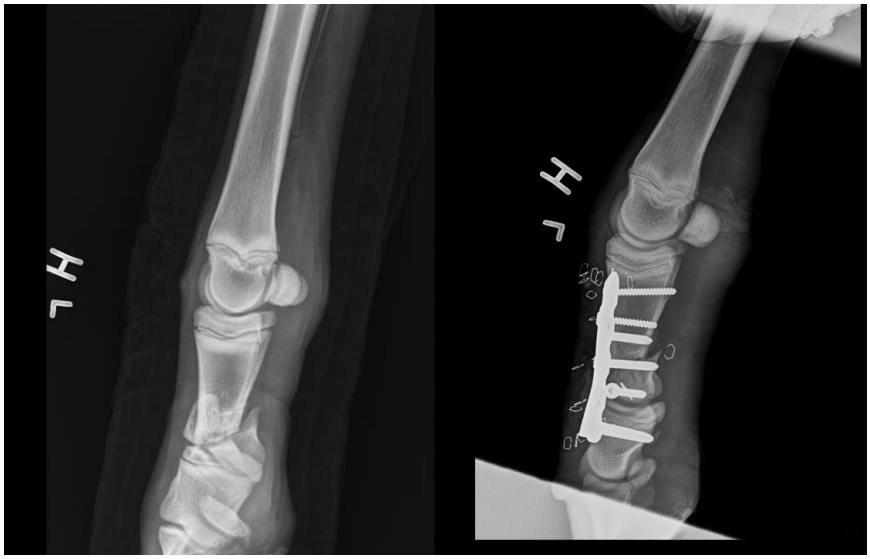
Questions?



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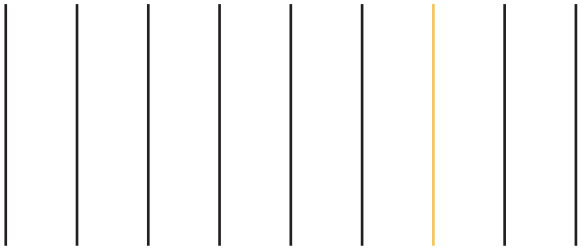
SUSTAINABILITY IN EQUINE VETERINARY PRACTICE

MAUREEN SUTTER
DVM



EQUINE

Sustainability in Equine Veterinary Practice

and what AAEP is working on

Maureen Sutter DVM
Red Oak Animal Hospital

Maureen Sutter DVM

- 2007 KSU grad
- Ambulatory Internship- RREH
- Kentucky Horse Racing Commission
- Red Oak Animal Hospital
- Kansas Equine Practitioners Group
- AAEP
  - Student Subcommittee of the Commission on Equine Veterinary Sustainability
  - Member Engagement Committee
  - Governance Task Force
  - Practice Owner Task Force
- Decade One Member
- Guiding Wildcats into Future Equine Vets mentor

Why is Change Needed in Equine Practice?

- Decreasing # of equine vets
- Demand > supply
- Large # of vets in retirement age
- Debt to income ratio is not sustainable
- Low compensation compared to SA
- Long hours worked
- Emergency Coverage
- Industry & practice culture

Timeline for Formation of the AAEP Commission on Equine Veterinary Sustainability

TRANSFORMING EQUINE PRACTICE

December 2021 AAEP Convention- Nashville

- Presentation by Dr Carol Clark
  - Chair of the Retention Task Force
- Results of AAEP funded research on why vets are leaving equine practice
- 1 year of qualitative research and interviews with practice owners, recent grads, and vet students

January 2022 AAEP Board Meeting

3 Key Initiatives

- Form a task force to investigate changes to the internship model
- Wanting to support expansion of peer mentorship groups
- Schedule a Practice Owner Summit to determine next steps of improving equine practice business model

May 2022 Practice Owner Summit

Facilitated Practice Owner Summit

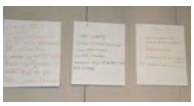
- Rep from each Veterinary Management Group (VMG)
- Rep from each Decade One group
- Several “At Large” Attendees from practices not in a peer mentorship group

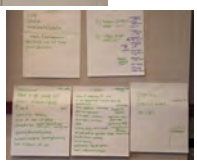
May 2022 Practice Owner Summit

Decision made to focus on:

- Internships
- Emergency Coverage
- Compensation
- Practice Culture
- Student Outreach
- Peer Mentorship groups

“Change The Numbers”





July 2022 AAEP Board Meeting

- Internship Task Force reported progress
- Peer mentorship groups & how to support them with AAEP
- Decision to start the AAEP Commission on Veterinary Sustainability
  - 5 Subcommittees charged with addressing the areas identified at the Practice Owner Summit
- Scholarship support for Decade One and MentorVet

decade one
where equine practitioners learn to thrive

MentorVet

September 2022 AAEP Executive Board Meeting

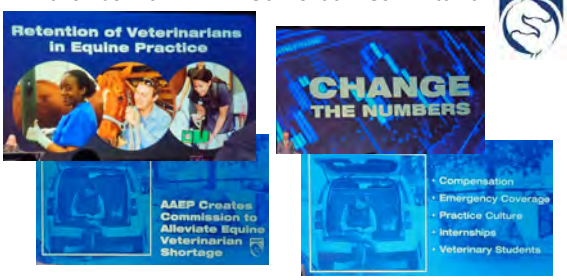
- AAEP Commission on Veterinary Sustainability
  - Co-chairs appointed
  - Committee members assigned from volunteers interested in helping with this initiative

Commission on Equine Veterinary Sustainability

- Internship Subcommittee
- Emergency Coverage
- Compensation Subcommittee
- Practice Culture
- Student Outreach

TRANSFORMING EQUINE PRACTICE

November 2022 AAEP Convention- San Antonio



November 2022 AAEP Convention

Updates

- Dr Jackie Christakos- Internship
- Dr Mike Erskine- Emergency Coverage
- Dr Jim Zeliff- Compensation
- Dr Julianne White- Practice Culture
- Dr Rhonda Rathgeber- Students
- Dr Amy Grice- Peer Mentorship Groups

Internship Subcommittee

- >70% of equine new grads choose to do internships
- Should be mutually beneficial for practice and the intern
- Educational experience
- Preparing Toolkits for prospective interns and for practices
- Chair: Dr Jackie Christakos

Internship Subcommittee- Resources

- Best Practices for AAEP Internship Practices
- Green flags/Red flags
- Core competencies
- Entrustable Professional Activities
- Taking the Reins
- Career Night Feedback Chart

Internship Subcommittee

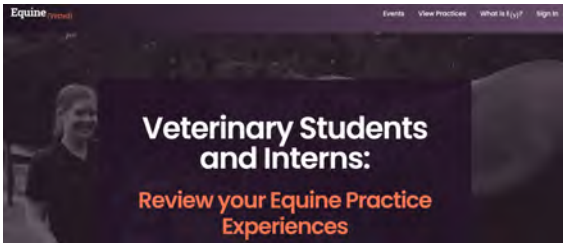
- "Avenues" is being restructured and rebranded with updated AAEP website- Transition to "Internship Hub"
- Standardized and searchable program
  - Salary and benefits
  - Contract basics
  - Average duty hours
  - Caseload
  - NOT a formal match program

Goal is transparency

Internship Subcommittee- Internship Hub

- AAEP Internship Exit Survey
  - Did program match internship description?
  - Would you recommend this internship program?
  - What improvements could this program make in the future?
- Eventually provide a "rating system" for practices as data is collected over years
  - Equinevetted.com is also working on this (website is up and running)

Equinevetted.com



Emergency Coverage Subcommittee

Emergency Coverage Subcommittee

- Common stressor for equine practitioners
- Models identified to show how other practices are providing unique options for emergency coverage
- Subcommittee will establish case studies and toolkits for these models
- Co Chairs: Drs Leann Kuebelbeck and Mike Erskine

Emergency Coverage- Current Models

- Not offering emergency coverage
- Offering part time coverage
- Haul in emergencies
- Utilizing referrals centers- emergencies & tertiary care
- Emergency cooperatives
- Telemedicine
- Utilizing vet techs for triage and treatment
- Utilizing relief vets
- Emergency only practices

Emergency Coverage- Current Models

AAEP Practice Life Podcasts

- "Strategies from the Emergency Coverage Subcommittee"
- "Creating a Shared On Call Network in Your Practice Area"

Compensation Subcommittee

- Typically lower starting salaries compared to small animal
- High student debt load
- Need to gather better data
- Co Chairs: Drs Travis Boston and Jim Zeliff

Compensation Subcommittee

Research findings related to compensation for equine vets

1. Average salaries
2. Emergency fee compensation
3. Compensation satisfaction
4. Average hours worked
5. Employee benefits in equine vet practice

Still to come…..

