

Table of ContentsFocus on the Pre-Purchase Examination in the Sport HorseLexington, KYMay 2 & 3, 2022

Sponsored by









Communicating with the Purchaser Before, During, and After the Pro Purchase Examination	2
Mark R. Baus, DVM	3
Purchase Examinations: Head to Tail Richard D. Mitchell, DVM, MRCVS, DACVSMR	6
Laboratory Tests and Ancillary Diagnostics for the Purchase Exam Richard D. Mitchell, DVM, MRCVS, DACVSMR	10
The Pre-Purchase in Review: Reflection of Historical Data Pertaining to Pre-Purchase Exams	15
Getting to the Heart of the Matter: Cardiac Evaluation During Pre-Purchase Examinations Mary M. Durando, DVM, PhD, DACVIM	18
Star Pupil: Perfecting the Ophthalmic Portion of the Pro Purchase Exam	"
Stephanie C. Bell, DVM, DACVO	
Differentiating Signs of Lameness versus Ataxia Steve Reed, DVM, DACVIM	28
Radiography: Evaluating Proper Positioning, Normal Anatomic Variants, and Insignificant Abnormalities in Prospective Equine Athletes Kent Allen, DVM, Cert. ISELP; Julia Petersen, MBA DVM; and Kurt Selberg, MS, DVM, MS, DAVCR, Cert. ISELP	30
Radiography of the Thoracolumbar Spine Kent Allen, DVM, Cert. ISELP; Julia Petersen, MBA DVM; and Kurt Selberg, MS, DVM, MS, DAVCP, Cert, ISELP.	35
Kuit Sciberg, 1915, D V 191, 1915, DA V CR, Cett. ISELI	

Alternative Imaging Techniques for Evaluation of the Purchase Examination Richard D. Mitchell, DVM, MRCVS, DACVSMR	39
Effective Dialogue Between Colleagues: Communicating Findings to Other Veterinarians	46
Kent Allen, DVM, Cert. ISELP; and Kristen Stowell, DVM	
Applications of Objective Lameness Measurement in the Pre-Purchase Exam Mark R. Baus, DVM	48
Evaluation of the Off-Track Thoroughbred for Their Second Career	52
Exploring Legal Pitfalls of the Pre-Purchase Exam Kit Miller, DVM; Jeffrey Berk, VMD, MRCVS; Mike Meuser, Esq; and Mike Casey, Esq	54

Communicating with the Purchaser Before, During, and After the Pre-Purchase Examination

Mark R. Baus, DVM

Author's address — Grand Prix Equine, 434 Main Street South Bridgewater, CT 06752; e-mail: mbaus@grandprixequine.com

Take Home Message: Buyers expect much from the veterinarian examining a prospective horse for purchase. It is essential that the examining veterinarian determine exactly what the buyer's expectations are for their new horse and from the examination. Similarly, how we communicate our findings to them is critical for helping them make a purchase decision.

Equine veterinarians are the gatekeepers in the highly unregulated business of buying and selling horses. There are very few transactions as costly as buying a horse that are conducted with less security. Long gone are the days when a "vetting" was looking at the eyes, listening to the heart and jogging the horse for soundness. Today's buyers now expect that everything possible is known about the horse they are interested in purchasing and they require that no stone be left unturned.

Before veterinarians were asked to evaluate a prospective horse for purchase, buyers would perform their own evaluation. As veterinary science matured and knowledge of a horse's health exceeded that of an experienced horseperson, veterinarians took over the role of performing the evaluation.¹ Although many horses are sold on good faith and are fairly represented, many are not. It is therefore incumbent on veterinarians to make sure they and their clients are fully informed before making a purchase decision.

The term "vetting" is now synonymous with a thorough investigation of every potential acquisition from the purchase of a business to the selection of a political candidate. As a profession, therefore, equine veterinarians should take their role in evaluating a horse very seriously to facilitate the buyer's ability to make an informed decision.

Who Influences the Buyer's Decision to Purchase a Horse?

• The trainer, or buyer's agent, often does the heavy lifting finding a horse for a prospective buyer. They

are usually rewarded with a commission, which is paid by the buyer, but only after the horse is purchased. Consequently, when the buyer's agent has selected a horse for the buyer and the pre-purchase exam has been performed, there is significant pressure placed on the buyer to finalize a purchase decision.

- The seller has the most significant conflict of interest when it comes to representing the virtues of a horse for sale. As far as they are concerned, the horse they are selling is perfect for any buyer and if your client does not want to purchase the horse, they have many buyers who do. It is therefore important to expedite the final purchase exam review to reduce the pressure sellers place on buyers.
- The veterinarian remains the most objective source of information regarding the purchase of a horse. The veterinarian is going to receive a set-fee regardless of the outcome or sales price and most veterinarians care deeply that their client purchases the right horse.

What a buyer expects from a pre-purchase examination is daunting. Buyers may be willing to live with imperfections, but surprises are unwelcome. It is therefore critical that the veterinarian answer the following questions before proceeding before proceeding with the examination:

- Where will the examination take place, who will be in attendance and who will ride the horse?
 - What is the experience level of the intended rider?
 - An advanced rider will expect more from a horse athletically
 - A novice rider will expect more from a horse behaviorally and safety is paramount
 - The veterinarian must not opine on the suitability of the horse to the rider
 - At what level will the horse be ridden or competed?
 - Does the buyer intend to do less than the horse is currently doing?
 - Does the buyer intend for the horse to do more than it is currently doing?
- Is the horse intended to be resold?

• Is the prospective buyer represented by an agent (trainer) and are they privy to all information from the exam?

Likewise, there is information the prospective buyer must know before formalizing the pre-purchase exam:

- Does the veterinarian have a thorough knowledge of the equine discipline in which the horse will be involved?
- Are there any conflicts of interest between the veterinarian and the horse, the owner of the horse, or the agent selling the horse?
- What ancillary services are offered by the veterinarian?
 - Radiographs
 - Ultrasound
 - Endoscopy
 - Gait analysis with inertial sensors
 - Blood tests
 - Reproductive exam
 - Photographs and video
- How will the findings be communicated?
- When will they be communicated?

Performing a Pre-Purchase Exam for a Non-Client

It is much easier to understand the needs of a buyer if they have been a longstanding client. Conversely, understanding the expectations and risk-taking abilities of a new client is far more difficult. It is important for the veterinarian to point out any conflicts of interest that might exist between the seller, the seller's agent, and the horse. This includes any interaction with the horse and the veterinarian's practice. Since the veterinarian does not have a relationship with the buyer, completing the buyer and seller forms prior to the examination is crucial. It is also important that the veterinarian communicate all findings to both the buyer and, with their permission, the buyer's veterinarian.

The Pre-Lease Examination

The pre-lease examination is performed with more and more frequency in lieu of the pre-purchase examination. In the author's practice, pre-lease examinations are performed with the same frequency as pre-purchase examinations. So, what is the difference between these two examinations? The short answer is nothing. In reality, the client seeking a pre-lease examination is doing so to reduce the risk of legal custody. Even though they wish to reduce said risk, they are more willing to take chances with a horse's soundness. It is therefore necessary to identify those risk factors as carefully for the pre-lease examination as for a pre-purchase examination.

Clients will use the findings of the pre-lease examination to negotiate the terms of the lease agreement between the lessor and the lessee. Some findings will be used to determine clauses in the lease agreement acknowledging preexisting conditions. For example, if a finding leads to a lameness that renders the horse unusable and it was noted in the lease agreement, the lease may be terminated with or without a return of a portion of the lease payment.

The term of the lease agreement (the length of time for the lease) is also a factor clients use to determine how much risk they can assume for a prospective lease. More risk will be assumed for shorter lease periods. Although one year is the typical term for leasing horses, shorter terms are common.

Lessees will often decline diagnostic imaging of horses for a pre-lease examination making it even more important to review existing radiographs. A horse's history is also critical to obtain prior to the examination to forecast the need for routine joint injections as well as helping the client to determine if preexisting conditions need to be included in the lease agreement.

Prior to the Examination

To begin the purchase exam process, it is necessary to formalize the relationship with the prospective buyer. If the buyer is new to the practice, they should complete the client agreement form used by the practice. Among other details, this agreement determines who will act as proxy for the buyer and how the buyer will pay for the services. A form outlining the details of the exam, requested and recommended ancillary services and an estimate for services will provide the client with information they need to know before agreeing to the pre-purchase exam.

It is also necessary to actively seek as much information as possible about the horse's past achievements and medical history. The seller is asked to disclose the medical history and all prior diagnostic images from all providers. Some veterinarians will not proceed with a pre-purchase examination without a full medical history from the prior and existing veterinarians. It is also possible to search online for performance records within the sanctioning body in which the horse competes. It is not the responsibility of the examining veterinarian to search for a horse's performance record, but it is necessary for the veterinarian to inquire if a horse has rested from riding or competing due to an injury.

Documentation

It is important to obtain signed documents from the buyer and seller prior to the examination. The following documents are recommended:

- Client Agreement Form: this document formalizes the relationship between the buyer and the veterinarian. This should be done for all new clients, particularly those who will not use the veterinarian's services after the pre-purchase exam.
- Veterinary Care Plan: this document outlines the services that are recommended by the veterinarian and the cost of those services. The potential buyer can select or decline specific services such as imaging and bloodwork.

- Buyer Agreement Form: this signed document states that the buyer understands the scope of the services offered by the veterinarian and how they intend to pay for the examination. This form allows the buyer to assign their trainer or buying agent to legally have access to the information generated at the pre-purchase exam.
- Seller Agreement Form: this signed document is a disclosure from the seller stating the horse's past use, competition, and medical history. The completed Seller Agreement Form will allow the veterinarian to obtain the medical history from the horse's past and present veterinary caregivers and farriers.
- Release of Liability by the rider or handler: this signed form mitigates the veterinarian's risk if the horse's rider or handler is injured during the examination.

Many newly purchased or leased horses will be insured for mortality and major medical events. It is necessary for the veterinarian to know prior to the examination if the horse will be insured so the findings can be properly identified on the required veterinary certificates of examination. The veterinarian must be aware that their findings might lead to an exclusion on the major medical or mortality policy. It is not the veterinarian's responsibility to know which findings will lead to an exclusion, but it is important to alert the buyer to those findings which may lead to an exclusion. It is recommended that the examining veterinarian report all abnormalities to the insurance company with appropriate explanation as to the abnormality's clinical relevance. Simply put, fully answer all questions but provide proper perspective. This approach will minimize the possibility of an exclusion by the insurance company while, at the same time, provide full and honest disclosure.

During the Examination

If the prospective buyer is present for the exam, it is important that after the clinical portion of the exam, the veterinarian summarize the findings before proceeding with imaging and blood tests. If the buyer is not at the exam, a phone call to them or their agent is necessary, especially if there is an equivocal finding. The details of this conversation, including any questions or concerns expressed by the buyer or their agent, should be included in both the pre-purchase examination record and report.

After the Examination

Once the examination and all ancillary services are concluded, the veterinarian will complete the purchase report and send it to the prospective buyer as quickly as possible. The report represents the highest level of accountability for the veterinarian, so its accurate and timely completion is crucial. Since buyers are awaiting the examination findings prior to making a final purchase decision, it is important that they see the written report and have a follow-up conversation with the veterinarian within a day of performing the examination. The report itself can be drafted on paper or in a digital format such as Microsoft Word, Excel or your practice management software. Once completed and signed, the final version can be scanned or converted into a secured PDF format and emailed to the buyer along with other documents, photographs, and videos. The report can be sent to the buyer in many different ways. It may be copied and pasted into the body of an email message or scanned and sent as an attachment. It is important to not send the report in a format that is alterable, such as Microsoft WordTM or Microsoft ExcelTM. It is advisable that an ink-signed report be mailed to the buyer along with other documents such as Coggins test results.

Technology allows for photographs and videos to be taken as needed and sent to the buyer to make an informed purchase decision and as a baseline for future reference. Sending media as an email attachment will quickly exceed the limit for file size. File sharing programs such as FileShareTM and DropboxTM will allow for folders to be created with unlimited storage capacity and are easily shared with other users. A link to these folders can be emailed to the buyer that will allow them to view all documents, photographs, and videos taken during the prepurchase exam.

Once the prospective buyer has received all data from the examination, except for blood test results, it is essential that the veterinarian and buyer talk to review all material, most notably the report generated from the examination. The phone conversation should be scheduled and open-ended. It is important that the buyer ask whatever question they may have, and that the veterinarian answer all questions as thoroughly as possible. Again, the details of this conversation should be summarized and archived.

The last piece of information before a purchase decision can be made is the drug test result. Veterinarians should inform the buyer exactly when this result is returned so they can tell the seller when the final purchase decision can be made.

In the author's opinion, the pre-purchase examination represents the highest level of responsibility that equine veterinarians have to their clients. Consequently, it is incumbent on the practitioner to understand what the prospective horse buyer requires and expects from the prepurchase examination process. Once that is established, the prepurchase exam will proceed with fewer conflicts and a better outcome for the buyer.

Purchase Examinations: Head to Tail

Richard D. Mitchell, DVM, MRCVS, DACVSMR

Author's address — Fairfield Equine Associates, 32 Barnabas Road, Newtown, CT, 06470; e-mail: rmitch2074@aol.com

Take Home Message: Purchase examinations of the performance horse should be carefully orchestrated, well executed, and repeatable. The conduct of the examination and the reporting process should take into consideration the business transaction between the veterinarian and buyer, the expectations of the buyer, and the physical characteristics of the horse in question. Special consideration should be given to certain physical findings based on the intended use of the horse.

I. GOALS

Before undertaking the purchase examination, the veterinarian should keep several important goals in mind. Firstly, the examination should be an objective assessment of the horse's physical condition. The exam should be a fact-finding mission to aid the purchaser in his or her decision to make a purchase. The analysis of physical findings may lead the veterinarian into some areas of speculation; however, it is essential to be as objective as possible and to rely on previous practical experience. It should be recognized that the purchase examination could serve as an introduction to a horse for which the practitioner may provide long-term care. Such future relationships may affect one's decision-making process relative to an individual client's needs. The veterinarian must be mindful of the intended use of the horse as well as the aspirations of the buyer.

It is most helpful to have knowledge of the discipline in which the horse will be involved. The variety of equine sports place different demands on the horse, and the examiner should be aware of the sometimes-subtle differences that may have significant effects. Some physical characteristics or conditions may be acceptable for certain levels of performance while not acceptable for others (i.e., a previous superficial flexor tendon injury that has healed with thickening may be acceptable in a hunt seat equitation horse but not acceptable in a prospective event horse). It is wise for one to decline performing a purchase examination on a horse that performs in a discipline in which one is not familiar.

The practitioner should discuss the goals of the examination and horse ownership with the prospective buyer. Understanding the client and trainer will help the examiner in his/her assessment of the job the horse is to do. It is not the veterinarian's job to say yes or no on the purchase, but it is his obligation to advise on how existing conditions may affect the horse's ability to perform the intended job. "The veterinarian must be openminded and should consider himself as a facilitator for the sales contract."¹

The scope of the examination can range from a simple resting physical and exercise examination to an intense investigation utilizing advanced imaging techniques and laboratory tests in addition to the basic physical examination. The extent and depth of the examination should be determined in part by the wishes of the buyer. Financial aspects related to certain procedures should be considered, however, not at the cost of the quality of the exam. Some latitude should be given to the veterinarian for interpretation of the needs of the examination as well.¹

II. THE CONTRACT

When the veterinarian agrees to perform a purchase examination, he or she is entering a business agreement with the purchaser. Some of the elements of the agreement will be discussed in this seminar by other authors. It is essential to understand the buyer's intentions and expectations of the horse and the proposed exam. The terms of employment and details of the examination should be discussed at the time of the initial request. Items such as the extent and depth of the exam and financial considerations should be discussed.

If the horse is to be purchased for resale, the veterinarian and buyer should discuss the potential concerns of subsequent examinations performed by unknown veterinarians. Findings (radiographs, endoscopy, etc.) of the purchase examination for resale should be well documented should questions arise on subsequent resale examination. Good documentation and images may well help save a sale in the future by providing good historical information for a later examining veterinarian.

The client should be clearly informed of the intended procedure and any statements that may be made at the end of the examination. It should be clearly stated that specific details and considerations such as lameness are only good for the day of exam. The client should be informed of how the examination will be initially reported as well as what to expect in the form of a written report.

The examiner should discuss with the buyer, prior to looking at the horse, any specialized investigations the buyer might have in mind. Explaining one's usual procedure and techniques may be enough to meet many clients' needs, and it will most certainly open doors to further discussion of additional diagnostic procedures that can be performed.²

Any conflicts of interest for the veterinarian must be disclosed to the buyer initially. Previous dealings with the seller, although he/she may not be a current client, could be perceived as a conflict of interest. It is very difficult in today's horse world not to have such conflicts arise, but they should be acknowledged, and the buyer should be given the option of having someone else perform the examination.

When performing the examination, it is good practice to have all involved parties, or their agents, present. This will provide an environment in which the examiner can ask pertinent questions of both the buyer and the seller regarding the horse's history and intended use, as well as assuring the buyer that a thorough and proper examination was performed.

The practitioner should be cautious not to compromise the standard of his/her examination because of physical conditions. Poor weather conditions or the lack of appropriate exercise facilities may hinder a thorough examination. Issues that arise that may result in having to modify the usual examination procedure should be noted in the subsequent report, such as reporting that an under-saddle examination was not possible. In the event of an uncooperative agent or seller, who makes it difficult to conduct the usual examination, the veterinarian may choose not to continue the examination in order to protect the interests of the buyer and himself.

III. THE PHYSICAL EXAMINATION

The examiner should specifically identify the horse including name, breed, sex, age, markings, tattoos, brands, microchip (if present), and height. It is essential to obtain as much information as possible about the horse's previous medical history including serious illness and any surgical procedures. Knowledge of preventive medical history may be useful as well. It can be wise to have the seller, or their agent, sign a statement relating to previous medical history.

The next major concern should be the competition history of the patient. Has this horse been competing? Last event? If none,

why? Have any injuries occurred that were the direct result of competition?

Getting to the specifics of the examination, all available organ systems should be evaluated. There should be a routine to the examination that is easily repeatable. Using a checklist or a computer template (the author's preference) will help keep the examiner on course.

A resting physical exam should be performed first. A practical approach to the examination can facilitate the efficiency of the process. The author ideally tries to observe the horse in its stall taking note of its behavior and stance. Also, examining the horse's eyes in the stall as a first step may eliminate the need for a mydriatic. The initial neurologic examination can also start by simply observing the horse in its stall before handling it. Observing the horse as it walks out of its stall may give clues as to its overall comfort, habits, and neurologic function.