6. Debt load vs salary
7. # of days worked and revenue impact
8. Revenue as compensation plus production

Compensation Subcommittee

Equine Veterinary Fee Survey Data

- Data from Decade One and VMG 16 members
- Broad cross-section of geographies and practice types
- 12 mo old data
- Periodically repeat survey

Compensation Subcommittee

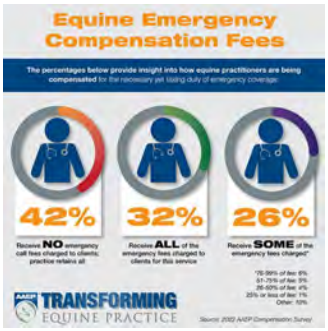
2022 Equine Medicine Salary and Lifestyle Survey

- Last AAEP Salary Survey was in 2007
- Email sent to 6,564 AAEP members
- Responses from 1,378 (21% response rate)
- Average salary of all responses $154,217
- Recent grads (2016-2019) reported average salary of $88,973

All Respondents	2021 Graduates	2020 Graduates	2019 Graduates	2018 Graduates	2017 Graduates	2016 Graduates	2016-2021 Graduates	2016-2019 Graduates (*excluding* 2021 grads & 2020 Interns)
$154,217	$45,115	$62,970	$77,601	$78,805	$91,803	$107,684	$76,581	$88,973

2011-2015 Graduates	2006-2010 Graduates	1996-2005 Graduates	1986-1995 Graduates	1976-1985 Graduates	Graduated prior to 1978	Males	Females
$123,465	$164,398	$187,044	$209,275	$177,307	$188,729	$210,873	$118,637

Table 1: Equine Medicine Salaries Overall and by Various Subgroups



Practice Culture Subcommittee

Co Chairs: Drs Stacey Cordivano & Kelly Zeytoonian

Practice Culture Subcommittee

7 pillars that contribute to a positive workplace culture:

1. Non-Salary Benefits
2. Physical & Mental Safety
3. Connection & Community
4. Mattering at Work
5. Professional & Personal Life
6. Communication
7. Opportunities for Growth

Practice Culture Subcommittee

- Communication Boundaries for the Equine Practice Handbook
- Non Salary Benefits Survey for Employees
- The Stay Interview
- The Key to Successful Teams for the Equine Practice Owner Handbook

Practice Culture Subcommittee

Student Subcommittee

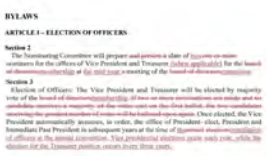
Co Chairs: Drs Rhonda Rathgeber & Scott Toppin

Fall 2023: Speaker's Bureau formed

Student Subcommittee

November 2023 AAEP Convention- San Diego

- AAEP General Membership Meeting
  - Proposed bylaws change up for vote that would allow 2 candidates for vice president and treasurer to be presented to the membership for a member vote



AAEP Governance Task Force

- Formed February 2024
- To review the bylaws and recommend changes to the Board of Directors
- Overall goal to keep the bylaws lean but modernize them to reflect the latest best practices, changes in membership desires, and technology
- Email sent to members May 16th and member comment period is open until June 17th
- Final set of revisions will be available before Annual Convention

Decade One

- Formed by Dr Amy Grice in 2015
- Peer network, career development goals, and business education
- First decade of practice or practice ownership
- Groups of 20-30 members
- Monthly virtual “Check In/ Catch Up” meetings
- Two in person meetings per year
- Meet for 3 years
- AAEP Decade One Scholarships

Decade One Curriculum

Business content modules/workshops

1. Personal & Professional Mission/ Vision/ Values
2. Financial Reports
3. Leadership/ Work Life Balance/ Boundaries
4. Effective Communication/ Negotiation
5. Small Business Primer: Inventory Management/ HR
6. Compensation/ Transition of Ownership/ Valuation

Starting Gate

- “A Winning Beginning” for equine-oriented veterinary students
- Groups of ~ 20-25 form for each graduation year – as many as needed
- New 1st year groups form annually
- Groups stay together for up to four years of veterinary school then can continue in Decade One groups for the early years of their professional careers as equine practitioners

Objectives of Starting Gate

- Minimizing attrition from the equine field before graduation
- Networking with peers from across the country
- Mentorship & Support from experienced equine veterinarian facilitators
- Planning a successful Equine Veterinary Career
- Receiving Business education to increase success
- Developing future leaders of the equine veterinary industry

Program Structure

- Monthly Zoom “Check-in and catch up” meetings with facilitators
- Quarterly Zoom educational meetings with content such as:
  - Managing Your Educational loans
  - Negotiating a Job Offer
  - Understanding Employment Agreements
  - Setting Boundaries
  - Cash flow and how to make a simple budget
  - Managing Stress and Building Resilience
  - Choosing Externships and Internships
  - Imposter Syndrome & Building Confidence

Signing Up

- Go to www.decadeonevet.com, and click on Starting Gate page tab
- Click the sign-up button
- Provide your contact information
- Write a short paragraph about why you want to be an equine practitioner
- AAEP Starting Gate Scholarships

MentorVet

- Founded in 2021 by Dr Addie Reinhard
- Community to support each other towards successful career fulfillment
- Evidence-based practices and novel research
- Online learning
- Financial coaching
- Social connections
- Vet Mentor Partnership
- Share resources
- Mental health coaching
- 10 hrs RACE CE
- AAEP MentorVet Scholarship

Kansas Equine Practitioners Group

- First meeting spring 2016
- Biannual meetings
  - February
  - October
- Lunch, Announcements, Continuing Education
- Sponsorship
  - Patterson, MWI, and Covetrus
  - Zoetis, BI, and Merck
- Currently on Board of Directors

Guiding Wildcats into Future Equine Vets

- Equine focused mentorship program with KSU students and local practitioners
- Engage students into the equine veterinary world
- Practitioners to provide information, support, and guidance
- Partnered with Boehringer Ingelheim
- Kick off event April 2022

Sustainability in Equine Practice Seminar

Opportunities in Equine Practice Seminar

- Initially ran from 2003-2012 with over 4,100 students
- Started up again in 2023
  - 273 students
  - 58 practices involved
- Travel and hotel funding provided for 3rd yr vet students to attend
- Various avenues and disciplines of equine practice, financials, employment, practice ownership, and marketing
- Presentations from practitioners, financial advisors, and practice management consultants
- Practice Exhibit Hall

Coming Spring 2024 – Register Today!

Questions?

CONGENITAL ANGULAR & FLEXURAL LIMB DEFORMITIES

JARROD TROY
DVM, DACVS-LS, CERP

EQUINE

Congenital Angular & Flexural Limb Deformities

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Assistant Professor
Iowa State University Veterinary Clinical Sciences

1

Conflict of Interest Disclosure:

I have no financial interest, arrangement, or affiliation with any company or organization.

2

Objectives

- Identify congenital angular limb deformities (ALD)
- Manage/treat congenital angular limb deformities
- Identify congenital flexural limb deformities (FLD)
- Manage/treat congenital flexural limb deformities

3

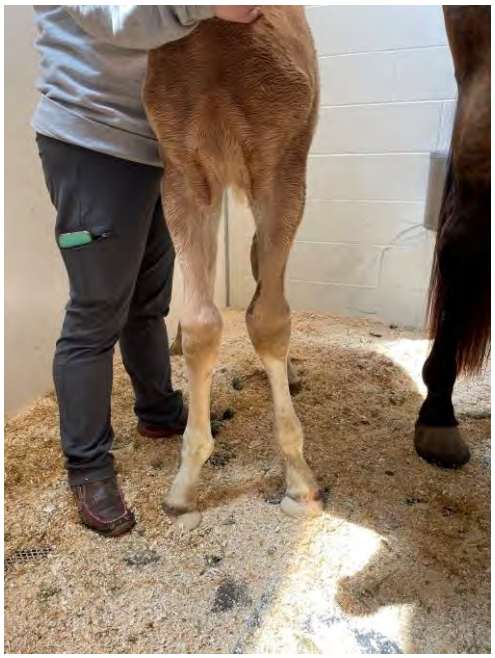
Outline

- Angular limb deformities (ALD)
- Flexural limb deformities (FLD)

4

Angular Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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Angular Limb Deformities Definition

- Lateral or medial deviation of the limb distal to a joint
- Lateral deviation – **Valgus**
- Medial deviation – **Varus**
- Joint must be described (e.g. fetlock varus)

6

Fetlock Valgus

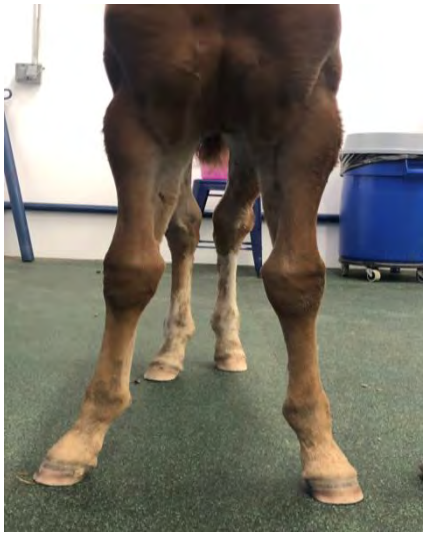
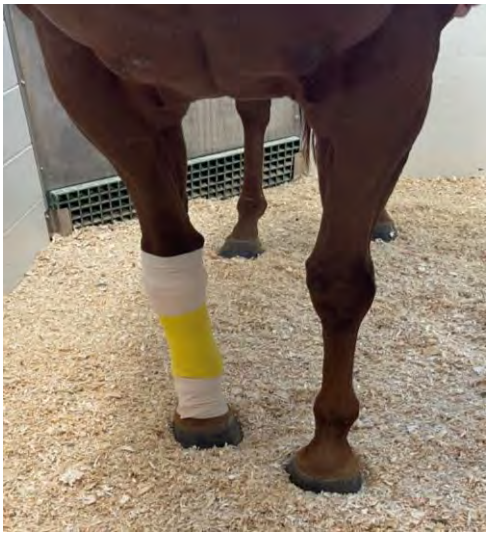