Fig. 1. Step back and do an overall visual inspection of the horse.

An overall visual examination of the whole horse is next, taking in body condition, symmetry, and obvious physical attributes and maladies. Specific physical characteristics, blemishes, and any abnormalities should be documented. A brief dental examination is appropriate to facilitate verification of age and any obvious dental conditions. This is a good time to perform sinus percussion and examine for cranial nerve abnormalities and skull asymmetries. The author then incorporates a modified acupuncture examination that facilitates a thorough whole-body palpation examination taking care to look for scars and/or other evidence of previous trauma, surgery, cutaneous reflexes, or unusual skin lesions. Limb palpation, manipulations, flexion and extension tests on the resting horse may give insight to problems that may appear on the exercise exam.³ Careful evaluation of neck mobility should be included in the examination. The author prefers to use some sort of "treat" to entice the horse to flex and reach naturally rather than attempting to force movement. Following passive flexions and palpations, application of the hoof testers to all four feet may indicate issues to be more thoroughly investigated as the examination proceeds. All pertinent information should be recorded.

Auscultation of the chest and abdomen before exercise is recommended. The use of a re-breathing bag is helpful in evaluating lung function and possibly evaluating low grade bronchial issues at rest. Take careful note of cardiac rate and rhythm at rest.⁴ Completion of auscultation is a good time for blood samples to be drawn before any significant exercise. Appropriate blood tests will be discussed later in this seminar.

Following the resting physical, an examination "in-hand" should be performed. Moving the horse at a walk and trot on a firm surface while on a lead can give the examiner a basic feel for the horse's motion while not being affected by a rider or driver. Walking the horse in circles and figures of eight can demonstrate discomfort or possible neurologic deficits. Flexion and extension tests of all limbs can then be performed with the horse jogging in hand. It may also be easier to evaluate conformational considerations with the horse in motion. Additional stress tests, such as the "wedge test" for palmar foot issues may be incorporated at this time.⁵ Positive results on flexion tests in a horse that does not demonstrate lameness prior to flexion probably should not be cause for termination of the examination. Such a horse should be evaluated under saddle for evidence of lameness and flexed again. Many positive flexion tests will be found to change during the exercise examination (perhaps as the horse warms or "loosens up") and these may or may not have clinical significance. Certainly, any positive response bears a closer look and subsequent explanation, if possible. Movement in hand also allows for a better evaluation of the horse from a neurological standpoint. Any suspicious movement or action dictates the need for a more intense neurologic evaluation.⁶ The in-hand examination may provide an opportunity to use inertial sensor devices that may aid in identifying and regionalizing the source of vague asymmetrical movement.^a Optionally, these devices may be utilized following the exercise examination according to examiner preference. Such devices may augment but not replace subjective evaluation of a possible lameness.⁷

The exercise examination should be first performed on the lunge line if possible, without posing risk to the horse. As an alternative, the horse may be trotted in circles on a firm surface and soft surface, if available, by a handler. Then an exercise examination in normal tack (under saddle or in harness) should follow. Subtle lameness may not be evident until the horse is asked to perform within its discipline. It is good practice to watch the horse do what it is specifically intended to do. As an example, an upper-level dressage horse should be observed doing some of the expected movements, such as half passes and pirouettes, while assessing its apparent comfort in doing so. At this stage, questionable flexion tests from the "in-hand" examination can be repeated and re-evaluated. Auscultation of the chest should be repeated during the exercise examination with careful assessment of cardiac and respiratory recovery as well as cardiac murmurs.8

Upon completion of a thorough physical examination, the veterinarian may have gained enough information to discontinue the exam or make other specific recommendations regarding further tests or special examinations. It may be advisable to consult with the buyer at this point, especially in

the case of the lame horse or upon finding some potentially serious defect that could affect performance. If it is the desire of the buyer not to accept a lame horse, it may be wise to discontinue the examination or revisit the horse another day. Another option is to offer diagnostics for the lame horse to localize the problem, acknowledging that it may be elusive, and doing so only with consent of the seller or his/her authorized agent. Another option is to pass the case back to the horse's normal veterinarian for diagnostics.

IV. SPECIAL EXAMINATIONS

Performance of a rectal examination is subject to debate by many performance-horse practitioners. Many horses may not be amenable to the procedure without the aid of chemical restraint, and there is some inherent risk in the procedure. If there is reason to suspect an abnormality that may be better elucidated by performance of a rectal examination, or if a mare is to be later used for breeding, then a rectal examination may be appropriate. Such an examination may further facilitate a rectal ultrasound examination for reproductive or musculoskeletal evaluation. Further evaluation for reproductive status for mares or stallions falls under the purview of a complete reproductive examination.

It is advisable in the performance horse to take basic survey radiographs of those regions most frequently associated with causes of lameness and performance problems. This will be detailed in a subsequent section of this seminar.

If the horse to be examined is to show in events where a respiratory noise would be considered an unsoundness and grounds for disqualification, i.e., USEF hunter divisions, or if respiratory capacity is questioned or a noise is noted, an endoscopic examination of the respiratory tract should be offered to the client. Eventers, because they challenge respiratory capacity in cross country, likewise should have respiratory endoscopy.

If, during the examination, suspicious results are obtained in evaluation of various tendons and ligaments or other soft tissues, it may be appropriate to perform an ultrasound examination of the involved structures. Ultrasound examination without clinical signs of disease (i.e., palpation abnormality, flexion responses, or lameness) may produce confusing information. If an ultrasound examination is performed, it is the author's opinion that the contralateral limb must also be examined. A basic understanding of the regional anatomy is essential for a proper analysis.¹

Blood testing for basic body functions is advisable in today's market. Tests for complete blood count (CBC) and serum chemistries should be performed. Testing for EIA (equine infectious anemia) (Coggin's test) is basic and will be necessary for interstate or international travel and may be required by law for the sale of a horse in some states. Special situations may determine the need for other less routine laboratory tests and these tests will be discussed in a later section of this seminar.

V. SUMMARIZE YOUR OBSERVATIONS

The examining veterinarian should summarize his or her basic assessment of the horse's physical condition for the buyer. Noted physical conditions should be discussed. The initial report should be made verbally to the client or his agent. If an agent is involved on behalf of the client, it is wise to inform him/her that the client will be receiving a written report of examination findings. Comments should be as factual as possible with minimal personal bias.

Even though the veterinarian is working for the buyer, there should be some concerns for the seller. The veterinarian should be prepared to provide any or all information to the seller with the informed consent of the buyer. A conversation about the results of the examination can be held "horse-side" with all related parties, but since the buyer is the client, this should be at his/her discretion.

The buyer should be offered a written report that reviews the significant findings of the examination. A set of guidelines for reporting the purchase examination is available on the website of the American Association of Equine Practitioners.⁸ The purchase examination report can serve as documentation of significant findings for future reference.

The examining veterinarian's summation should aid the buyer in his decision on purchasing but not make the decision for him. In the author's opinion, it is not the responsibility of the veterinarian to assess suitability of the horse to a rider or determine an appropriate value for the horse in question.

VI. ACKNOWLEDGMENTS

The author has no financial interests or conflicts of interest relative to the contents of this manuscript.

REFERENCES AND FOOTNOTE

- Mitchell RD, Dyson S, Purchase Examination of the Performance Horse; Ross, MW and Dyson S, *Diagnosis and Management of Lameness in the Horse*, 2003, W. B. Saunders, Philadelphia, PA, pp 951-964
- 2. Moyer W, Werner H, Purchase Examination Guidelines for Risk Reduction, AAEP Proceedings, 1999
- 3. Stashak, TS, *Adam's Lameness in Horses, Fourth Edition*, 1987, pp. 107-120
- 4. Slack JoAnn, Cardiac prepurchase examination: Your role and what to expect from a specialist, *Proceedings Annual Penn Vet Conference*, 2106, Philadelphia, PA
- 5. Turner, TA, How to use manipulative tests to diagnose and manage equine foot pain, in *Proceedings*. Am Assoc Equine Pract 2014;6:59-61.
- 6. Grant, BD and Cannon, JH, Is he lame or is he neurologic, aaep.org/horsehealth/he-lame-or-he-neurologic
- Keegan KG, Wilson DA, Kramer J, et al, Comparison of a body mounted inertial sensor system-based method with subjective evaluation for detection of lameness in horses, *Am J Vet Res*, Vol 74, No. 1, January 2013, pp. 17-24
- 8. aaep.org./guidelines, Guidelines for reporting purchase examinations.
 - a. EquinosisQ, Columbia, MO 65203.

Laboratory Tests and Ancillary Diagnostics for the Purchase Exam

Richard D. Mitchell, DVM, MRCVS, DACVSMR

Author's address — Fairfield Equine Associates, 32 Barnabas Road, Newtown, CT, 06470; e-mail: rmitch2074@aol.com

Take Home Message: Dependent upon client requests, completion of the purchase examination can include a variety of laboratory tests as well as various imaging techniques such as endoscopy, radiography, and ultrasonography. Other more advanced imaging techniques such as thermography, scintigraphy, and magnetic resonance imaging may be appropriate in some cases. What tests and imaging are appropriate depends on the information gathered during the physical examination, the horse's intended discipline, import/export, and state jurisdiction requirements as well as client wishes.

I. LABORATORY TESTS AND ANCILLARY DIAGNOSTICS FOR THE PURCHASE EXAMINATION

Routine Health Testing

n order to better assess the current health status of the horse, testing for complete blood count and serum chemistries is advisable to provide information about basic health status.

Testing for equine infectious anemia (EIA) (Coggin's test) will be necessary for interstate or international travel. Many states require by law a Coggin's test if the horse is sold at public action but not for private sale. It's good practical insurance to do a test.

Hormonal and Metabolic Testing

Since many older horses are often offered for sale, it may be wise to perform hormonal and metabolic assays, such as ACTH, insulin, glucose, and leptin to aid in screening for pituitary pars intermedia dysfunction (PPID) and equine metabolic syndrome (EMS), especially with those deemed overweight or have unusual fat distribution. It is the author's opinion that this is very important in older ponies (>15 years) as they are commonly affected with such issues although there is conflicting data in various studies on PPID.¹

Pre-Import Testing

If the horse is being purchased outside of the United States, and is to be imported to the US, pre-import testing for piroplasmosis, dourine, and glanders as well as EIA should be performed before the horse is shipped to the US. These tests will be required to be performed again upon presentation to the US port of entry.² (Australia imports are exempt from dourine and glanders). Knowing the result prior to importation may prevent significant delays and possible economic loss for the buyer if the horse is positive for any these importation tests. An import permit (VS Form 16-6A, United States Veterinary Permit For Importation and Transportation of Controlled Materials and Organisms and Vectors)) for submitting blood samples to the National Veterinary Services Laboratory (NVSL), Ames, IA can be obtained through the USDA AVIC's office. This process can take time (4 weeks), so if foreign origin purchase exams are likely to be done it is best to acquire it in advance. These permits must be renewed yearly. The permit will allow the veterinarian to import blood into the US accompanied by the permit to be submitted to NVSL. Alternatively, a colleague in the country of origin can perform the pre-import testing, but the fact that the tests are not done in the USDA laboratory may produce a different result.

Foreign origin mares and stallions should have initial screening for contagious equine metritis (CEM) if coming from countries that are of concern to the USDA. Bacterial culture may be taken from both mares and stallions and complement fixation (CF) testing may be done on mares.³ These tests are normally submitted to labs of the country of origin by a local colleague, but these horses will again undergo quarantine and testing in the US upon arrival regardless of the foreign laboratory's result.

Regional Disease Considerations

Certain regions of the United States may present regional diseases that warrant testing such as Lyme Disease in the northeast or vesicular stomatitis (VS) in the southwest. Lyme disease tests may include simple titers and Western Blot combinations^a or Lyme multiplex that identifies multiple Lyme antibodies.^b Testing indicates exposure but not necessarily

active infection in all cases. A negative VS test will be required within 10 days of departure for a horse going to Europe.

Additional Infectious Diseases

This author does not test routinely for equine protozoal myelitis (EPM),^c common in many regions of the US, as serum testing is inconclusive, and identification of neurologic issues during the physical examination likely will result in negative advice for purchase. However, presence of subtle neurologic signs might be cause to perform one of the available serum tests.

Testing for equine viral arteritis (EVA) in stallions is advisable if the horse could potentially be going to Europe (EU).^d A negative EVA titer or proof of negative titer prior to vaccination and subsequent vaccination is required for stallions entering the EU.⁴

Genetic Testing

Several commercial laboratories and breed associations are now offering genetic testing that identifies genetic markers that are characteristically associated with specific physical conditions and abnormalities in certain breeds. Testing for a genetic predisposition for polysaccharide storage, as an example, may influence a decision for purchase because of concerns for exercise related myopathies or for future breeding that might perpetuate such a trait. The list of potential genetically related diseases is continuing to grow. The American Quarter Horse Association (AQHA) offers genetic testing through cooperation with the Veterinary Genetics Laboratory at the University of California-Davis. The basic testing covers five heritable diseases including glycogen branching enzyme deficiency disorder (GBE), hereditary equine regional dermal asthenia disorder (HERDA), hyperkalemic periodic paralysis disorder (HYPP), malignant hyperthermia (MH), and polysaccharide storage myopathy disorder (PSSM). Etalon Diagnostics, Menlo Park, CA, as an example of commercial laboratories available and offers a variety of tests such as "DNA mini panel" that examines for fifty-five genetic markers that may be associated with physical manifestations in multiple breeds. Hair samples are typically the material provided for such tests.

Drug Testing

Testing for the administration of medications is an important service, but its limitations should be explained to the client. Not all medications will readily show in serum or plasma samples depending upon the time or administration and the type of medication, and this should be discussed with the client prior to the examination. Urine, if obtainable, and in addition to blood, may improve the possibility of identifying more medications. Purchase examination drug screens generally look for a broad range of tranquilizers, anesthetics, NSAIDS, and corticosteroids. If necessary, urine samples may be more easily acquired with the administration of the diuretic furosemide; however, the author prefers trying to collect a sample without administration of a diuretic if the client requests such testing. Administration of any drug during the purchase exam must come with owner or agent consent. Two laboratories that are frequently used by the author are: Center for Tox Services, 1819 W. Drake Drive, #102, Tempe, AZ 85283 and Cornell Diagnostic Lab, College of Veterinary Medicine, Upper Tower Road, Ithaca, NY, 14853. Recently, the University of Kentucky Diagnostic Laboratory, 1501 Bull Lea Road, Lexington, KY 40511, that does drug testing for the United States Equestrian Federation (USEF) has begun pre-purchase and elective drug testing. Samples are best sent express delivery to the lab of choice to arrive on a weekday. Clients are generally advised to make a sale pending the outcome of a negative drug test, thereby having the privilege to return the horse if unacceptable medications are detected.

II. ENDOSCOPY

Endoscopy of the upper airway is frequently incorporated in the purchase examination. Many upper airway abnormalities may not be that apparent on physical examination but readily apparent on endoscopic examination. Many upper airway problems may be progressive and lead to significant dysfunction later.⁵ A thorough examination for laryngeal function, presence of any abnormal anatomy or significant evidence of inflammation of the pharynx, nasal passages. or trachea is essential. Any abnormalities should be carefully recorded and, if possible, documented with actual images. Dynamic endoscopy units are now available that allow for exercising the horse and evaluating function.^e This technique may be most applicable in horses that make a noise yet have a relatively normal resting endoscopic examination. Respiratory endoscopy (upper and lower airways) should be offered wherever possible to the prospective buyer, but if declined it should be recorded in the purchase examination report.

Gastroscopy could be considered in the case of the horse with a history of recurrent colic, previous treatment for ulcers, inconsistent performance, or in a horse that appears unthrifty.⁶ This procedure requires some preparation (fasting) and more elaborate equipment is required, but it is relatively simple in the hands of an experienced examiner. Referral for such a procedure may be appropriate. Again, accurate records should be kept, and images should be acquired.

III. DIGITAL RADIOGRAPHY

Almost since the advent of radiology in equine practice, radiographs have been considered a means of enhancing the physical examination for purchase. Radiography allows the examiner to review the skeletal structure for evidence of previous disease or issues that may predispose the horse to future problems related to structure. Problems evident during the physical examination may be more completely evaluated and occult issues may be recognized. Many clients may believe the radiographic examination is more important than the physical exam. This surely is not the case, but good imaging can go a long way toward providing a more complete evaluation of a horse for purchase.⁷ Other clients may decline any radiographic examination, but this may result in an incomplete evaluation and should be noted in the written record. A discussion with the potential buyer should occur prior to any radiographic imaging, ideally before the physical examination.

There should be a discussion regarding the value of a radiographic evaluation and the information that may be obtained. It is important to convey the understanding that radiographic imaging may not reveal all musculoskeletal abnormalities but can sometimes detect issues not readily apparent in the thorough physical examination.

Even with today's digital radiographic technology good technique is of paramount concern when performing the radiographic examination. Consistency of positioning is essential for reliable and repeatable evaluation of images.⁸ This may be the hardest aspect of radiography to teach and consistently execute. Proper preparation of foot structures with shoe removal and thorough cleaning is essential. New digital radiography equipment, both computed (CR) and direct (DR), allows for a wider range of technique of exposure, but poor images can still be produced, thus the technician/veterinarian must strive to use good repeatable technique. With DR equipment, since an image is immediately produced, there is little excuse for poor positioning and exposure because the image can simply be repeated. Technique charts can be simpler but are still necessary. Of course, some patients are more cooperative than others, and certain horses can make the examination more complicated. Use of sedation techniques, after blood samples have been taken with owner or agent consent, is appropriate for acquiring a complete set of diagnostic images in many cases.

A good working knowledge of radiographic anatomy is also necessary to avoid making issues of normal structures that are erroneously interpreted as lesions. This often is the case in images interpreted by less experienced evaluators. Seeking advice from more experienced colleagues or imaging specialists on unusual findings is a sound practice and can be a useful learning experience.

Specific interest should be paid to certain anatomical sites related to the proposed use and discipline of the horse in question. Knowledge of the discipline in which the horse is to function is essential in order to make appropriate decisions related to imaging. With the English sport horse or Western performance horse, certain common lameness issues are known to occur more frequently, and the choice of radiographs should be based on likely probability. Also, findings in the physical examination may direct what radiographic views may be essential. The most common purchase examination radiographs of the English Sport Horse include images of the fore feet and fetlocks, hind fetlocks, hocks, and stifles. Images of the back and neck will be requested by some buyers, and the veterinarian needs to be prepared to offer that service. The author is of the opinion that the carpus should be included if the horse is a repurposed ex-racehorse or if it is likely to become an eventer. At the very least, dorsopalmar, lateral to medial and flexed lateral images should be made of the carpus, but obliques and skyline views may prove very helpful for a full assessment.