Photo courtesy of Dr. Aubrey Cordrey

Carpal Valgus & Fetlock Varus



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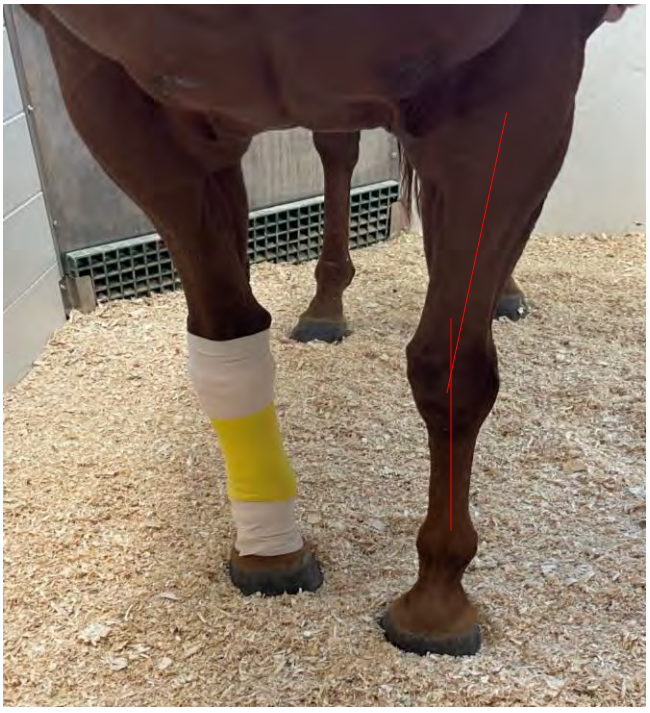

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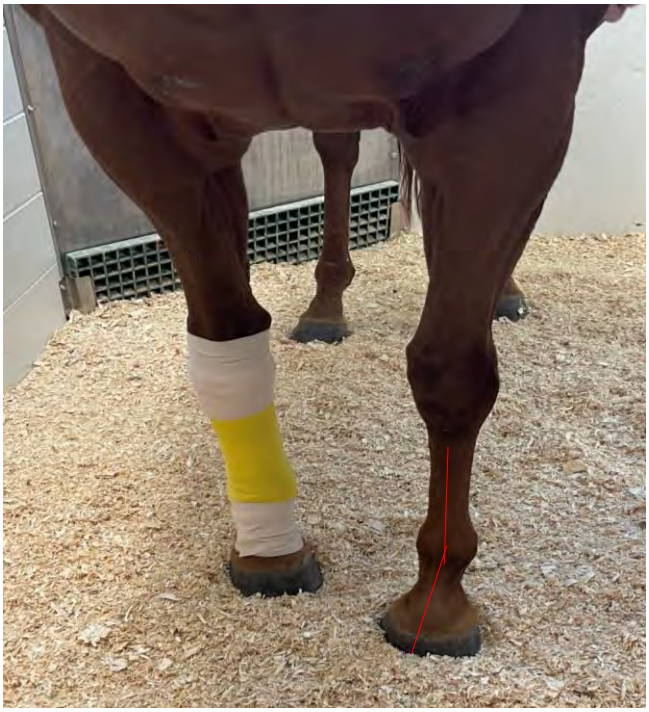

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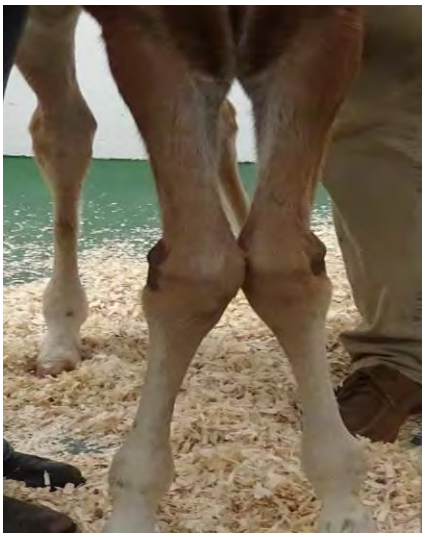
Fetlock Varus

Carpal Valgus (Bilateral)



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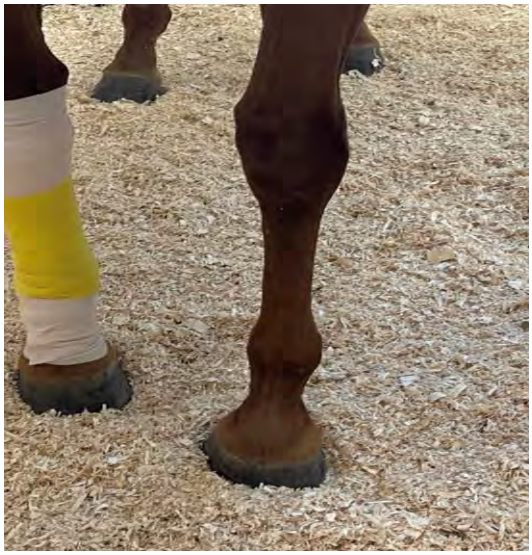
Angular Limb Deformities Lay-Terms

- "Pigeon toed" – inward rotation of foot due to varus deformity



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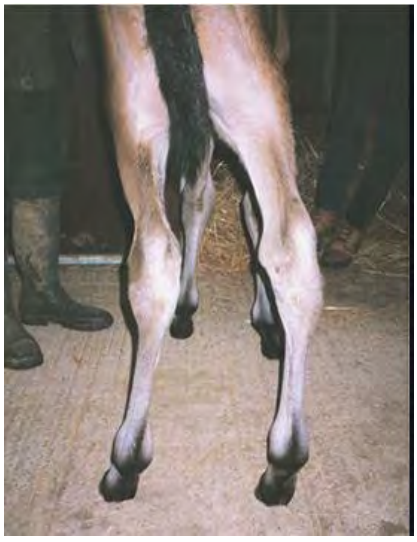
Angular Limb Deformities Lay-Terms

- "Pigeon toed" – inward rotation of foot due to varus deformity
- "Windswept" – tarsal valgus & tarsal varus combination



https://thehorsesback.com/crooked-legs-angular-limb-deformities/

12

Angular Limb Deformities Lay-Terms

- "Toed out" – normal in foals. Outward rotation of carpus & fetlock due to lack of chest muscles

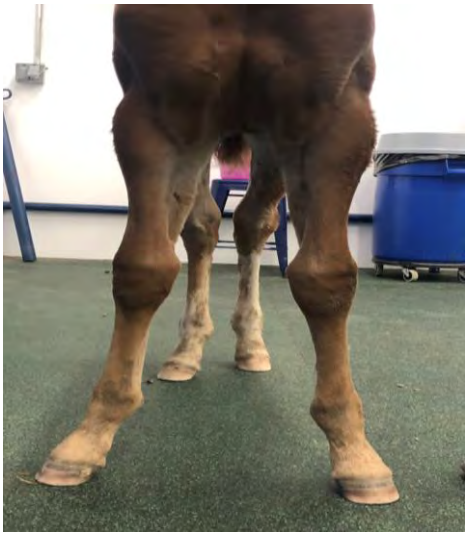


Photo courtesy of Dr. Aubrey Cordrey

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Angular Limb Deformities Lay-Terms

- "Toed out" – normal in foals. Outward rotation of carpus & fetlock due to lack of chest muscles
- Not normal - If carpus points out but the toes point straight forward → fetlock varus

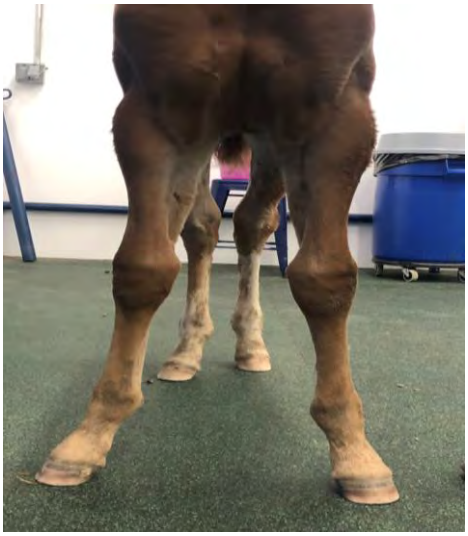

Photo courtesy of Dr. Aubrey Cordrey

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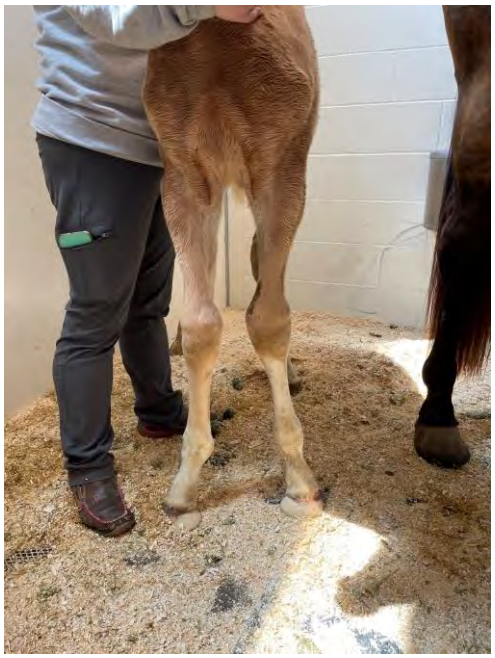
Angular Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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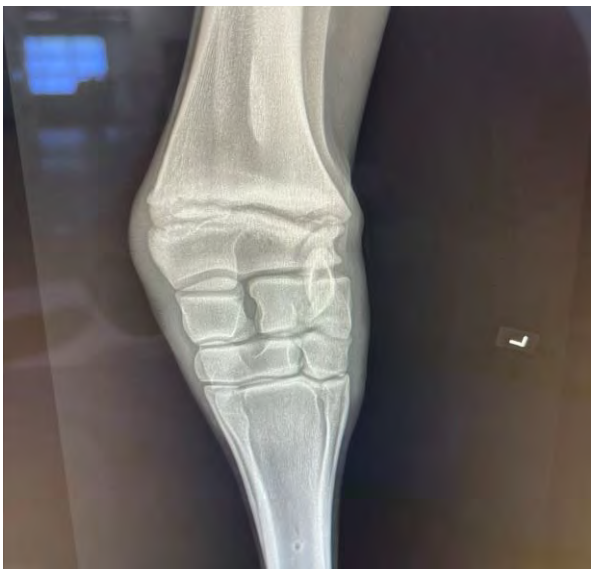
Angular Limb Causes

- Excessive unilateral physeal growth



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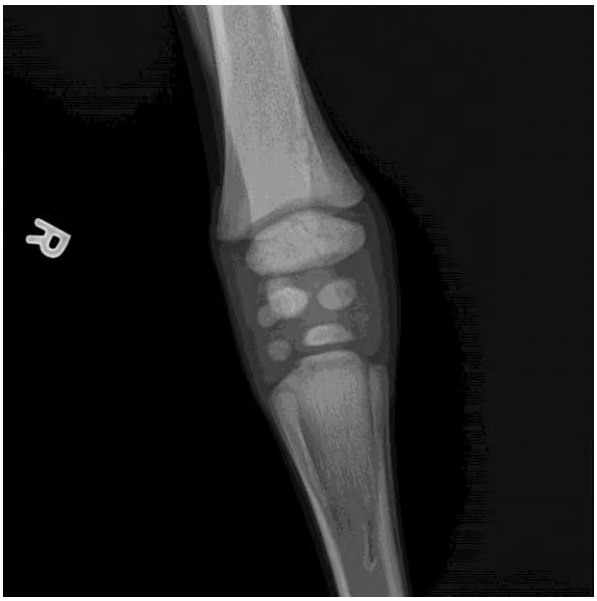
Angular Limb Causes

- Excessive unilateral physeal growth
- Incomplete ossification and crushing of cuboidal bones



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Angular Limb Causes

- Prematurity/dysmaturity
- Placentitis
- Twins
- Soft tissue laxity

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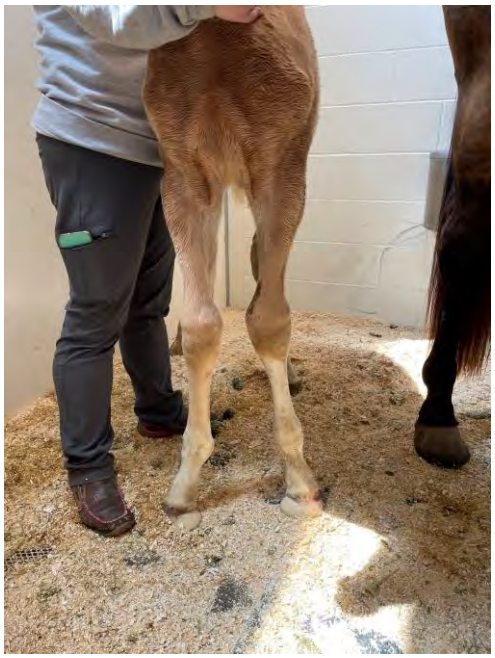
Angular Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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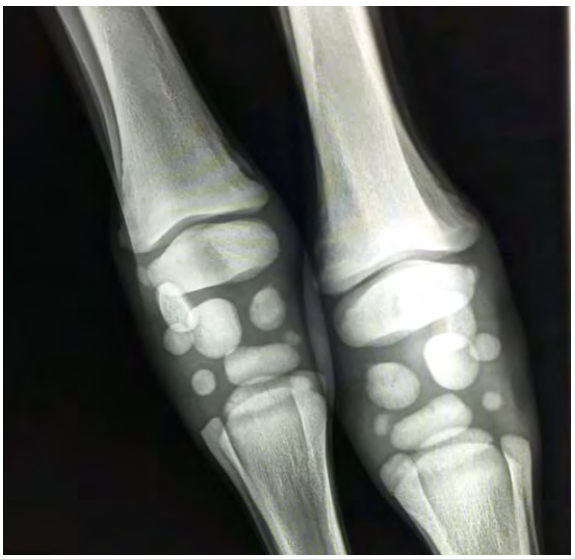
Angular Limb Diagnosis

- Observation
- Palpation
- Radiographs



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Angular Limb Observation

- Begin early in life
- In front of or behind the foal
- Perpendicular to frontal plane of examined limb
- Watch foal walking – may make deformities easier to see

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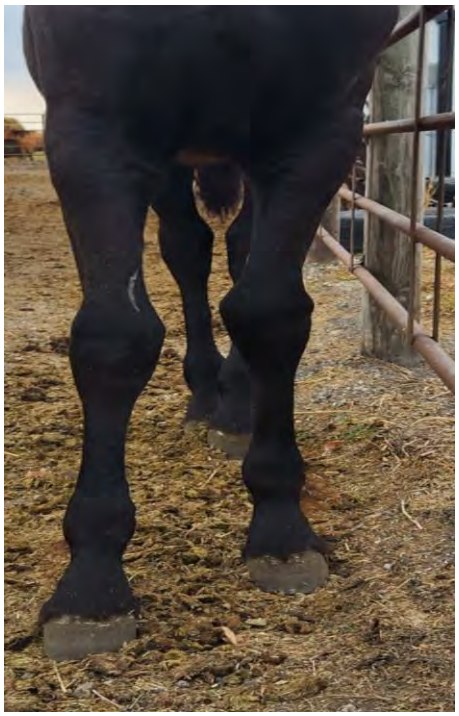

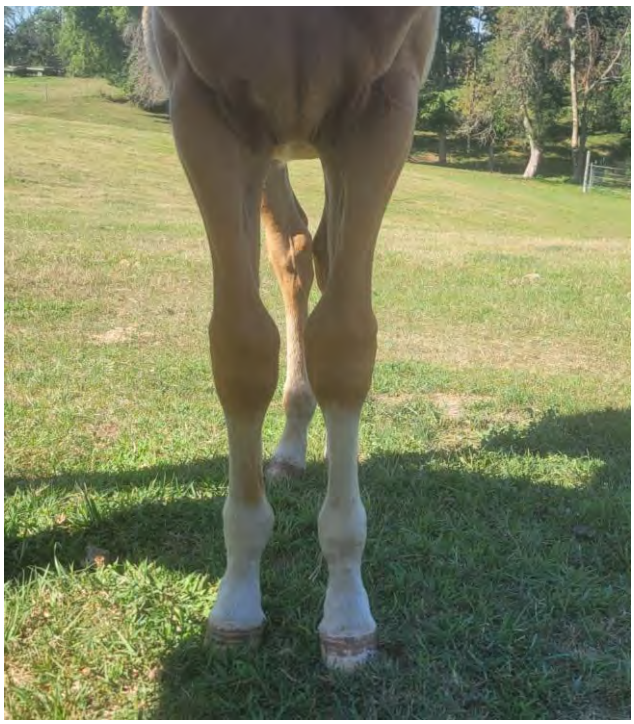

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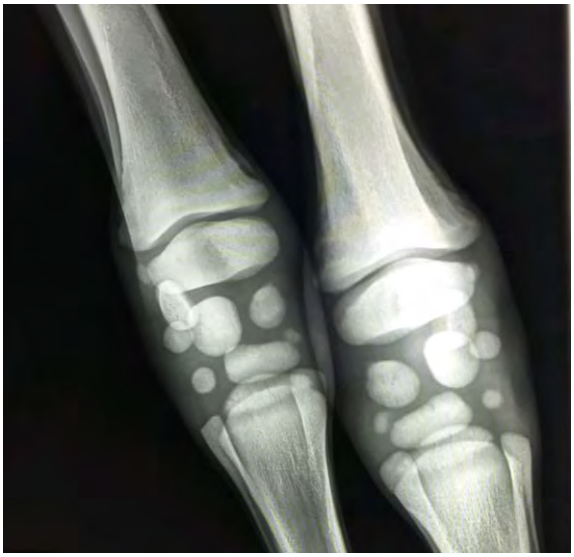
Angular Limb Diagnosis

- Observation
- Palpation
- Radiographs



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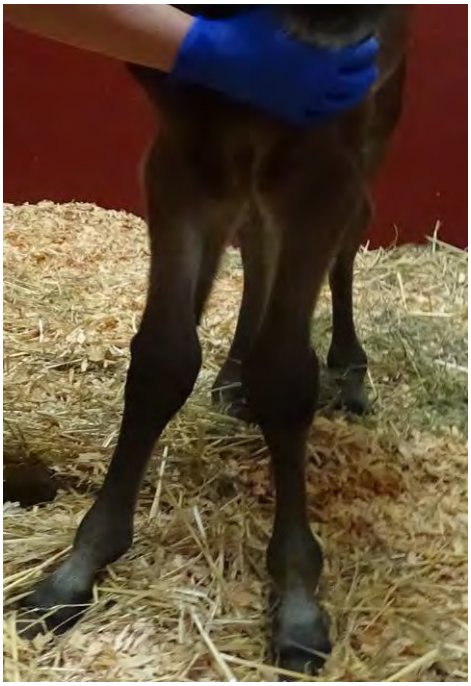
Angular Limb Palpation