Questionable radiographic findings may occur and the need for further evaluation may arise, and additional information may be gained by ultrasound and thermal imaging. It may prove necessary to seek further information and consider referral for nuclear scintigraphy, CT, or MRI examination if the client is so inclined and the seller grants consent. This will be discussed in a later section of the seminar.

IV. ULTRASONOGRAPHY

As the use of diagnostic ultrasound has become commonplace in the evaluation of musculoskeletal problems, its use in the purchase exam has increased. It is not uncommon for a concerned buyer to request to have "all four limbs scanned." This request is problematic, just as with radiographic exams, because the understanding and expectations of the buyer may not be on the same level as the examining veterinarian. Because of the vast number of structures that may be evaluated in the horse, and because of significant variation in the skill levels of veterinarians performing ultrasound examinations, a clear discussion of expectations with the intended purchaser should occur prior to any action. It is best to clearly understand client expectations and inform the client of technical limitations prior to the exam. It may be best to discuss looking at specific structures or areas that raise suspicion based on flexions and palpation as is done in the radiographic examination.⁹ If a very complex examination is indicated, it may be best performed by someone who is more experienced in ultrasound evaluation, especially if less routine structures are to be evaluated. Perhaps no exam is indicated at all, but again the wishes of the buyer should be respected, and referral may be appropriate.

When performing the ultrasound examination, the sale horse may present some technical difficulties. Fine haired horses may present few technical problems with the use of warm water or alcohol and plenty of coupling gel; however, long hair may dramatically reduce the ability to view structures adequately. The seller may be unwilling to allow the horse to be clipped, and this may make the exam impractical, if not impossible. It is better to perform no exam at all than to perform one that is clearly technically inadequate under the guise of a proper exam. Obviously clipping a horse marks "the spot," but clipping one symmetrically on the other limb only says it was examined but not specifically for what. Consistently following the same practices as in the case of radiography will provide for repeatable examinations and potentially minimize legal liability issues in the future. When performing an ultrasound examination, examination of the contralateral structure is always recommended to provide a means of comparison.



Fig. 1. Comparative images of forelimbs demonstrating thickening and change of shape in the inferior check ligament of the right fore limb as compared to a normal left fore.

V. THERMOGRAPHY

Thermal imaging can be a useful screening tool for the purchase examination. For the sport horse, scanning the limbs and back in general with a modern infrared camera can be beneficial and reasonably quick to perform. Early pathology in the distal limb may be detectable as well as foot balance issues that are producing subtle inflammatory changes. Thermographs of the back may indicate deviations in expected patterns which may be further evaluated by other means. Muscle pathology in various regions may be detectable using thermal imaging. Such tools may also be used to monitor resolution of inflammation on subsequent examinations.¹⁰ Ambient temperature may have some effects on this technique. Again, this tool is best used in the hands of an experienced operator.



Fig. 2. Thermography may aid in detection of areas of inflammation as illustrated in the left fore limb palmar metacarpal region.

VI. OTHER TESTS AND CONSULTATIONS

In the event of an unusual finding on the ophthalmologic examination, especially if the examining veterinarian has limited experience with the type of lesion, recommending a second opinion from a veterinary ophthalmologist is advisable. Evidence of chronic keratopathy, uveitis, buphthalmos, or possible blindness may justify recommending a second opinion before purchase. This may be a unique situation according to the case and the comfort level of the examiner based on his or her previous experience.

Suspected cardiac arrhythmias or significant murmurs may warrant second opinions or at the very least performance of an electrocardiogram and/or an echocardiogram. Calling upon an internal medical specialist is often well received by the buyer and can help to better document the suspected abnormality for future reference.¹¹

Suspected neurologic abnormalities may be encountered in the course of the examination. A careful evaluation of the horse's neurologic function should be part of the routine examination. Care should be taken to differentiate if the horse is lame or if, in fact, there is a probable neurologic deficit. Often detection of a neurologic abnormality may simply result in discontinuing the examination but offering a further work up (or referral) may be in the best interests of both client and seller. Certainly, some neurologic conditions can be temporary or manageable, and the horse may prove suitable on another day with appropriate care. Recognition of neurologic deficits or subtle ataxia may justify serum testing for EPM and Lyme disease if client interest persists, and a closer look with cervical vertebral radiographs or CT examination may be offered.

ACKNOWLEDGMENTS

The author has no financial interests or conflicts of interest relative to commercial items mentioned or the contents of this manuscript.

REFERENCES AND FOOTNOTES

- 1. McFarlane D. Equine pituitary pars intermedia dysfunction, *Vet Clinics of North America, Equine Practice*, Apr 2011;27(1):93-113.
- 2. USDA-APHIS website, Equine Import and Export Information.
- 3. USDA-APHIS, Contagious Equine Metritis Fact sheet, May 2014.
- 4. USDA-APHIS website, Equine Import and Export Information.
- 5. Soule SG. History and philosophy of pre-purchase examinations, in *Proceedings*. Am Assoc Equine Pract 1987;33:205.
- 6. Mitchell, RD, Prevalence of gastric ulcers in hunter/jumper and dressage horses evaluated for poor performance, Association of Equine Sports Medicine Conference, Sept. 2001.
- 7. Mitchell, RD. Imaging considerations in the purchase examination of the performance horse, *NEAEP Proceedings*, Sept 2011.
- 8. Redding R. Anatomy and imaging of the equine foot and digit, in *Proceedings of the Ocala Equine Conference*, Jan 25, 2020, Ocala, FL.
- 9. Mitchell RD, Dyson S. Purchase examination of the performance horse; Ross, MW and Dyson S, *Diagnosis and Management of Lameness in the Horse*, 2003, W. B. Saunders, Philadelphia, PA, pp 951-964.
- 10. Turner TA. Evaluating the sore performance horse, *Compendium Equine Seminars 2001*, Veterinary Learning Systems, 8-13.
- 11. Slack JoAnn, Cardiac prepurchase examination: Your role and what to expect from a specialist, in *Proceedings Annual Penn Vet Conference*, 2106, Philadelphia, PA.
 - a. UConn Diagnostic Lab, Storrs, CT 06269.
 - b. Antech Diagnostics, New Hyde Park, NY, 11042.

- c. EDS, LLC, Lexington, KY 40511.
- d. Cornell University Diagnostic Lab, Ithaca, NY 14853.
 e. Tele-View Dynamic Equine Exercise Endoscope, Advanced Monitors Corporation, San Diego, CA 92121.

The Pre-Purchase in Review: Reflection of Historical Data Pertaining to Pre-Purchase Exams

Kent Allen, DVM, Cert. ISELP; Abigail Atkins, DVM; and Julia Petersen, MBA, DVM

Authors' address — Virginia Equine Imaging, 2716 Landmark School Road, The Plains, VA 20198; email: kallendvm@aol.com.

I. INTRODUCTION

he sport horse pre-purchase exam (PPE) calls on the detective and intuitive skills of the veterinarian to find any current or potential sources of unsoundness and/or medical problems in accordance with their intended use. Horses may or may not be recommended for purchase, depending on the client's goals and what is uncovered during the examination. Historically, and for the purposes of this paper, this recommendation or non-recommendation is termed as either "passing" or "failing" a PPE. Pre-purchase evaluations can vary widely depending on the population of horses examined and potential use of the horse; however, crossover does occur in relation to notable abnormalities and outcomes. The purpose of this paper is to assess the protocol and data from 700 sport horse pre-purchase examinations performed at Virginia Equine Imaging^a alongside multiple retrospective studies and compare some of the most common reasons why horses "pass" or "fail" the PPE.

The Physical Examination

The first part of the pre-purchase examination involves carefully evaluating the horse's cardiovascular, respiratory, gastrointestinal, ocular, and musculoskeletal systems at rest. This is also when any desired blood work is performed. This may include a complete blood count, chemistry, Coggins, drug screening and/or common tests such EPM and Lyme titers. Although it is important to systematically evaluate the horse during the physical examination, it is fairly rare to "fail" a horse based on their physical examination alone. In the 2014, retrospective study performed at Virginia Equine Imaging^a, 4% of horses failed due to issues pertaining to this portion of the PPE with the majority of the issues involving cardiac abnormalities on auscultation or elevation in muscle enzymes

on bloodwork. A retrospective study performed in 1992 by Dart et al.¹ evaluated 134 PPE performed over a 2-year time period on pleasure and sporthorses. In this study, horses that had abnormalities during the physical examination had additional testing including endoscopy (15%), transrectal palpation (3%). hematologic analysis (2%).electrocardiography (2%), and drug testing for analgesic agents (2%). Whether these horses "passed" or "failed" after these exams was not discussed. In 2019, Barrett and Arkins² evaluated veterinary pre-purchase examination certificates for 13,603 3- and 4-year-old Thoroughbred National Hunt horses from Irish sales, with 9.9% found to make abnormal respiratory noises and 5.3% being diagnosed with recurrent laryngeal neuropathy via upper airway endoscopy. These findings would make the horse unsuitable for their intended use and therefore have "failed" the physical examination portion of the PPE.

The Soundness Evaluation

Next, the soundness evaluation is performed where the horse is observed at a walk, trot, and canter on various surfaces along with limb flexions. Any indication of lameness is noted and any notable lameness (typically grade 2/5 or higher) is deemed a sufficient grade to "fail" this portion of the evaluation. Of the 700 horses that presented on initial presentation at Virginia Equine Imaging, 255 horses or 36% were considered lame at the time of their pre-purchase examination. This is by far the largest portion of horses that failed the PPE. In another retrospective study performed by Hoogmoed et al.³ evaluating 510 sport horse PPEs over a 9-year time span, the percentage of lame horses who were lame at the time of presentation for a PPE was notably higher at 52.8%.

Diagnostic Imaging

Diagnostic imaging is performed next with radiographs being the most routinely performed. A full set of x-rays gives valuable information by which to base the purchase decision, a baseline for that particular horse and a basis for later arguing that x-ray findings in the horse have been unchanged over a period of time. At Virginia Equine Imaging, a full set of pre-purchase radiographs would include the following views:

- *Front feet and Navicular views:* Lateral, Dorsalpalmar, Dorsoproximal-palmarodistal oblique (Hickman 60-degree view), Palmaroproximalpalmarodistal oblique (navicular skyline)
- *Fetlocks (front)*: Lateral, Dorsal-palmar, Medial and Lateral obliques
- *Carpus*: Flexed lateral
- Fetlocks (hind): Lateral, Dorsal-plantar
- *Hocks*: Lateral, Dorsal plantar, Medial and Lateral obliques

Additional radiographs may be required based on the clinical exam findings or at the request of the buyer or the examining veterinarian.

- *Stifle*: Lateral, Caudal-cranial, Caudolateralcraniomedial oblique
- **Back:** Lateral providing clear evaluation of both the spinous processes and dorsal articular processes
- *Neck*: Lateral providing clear evaluation of the dorsal articular facets and poll.

Diagnostic Imaging Findings

Most of the horses that present for a sport-horse pre-purchase examination will have a set a radiographs taken. In the retrospective examination performed at Virginia Equine Imaging, there were 512 horses or 73% of horses that proceeded on with radiographic imaging. Of horses that passed on the initial lameness evaluation, 13% failed due to imaging abnormalities. The horses that failed on pre-purchase examination, had the following top ten radiographic abnormalities: hock osteoarthritis, fetlock osteoarthritis, navicular bone changes, dorsal spinous impingement ("kissing spine"), pastern osteoarthritis, fetlock OCD, sidebone, hock OCD, sesamoiditis, and stifle OCD (Fig. 1). Additionally, there were a few radiographic abnormalities that were solely found in horses that failed on pre-purchase examination, including the following: rotation of the coffin bone, shoulder bone cyst, navicular bone cyst, bony sequestrum, and fracture. If a fetlock cyst was found, 80% of fetlock cysts were severe enough to fail a horse on pre-purchase. The same applies for 75% of pastern cysts, 63% of pedal osteitis, 62% of stifle OCDs, and 56% of sesamoiditis cases.

Of the horses at Virginia Equine Imaging that passed the radiographic portion, the top ten radiographic abnormalities included the following: hock osteoarthritis, fetlock osteoarthritis, navicular bone changes, dorsal spinous impingement ("kissing spine"), pastern osteoarthritis, fetlock OCD, sidebone, hock OCD, bony remodeling of the dorsal articular processes of the back, and coffin bone osteoarthritis. Of these abnormalities, the ten most prominent radiographic findings comprised osteoarthritis of the lower hock joints (73%) and fetlock joint osteoarthritis (37.5%) (Fig. 2).

Radiographic abnormality:	% of horses
Hock OA	50
Fetlock OA	27.6
Navicular changes	21.8
Pastern OA	12.5
Fetlock OCD	9.9
Dorsal spinous process impingement	9.8
Hock OCD	7.8
Sesamoiditis	7.8
Sidebone	4.6
Stifle OCD	4 1

Fig. 1. The chart shows the top 10 radiographic abnormalities in horses that failed the PPE.

Radiographic abnormality:	% of horses
Hock OA	73
Fetlock OA	37.5
Navicular changes	16.8
Doral spinous process impingement	11
Pastern OA	7.5
Fetlock OCD	6.3
Sidebone	6.3
Hock OCD	5
Osteoarthritis of the dorsal articular processes	2.8
Coffin hone OA	2.8

Fig. 2. The chart shows the top 10 radiographic abnormalities in horses that passed the PPE.

In Hoogmoed's retrospective study,³ radiography was the most common diagnostic procedure performed at 61.6%, with views of the front feet requested most often (86.6%) followed by the tarsi (68.1%). Higher degrees or grades of change for the navicular bone and distal phalanx were associated with lameness, whereas greater change in the tarsi were less likely to be associated with lameness. Breed differences were noted as well, with Warmbloods displaying greater degrees of change of the navicular bone and distal phalanx in comparison to Thoroughbreds, however, typically were not as lame.

In the young Thoroughbreds evaluated in the Barrett and Arkins retrospective study,² metacarpal/metatarsal exostoses affected 17.1% and tarsal-plantar desmitis affected 19.4% of the sales population.

Occasionally, depending on the findings during the clinical evaluation or at the request of the buyer, ultrasonography of various portions of the distal limb will be performed. At Virginia Equine Imaging, 18 of the 700 horses had an ultrasound of the distal limb.^a Of the 18 horses that were scanned, 3 passed the pre-purchase exam, one with a SDFT injury and another with a suspensory ligament injury. The remaining 15 horses failed the pre-purchase exam. Of the 15 horses that failed, 2 were due to a SDFT injury, 11 due to a suspensory ligament injury, one due to a DDFT injury, and one due to an inferior check ligament injury (Fig. 3).

	Passed (Number of Horses)	Failed (Number of Horses)
SDFT	1	2
Suspensory	2	11
DDFT	0	1
Inferior check	0	1

Fig. 3. The chart shows 18 horses that had ultrasound abnormalities and whether they passed or failed.

II. CONCLUSION

Overall, of the 700 horses that received a pre-purchase examination in Virginia Equine Imaging's retrospective study^a, 4% failed due to a physical examination finding, 36% failed due to a lameness and 13% failed due to finding abnormalities on imaging. There were a total of 77 horses that were re-presented and of those 77, 36 or 69% passed on the re-presentation. Of the 700 pre-purchase exams included in the study, there was an overall pass rate of 52% (364/700) and 48% failure rate of horses during a pre-purchase examination.

In summary, a horse may "pass" or "fail" a pre-purchase examination for a variety of reasons. It is important to consider the horse's job, breed, clinical history, and owner expectation as this may impact the outcome of the pre-purchase examination. Finally, it is also vital to fully assess the horse clinically for a lameness evaluation and medical problems to ensure a high-quality pre-purchase examination, and therefore allow for an accurate interpretation of the examination.

III. ACKNOWLEDGMENTS

Declaration of Ethics

All information gathered for this paper was in accordance with the AVMA Principles of Veterinary Medical Ethics.

Conflict of Interest

There are no financial interests or conflicts of interest to be addressed.

REFERENCES AND FOOTNOTE

- Dart, AJ, Synder, JR, Pascoe, JR, Meagher, DM, et al. Pre-purchase evaluation of horses: 134 cases (1988-1990). J Am Vet Med Assoc 1992;201:1061-1067.
- 2. Barrett E, Arkins S. Abnormalities detected at prepurchase examination of National Hunt racehorses presented at sale. *Equine Vet J* 2020;52:281-289.
- 3. Van Hoogmoed, LM, Synder JR, Thomas, HL, and Harmon, FA. Retrospective evaluation of equine prepurchase examinations performed 1991-2000. *Equine Vet J* 2003;35:375-381.

a. Virginia Equine Imaging. A Retrospective study of 700 Pre-purchase examinations. Unpublished study 2014.

Getting to the Heart of the Matter: Cardiac Evaluation During Pre-Purchase Examinations

Mary M. Durando, DVM, PhD, DACVIM

Author's address — 523 Chesterville Road, Landenberg, PA 19350; e-mail: mdurando2004@yahoo.com

I. INTRODUCTION

thorough cardiac evaluation is an important component of a pre-purchase examination. While musculoskeletal disorders are a much more common cause limiting athletic ability and potential, cardiac dysfunction does occur, and can not only be performance limiting, but also affect safety. Because cardiac abnormalities causing decreased performance or impacting safety are not that common, it can be challenging to determine the significance of observed physical exam abnormalities. In addition, healthy, well-performing equine athletes have a high prevalence of murmurs and arrhythmias.¹⁻⁹ Many of these are normal and physiologic; however, even those with a pathologic cause of cardiac disease may be welltolerated, causing no decrease in performance ability or longevity. From the owner perspective, there are fewer overt "physical cues" to see compared with lameness problems that they can see or feel when riding. Therefore, in some cases it may be more difficult to convince owners of the need to pursue further diagnostics.

It is critical to know the goals of the prospective buyer. The discipline, and at what level the horse will be asked to compete are both critical, as is how experienced the buyer is. Whether they intend to keep the horse until retirement, sell it after a few years (i.e., after a child outgrows it), or turn the horse around quickly after additional training may also affect interpretation of abnormalities. After this, a thorough history (or as much as can be ascertained) is helpful. This should include performance history, as well as medical history. If the horse is green, and has not yet competed, information regarding fitness and if there have been any concerns should be sought out. The horse's signalment can provide information helpful to the interpretation of some abnormalities that may be found, as interpretation may differ in the context of the horse's breed and age.