- Joint laxity vs. bone change
- Move joint into normal position – laxity
- Cannot move joint – bone change



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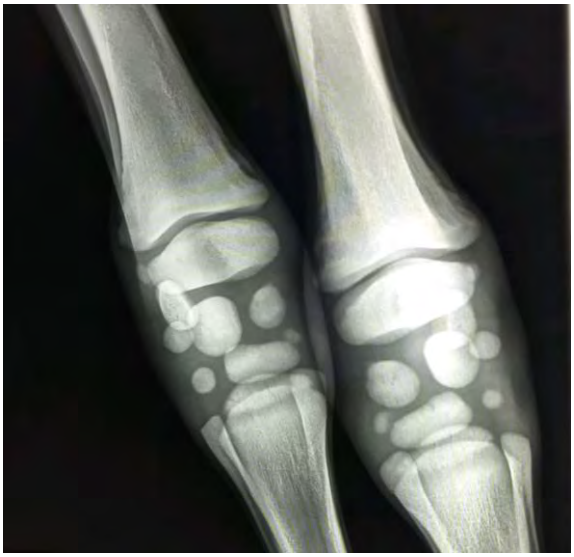
Angular Limb Diagnosis

- Observation
- Palpation
- Radiographs



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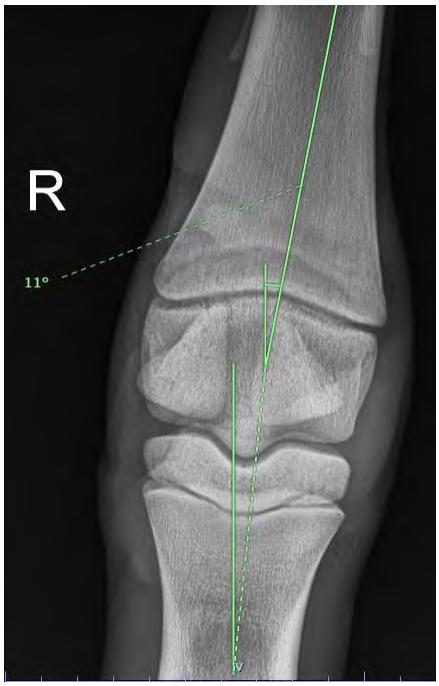
Angular Limb Radiographs

- Dorsal-palmar/plantar views
- Need at least mid-diaphysis of bone above and below affected joint
- Measure angles with diaphyseal lines – visual observation is important



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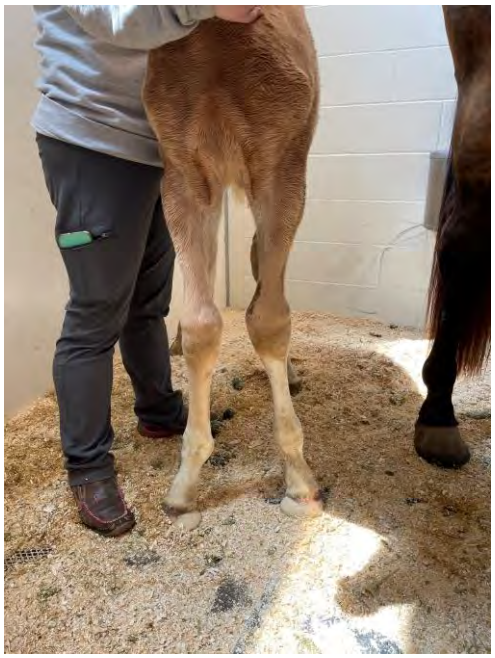
Angular Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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Angular Limb Treatment

- Joint laxity – controlled exercise & self limiting
- Incomplete ossification – keep bone crushing from occurring
- Excessive physis growth – physeal acceleration or retardation

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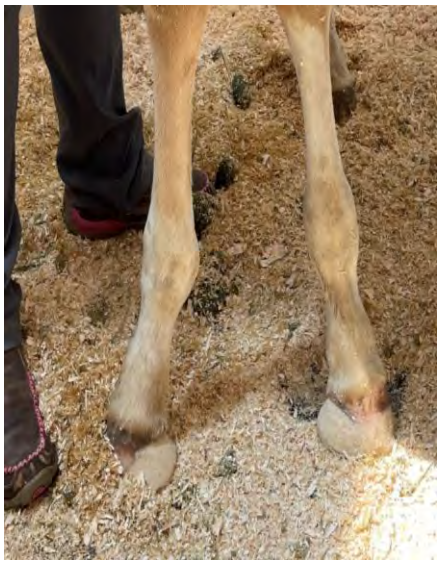
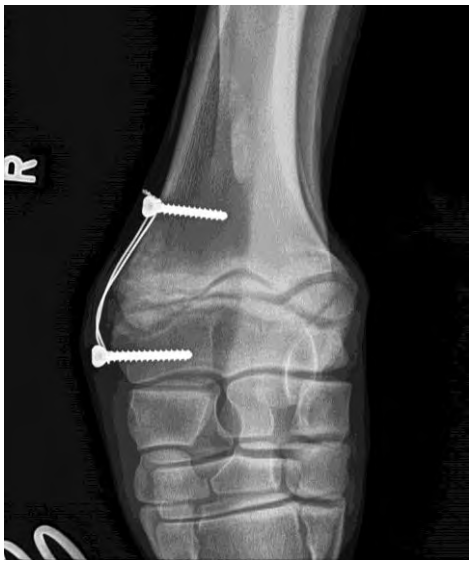
Unilateral Physeal Growth Treatment

- Non-surgical
- Surgical





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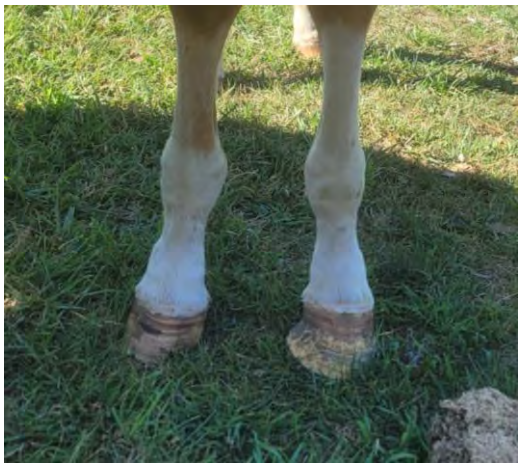
Unilateral Physeal Growth – Non-surgical

- More successful during rapid growth phase of physis
- Fetlock – 2 months
- Tarsus – 4 months
- Carpus – 6 months



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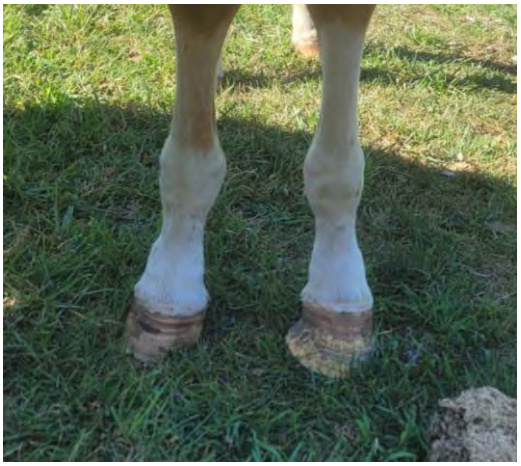
Unilateral Physeal Growth – Non-surgical

- Stall rest and controlled exercise if $>10^0$ angle
- Hoof trimming every 2-4 weeks and create large solar surface
  - Valgus – lower outside hoof wall
  - Varus – lower inside hoof wall
- Hoof extension to slow physis growth



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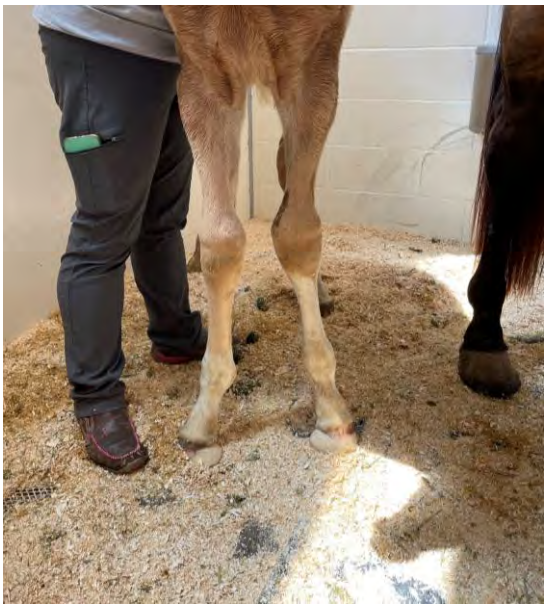