Physical Exam

The physical exam should be conducted with patience and a methodical approach.¹⁰⁻¹³ While the cornerstone of the cardiovascular examination is thorough auscultation, observation from a distance should be done first. This includes evaluation of the horse's general demeanor, attitude, and body condition. Respiratory rate, and overall respiratory effort are noted. Abnormalities of the respiratory tract are more commonly associated with primary respiratory disease; however, they can be an indicator of significant cardiac disease. Palpation of peripheral arterial pulse quality and venous filling/distension should be performed. Presence of a jugular pulse should be noted. Arterial pulse quality represents the difference between systolic and diastolic pressures, rather than the actual pressure. Assessment of peripheral pulse quality is subjective; however, it is a very important determinant of cardiac function. Barely palpable pulses may indicate a decreased cardiac output (pumping ability of the heart), while bounding peripheral pulses, even if only a quiet diastolic murmur is present, may indicate significant aortic insufficiency. Assessment of bounding peripheral pulse quality, in conjunction with a diastolic murmur, is much more reflective of the severity of disease than murmur intensity alone.¹⁴⁻¹⁶

Jugular fill and distension is an indication of central venous pressure. Normal central venous pressure results in jugular vein fill $\sim 1/3$ of the way up the neck, if the horse has a neutral head position. If its head is lowered, the fill will travel further up the neck in a normal horse. If central venous pressure is increased secondary to right heart disease or failure, the distension will extend further cranial, and can extend as far as the mandible. It can be determined if pathologic by placing the horse in a more upright head position, and while occluding the jugular vein proximally, milking the blood towards the heart. If the vein fills the length of the neck, this can indicate cardiac disease (or potentially a mass obstructing venous return).

Auscultation

The heart and lungs should be thoroughly auscultated next.^{17,18} The exam should be conducted inside, out of any wind, and also preferably not in the presence of activities that agitate the horse

(feeding, a lot of traffic in and out, etc.). It is very important that the examination area be quiet. Do not hesitate to ask radios and fans to be turned off, nearby mowing to stop, the barn crew weed-eating to wait, or people who are talking to hold their conversations out of earshot! Auscultation should always be systematic, and the entire cardiac silhouette, on both sides of the thorax should be listened to. The mitral valve is in the 5th intercostal space (ICS), (by the caudal aspect of the triceps), just dorsal to the point of the elbow. This is also where the apex beat is palpable. The aortic valve is in the 4th ICS, dorsal to the mitral valve, and the pulmonic valve is in the 3rd ICS, slightly ventral to the aortic valve. The tricuspid valve is best heard from the right side, in the 4th ICS, medial to the triceps. The valves are easier to auscultate if the horse's leg on the side the examiner is listening from is placed slight cranial to the other leg (particularly the pulmonic and tricuspid valves).

Acquiring a heart rate should be done first, once the horse has adjusted to the stethoscope; this should be calculated over at least 30 seconds. Cardiac rhythm should then be determined. Typical descriptors are regular (i.e., normal sinus rhythm), regularly irregular (i.e., 2nd degree atrio-ventricular block, sino-atrial block, or occasional premature beats), or irregularly irregular (i.e., atrial fibrillation, some cases with frequent and non-conducted APCs, or complex arrhythmias). Simultaneous palpation of arterial pulses for pulse deficits in the presence of an irregular rhythm should be done. Any rhythm other than regular, sinus rhythm, or occasional 2nd degree AV or sinus block that is abolished by excitement or exercise requires an ECG in a pre-purchase exam setting.

Once the rate and rhythm have been established, the presence of murmurs or other abnormal sounds should be noted. Several ways of describing murmurs are used, to help convey the significance and likely cause of the murmur, as well as to appreciate changes that may occur over time. This includes timing, intensity, duration, shape, character and point of maximal intensity. Timing refers to when in the cardiac cycle the murmur occurs (systolic, diastolic or continuous). It can be helpful to palpate the peripheral arterial pulse simultaneously, especially in loud murmurs that obliterate the heart sounds, to determine this. Intensity is the loudness of the murmur, and is usually graded on a 1-5 or 1-6 scale. Duration is how long in the cardiac cycle the murmur lasts. This can be described as early, mid, late, holo or pan systolic or diastolic. Holosystolic or diastolic murmurs occupy the entire systole (or diastole), however both S1 and S2 can be heard. Pansystolic or diastolic murmurs obliterate one or both heart sounds. While the intensity of the murmur does not necessarily correlate with the severity of the disease, a louder murmur lasting longer in the cardiac cycle is usually of more importance than a softer murmur only lasting in the early phase of systole of diastole. Shape is how the murmur changes in intensity over time. They are typically described as crescendo (increasing intensity), decrescendo (decreasing intensity) or band-shaped (plateau equal intensity throughout). Character is usually described in terms such as soft, harsh/coarse or musical/honking. A musical or honking murmur is usually caused by a vibrating structure, such as a fenestration or tissue tag on a valve, or a ruptured chordae tendineae. The frequency of these murmurs (i.e., the

"dive-bomber" murmur of aortic regurgitation) makes the sounds quite easily heard, and can be very impressive. Do not overlook other soft murmurs in conjunction with these, as the presence of a separate systolic murmur may make the murmur of more concern. Point of maximal intensity is simply where the murmur is loudest. Other abnormal sounds that may be heard are clicks or squeaks (these are usually benign), or rubs. Rubbing sounds can be caused by pericardial friction rubs, or in some cases pleural friction rubs. These should be able to be differentiated based on their relation to either respiration or heart rate.

Exercise Testing

The exercise test is a critical part of the PPE for any performance horse. Athletic horses have such a tremendous cardiac reserve and aerobic capacity that evaluation at rest is unlikely to reflect how well the horse may tolerate exercise.¹⁹⁻²² The increased physical demands of exercise will help to determine if a mild or subtle lesion will be a problem, or help to unmask an abnormality not seen at rest. It is very important that the exercise test mimic the intended use of the horse (up to the horse's level of training).¹⁵ This allows the veterinarian and prospective buyer to see how the horse tolerates the workload that will be asked of him, as well as how he recovers from it. Along with the subjective determination of exercise tolerance, auscultation in the immediate post-exercise period is important. This allows discovery of irregular cardiac rhythms associated with exercise, determination if a resting arrhythmia was abolished by exercise, and whether any new murmurs are audible or changes in murmur description have occurred. In addition, the heart rate recovery can give a general idea of the horse's fitness or tolerance for a particular intensity of exercise.

All findings should be well-documented, and discussed with the prospective buyer. Any concerns uncovered by the exam warranting further diagnostics should be explained, and the diagnostic tests recommended explained. Whether the buyer wants to proceed to additional recommended tests, proceed without additional diagnostic tests, or abandon the sale completely should also be well-documented. Any concerns at the physical exam may warrant recommendation of additional diagnostics such as electrocardiography, echocardiography (ECG), exercise test with ECG in place or a 24-hour Holter monitor. Potentially, additional bloodwork such as cardiac troponin I measurement may also be useful. After discussion of the benefits and potential pitfalls of the recommended tests, it becomes the client's decision whether to pursue them.

Assessing Cardiac Rhythm

A resting ECG can be acquired with several different types of equipment. ECG units from hospitals, electrodes that are part of blood pressure monitoring for anesthesia, Holter/telemetry units and smartphone-based electrocardiograms with phone apps (i.e., Kardia/AliveCor) can be used.²³ In most situations, a simple base-apex recording is sufficient, although on occasion, 3, 6, or 12 leads are helpful to determine the specific arrhythmia. Acquiring an ECG during exercise requires an

ambulatory ECG (telemetry or Holter unit), as the horse cannot be connected to stationary units when exercising in the field. These consist of electrodes and leads placed on the horse, connected to a monitor on the horse, and transmitting to a base unit (telemetry) or recording directly on the monitor (Holter). The availability, portability, and relative inexpensiveness of these units has made them attractive for field use. These units can record during exercise, or for extended periods (i.e., overnight), if intermittent arrhythmias are suspected. When used for exercise evaluation, the electrodes are typically placed in a modified base-apex position, to simplify lead placement, and give a good recording with large complexes.²⁴ When placed for overnight recording, the electrodes may be placed differently, to acquire more leads. Motion artifact can be a problem in proper interpretation of recordings from exercise. These can be challenging to position electrodes in such a way as to minimize artifact; however, it is crucial to do so, as if there is much motion artifact, the trace will be unreadable.

An ECG should be recommended in any horse with a suspected arrhythmia at rest during a pre-purchase exam.¹⁵ If this is confirmed to be a physiologic arrhythmia abolished by sympathetic stimulation, and no other cardiac abnormalities are noted, an exercise ECG is not usually warranted. However, any concerns with the horse clinically or historically, the presence of a more concerning arrhythmia (i.e., premature beats, or 2nd degree AV block persisting in the post-exercise period), or an arrhythmia with a murmur, warrant recommendation of an exercise ECG. This will help to determine the clinical relevance of the arrhythmia, and any risks that may be associated with it. In cases of an intermittent arrhythmia, longer recordings (i.e., 24-hour/overnight) are necessary to determine the frequency of the arrhythmia.

Assessment of Murmurs

Any murmur other than a physiologic murmur should prompt with the recommendation to be investigated an echocardiogram, in a pre-purchase setting. The difficulty is in differentiating physiologic from pathologic murmurs, based on auscultation.^{1,25,26} While a louder (>/=3/6), coarse, holo or pansystolic or diastolic murmur, or a musical or "dive bomber" murmur should clearly be recommended to be evaluated with an echocardiogram, it is less clear whether a softer murmur requires further evaluation. Physiologic murmurs are usually soft (</=3/6), and do not occupy all of systole or diastole. However, some pathologic murmurs, particularly diastolic murmurs, also may be of low intensity. Further complicating decisions, the prevalence of murmurs and valvular regurgitation increases with training, even in horses performing well.^{3,27,28} Therefore, in many situations, an echocardiogram is needed to determine the cause of the murmur, and if pathologic, the severity of the underlying disease causing this murmur. This will help to determine if the horse is likely to be suitable for the intended use. In addition, any horse in a pre-purchase setting that has a non-physiologic arrhythmia (i.e., other than a vagallymediated arrhythmia abolished by sympathetic stimulation) should be recommended to have an echocardiogram to determine normal structure and function and to determine safety concerns.

II. SUMMARY

The signalment, history and physical exam/auscultation findings are the basis for determining normal cardiac function in a pre-purchase setting. If any concerns are uncovered during this portion of the exam, further diagnostics, such as echocardiogram, electrocardiogram, and exercising ECG or 24-hour Holter may be indicated. The results of these tests will help to determine whether the horse is suitable for the prospective buyer, and their demands and goals for the horse.

REFERENCES

- 1. Kriz NG, Hodgson DR, Rose RJ. Prevalence and clinical importance of heart murmurs in racehorses. J Am Vet Med Assoc 2000;216:1441-1445.
- 2. Patteson MW, Cripps PJ. A survey of cardiac auscultatory findings in horses. *Equine Vet J* 1993;25(5):409-415.
- 3. Young LE, Wood JLN. Effects of age and training on murmurs of atrioventricular valvular regurgitation in young Thoroughbred. *Equine Vet J* 2000;32:195-199.
- 4. Buhl R, Ersboll AK, Eriksen L, et al. Use of color Doppler echocardiography to assess the development of valvular regurgitation in Standardbred trotters. *J Am Vet Med Assoc* 2005;227(10):1630-1635.
- 5. Young LE, Rogers K, Wood JL. Heart murmurs and valvular regurgitation in Thoroughbred racehorses: Epidemiology and associations with athletic performance. *J Vet Intern Med* 2008;22(2):418-426.
- Ryan N, Marr CM, McGladdery AJ. Survey of cardiac arrhythmias during submaximal and maximal exercise in Thoroughbred racehorses. *Equine Vet J* 2005;73(3):265-268.
- 7. Physick-Sheard PW, McGurrin MK. Ventricular arrhythmias during race recovery in Standardbred Racehorses and associations with autonomic activity. *J Vet Intern Med* 2010;24(5):1158-1166.
- 8. Buhl R, Meldgaard C, Barbesgaard L. Cardiac arrhythmias in clinically healthy showjumping horses. *Equine Vet J Suppl* 2010(38):196-201.
- Barbesgaard L, Buhl R, Meldgaard C. Prevalence of exercise-associated arrhythmias in normal performing dressage horses. *Equine Vet J Suppl* 2010(38):202-207.
- Young L. Diseases of the heart and vessels. In: Hinchcliff KW, Kaneps AJ, Geor RJ, editors. *Equine* Sports Medicine and Surgery. Saunders Elsevier, 2004;728-767.
- 11. Reef VB. Assessment of the cardiovascular system in horses during prepurchase and insurance examinations. *Vet Clin North Am Equine Pract* 2019;191-204.
- Durando MM, Young LE. Cardiovascular examination and diagnostic techniques. In: Robinson NE, editor; *Current Therapy in Equine Medicine*, 5th *edition*. St Louis, MO, Saunders, 2003;572-585.

- Keen JA. Examination of horses with cardiac disease. In: Schwarzwald CC, Mitchell KJ, editors. *Clinical Cardiology*. Philadelphia, Elsevier, 2019;23-42.
- Reef VB, Spencer P. Echocardiographic evaluation of equine aortic insufficiency. Am J Vet Res 1987;48:904-909.
- Reef VB, Bonagura J, Buhl R, et al. Recommendations for management of equine athletes with cardiovascular abnormalities. J Vet Intern Med 2014;28(3):749-761.
- Boegli J, Schwarzald CC, Mitchell KJ. Diagnostic value of noninvasive pulse pressure measurements in Warmblood horses with aortic regurgitation. *J Vet Intern Med* 2019;33(3): 1446-1455.
- Blissitt KJ. Auscultation. In: Marr CM, Bowen IM, editors; *Cardiology of the Horse, 2nd edition*. London, Saunders Elsevier, 2010;91-104.
- Schwarzwald CC. Disorders of the cardiovascular system. In: Reed SM, Bayly WM, Sellon D, editors. *Equine internal medicine*, 4th edition. St Louis (MO), Saunders, 2010;387-541.
- 19. Jones JH, Lindstedt SL. Limits to maximal performance. *Ann Rev Physiol* 1993;55:547-569.
- Poole D, Erickson H. Heart and vessels: Function during exercise and training adaptations. In: Hinchcliff KW, Kaneps AJ, Geor RJ, editors; *Equine Sports Medicine and Surgery*. St Louis (MO), Elesvier Saunders, 2014;667-694.
- Courouce-Malblanc A, Hodgson DR. Clinical exercise testing. In: Hodgson DR, Mckeever KH, McGowan CM, editors; *The athletic horse, principles and practice of equine sports medicine*. St Louis (MO); Elsevier Saunders, 2014;366-378.
- 22. Munsters CC, van Iwaarden A, van Weeren R, et al. Exercise testing in warmblood sporthorses under field conditions. *Vet J* 2014;202:11-19.
- 23. Vezzosi T, Bonelli F, Sgorbini M, et al. Evaluation of a smartphone electrocardiograph in healthy horses: Comparison with standard base-apex electrocardiography. *J Equine Vet Sci* 2016;67.
- 24. Patteson MW. *Equine Cardiology*, 1st edition, Oxford: Blackwell Science, 1996;41.
- Reef VB. Heart murmurs in horses: Determining their significance with echocardiography. *Equine Vet J* Suppl 1995;19:71-80.
- Reef VB, Bain FT, Spencer PA. Severe mitral regurgitation in horses: Clinical, echocardiographic and pathologic findings. *Equine Vet J* 1998;30:18-27.
- 27. Young LE. Cardiac response to training in 2 YO Thoroughbreds: An echocardiographic study. *Equine* Vet J Suppl 1999;30:195-198.
- 28. Buhl R, Ersboll AK. Echocardiographic evaluation of changes in left ventricular size and valvular regurgitation associated with physical training during and after maturity in Standardbred trotters. *J Am Vet Med Assoc* 2012;240:205-212.

Star Pupil: Perfecting the Ophthalmic Portion of the Pre-Purchase Exam

Stephanie C. Bell, DVM, DACVO

Author's address — Hagyard Equine Medical Institute, 4250 Iron Works Pike, Lexington, KY 40511; e-mail: sbell@hagyard.com

I. INTRODUCTION

he ophthalmic evaluation is an important component of the pre-purchase examination (PPE). In this paper and accompanying talk, a systematic approach to the ophthalmic examination will be reviewed. This talk will focus on identification of ophthalmic abnormalities and anomalies and how to distinguish these from variations of normal. Potential clinical significance of ophthalmic findings will be discussed.

The American Association of Equine Practitioners Guidelines state: The veterinarian should list all abnormal or undesirable findings discovered during the examination and give his or her qualified opinions as to the functional effect of these findings. The veterinarian should make no determination and express no opinions as to the suitability of the animal for the purpose intended. This issue is a business judgment that is solely the responsibility of the buyer that he or she should make on the basis of a variety of factors, only one of which is the report provided by the veterinarian.¹ It is ultimately the buyer's responsibility to determine if the horse is suitable for their intended use.

Between 5% and 10% of horses have been reported to have important ophthalmic lesions that may affect vision or function.² The examiner should identify any abnormalities or variations of normal and if possible render a written judgment as to the significance of their findings based on the information at hand.²

Common abnormalities to look for include eyelid or third eyelid tumors, globe size abnormalities, exophthalmos/enophthalmos, corneal edema, corneal opacities, aqueous flare indicative of uveitis, hyphema, hypopyon, iris synechia, cataracts, vitreous opacities, chorioretinal scars, retinal detachment, and optic nerve abnormalities.³

The ophthalmic examination is outlined below and is organized by ocular structures in the order in which the author generally performs the eye exam.

II. THE OPHTHALMIC EXAMINATION

The ophthalmic examination should be performed in a systematic manner.⁴ It is helpful to perform the exam in the same order each time. Ideally, a medical history of the horse should be available to the examining veterinarian to correlate any clinical findings with medical events or accidents (e.g., corneal scar responding to history or corneal ulcer and treatment).⁵ Permission to examine the horse and administer medication to dilate the pupils should be obtained from the seller. Document whether the horse was observed moving/working or only standing, as well as whether or not pupillary dilation was performed.

The veterinarian should have the following equipment:

- Focal bright light source, such as a penlight or Finoff transilluminator
- Magnification is often helpful, such as an Optivizor
- Indirect fundoscopic lens (example: 20-D or 2.2 Panretinal lens)
- Direct ophthalmoscope (especially useful for slit beam setting)

The initial part of the ophthalmic exam should include observation of the horse in its surroundings in a well-lit area. The horse should be observed for alertness to movement and persons or other animals approaching.⁵ A step by step approach as outlined below will ensure all components of the exam are complete.³

Symmetry: The examiner should assess the horse for facial, orbital and globe symmetry. This may be best evaluated with the veterinarian standing in front of the horse to assess globe position, size, and ocular discomfort. In particular, the relative angulation of the upper eyelashes should be assessed. Lowering of the angle of the upper eyelashes is a subtle indicator of ocular discomfort in the absence of overt blepharospasm or epiphora.⁶

Observe the face closely for signs of present or past tearing or other ocular discharge.

Palpation of both orbits should be performed.³ Retropulsion of both globes is performed by pushing the globe back into the orbit through closed eyelids. **Note: retropulsion should never be performed in a fragile globe with a corneal defect. Retropulsion should be bilaterally symmetrical and non-painful. Decreased retropulsion suggests the presence of a retrobulbar mass. Retropulsion can also be used to help distinguish between exophthalmos (decreased retropulsion) and buphthalmos (enlarged globe, normal retropulsion).³ Retropulsion is also used to extrude the 3rd eyelid and allow for close examination of this structure (see Adnexal section).

Vision and Ocular Reflexes: The veterinarian should note how the horse reacts to its surroundings.⁵ With vision loss, especially chronic, horses may adapt and continue to perform. Thus, it is important to test ocular reflexes, including menace response, dazzle reflex, and pupillary light reflexes prior to pharmacologic pupillary dilation. In some cases, a maze test may be performed by covering one eye and having the horse navigate through obstacles.

The menace response tests cranial nerves II (optic) and VII (facial) and requires an intact visual and motor cortex. Thus, this is a learned cortical response in which a "menacing gesture" is performed with the observer's hand and the horse sees this and reacts by blinking. Care should be taken to avoid stimulation of aural and tactile senses (air movement or inadvertently touching vibrissae). The menace response should be evaluated throughout the horse's visual field in all quadrants (i.e., hand motions from cranial, perpendicular, and caudal to the eye). The horse's total visual field extends almost 360° (146° of uniocular vision with 65° of binocular vision anteriorly), with a small blind spot posteriorly.⁵

The dazzle reflex also tests cranial nerves II (optic) and VII (facial) and the retina. This is a subcortical reflex and does not require cortical processing. The horse should blink when a focal bright light source is shone into the eye.

It is important to ensure the palpebral reflex is intact and the horse is able to blink in order to adequately evaluate the menace response and dazzle reflex. The palpebral reflex tests cranial nerves V (trigeminal) and VII (facial). The periocular area is touched which stimulates the sensory portion of the trigeminal nerve and results in blinking via the facial nerve.

Pupillary light reflexes (PLRs): Pupil size and symmetry should be evaluated using the focal light source.⁵ The light should then be used to assess the pupillary light reflex in each eye. Light shone into one eye should cause both pupils to constrict (direct and consensual PLRs). The PLR tests cranial nerves II (optic) and III (oculomotor).⁴

Adnexa: Any discharge should be noted. The eyelid borders should be smooth and free of scars or regions of ulceration. Eyelid closure should be complete.⁵ The globe should be retropulsed to extrude the third eyelid for examination. The

conjunctiva should be smooth and pink with no irregularities. Common defects to look for include tumors (squamous cell carcinoma, sarcoid, melanoma etc.), eyelid irregularities from prior trauma, entropion, conjunctival hyperemia +/- follicles consistent with conjunctivitis.

**The remainder of the ophthalmic examination is best performed in a dark or dimly lit area. Magnification is helpful in examining the cornea, anterior chamber, iris, and lens.³

Cornea: The cornea should be smooth and clear with a lustrous tear film. Any opacity to the cornea should be recorded for size, position, and density and further evaluated with a slit beam to determine depth.⁵ Congenital opacities are rare and usually nonprogressive.⁶ Acquired corneal scarring or fibrosis is more common and an inactive lesion is generally nonprogressive. A thorough history may supplement findings if, for example, a corneal scar from a previous ulcer is present. It is important to determine if the corneal opacity is part of a larger disease process such as keratitis or uveitis.³ An inactive corneal opacity can be large enough to interfere with vision. The size and location of any corneal opacity is important when considering possible effect on vision.

Linear keratopathy or Haab's striae may be noted. These represent a break in Descemet's membrane. The significance in horses is still under study and may be different from that in small animals. In small animals, Haab's striae are pathognomonic for an intraocular pressure spike or glaucoma.⁷ In horses, they may be due to trauma, an isolated episode of elevated intraocular pressure, or incidental finding.⁶

Corneal edema can be due to various underlying diseases, including ulceration, endothelial disease, uveitis, glaucoma, intraocular mass, immune-mediated keratitis, etc.

Anterior chamber: The anterior chamber should be optically clear.⁵ Reflections of the focal light source can be seen at the cornea and iris/lens interface. For the lens, the light can be seen at the anterior and posterior lens capsule. The clarity of these reflections of light can be altered with disease.³ The presence of protein and cells within the anterior chamber results in internal reflection of light known as aqueous flare and is indicative of uveitis.³ This can be observed by shining the focal light source directly on the cornea so it is a focused beam, and the examiner looks at a ninety degree angle to the light as it crosses through the anterior chamber. This should be clear and not cloudy or murky. Aqueous flare may look like the beam from car headlights on a foggy, rainy night. Debris or pigment deposition on the corneal endothelium or anterior lens capsule may indicate previous uveitis.⁵

Iris including corpora nigra: The iris forms the pupil, which is more horizontal when constricted and round when dilated. The iris may vary in color; combinations of brown and blue irides (heterochromia iridis) are a variation of normal. These should be differentiated from regions of hyper or hypo pigmentation of the iris from past uveitis.

The corpora nigra or granula iridica are normal round structures which arise from the posterior pigmented epithelium of the iris and are found at the dorsal and ventral pupillary margins.⁶ Corpora nigra may have a wide variation of normal in terms of shape and size. It is important to compare the corpora nigra between both eyes to look for symmetry. Atrophy, shrinkage, or coalescence of corpora nigra may be indicative of past uveitis. Corpora nigra may also become cystic and enlarged, which can result in visual impairment from partial blockage of the pupil or impingement on the corneal endothelium causing corneal lesions.⁶ Iridal cysts may be present separate from the corpora nigra along the margin of the pupil or rarely free-floating in the anterior chamber.¹³ Iris cysts arise from the posterior pigmented epithelium of the iris and may peek over the pupillary margin into the anterior chamber.⁶ It is impossible to predict which cysts are likely to enlarge.⁶

Adhesions of the iris to the cornea are known as 'anterior synechia.' This is usually indicative of past corneal ulceration/rupture or uveitis. Anterior synechia should be differentiated from persistent pupillary membranes (iris to cornea) which are congenital.⁶ PPMs typically originate at the iris collarette, and anterior synechia typically originate from the pupillary margin.¹⁴ Adhesions of the iris to the lens are known as 'posterior synechia' and generally indicate previous uveitis.⁵ Differentiating a single episode of uveitis vs. equine recurrent uveitis is generally not possible with a single examination.

Iris hypoplasia or coloboma refers to thin or absent iris tissue and is generally congenital. This typically does not cause a problem unless it is prominent enough to result in sensitivity to bright lights.⁶

Lens: There is no consensus regarding pupillary dilation for a PPE. Realistically the pupils of the horse are often not dilated. However, in order to view the lens in its entirety, pharmacologic dilation is required.³ It should be noted in the report whether or not the pupils were dilated for the exam. If the pupils are dilated, this should be performed after any moving part of the exam, and it is important to inform the owner or agent that depth perception may be altered and vison may be impaired for a few hours. Pupillary dilation may also reveal subtle posterior synechia, which as described above indicates past uveitis.³ The most commonly used short acting mydriatic is tropicamide 1%.

Opacities of the lens and its capsule (developmental or acquired cataracts) or retrolental opacities associated with fetal tissue remnants are common findings in PPE.⁶ The lens is best examined with both direct illumination and retroillumination to identify lenticular opacities. Using direct illumination, the observer should look for cloudiness or white opacities within the lens. Retroillumination uses the reflection of light from the back of the eye (tapetum or red reflex in a non-tapetal horse) to highlight lenticular opacities. Retroillumination causes opacities to appear dark against a light background.³

All cataracts have the possibility of progression; certain characteristics can aid in prediction of progression and

prognosis.³ Cataracts can be classified based on etiology (primary vs. secondary), age of onset – if known (congenital, developmental/juvenile, senile), stage of maturity (incipient, immature, mature, hypermature), and location within the lens cortex or capsule.^{3,8,9} A history may be very helpful in determining age of onset and whether the cataract is primary or secondary. The most common cause of cataracts in horses is secondary to uveitis. However, if no other signs of past uveitis are present (posterior synechia, melanin on anterior lens capsule, aqueous flare, corpora nigra atrophy, etc.), cataracts can be primary and divided into categories.

Congenital or developmental cataracts are the result of abnormal growth during embryogenesis.³ The nucleus (center) is the first part of the lens to form in utero; thus, nuclear cataracts are often congenital and present at birth. These typically do not progress and in some cases become smaller relative to the rest of the lens as the animal ages.⁹ Developmental/juvenile cataracts are typically confined to a defined anatomic location within the lens, such as the anterior/posterior suture line and within the nucleus.^{3,6} These cataracts are typically non-progressive or very slowly progressive.

Primary aphakia and microphakia are rare and may occur with other anomalies of the eye including coloboma.⁹ These may be undetected without pharmacologic dilation. Microphakia or "small lens" can occur alone, but is usually found with other abnormalities such as microphthalmia or lens luxation.¹⁴ Microphakia is usually associated with elongated lens zonules and normal ciliary body processes which are visible with pupillary dilation.¹⁴ Lens coloboma is a notch-like defect at the equatorial lens and often has absence of lens zonules in this region.^{9,14}

Senile cataracts are generally seen in horses 20 years or older. They are often nuclear and may progress. Cataracts must be differentiated from nuclear/lenticular sclerosis, which is an expected aging change. Lenticular sclerosis does not cause vision loss or interfere with the tapetal reflection.³ Therefore, if a complete tapetal reflection is visible with retroillumination, there is no evidence of cataract formation.

Equatorial cataracts are located at the equator/peripheral lens and can easily be missed without pupillary dilation. The equator is the most metabolically active region of the lens. Cataracts in this location tend to be progressive, especially if vacuolation is seen.³

Cortical cataract formation may occur in any aged horse and may be unilateral or bilateral; progression is difficult to predict.⁵

Lens luxation or subluxation is usually a consequence of trauma or uveitis.⁶ This can be identified with a slit beam examining the iris-lens axis which should be continuous. A 'dip' or 'step' in this slit beam at the iris-lens interface can be indicative of a lens subluxation or luxation.

Opacities of the lens capsule without changes to the lens cortex may indicate previous uveitis or be the remnants of a

persistent pupillary membrane (anterior) or persistent hyaloid artery (posterior).⁵

Vitreous: The vitreous is a hydrogel which should be optically clear. The central vitreous is variably liquified in horses of all ages, with liquefaction and mobility of the vitreous increasing with age.⁶ With age and/or inflammation, condensations or occlusions (similar to 'floaters' in humans) may become visible. If the vitreous is highly liquefied, these inclusions may be quite motile as they move with the vitreous during eye movements. The degree of liquefaction and the presence of dense floaters should be recorded in the PPE report.⁵ If the eye has no other indicators of past uveitis, most horses function well with variable amounts of vitreous floaters.⁶ However, there have been a few reports in the literature of aberrant behavior while performing attributed to vitreal floaters; thus, the report should state that the clinical significance of these floaters may be uncertain.^{6,10}

Vitritis is inflammation of the vitreous and a part of posterior uveitis or panuveitis. Inflammatory cells and debris may become suspended within the vitreous hydrogel, along with fibrin, hemorrhage, vitreal membranes. These can result in vitreoretinal detachment.⁶ Although vitreal abnormalities can occur in the absence of anterior segment abnormalities, other evidence of previous uveitis (posterior synechia, cataract, corpora nigra atropy, etc.) in conjunction may raise the suspension for equine recurrent uveitis (ERU).⁵

Fundus: The horse's fundus can be examined using both indirect and direct ophthalmoscopy. Ideally, both methods should be used as outlined below to examine the fundus through a dilated pupil. Indirect ophthalmoscopy requires a focal light source and a handheld lens (20 diopter or panretinal 2.2). This method gives the best overall wide-field view of the fundus and is helpful in identifying lesions that may require closer examination with the direct ophthalmoscope. Remember the image you obtain with indirect ophthalmoscopy is upside-down and backwards. The direct ophthalmoscope provides a very magnified view which is approximately 15 times that of indirect ophthalmoscopy.³ The author recommends indirect ophthalmoscopy always be performed to provide a broad screening view, as lesions can be missed if only direct ophthalmoscopy is used due to the narrow field of view at high magnification.

Many variations of normal exist for the equine fundus and can vary with coat and iris color. It is important to differentiate these variations of normal from pathologic changes. The tapetum has a wide variety of color range including but not limited to green, yellow, blue, orange. The non-tapetal fundus may vary from brown to black to absent pigment. Horses may also be lacking a tapetum ('atapetal') especially when color dilute with blue irides. These atapetal horses may also have little to no pigment in the nontapetal fundus, so the examiner is actually viewing the entire choroidal vasculature pattern.⁵ In these horses, the fundus appears more red but is still a variation of normal. There may also be focal areas lacking pigment or tapetum in one or both eyes as a normal retinal variation, so the examiner sees the orange/red choroid.⁵ Red dots are often seen within the tapetal fundus and represent the end-on view of choroidal capillaries also called "stars of Winslow"; these should be recognized as normal and not be confused with retinal hemorrhage.^{5,11}

The major retinal abnormalities to look for include retinal detachment/separation, chorioretinitis or chorioretinal scarring, changes to the optic nerve such as atrophy or inflammation.³ Fundic pathology may be recognized by looking for ophthalmoscopic indicators of fundic disease,⁶ which include the following:

- Loss or attenuation of peripapillary retinal blood vessels
- Raised hyporeflective sometimes 'fluffy' lesions (chorioretinitis)
- Regions of pigment clumping or pigment loss (chorioretinal scarring) – including
 - o butterfly lesions (peripapillary)
 - multifocal bullet-hole lesions
- Retinal detachment partial vs. complete with tear (rhegmatogenous); with a tear, a 'veil' of retina is seen over the optic nerve head
- Pale or small optic nerve head (optic nerve atrophy)
- Reddened/hyperemic or enlarged optic nerve head (inflamed optic nerve)
- Attenuation of choroidal blood vessels +/- white scleral show
- Mass or neoplasia

Interpretation of fundic lesions can be quite challenging in regard to their clinical significance. If an equivocal finding is present, such as retinal detachment or optic nerve atrophy, you may state with confidence that the eye is visually impaired or blind.

In cases of more subtle lesions, or especially chorioretinal scarring, clinical significance may be more difficult to discern. The "classic" inactive chorioretinal scar is an area of depigmentation and pigment clumping that radiates around the optic nerve head, although lesions can be confined to one "butterfly lesions".¹¹ side; these are peripapillary Historically, these were thought to be pathognomonic for ERU.⁵ However, this is no longer believed true as these butterfly lesions may be due to a single incidence of trauma or a single systemic infection.⁶ A butterfly lesion can be associated with ERU, but in many eyes the anterior segment often appears normal and no changes are noted in the retinal blood vessels. These changes can occur with ERU, even in the absence of anterior segment disease. However, remember that a single episode of optic neuritis or peripapillary chorioretinitis could result in similar changes.¹¹ It is important to evaluate the extent of the scarring as well as the presence or absence of retinal or choroidal vascular attenuation to help offer a prognosis in these cases.

Table 1: Significance of Pre-purchase	Ocular Examination Findings	(reprinted with permission	1 from Dr. Ann Dwyer) ²
	0		v /

Un	equivocal significance	Un	certain significance	Va	ariants or minor blemishes
٠	Sarcoids, other adnexal tumors or	•	Past sinus trauma (dents or raised	٠	Healed small notches or gaps in the
	masses		areas)		tarsal margin with no trichiasis
•	Dysplasia of eyelid tissue or	٠	Eyelid skin that lacks pigment	٠	Persistent pupillary membranes that
	conjunctiva	•	Solar blepharitis		bridge iris stroma
•	Ectropion or entropion	•	Small focal corneal scars	٠	Small iris colobomas or nevi
•	Lid motility disorder	٠	Pigment deposits on cornea or	٠	Heterochromia iridis
•	Trichiasis, old lid repair that does		lens with no other ocular	٠	Small granula iridica cysts
	not frame a normal aperture		abnormalities	٠	Small vacuolations in the lens
•	Chalazion	٠	Lipid deposits in the cornea	٠	Mittendorf's dot
•	Exophthalmos, microphthalmos,	٠	Single corneal stria	٠	Faint retrolenticular fibroplasia
	enophthalmos or buphthalmos	٠	Large iridociliary cysts	٠	Prominent suture lines in the posterior
•	Pronounced or unilateral	٠	Iridal hypoplasia		lens
	strabismus	٠	Large granula iridica cysts	٠	Small focal inclusions in the vitreous
•	Impaired pupillary light reflexes	•	Small focal cataracts	•	Persistent hyaloid vasculature
•	Large corneal scar near axis	٠	Vitreal syneresis	٠	Variations in the color of the tapetum
•	Multiple punctate corneal	٠	Vitreal membranes	٠	Partial albinism
	opacities	٠	Focal "bullet hole"	٠	Circumpapillary marginal pigment
•	Mineralized corneal deposits		chorioretinopathy without other		proliferation
•	Corneal edema		abnormalities	٠	A few scattered chorioretinal scars
•	Multiple corneal stria, branching	٠	Diffuse "butterfly wing"	٠	Ectopic myelination of the disc
	stria		peripapillary chorioretinopathy	٠	Small fundic colobomas ("window
•	Corneal vascularization		without other abnormalities		defects")
•	Flare, hyphema, hypopyon	٠	Proliferative optic neuropathy		
•	Miosis	٠	Senile retinopathy		
•	Eccentric pupil shape				
•	Synechia				
•	Mature cataracts				
•	Extensive cortical cataracts				
•	Lens luxation, subluxation				
•	Elevated intraocular pressure				
•	Multiple opacities in vitreous				
•	Vitritis				
•	Extensive peripapillary				
	chorioretinitis with vessel				
	attenuation				
•	Retinal detachment				
•	Optic nerve atrophy				
•	Optic neuritis				
•	Phthisis bulbi				

Focal chorioretinal scarring is also commonly recognized and is termed 'bullet-hole' lesions. These lesions are generally multifocal, in the pigmented non-tapetum ventral to the optic disc, and are small, white with a pigmented center, and flat.¹¹ It has been suggested these lesions may be the result of previously chorioretinitis such as due to viremia or respiratory disease. These are often incidental findings in horses of all age groups; although, histologically retinal architecture is affected. Historically, it was suggested that the number of scars may have an effect on vision. However, a recent study found retinal function which was evaluated using full-field electroretinogram (ERG) was within normal limits in two horses with extensive bullet-hole lesions.¹² Since inactive multifocal chorioretinopathy does not appear to affect vision and is non-progressive, despite the potential to be a post-inflammatory change, the current consensus is to consider it an incidental finding.¹¹

To summarize recommendations regarding chorioretinal scarring, any lesion should be documented. Significance may be difficult to discern especially without advanced diagnostic testing such as optical coherence tomography (OCT) or electroretinogram (ERG). More information is constantly being learned about the clinical significance/impact on vision of the ocular lesions that are identified. As these advanced diagnostic tests become more commonly used in equine ophthalmology, the significance of what is identified on ophthalmic exam will be better elucidated.