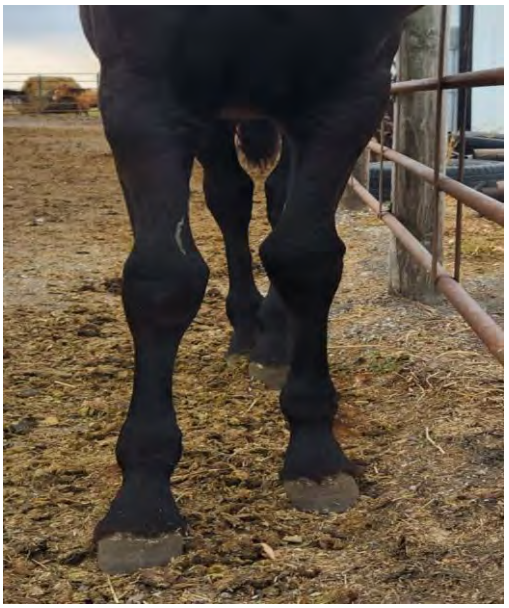

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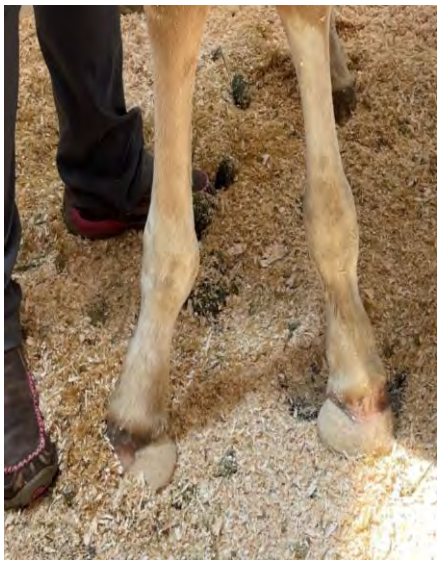
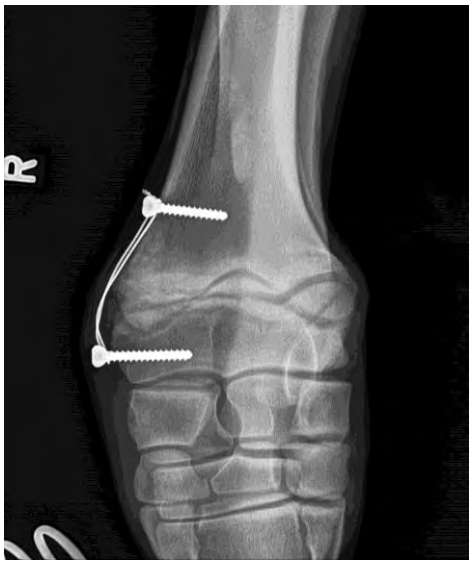
Unilateral Physeal Growth Treatment

- Non-surgical
- Surgical





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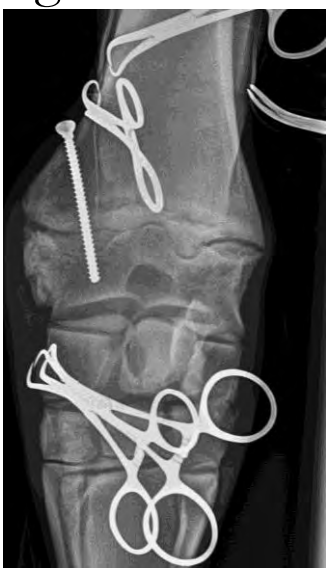
Unilateral Physeal Growth – Surgical

- Growth retardation after rapid growth phase or severe ALD (>10^0)
- Transphyseal bridging
- Transphyseal screw
- Implant must be removed – overcorrection for opposite ALD possible



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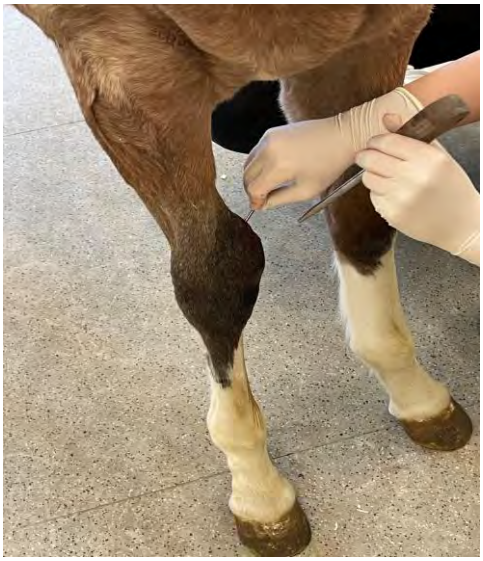
Unilateral Physeal Growth – Surgical

- Implant removal just before the limb is straight to prevent "lag phase" overcorrection
- Weekly images



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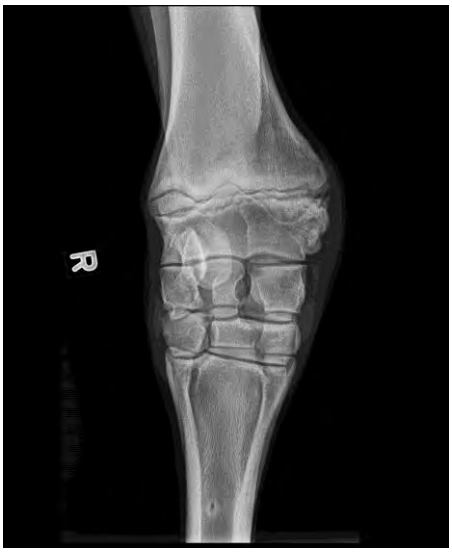
Unilateral Physeal Growth – Surgical

- Periosteal transection (periosteal stripping)
- Growth acceleration of "slow growing side"
- Must occur during rapid growth phase
- Efficacy is controversial



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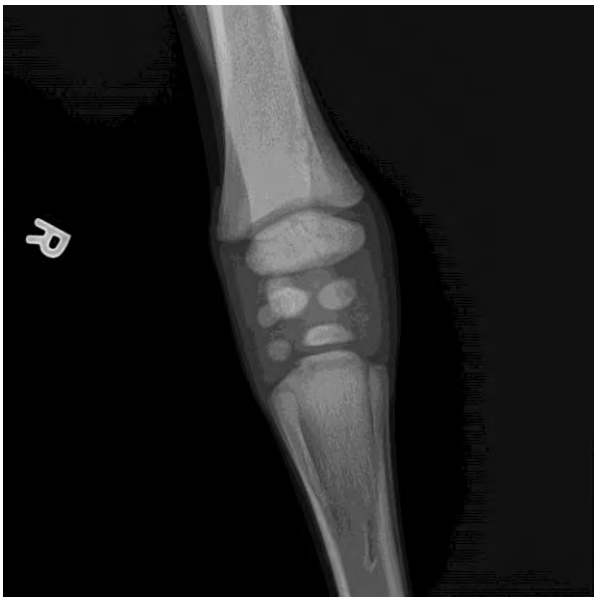
Angular Limb Causes

- Excessive unilateral physeal growth
- Incomplete ossification and crushing of cuboidal bones



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Angular Limb Causes

- Excessive unilateral physeal growth
- Incomplete ossification and crushing of cuboidal bones
- Diaphyseal curvature or malunion

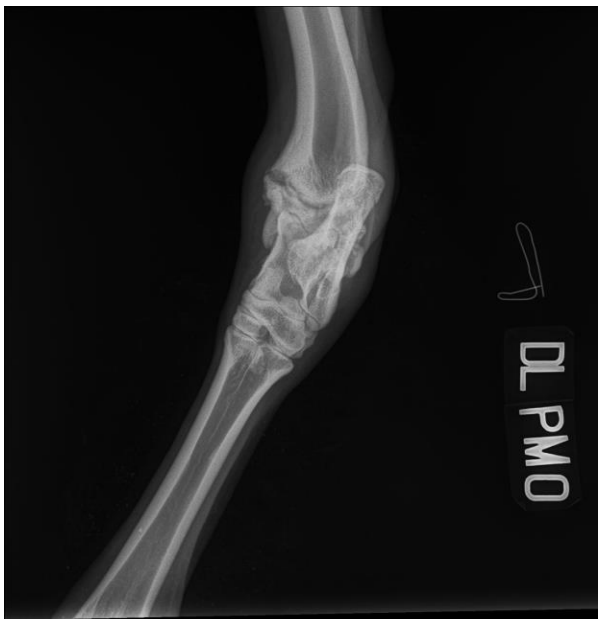

Photo courtesy of Dr. Paul Merkatoris

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Angular Limb Causes

- Wedge ostectomy
- Step ostectomy
- Implant or transfixation pin cast stabilization needed

Photo courtesy of Dr. Paul Merkatoris

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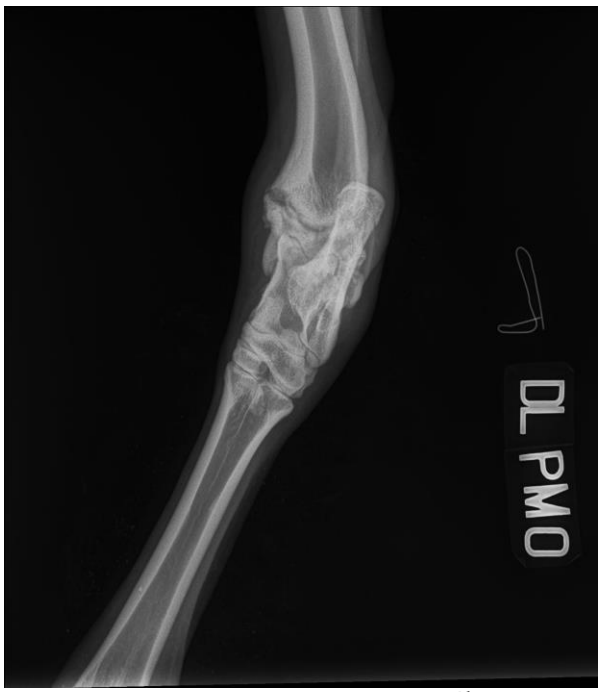