III. CONCLUSIONS

Horses do not pass or fail the ocular component of the PPE. The purpose of the examination is to identify and document existing lesions or abnormalities for the buyer so the buyer may make an informed decision.⁵ The two most important parts of the ophthalmic examination should be assessment of comfort and vision.³

The greatest dilemmas occur when the clinical significance of a lesion is uncertain, or when a lesion is noted that could either progress or remain static. Examples include peripapillary lesions/chorioretinal scars, some corneal opacities, many focal cataracts. An excellent reference table summarizing clinical significance of PPE ocular findings is included with permission from Dr. Ann Dwyer (Table 1).²

Buyers may always be given the option of obtaining a second opinion from a veterinary ophthalmologist when lesions are discovered. When an unusual abnormality is identified, offering referral to a veterinary ophthalmologist is appropriate. An ophthalmologist may be able to provide additional expertise along with advanced testing. If the buyer declines referral, the report should document that referral was offered but declined.²

ACKNOWLEDGMENTS

Dr. Stephanie Bell has no conflict of interest.

REFERENCES

- 1. <u>https://aaep.org/guidelines/reporting-purchase-examinations</u>
- Dwyer, A. Practical Field Ophthalmology. In: Gilger B, ed. Equine Ophthalmology 3rd edition. Chapter 3, Wiley Blackwell, 2017:76-82.
- Scherrer N, Utter M, Monk C. How to perform the ocular portion of the pre-purchase examination, in *Proceedings*. Am Assoc Equine Pract 2013;59:191-194.
- Stoppini R, Gilger B. Equine ocular examination basic techniques. In: Gilger B, ed. *Equine Ophthalmology 3rd edition*. Chapter 1, Wiley Blackwell: 2017:1-34.
- 5. Karpinski L. The prepurchase examination. *Vet Clin Equine* 2004;20:459-466.
- 6. Matthews AG. Eye examination as part of the equine prepurchase examination. Review article. *Equine Vet Educ* 2016;28(10):566-591.
- 7. Maggs D, Miller P, Ofri R. Slatter's Fundamentals of Vet Ophthalmology 5th edition. Elsevier, 2013.
- 8. Matthews AG. Lens opacities in the horse: A clinical classification. *Vet Ophthalmology* 2000;3:65-71.

- McMullen R, Gilger B. Diseases and surgery of the lens. In: Gilger B, ed. Equine Ophthalmology 3rd edition. Chapter 9, Wiley Blackwell, 2017:416-452.
- Miller P, Murphy CJ. Equine vision: Normal and abnormal. In: Gilger B, ed. Equine Ophthalmology, 2nd edition, Chapter 11, Elsevier Saunders, 2010:397-433.
- Allbaugh R, Townsend W, Wilkie D. Diseases of the equine vitreous and retina. In: Gilger B, ed. *Equine Ophthalmology 3rd edition*. Chapter 11, Wiley Blackwell, 2017:469-507.
- 12. Allbaugh R, Ben-Shlomo G, Whitley R. Electroretinogram evaluation of equine eyes with extensive 'bullet-hole' fundic lesions. *Vet Ophthalmology* 2014;17, Supplement 1:129-133.
- Gilger B, Hollingsworth S. Diseases of the uvea, uveitis, and recurrent uveitis. In: Gilger B, ed. *Equine Ophthalmology 3rd edition*. Chapter 8, Wiley Blackwell: 2017:369-415.
- Leiva M, Pena T. Ophthalmic diseases of foals. In: Gilger B, ed. Equine Ophthalmology 3rd edition. Chapter 8, Wiley Blackwell: 2017:369-415.

Differentiating Signs of Lameness versus Ataxia

Steve Reed, DVM, DACVIM

Authors' addresses - Rood and Riddle Equine Hospital, PO Box 12020, Lexington, KY 40580-2070; e-mail: sreed@roodandriddle.com.

I. INTRODUCTION

When trying to distinguish whether a horse is showing clinical signs indicative of lameness or ataxia, one of the most useful procedures is the assessment of gait. For gait assessment to be useful and meaningful it must be reproducible and consistent between different examiners. When trying to distinguish whether a horse is lame or ataxic, one of the most useful procedures is the assessment of gait. This exam should be accurate and reproducible between examiners as it influences the next diagnostic and treatment processes, assesses suitability to ride and for purchase, and most importantly assesses safety to the handlers and riders.

Veterinarians are often called to examine horses with spinal cord diseases such as cervical vertebral stenotic myelopathy, (CVM), equine protozoal myeloencephalitis, (EPM), equine degenerative myeloencephalopathy (EDM), and trauma. These diseases produce gait changes due to general proprioceptive deficits and paresis. To evaluate gait deficits during the neurologic exam, the horse should be examined while standing, walking, backing, walking over an obstacle, walking with its head elevated, walking up and down an incline, and while turning in large and small circles. Neurologic gait deficits result in horses appearing irregularly irregular while moving. Horses with musculoskeletal problems may show weakness along with lack of joint flexion or spasticity but appear regularly irregular, which is best observed while trotting. Performance of a lameness exam involves watching the horse at a walk and trot prior to and after manipulation of a limb. This is often accompanied by administration of local anesthesia either over a selected nerve or intraarticular to evaluate change in gait following this procedure.

While examining the horse the veterinarian is often asked or expected to grade the degree of ataxia or lameness. To do this the rating scale needs to be reliable, valid, responsive, and sensitive enough that the examiner can identify even small gait deficits. One goal of the exam is to recognize the clinically minimal important difference between 2 treatment groups or subtle changes over time Some authors found a higher overall agreement for scoring of ataxia compared to previous studies assessing lameness scoring in a clinical setting using a 6-point scale.¹ The authors noted that examiners could more reliably differentiate clinical signs of subtle lameness compared to distinguishing subtle signs of ataxia. Horses with signs of severe ataxia could easily be recognized by many examiners; however, they still struggled with consistency when rating the degree of ataxia.² The examiners did not have the same difficulty with grading severe grades of lameness. Interestingly, when compared to a study on dogs with neurologic deficits using the Texas spinal cord injury scale, which evaluates gait, proprioceptive positioning and nociception, there was very good consistency in grading between examiners. In conclusion it is important that the examiner perform a thorough, careful, neurologic exam which is repeatable and consistent so it can be easily repeated when making critical decisions about horses. Neurologists evaluating humans³ utilize many tests during the neurologic exam including gait, stance, sitting, speech disturbance, finger chase, nose-finger test, fast alternating hand movements, and heel-shin slide; obviously many things which are impossible for horses to perform and for equine neurologists to interpret.

When horses have concurrent signs of lameness and ataxia, the degree of difficulty in distinguishing the cause or relative percent contribution of gait deficits becomes even more difficult. The use of objective kinematic assessment of ataxic horses has the potential to provide more consistent results between examiners. Some of these tools include measures of postural sway and inertial sensors systems (e.g., Equinosis Lameness Locator).⁴ Alternatively, gathering a group of well qualified, experienced veterinarians to examine videos of known affected horses (i.e. post-mortem confirmed) with the aim to establish a scale with improved sensitivity and the ability to detect clinically-minimum differences in signs and severity

of neurologic deficits this would be very helpful for the profession, especially with regard to decisions about prognosis and horse and rider safety.

Evaluating and differentiating clinical signs of lameness and ataxia is an important part of the day for veterinarians examining athletic horses. Signs of subtle weakness and ataxia are often difficult to isolate and the decision to assure the client and the rider that a horse is safe to perform its intended use often falls on the veterinarian. In some cases, this decision may determine whether a horse is retired, changed to another discipline, or even destined for euthanasia. All of which have important medical and financial consequences. Therefore, being able to discern the cause of the gait abnormality and carry out proper treatment is an important responsibility. These tasks can be especially onerous considering the difficulties associated completing an accurate and repeatable neurologic examination, ante-mortem diagnostic testing, the wide variety and selection of treatment options, variability in disciplines and athletic demands, and genetic influences on gait mechanisms in horses.

Locomotion in mammals relies on a central pattern-generating circuitry of spinal interneurons that coordinates limb movement.⁵ These networks produce left–right alternation of limb movements and coordinated activation of flexor and extensor muscles. A stop codon in the *DMRT3* gene has a major effect on the pattern of locomotion in horses. The *DMRT3* mutation has had a significant effect on the diversification of the domestic horse, as the altered gait characteristics of a number of breeds apparently require this mutation. Specifically, the mutation, which is permissive for the ability to perform alternate gaits, has a favorable effect on harness racing performance where horses are required to pace during competition.

II. CONCLUSION

Lame horses show gaits that are regularly irregular while ataxic horses show gaits which are irregularly irregular. performing a thorough neurological examination, done on more than one occasion, is best to detect signs of mild ataxia. A careful neurologic exam is particularly important when part of a purchase examination and when it is part of the decision tree for either euthanasia or retirement.

REFERENCES

- 1. Keegan KG, Dent EV, Wilson DA, et al. Repeatability of subjective evaluation of lameness in horses. *Equine Vet J* February 2010.
- 2. Olsen E, Dunkel B, Barker WHJ. Rater agreement on gait assessment during neurologic examination of horses. *J Vet Internal Med* 2014;28:630-638.
- **3.** Shahrokhi M, Asuncion R. Neurologic exam. StatPearls Publishing, January 2022.
- **4.** McCracken MJ, Kramer J, Keegan KG. Comparison of an inertial sensor system of lameness quantification with subjective lameness evaluation. *Equine Vet J* 2012;44(6):November, 2012.

5. The effect of the gait keeper mutation in the DMRT3 gene on gaiting ability in Icelandic horses.

Radiography: Evaluating Proper Positioning, Normal Anatomic Variants, and Insignificant Abnormalities in Prospective Equine Athletes

Kent Allen, DVM, Cert. ISELP; Julia Petersen, MBA DVM; and Kurt Selberg, MS, DVM, MS, DAVCR, Cert. ISELP

Authors' addresses — Virginia Equine Imaging, 2716 Landmark School Road, The Plains, VA 20198; Colorado State University, 300 West Drake Road, Fort Collins, CO 80523; e-mail: ktselberg@gmail.com (Selberg).

I. INTRODUCTION

The radiographic examination is an essential part of the equine lameness diagnostic process. Using correct, systematic positioning and equipment techniques allows practitioners to take radiographs that are of high diagnostic quality. Positioning of the horse can drastically affect the ability to take high quality radiographs. First, the horse must be appropriately sedated to prevent movement and be positioned as square and symmetrically as possible. For the majority of the radiographs taken with a portable handheld generator, the generator should be held 23" or 58.4 cm from the plate to achieve the best exposure. In addition, the x-ray beam should be collimated to the area of interest on the plate to prevent radiation scatter and to improve image quality.

Next, it is important to understand what normal variants are present in the horse as they are vital to proper radiographic interpretation and are an essential component of assessing a horse during a pre-purchase examination (Fig. 1 for common pre-purchase radiographs). A normal variant is described as "an atypical finding present in a percentage of the population that generally has no clinical significance and is considered within the spectrum of normal findings".¹

The Front Foot

There are several projections of the foot that are typically taken: LM, DP, DP65, and PaPrPaDio (navicular skyline) (Figs. 2 and 3). For the LM and DP views, the horse's feet should be placed up on blocks and standing square. The generator should be lev-

Joint	Radiographic Views*
Front Feet	LM, DP, DP65, PaPrPaDio
Front Fetlocks	LM, DP, DLPMO, DMPLO
Hind Fetlocks	LM, DP (+/- DLPMO, DMPLO)
Hocks	LM, DP, DMPLO, DLPMO
Carpus	LM, DP, Flexed LM
Stifles	LM, CdCr, CdCrMO

Fig. 1. Common views taken on a pre-purchase examination.

*Radiographic Views Abbreviations: LM: Lateromedial, DP: Dorsopalmar, DP65: Dorsoproximal-palmarodistal, PaPrPaDio: Palmaroproximal-Palmarodistal Oblique, DLPMO: Dosolateral-Palmaromedial Oblique, DMPLO: Dorsomedial-Palmarolateral Oblique, CdCr: Caudocranial, CdCrMO: Caudocranial-Medial Oblique

el and parallel to the ground with the beam centered 1 cm below the coronary band or focused on an area of a suspect lesion (such as the third phalanx). With the LM view, the beam should be aligned with a line tangential to the heel bulbs. With the DP view, the beam should be parallel to the ground, aiming at 1 cm below the coronary band. Additionally, the technique should be increased to improve the radiographic quality to ensure proper penetration. Remember to take the angle of the floor the horse is standing on into account. Is the floor level or angled such as in a wash rack? For the DP65 view, the horse should be standing square and up on a tunnel or placed in a Hickman stand. If using a Hickman stand, the horse's foot is already placed at a 65 degree angle so the generator will be held horizontally and centered ½ inch above the coronary band. If the horse's foot is placed on a tunnel, then the generator should be angled 65 degrees down and centered ½ inch above the coronary band. It is important to remember to properly clean the foot and pack the sulci and frog to prevent air artifact. Finally, it is important to make sure the navicular bone is not covering the DIP joint. For the navicular skyline (PaPrPaDio) view, the foot should be placed on the tunnel with the leg extended caudally behind the shoulder with the foot fully contacting the ground and in the center of plate/tunnel.¹ Again, it is vital that the foot is properly cleaned and sulci and frog are packed. The generator should be angled down 45 degrees centered on heel bulbs or the palmar pastern. However, please note that the angle may change depending on the slope of the pastern (i.e., conformation of the foot). For example, if there is an upright hoof conformation then the beam angle will need to be increased.¹



Fig. 2. Well positioned radiographic LM and DP views of the foot.

There are many normal variations of the foot. The ones listed here are just a few of the more common ones noted on prepurchase examinations. The palmar process can have variable ossifications. A small circumscribed bony fragment palmar to palmar process of P3 may be a separate center of ossification.² Some degree of ungual cartilage ossification is normal and typically has no clinical significance. A common normal variant that is often misinterpreted as pathology is along the dorsal margin of the distal interphalangeal joint. The dorsodistal aspect of the middle phalanx and extensor process of the distal phalanx can have various shapes from round and blunted to sharp and pointed. However, it is important to verify that the sharply pointed contours are truly osteophytes. If it is a normal variant, then it will generally be bilaterally symmetric without other signs of joint pathology. Additional radiographic views such as a dorso-60proximo45-lateral-palmarodistomedial oblique and opposing dorso-60proximo45-medialpalmarodistolateral oblique can be acquired to verify if the pointed contour is an actual osteophyte or if it is simply a normal variant.¹

Additionally, there are normal variations of the extensor process shape, separate centres of ossification of the palmar processes, ossification of the ungual cartilages, separate centres of ossification of the ungual cartilages and the crena maginalis solaris.³

The navicular bone can also have several different anatomic variations. There can be an appearance of sclerosis of the spongiosum of the navicular bone due to the angulation on the navicular skyline view. The navicular bone flexor cortex can have different thicknesses and shape variations of the central eminence as well as there can be fusiform lucency of the flexor central eminence. The flexor cortex can have variable thickness and the sagittal ridge can have variable shapes including a crescent-shaped lucent region that can be visualized on the navicular skyline view. This is important to separate from a flexor cortex erosion which is a clinically relevant finding.



Fig. 3. Properly positioned D65Pr-Pa and PaPrPaDio (navicular skyline) views that highlight the navicular bone.

The Fetlock

The next anatomy that is commonly imaged is the fetlock including both the front and hind joints. For both front and hind limb views of the fetlock joint, it is important that the horse stands squarely underneath itself with the cannon bone as straight as possible. If the horse is not standing squarely underneath itself then the condyles of the third metacarpal/metatarsal bones will not be appropriately superimposed. There are typically 4 views that are taken of the fetlock joint: LM, DP, DLPMO, and DMPLO (Figs. 4 and 5). An additional view that can be taken is the flexed LM, which allows for improved visualization of the articular surfaces of the proximal sesamoid bones and the sagittal ridge of the third metacarpal bone.



Fig. 4. Properly positioned LM, DP and Flexed LM radiographs of the front fetlock joint.



Fig. 5. Properly positioned DLPMO and DMPLO radiographs, respectively.

For the LM view, the generator is held parallel to the ground aiming at the metacarpal/metatarsal condyles. The ideal image would have the sesamoids superimposed and one should be able to see clearly through fetlock joint space.

For the DP view, it is important to remember to increase the technique to ensure proper penetration so that both soft tissues as well as bony trabeculae can be fully visualized. The generator should be angled 30 degrees down and centered on the fetlock joint to ensure that the sesamoids are fully lifted off and not obstructing the fetlock joint.

Finally, for the DLPMO and DMPLO views, the generator should be aimed dorsally onto the front fetlock joint at a 20

degree angle and onto the hind fetlock joint at a 15 degree angle (Fig. 5).

A normal variation of the fetlock joint is when there is superimposition of the metacarpal/metatarsal condyles that create an appearance of a fracture line or fragment when in reality it is simply due to radiographic beam angulation (Fig. 6).



Fig. 6. Superimposition of the metacarpal condyles which create the appearance of a fracture line.

The Carpus

The carpus is occasionally added into the pre-purchase radiographic package, particularly if the horse is a Thoroughbred with a history of racing. The common views include a LM, DP, flexed LM, and oblique views (DLPMO, DMPLO) (Fig. 7). For the LM view, the generator is held lateral to carpus centered on the carpal joints, aiming parallel to the ground or occasionally aiming 10 degrees downward through the carpal joints. For the DP view, the generator is held dorsal to carpus and parallel to the ground, aiming centered on carpal joints. Again, remember to increase technique or decrease the distance between the generator and the plate, for this view to allow for adequate penetration. For the oblique views, such as the DLPMO and DMPLO, the generator should be held dorsal to the carpus 55 degrees laterally or medially (respectively). Finally, for the flexed lateral, an additional person is required to hold up and flex the carpus so that the carpal joints are opened up and the carpal bones may be separated so as to be better visualized.