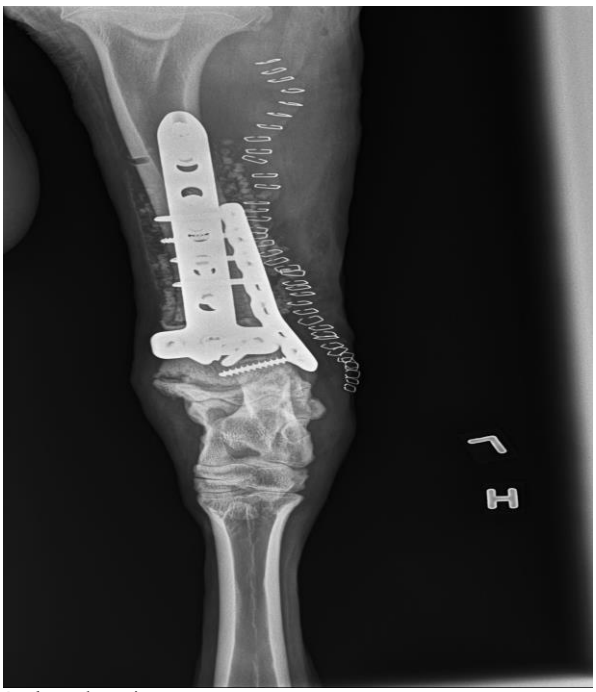

Photos courtesy of Dr. Paul Merkatoris

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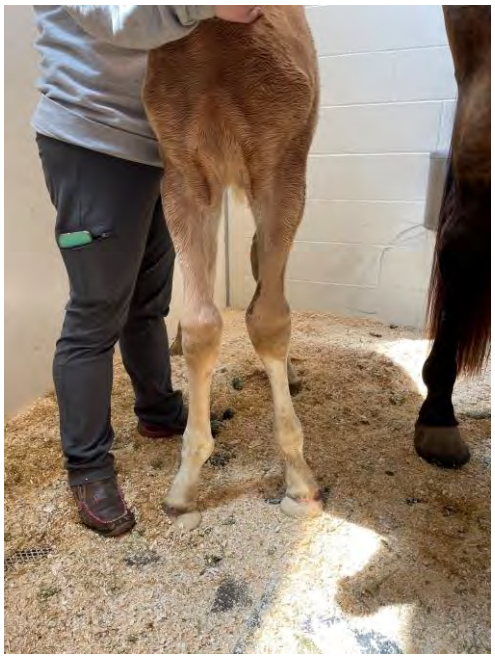
Angular Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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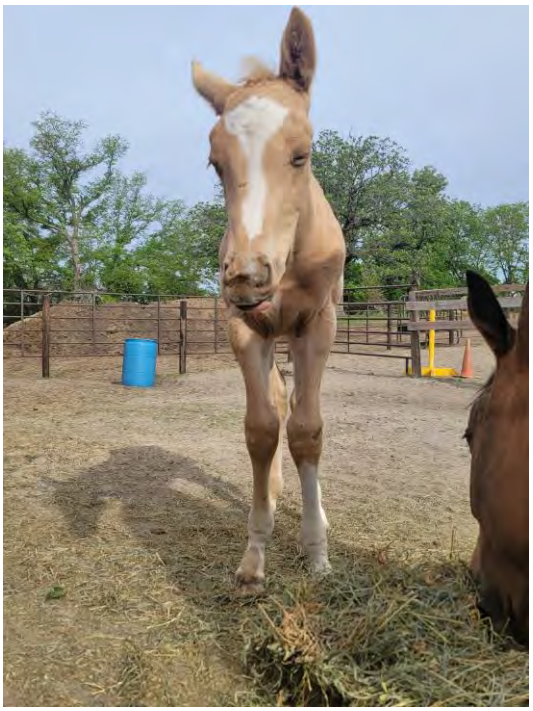
Outline

- Angular limb deformities (ALD)
- Flexural limb deformities (FLD)



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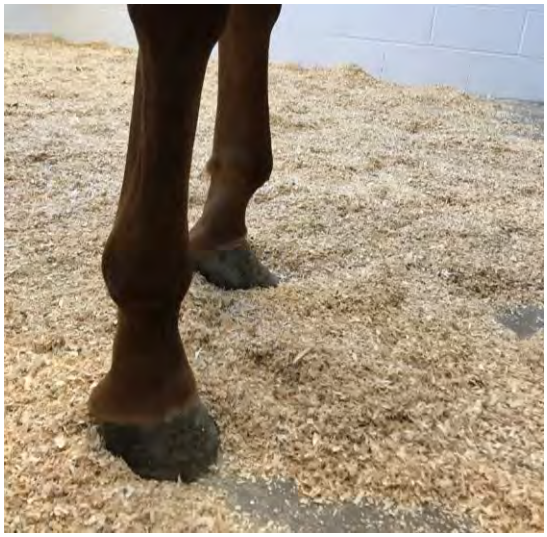
Flexural Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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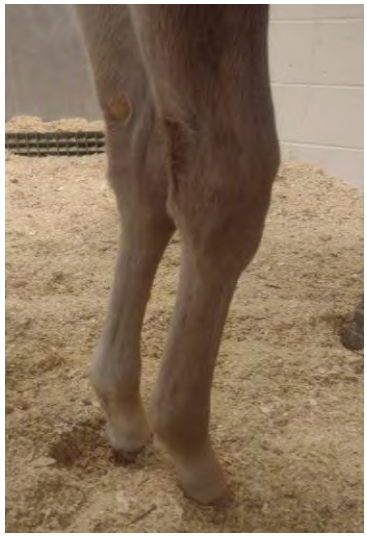
Flexural Limb Definition

- "Laxity" – hyperextension of a joint
- "Contracted" – hyperflexion of a joint



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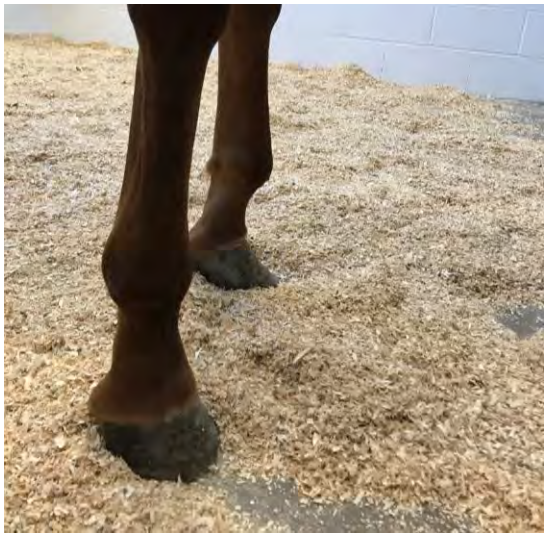
Flexural Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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Flexural Limb Causes

- Intrauterine positioning
- Genetics
- Teratogens

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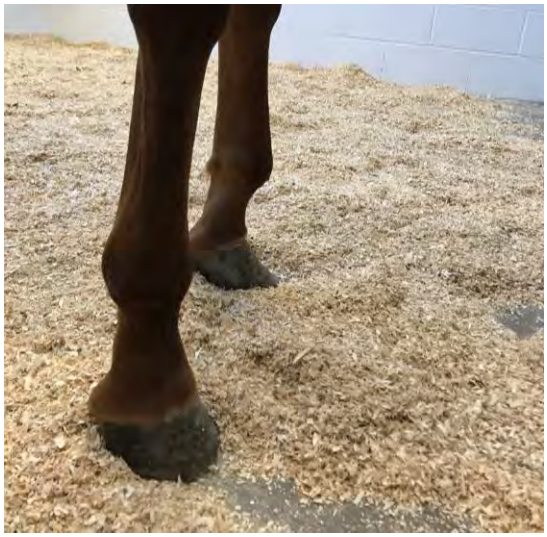
Flexural Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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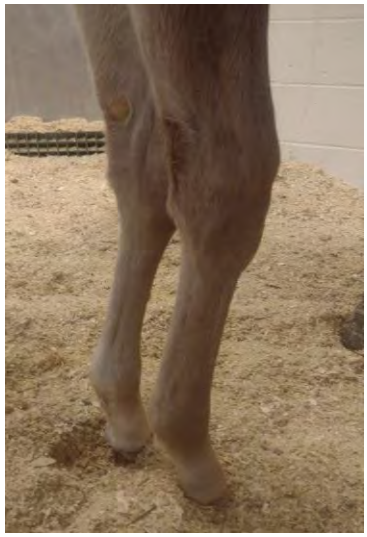
Flexural Limb Diagnosis

- Observation typically only needed
- Palpation to determine if joint can be straightened
- Sometimes radiographs



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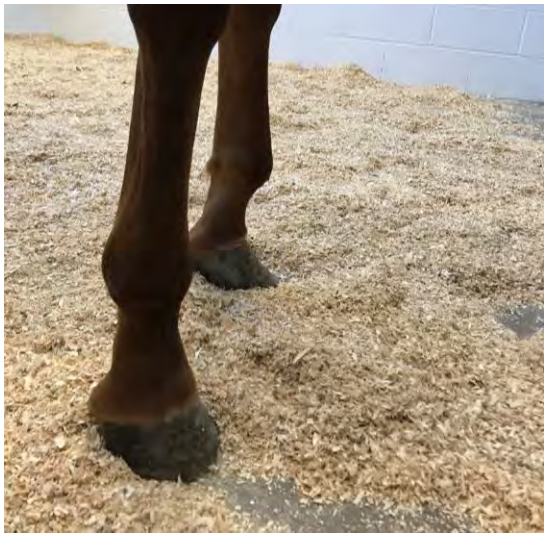
Flexural Limb Deformities