There are a few normal variants of the carpus. One common variant that is often confused with a fracture of the distal radius is when a skeletally mature horse has an incomplete closure of the separate center of ossification that resides at the distal aspect of the styloid process. In young horses there is a well-defined lucent to ovoid region that runs obliquely between the distal radius and the separate center of ossification on the styloid process of the ulna. If this does not fuse with age, then it can be mistaken as a fracture in the distal radius rather than a variant in the adult horse. Additionally, there is a smooth indentation on the caudal aspect of the distal radius that looks like a lucent



Fig. 7. Properly positioned LM, DP, and flexed LM of the carpus. The oblique views of the carpus are not shown here.

area on the dorsopalmar view on the carpus and is often mistaken for a cyst-like lesion. However, this can be distinguished from true pathology because there is no presence of joint pathology or sclerosis surrounding the lucent area.¹ Finally, the first and fifth carpal bones are inconsistently found in horses. The first carpal bone was found in 29% of horses, while the fifth carpal bone was found in only 1.4% of horses.⁴ The first carpal bone can have a variation when it does not separate from the second carpal bone, causing it to have an oblong and irregular palmar surface that should not be mistaken for pathology. Additionally, the fossa of the first carpal bone can be prominent within the second carpal bone, which is often confused with a cyst-like lesion within the second carpal bone, but again a normal variant will lack surrounding sclerosis and joint pathology.¹

The Tarsus

For the hind limbs, in addition to the hind fetlock views, the tarsus and stifle are often radiographed. There are 4 common views that are typically acquired of the tarsus on pre-purchase exams: LM, DP, DLPMO, DMPLO (Fig. 8). It is important to have the horse stand square with its metatarsal bone as straight/perpendicular to the ground as possible. For the LM view, the plate will be parallel to the heel bulbs with the generator aiming 5 degrees down and centered on the tarsal joint. For the DP view, the generator will be aiming from dorsal to plantar on the tarsus with the generator held parallel to the ground and centered on the tarsal joint. Again, it is important to remember to increase the technique to allow for proper tissue penetration and create a high-quality radiograph. For the DLPMO and DMPLO views, the generator will be aiming dorsal to the tarsus 45 degrees lateral from the mid-sagittal plane (or 45 degrees medial for the DMPLO) with the generator parallel to the ground and centered on the tarsal joint.

There are a couple of normal variations of the tarsus. One normal variant is that the shape of the distal aspect of the medial trochlear ridge can vary from pointed to rounded and even have a separate osseous body that is often referred to as a "dew drop" lesion. Additionally, the mid dorsal aspect of the medial trochlear ridge can be flattened or even focally concave, which is a variation of normal rather true osseous pathology.¹ Finally, another variant is that the subchondral bone overlapping with the intertarsal joints can create indistinct joint spaces that should not be confused with narrowing of joint spaces.





Fig. 8. Properly positioned tarsus radiographs. A, LM; B, DP; C, DMPLO; D, DLPMO.

The Stifle

Finally, the stifle is occasionally imaged as a part of a prepurchase radiographic package or added on when there is a clinical indication that there might be pathology. There are typically 3 images that are acquired of the stifle: LM, CdCr, and CdLCrMO (Fig. 9). To acquire high quality images of the stifle, the horse needs to be square and fully weight-bearing. The plate will need to be up into the inguinal region as high as the horse will tolerate to ensure that the full stifle joint and patella will be in the radiograph. The stifle radiographs can be acquired with a higher power generator or with a handheld portable generator, depending on what is available to your practice. The recommended technique is 90-100 kVp and 16 mAs. When taking the LM view, the generator will be parallel to the ground and perpendicular to the mid-sagittal plane of the stifle joint. It is important to ensure that the generator is perpendicular to the horse and plate, i.e., if the horse is toed out then the generator needs to be positioned more caudally to ensure that the 90 degrees to the plate positioning will occur. The femoral condyles should be superimposed and the patella, proximal tibia, and distal femur should all be fully visualized. For the CdCr views, the generator will be aiming from caudal to cranial with a 5 to 10 degrees downward angle. Please note that the generator will need to be held higher than it would for the LM due to the downward angulation. Additionally, the generator

will likely need to be held closer than 23" (58.4 cm) to the plate if using the handheld generator as well as increase the technique in order to get appropriate tissue penetration to see the cruciate ligament attachment sites and distinct margins of the intercondylar fossa. It is also important to note that the conformation of the horse as well as the positioning of how far underneath itself the horse is standing will affect the downward angulation that the radiograph needs to be taken. Finally, when acquiring the Cd45LCrMO view, the generator will be aiming from caudal to cranial to the stifle joint with a 45-degree lateral angulation from the mid-sagittal plane with the generator parallel to the ground and aiming at the stifle joint. Again, the degrees from lateral may change if the horse is more toed out and the generator may need to be more caudal to ensure that it stays perpendicular to the plate.



Fig. 9. Properly positioned LM, CdCr, and CdLCrMO radiograph of the stifle (from left to right).

A normal variation for the stifle joint is that the lateral trochlear ridge can look flattened if the beam was angled too far cranially. This can make the trochlear ridge have ill-defined margins but should not be called an OCD.² Additionally, the medial femoral condyle can have normal variations in shape that vary from flat to rounded as can be seen on the caudocranial view as well as it is affected by the generator beam angle. If there is a question regarding true pathology in the stifle, then a flexed lateral oblique view should be acquired.¹

Conclusion

It is important to use proper positioning in order to achieve the highest quality of radiographs during a pre-purchase examination. High quality radiographs and an adequate understanding of the normal radiographic variants that can be found in horses is key to be able to provide a full clinical assessment on a horse so as to be able to provide the buyer with complete information during the pre-purchase exam and prevent misdiagnosis.

II. ACKNOWLEDGMENTS

Declaration of Ethics

All information gathered for this paper was in accordance with the AVMA Principles of Veterinary Medical Ethics.

Conflict of Interest

There are no financial interests or conflicts of interest to be addressed.

REFERENCES

1. Hinkle FE, Johnson SA, Selberg KT, et al. A review of normal radiographical variants commonly mistaken for pathological findings in horses. *Equine Vet Educ* 2019;1-9.

2. Butler JA, Colles CM, Dyson SJ, et al. *Clinical Radiology of the Horse* 3rd *ed*.West Sussex: John Wiley & Sons, 2008;69:371.

3. Becht JL, Park RD, Kraft SL, et al. Radiographic interpretation of normal skeletal variations and pseudolesions in the equine foot. *Vet Clin North Am Equine Pract.* 2001;17:1-18.

4. Simon V, Dyson SJ. Radiographic anatomic variation of the carpus in horses with carpal lameness and control horses. *Vet Radiol Ultrasound* 2010;51:601-606.

Radiography of the Thoracolumbar Spine

Kent Allen, DVM, Cert. ISELP; Julia Petersen, MBA DVM; and Kurt Selberg, MS, DVM, MS, DAVCR, Cert. ISELP

Authors' addresses — Virginia Equine Imaging, 2716 Landmark School Road, The Plains, VA 20198; Colorado State University, 300 West Drake Road, Fort Collins, CO 80523; e-mail: ktselberg@gmail.com (Selberg).

I. INTRODUCTION

iagnosis of back pathology in horses involves a thorough history, clinical evaluation, and radiography of the spine. Several of the most common presenting complaints that clients have that could indicate pathology in the horse's back include poor performance, lack of forward propulsion under saddle, and behavioral problems such as bucking or rearing. Clinical signs of back pain include pain on palpation of the spinous processes and/or epaxial muscles, restriction in flexion-extension and lateral bending of the thoracolumbar spine and/or a positive reaction to weight being placed on their back. This can manifest as a raised head or extended trunk upon the application of weight to the back or with tightening of the girth or cinch. There are several common, distinct sources of pain that horses can have including epaxial muscular pain, osteoarthritis of the articular processes, and spinous impingement ("kissing spine"). In order to evaluate the back and diagnose these problems, radiographs should be taken. Proper radiographs of the back would ideally include radiographs of both the articular processes as well as the spinous processes in order to visualize and assess both anatomical locations. However, articular processes are commonly left out of the radiographic study as they require a high-power generator that can achieve 125-135 Kvp and 160 mAs, which most handheld generators simply cannot achieve. Therefore, pathologic change in the articular processes goes largely underdiagnosed. This is problematic because it is suggested that osteoarthritis of the articular processes, as opposed to spinous impingement, is more likely to elicit pain on palpation of the back.^{1,2}

Anatomy

The axial skeleton is broken into several sections of the spine: cervical, thoracic, lumbar, and sacral vertebrae. The "back" consists of the thoracic and lumbar spinal regions. There are typically 18 thoracic vertebrae and 6 lumbar vertebrae, though can rarely have variations of 19 and 17 thoracic and 7 and 5 lumbar vertebra (Fig. 1). The thoracic vertebral bodies are short and constricted in the middle with flared end plates for articulation. Both of the cranial and caudal articular processes are small with the cranial facet facing almost directly ventraldorsal. In contrast, the lumbar spine's articular processes are concave caudally and convex cranially with fused mammillary processes.³ Functionally, the thoracic spine's primary movement is lateral as the articulations are horizontal to the ground, while the lumbar spine's articulations are more vertical and therefore the primary movement is in a dorsoventral manner which is required for locomotion.

Anatomy: The Muscles Involved

There are several muscles that are key components for back functionality. The longissimus muscles are external back muscles that are palpated when evaluating a horse's topline. These muscles often palpate sore and show muscle spasm and signs of discomfort when deeper pathology is present. The longissimus muscles run the entire length of the horses back and can easily get fatigued if they are asked to support and stabilize the spine. The multifidus muscle lies deeper within the spine and forms attachments between individual vertebrae. Each segment of this muscle is short and controls only a few vertebrae. Since the muscle segments are much shorter, they are more effective at stabilizing and supporting the spine. However, if this muscle becomes weakened, the longissimus muscle will have to work harder to compensate, which leads to pain and muscle spasm of these external muscles of the back. The longissimus muscle extends the back and neck and stabilizes the vertebral column; it originates from the spinous processes and inserts onto the transverse processes and maxillary

processes of C4-7 and tubercle ribs. The multifidus muscle extends the back and unilaterally rotates the vertebral column. It originates from the spinous processes of the vertebrae and attaches onto the more caudal transverse processes of the vertebrae (Fig 2).⁴





Fig. 1. Images show the thoracic spine (top) and lumbar spine (bottom).





Fig. 2. Top image shows the multifidus muscle with its origin and insertion. Bottom image shows the longissimus muscle on dissection. (Courtesy of Dr. Kurt T Selberg)

Why Are Radiographs Important?

There are several performance limiting orthopedic problems that horses can have in their back. They can have any of the spinous impingement ("kissing following: spine"), osteoarthritis of the articular processes, primary muscle or ligament soreness, secondary muscular soreness due to a primary lameness, spondylosis, and fractures of the bony structures.⁴ In 102 French trotters, 96% of the horses with clinical signs had radiographic lesions of the back, and it was found that horses in the clinical group had a higher number of affected interspinous spaces with a higher grade of lesions as well as the clinical group had a higher number of periarticular proliferation of synovial intervertebral articulations with a higher grade of lesions.⁵

Diagnosing the Problem: Radiographs

Radiographs taken with a high-powered generator can acquire images of both the spinous processes as well as the deeper articular processes of the back. A lateral radiograph that is centered over the epaxial muscles shooting horizontally with a small amount of light along the top of the plate can be used to image the spinous processes. These images can be acquired with a handheld generator or a high-powered ceiling mounted generator (Fig. 3).



Fig. 3. Left image depicts how to take radiographs of the spinous processes with a handheld generator. The right image shows a high-powered ceiling mounted generator.

Oblique projections can be acquired shooting left/right ventral 20-30 degrees to left/right dorsal oblique with the plate laid on the epaxial muscles and the generator placed on the horse's lateral thorax (Fig. 4).

While the handheld generator can acquire excellent quality images of the spinous processes, they are unable to adequately expose the articular process joints of the thoracolumbar spine due to the thick overlying epaxial muscles. A high-powered xray generator is typically required to achieve an exposure to assess the articular process and vertebral bodies. With a highpower generator the typical settings that are used are as follows. When imaging the spinous processes, the settings are kvp 100 with mAs ranging from 8 at the withers to 32-40 in the lumbar region. When imaging the articular processes, the settings include kvp 125-135 (135 for the lumbar region) with









Fig 4. Common images of the spinous processes of the thoracic spine.

a mAs of 140-160 (160 for the caudal thoracic and lumbar region). Additionally, it is *vital* to collimate down to just the area of interest as well as decrease the distance between the generator and the horse (typically only a few inches from the horse's side) to reduce scatter and increase penetration to ensure a quality image that is clear and crisp with adequate technique (Figs. 5 and 6). The generator should be focused directly on the articular processes, which usually lie about 15-20 cm ventral

midline in a typical Thoroughbred horse.⁶ Please note that the horse must be properly sedated as motion gets amplified the closer the generator gets to the horse, therefore it must stand quietly without movement and standing squarely and evenly on all 4 feet. Then the image acquisition should be timed with the moment after the horse has fully exhaled.⁶ This will provide the best quality of images with the ribs most likely to be out of the way of the articular processes of the back. Typically, it requires 4 images from withers to lumbar region to acquire all of the spinous processes.



Fig. 5. Top image is a radiograph of the articular processes in the lumbar and thoracolumbar region. The bottom image is the thoracolumbar spine as an anatomical reference.



Fig. 6. This image shows osteoarthritis in the three lumbar articular processes on the left (cranial) side of the model as compared to the normal lumbar articular processes on the far right (caudal) side of the model.

II. CONCLUSION

Radiographs of the spine are simple to achieve with the correct equipment and proper technique and are a key component for accurate and complete diagnosis of thoracolumbar pathology.

III. ACKNOWLEDGMENTS

Declaration of Ethics

All information gathered for this paper was in accordance with the AVMA Principles of Veterinary Medical Ethics.

Conflict of Interest

There are no financial interests or conflicts of interest to be addressed.

References

- 1. Girodroux M, Dyson S, Murray. Osteoarthritis of the thoracolumbar synovial intervertebral articulations: Clinical and radiographic features in 77 horses with poor performance and back pain. *Equine Vet J* 2009;31:130-138.
- 2. Denoix J-M. Lesions of the vertebral column in poor performance horses. In: *Proceedings of the World Equine Vet Assoc Symp* 1999:99-107.
- Sisson S, Grossman JD, Getty R. Sisson and Grossman's The anatomy of the domestic animals. 5th ed. Philadelphia: Saunders, 1975.
- 4. Selberg KT. Equine Back: Anatomy, Diagnosis, and Treatment. 2019.
- 5. Cousty M, Retureau, C, Tricaud C. et al. Location of radiological lesions of the thoracolumbar column in French trotter with and without signs of back pain. *Vet Rec* 2010;166:41-45.
- Butler JA, Colles CM, Dyson SJ, et al. *Clinical Radiology of the Horse 3rd ed*.West Sussex: John Wiley & Sons, 2008;69:371.

Alternative Imaging Techniques for Evaluation of the Purchase Examination

Richard D. Mitchell, DVM, MRCVS, DACVSMR

Author's address — Fairfield Equine Associates, 32 Barnabas Road, Newtown, CT, 06470; e-mail: rmitch2074@aol.com

Take Home Message: The examination for purchase may present issues that are difficult to interpret, complicating the ability to provide the client with practical advice. The use of multiple imaging modalities may clarify issues that arise. Radiography has been the gold standard for imaging in the purchase examination process, but ultrasound, thermography, nuclear scintigraphy, MRI, and CT may enhance the veterinarian's ability to give good advice to the client. Newer imaging technologies may be integrated to offer a more complete assessment.

I. DIGITAL RADIOGRAPHY

he decision of what to image radiographically can be the subject of much debate. Knowledge of the discipline in which the horse is to function is essential in order to make appropriate decisions related to imaging. With the English sport horse or Western performance horse, certain common lameness issues are known to occur more frequently, and the choice of what regions to radiograph should be based on likely probability. Additionally, any other skeletal findings that raise concern during the resting physical and exercise examinations should also be evaluated. Good positioning and technique are critical for consistent evaluations.¹ Radiographic examination may expose old problems that have since resolved. Some injuries, such as suspensory enthesopathies, will remain radiographically evident but may predispose to injury in the future. Having access to previous radiographs can be extremely valuable in the assessment of the significance of abnormal findings. For example, a proximal plantar P1 fragment in a hind fetlock may not represent as much risk for future hind limb lameness when found in a 10-year-old jumper if it was known to be there when the horse was four years old (Fig. 1). Comparison to previous radiographs may also help predict the long-term significance and progression of some lesions as well. For example, moderate osteoarthritic changes associated with a pastern joint in a warmblood found in today's examination may carry less significance if known to have been there on radiographs two years prior.



Fig. 1. A proximal plantar P1 fragment in an eight-year-old Warmblood presented for purchase examination, demonstrating no effusion or lameness.

It is possible that the radiographic examination may produce results that seem inconsistent with the physical examination. Bony lesions may be identified that one would expect to be related to lameness, yet the horse is sound. Further radiographic images using less routine projections may be necessary for a more complete evaluation. Other imaging techniques, such as ultrasound or scintigraphy, can be employed in order to yield more information about the significance of a radiographic finding. A subsequent second physical examination on a different day may also be of benefit. As mentioned previously, previous images of the horse that demonstrate the existence of a lesion for several years is important for interpreting current clinical significance.

The development and advancement of digital radiography has allowed for diagnostic field radiographs of the neck and some parts of the thoracolumbar spine. Lateral images of the cervical spine may demonstrate the presence of osteoarthritis, vertebral anomalies, and abnormalities of the vertebral canal, such as stenosis. One can also acquire very diagnostic oblique images of the cervical articular processes with practice (Figs. 2A and 2B).



Fig. 2A. Field radiograph using portable machine and DR technology demonstrating enlargement of an articular process joint. Cranial is to the left.



Fig. 2B. Field radiograph using portable machine and DR technology demonstrating articular process osteoarthritis (oblique view). Cranial is to the left.

Portable generators in the 80 to 90 kVp range enable one to acquire diagnostic images of some thoracic vertebral bodies and articular process joints in the field. (Fig. 3) Care needs to be taken to minimize radiation exposure for the operators.