- Definition
- Causes
- Diagnosis
- Treatment



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Flexural Limb Treatment

- Laxity
- Contracted

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Flexural Limb Treatment – Laxity

- Controlled exercise – no muscle fatigue
- Heel extension if not walking on soles
- Light bandage wraps on skin areas bearing weight (e.g. heels; fetlock)

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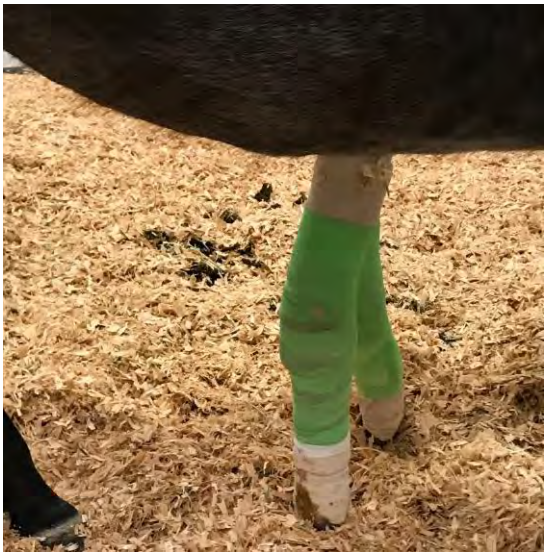
Flexural Limb Treatment

- Laxity
- Contracted

52

Flexural Limb Treatment – Contracted

- Bandages
- Caudal splints – straighten as much as possible without increasing pain
- Toe extensions
- Pain management



53

Flexural Limb Treatment – Contracted

- Splints – PVC pipe or fiberglass cast material
- Cast material molds but breaks easier
- Time with splint on and time with splint off (12 hours on – 12 hours off guideline)
- Splints risk common digital extensor tendon rupture – bandage/splint until heals

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Flexural Limb Treatment – Contracted

- Splints need to not move out of place
- Must monitor for pressure sores – typically top, bottom, or joint areas

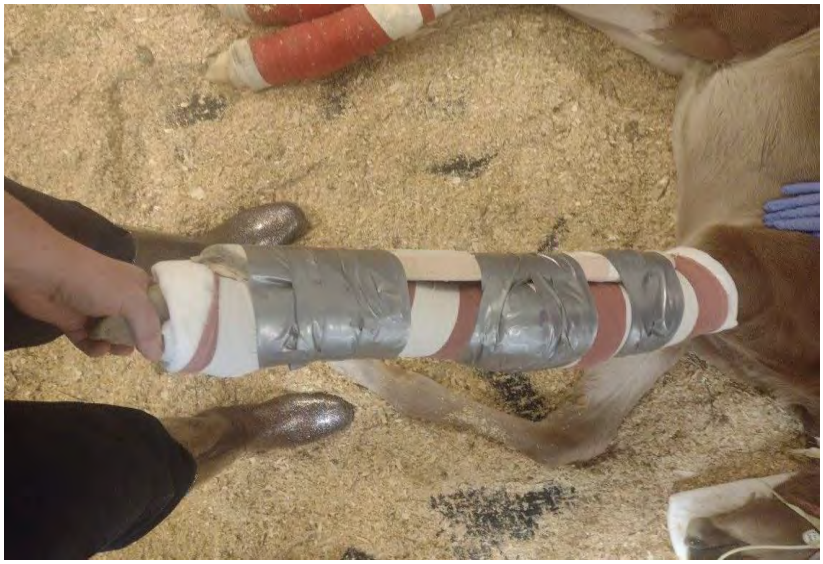

Photo courtesy of Dr. Jackie Willette

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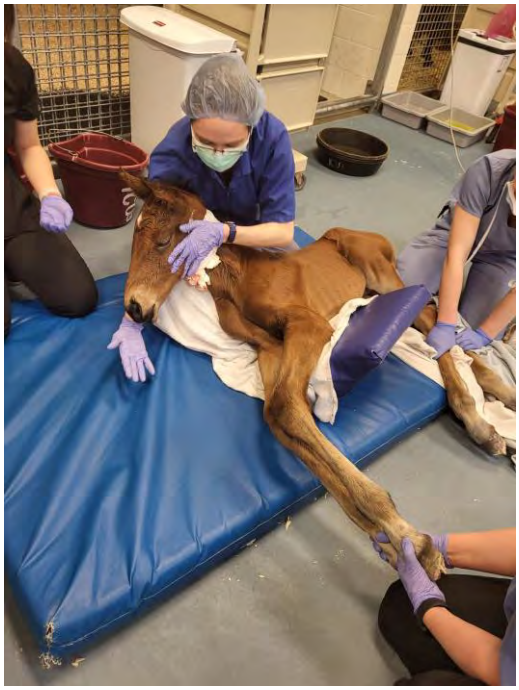
Flexural Limb Treatment – Contracted

- Foals unable to stand due to contracted tendons need to be managed for failure of passive transfer and sepsis

56



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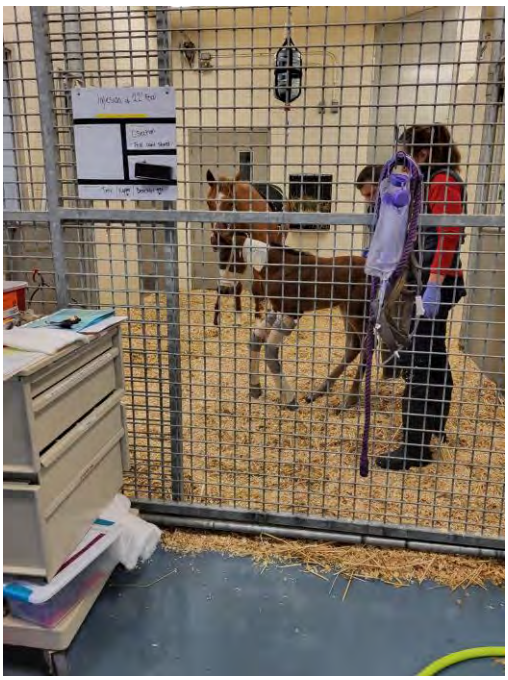

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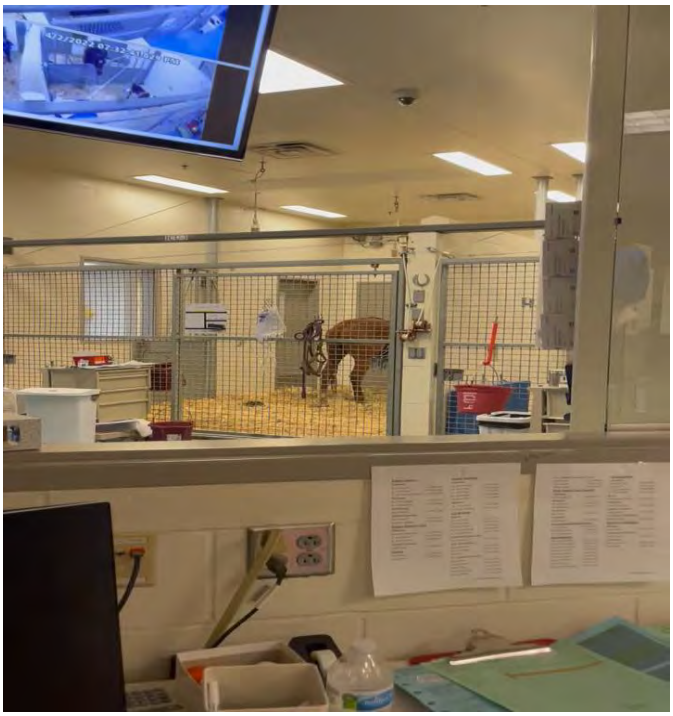

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Flexural Limb Treatment – Contracted

- Surgery if no response to non-surgical management
- Transection of flexor carpi ulnaris & ulnaris lateralis tendons
- Can be successful – concern about athleticism

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Summary

- Congenital angular and flexural limb deformities are common in foals
- Early observation aids many being managed without surgical intervention
- Surgical intervention if non-surgical management is unsuccessful or severe deformity

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Questions?

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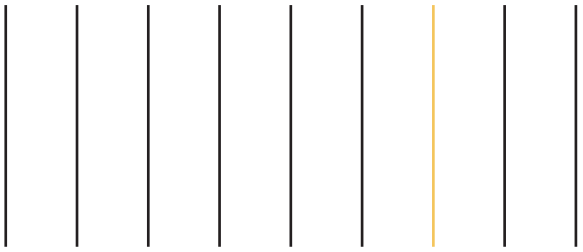
EQUINE COLIC: IMPROVING PATIENT OUTCOMES & PREPARING OWNERS FOR REFERRAL

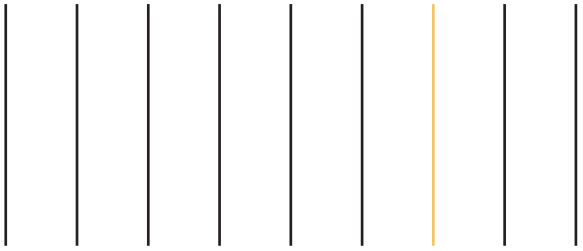
MEGHAN MCCARTHY
DVM, MS



EQUINE

NO HOOF, NO HORSE: FIELD APPROACHES TO COMMON HOOF INJURIES & DISORDERS

MEGHAN MCCARTHY
DVM, MS



EQUINE

CONFERENCE EVALUATION

Thank you for joining us!