II. THERMOGRAPHY

Thermal imaging can be a useful screening tool for the purchase examination. For the sport horse, scanning the limbs and back in general with a modern infrared camera can be beneficial and reasonably quick to perform. Early pathology in the distal limb may be detectable (Fig. 4) as well as foot balance issues that are producing subtle inflammatory changes.² Thermographs of the back may indicate deviations in expected patterns that may be further evaluated by other means such as ultrasound examination. Muscle pathology in various regions of the neck, back, and croup may be detectable using thermal imaging. Such tools may also be used to monitor resolution of inflammation on subsequent examinations.³



Fig. 3. Oblique thoracic image of a 16.2 hand Warmblood, 84 KVP/.18 sec with a portable generator, demonstrating marked, multifocal, ventral spondylosis. Such lesions may be associated with stiffness and poor performance, in the author's experience.



Fig. 4. The above image indicates an area of possible inflammation in the left palmar metacarpal region that may justify a closer look with ultrasound imaging.

III. ULTRASONOGRAPHY

The soft tissue structures of the metacarpal and metatarsal regions are most commonly examined with ultrasound during purchase examinations. Previous palpation or thermography screening may have suggested soft tissue inflammation in a specific region which may be more completely evaluated with ultrasound.

There is a high incidence of suspensory ligament injury in jumper, dressage, and event horses.⁴ (Fig. 5) Similarly, injury to the flexor tendons and digital flexor tendon sheath (DFTS) is not infrequent with varying distribution of affected structures between the fore and hindlimbs.⁵ The tendinous and ligamentous structures of the pastern can also be injured and ultrasonographic assessment of this region should be included

if physical examination findings, such as swelling and sensitivity, sufficiently raise suspicion about these areas (Fig. 6). The size, shape, and fiber pattern of the distal sesamoidean ligaments and flexor tendons should be compared between affected and non-affected limbs. The degree of DFTS effusion and synovial proliferation as well as the thickness of the annular ligaments can also be evaluated.

Knowledge of the complicated anatomy of the lower limb is required for proper evaluation, but the majority of the tendinous and ligamentous structures proximal to the distal sesamoidean (navicular) region can be readily imaged.⁶ Good preparation of the site to be examined is essential. Clipping is not always an option in a horse offered for sale, and if the horse's hair coat is such that diagnostic images are not possible, one can ask the seller or the agent for permission to clip. If done, this should be in a careful and symmetrical manner so as not to "label" the horse. Many show horses have very short hair coats that do not present an issue for ultrasound examination while others may be more challenging. If the examination will be compromised by hair coat such that the images are non-diagnostic, the client should be so informed.



Fig. 5. Left hind suspensory origin is thickened with an inhomogeneous fiber pattern. The origin enthesis is irregular compared to the right hind. The horse demonstrated a mild left hind lameness but no obvious enlargement on palpation.

As for the distal limb, the proximal third of the collateral ligaments of the distal interphalangeal joint (DIPJ) may be evaluated with a 7.5-10 MgHz linear transducer on the medial and lateral aspects of the coronet band. Significant response to distal limb flexion and evidence of DIPJ effusion might suggest looking at these structures. This technique requires special preparation of the coronet with clipping (in some cases) and thorough hydration of the skin along with some practical experience. The middle and distal thirds of the DIPJ collateral ligaments cannot be visualized due to acoustic impedance from the hoof wall.

As previously mentioned, the palmar or plantar pastern should be examined if thickening or significant DFTS effusion is noted. The palmar fetlock and pastern, dorsal fetlocks and pastern and dorsal coronet may also be examined if indicated.



Fig. 6. Ultrasound images of a right fore palmar pastern that was mildly thickened on palpation demonstrating a lesion in the right straight distal sesamoidean ligament. The normal left pastern is on the left.

The solar aspect of the foot, with some trimming and soaking preparation of the frog, may be examined by a transcuneal approach to visualize the distal deep digital flexor tendon (DDFT), the navicular bone and the insertion of the DDFT on P3 (Fig. 7).⁷ This technique would likely only be utilized when there was a high suspicion of palmar foot pain and may require a follow-up visit. (This technique may prove difficult in hot, dry climates without extensive poulticing and soaking.) A 7.5-8 MHz linear probe works well for this view. The proximal aspect of the navicular bone, the navicular bursa, DDFT, and collateral sesamoidean ligaments may be visualized with an 8 MHz microconvex probe placed between the bulbs of the heel. A limited view is available but may demonstrate evidence of distal deep digital flexor abnormalities, navicular bursal effusion and thickening of the collateral sesamoidean ligaments. Again, this is a technique that requires some practical experience and good anatomical knowledge.



Fig. 7. Transcuneal ultrasound image and corresponding anatomy of the navicular bone and distal deep digital flexor tendon viewed with 8 MHz linear probe.

If during the examination, local pain or stiffness in the neck is noted, ultrasound examination may be very helpful in evaluating the cranial and dorsal margins of the articular processes and the degree of effusion and capsular thickening/capsulitis (Fig. 8). Back pain may be further evaluated with ultrasound by evaluating structures such as the spinous processes, supraspinous ligament, and thoracolumbar articular process joints.



Fig. 8. Illustration of probe position across a cervical facet and resultant image demonstrating an osteophyte and fluid within the joint capsule.

IV. NUCLEAR SCINTIGRAPHY

Often a horse may demonstrate a faint lameness or radiographic findings of the feet and navicular bone that are suspicious of pathology. Many exceptional equine athletes may exhibit mild issues of various areas, and clients are still interested in purchasing them. If additional radiographic images are not conclusive or not possible, nuclear scintigraphy may aid the decision process, if available. Obviously, this is the buyer's choice and financial responsibility, but the seller must be willing to allow this semi-invasive procedure. Areas of increased radiopharmaceutical uptake (IRU) are characteristic to some structures in working horses and knowledge of this is required,⁸ but this imaging modality can be extremely helpful in evaluating the significance of the findings of other modalities such as radiography and ultrasound. Radiographically abnormal navicular bones can sometimes be attributable to individual variation, and comparison between contralateral limbs is vital. However, a radiographically abnormal navicular bone that demonstrates intense IRU on scintigraphy is more likely to be indicative of inflammation and is of greater clinical significance than one with a normal uptake pattern. (Fig. 9)



Fig. 9. Abnormally shaped navicular bone with proximal enthesophyte formation in a horse with faint lameness that subsequently demonstrated intense radiopharmaceutical uptake on scintigraphic imaging.

Radiographic and ultrasonographic findings may be concerning for a possible suspensory origin lesion. Nuclear scintigraphy can be useful in assessing the current state of activity in the proximal palmar/plantar metacarpus/tarsus and therefore providing valuable information by which the clinician may predict outcomes. An example follows in Figs. 10 and 11.



Fig. 10. Radiographic image of the left proximal metatarsus demonstrating lysis and sclerosis at the suspensory ligament origin. Ultrasound indicates abnormal dorsal fiber pattern and an irregular bony origin.



Fig. 11. Nuclear scintigraphic images of the left hind limb of the same horse in Fig 10, demonstrating IRU at the origin of the left hind suspensory ligament. The right hind by comparison, in the image on the right, appears to be within normal limits.

Variations of normal anatomy may be innocent but can in some cases be the tell-tale signs of developing pathology. Investigating such findings with a combination of imaging techniques may prevent unfortunate consequences later. An example follows in Figs. 12-14.



Fig. 12. Purchase examination image on the left and lameness examination image on the right 6 months post-purchase that blocked to an abaxial sesamoid block. Area of sclerosis and region of subchondral injury of the sagittal groove of the proximal first phalanx (P1) which may be enhanced by a slightly flatter beam angle.



Fig. 13. Nuclear scintigraphic image (left) showing focal zone of IRU on the proximal aspect of the left front first phalanx (P1) and corresponding dorsal plane MRI short tau inversion recovery (STIR) image demonstrating subchondral osseous fluid associated with subchondral bone injury which was associated with an incomplete sagittal sulcus fracture.



Fig. 14. Post-surgical image of the previously noted left front fetlock six months after screw placement. The patient was responding favorably.

The previous set of figures illustrate a subtle lesion that went unrecognized in the purchase examination that in retrospect led to a problem that was fortunately successfully resolved. It certainly can be rewarding to identify an issue that might lead to subsequent problems, but care should be taken not to overinterpret the significance of radiographic findings and excessively negatively prognosticate, particularly when the horse is not currently exhibiting signs of lameness. Litigation has been pursued in cases for failure to identify abnormalities during a pre-purchase examination but also in cases in which the veterinarian assigned unfounded, excessive risk to the purchase of a horse. Seeking a second opinion on peculiar findings, especially for the less experienced clinician, is often much appreciated by the buyer and seller alike.

Magnetic Resonance Imaging

The advent of standing magnetic resonance imaging (MRI) has made this imaging technique much more practical and available for the further investigation of suspected problems discovered in the purchase examination. Advances in technology have made good quality images possible in the standing horse, reducing the need for general anesthesia in many cases involving the distal limb. A seller may find this is a more acceptable way to allow the horse to be imaged. The modality is especially useful for the evaluation of suspected issues in the distal limb and within the hoof capsule.⁹ MRI is not a screening tool but is very useful for examining structural details and detecting inflammation in specifically targeted areas. Examples would be suspected subchondral cyst-like structures, an abnormal navicular bone found on routine radiography, or suspected tendon or ligament pathology on ultrasound.

An example of a purchase examination where MRI was very helpful follows: The horse in question was a 12-year-old Grand Prix Dressage horse that had been successfully competing in FEI classes in Europe. Physical examination was unremarkable except for positive distal limb flexion tests in both fore limbs. There was no apparent lameness working on a lunge or under saddle. Radiographs indicated some varying bone densities in the subchondral bone of proximal P1 in both forelimbs, suggestive of subchondral bone injury. An MRI unit was conveniently located nearby and an examination was recommended. A standing MRI examination of both fore fetlock regions was performed. Radiographic and MRI images are shown in Figs. 15 and 16 respectively. Significant pathology was identified in the subchondral bone of proximal P1 in both fore limbs on radiography that appeared to be active on MRI (bone fluid or edema) (Fig 17). The horse was also discovered to have similar radiographic lesions in the RH fetlock.



Fig. 15. Radiographic images of both fore fetlocks demonstrating subchondral sclerosis and focal lucent areas bilaterally.



Fig. 16. Dorsal plane MRI STIR images of both fore fetlocks demonstrate focal zones of hyperintense signal indicative of osseous fluid in proximal P1.



Fig. 17. Sagittal MRI images of the right fore fetlock (STIR on the top and T1 on the bottom) demonstrate an extensive lesion associated with the sagittal groove that is indicative of subchondral bone injury or possibly incomplete fracture.

The right fore fetlock appeared to have a more distinct area of intraosseous fluid signal and subchondral defects that presented a high risk for affecting future soundness (Fig 17). This information resulted in the buyer declining the purchase of the horse.

MRI provides a means by which to evaluate the current activity of bone lesions and accompanying soft tissue changes. While nuclear scintigraphy may give some idea of local bone activity or increased blood flow, MRI adds the benefit of providing information regarding osseous structure as well.

V. COMPUTED TOMOGRAPHY

Recent developments in in computed tomography (CT) are increasing the availability of this technology for the equine patient.¹⁰ Standing units (Fig. 18) have been developed which allow for imaging of the head, neck, and distal limbs.^a As standing units become more available, this modality can be used to further interrogate questionable osseous radiographic findings in the purchase examination process. Utilization of standing units requires less sedation and significantly shorter scanning time compared to MRI. While CT is not ideal for soft tissue structures when compared to MRI, the superior bone resolution of CT allows excellent visualization of subchondral bone lesions.⁷ Some units can even evaluate the cervical spine to C7-T1 if there is concern about the degree and distribution of osteoarthritis identified on survey images.

VI. CONCLUSION

Multiple alternative techniques for imaging are available to the equine practitioner for the complete and accurate evaluation of the horse presented for purchase. In addition to an initial thorough physical examination, the integration of multiple imaging techniques and modalities will provide the necessary information for the client to make an informed decision regarding the prospective purchase.



Fig. 18. On the top is an image of a standing CT unit capable of imaging the lower limbs. The bottom left radiographic image demonstrates a possible central tarsal bone fracture and the CT image on the right confirms the presence of the central tarsal bone fracture which was captured by the unit pictured on the left.

VII. ACKNOWLEDGMENTS

The author has no financial interests or conflicts of interest relative to commercial items mentioned or the contents of this paper.

REFERENCES AND FOOTNOTE

- 1. Dyson S, Radiography and Radiology, In: *Diagnosis and Management of Lameness in the Horse*, Eds, Ross M and Dyson SJ, Saunders, Philadelphia, pp. 153-166.
- 2. Turner TA. Evaluating the sore performance horse, in *Proceedings*, Compendium Equine Seminars from October–December 2001;8–13.
- Soroko, M and Howell, K, Infrared thermography: Current Applications in equine medicine, *J Equine Vet Sci* Sept. 2018;90-96.
- 4. Murray RC, Dyson SJ, Tranquille C, et al. Association of type of sport and performance level with anatomical site of orthopaedic injury diagnosis. *Equine Vet J (Suppl)* 2006;36:411-416.
- 5. Boswell RP, Mitchell RD, Dyson SJ. Lameness in the Show Hunter and Show Jumper. In: *Diagnosis and*

Management of Lameness in the Horse, Eds, Ross M and Dyson SJ, Saunders, Philadelphia, 2003;951-975.

- 6. Denoix, JM. The Equine Distal Limb, Jul 2000, CRC Press.
- 7. Jacquet S, Denoix JM. Ultrasonographic examination of the distal podotrochlear apparatus of the horse: A transcuneal approach, *Equine Vet Educ* Feb 2012;90-96.
- Dyson SJ, Martinelli MJ. Image description and interpretation in musculoskeletal scintigraphy. In: *Equine Scintigraphy*, Eds: SJ Dyson, RC Pilsworth, AR Twardock, M Martinelli, EVJ, Newmarket, Suffolk, 2003;89-91.
- 9. Redding R. *Anatomy and Imaging of the Equine Foot and Digit*, Proceedings of the Ocala Equine Conference, Jan 25, 2020, Ocala, FL.
- Curtiss, AL, Wulster, KB, Darko, S, et al., Validation of standing cone beam computed tomography (CT) for diagnosing subchondral fetlock pathology in the Thoroughbred racehorse, 2018 Am Coll Vet Rad IVRA Joint Scientific Conference, Fort Worth, TX, USA Oct 14– 19, 2018.
 - a. Asto CT, LLC, 3300 Commercial Avenue, Madison, WI 53714.

Effective Dialogue Between Colleagues: Communicating Findings to Other Veterinarians

Kent Allen, DVM, Cert. ISELP; and Kristen Stowell, DVM

Authors' addresses — Virginia Equine Imaging, 2716 Landmark School Road, The Plains, VA 20198; email: kallendvm@aol.com (Allen); Elkhorn Veterinary Clinic, 205 East O'Connor Drive, Elkhorn, WI 53121 (Stowell)

I. INTRODUCTION

ommunication with veterinary colleagues is crucial to the success of a pre-purchase examination. The communication with numerous team members during a multifaceted pre-purchase exam will be explored in the following sections.

Who Is Involved in a Pre-Purchase Examination?

First and foremost, there may be numerous parties in a single pre-purchase exam. The constant players include the buyer, seller, and the examining veterinarian. Other participants in a pre-purchase exam may also include an agent of the buyer and/or seller, the normal veterinarian of the seller who has examined the horse previously, and/or specialist veterinary professionals at the request of the examining veterinarian or the seller's veterinarian. Consequently, communication must be maintained between all groups involved. It is the responsibility of the examining veterinarian to consistently discuss all aspects of the pre-purchase exam with each distinct party. In the case of a foreign horse being vetted, it is not uncommon for the exam to be performed by an international veterinarian, and for the findings of the exam to be reported to the buyer's domestic veterinarian. For example, if an American is purchasing a European horse, a European veterinarian may perform the prepurchase exam. The buyer may then ask their regular American veterinarian to add his/her interpretation to those results.

The Clinical Exam

Due to the multitude of parties involved, a consistent and methodical clinical examination of the horse is required as the basis for all subsequent communication. Most veterinarians choose to evaluate the movement of the horse with no video recordings or objective analysis. However, some clinicians will choose to video record while others may opt to use a quantitative lameness evaluation technique. It is important to note if there is any significant gait asymmetry or lameness appreciated in the examination, it is vital to document these findings. Video recordings prove very useful for this purpose and serve as an effective means of documentation for future communications with the buyer, seller, and especially other colleagues involved with the pre-purchase exam.

Communicating Imaging Recommendations and Findings

As the pre-purchase examination moves to the imaging portion, it is of paramount importance to distinguish and communicate with the buyer as to what imaging is recommended, what imaging the overseeing veterinarian is requesting, and what the seller will allow to be done on the horse. This includes logistical aspects required for gathering the imaging, such as whether the seller will allow the clipping of limbs for ultrasound imaging. Regardless of the type of imaging that is recommended, it is vital to make sure the client is aware of the recommended imaging and the cost involved. If more than a radiographic exam is recommended during a pre-purchase exam, then the seller must be informed so that they know and approve of the additional imaging and techniques. High quality diagnostic imaging is not only necessary for immediate interpretation, but also, so that the various future parties involved after the initial pre-purchase examination can offer their opinions and prognosis based on the diagnostic information provided. Meticulous assessment of the quality, labeling, and positioning of any diagnostic imaging is essential. This attention to detail ensures that the images are of diagnostic quality and will limit the need for other veterinarians to request that the imaging be re-done.

Pre-Purchase Documentation

Finally, detailed documentation of the examination findings accompanied by the veterinarian's opinions is critical and may be time sensitive. The documentation may be formatted as worksheets or as a letter summarizing the findings. Furthermore, this is the stage of the pre-purchase exam where it may be prudent to seek an expert opinion on any imaging, such as contacting a board-certified radiologist. Moreover, if there is any concern regarding the horse systemically, it would be the time to recommend additional specialized veterinary opinions to include, but not limited to, ophthalmic or cardiac consultations, and/or drug screening. It is important to add the additional opinions to the documentation so that each party has access to all the relevant material. With the consent of the buyer, this medical information should be shared with the purchaser and/or their veterinarian. If there has been any verbal communication with the buyer, the buyer's agent, or a veterinarian prior to the report being written, it is vital that the written documentation reflects the verbal communication. The full detailed report of the pre-purchase examination should be sent to all parties for review as quickly as possible, so that there is time to ask suitable questions, prior to irrevocable economic decisions being made.

How to Communicate About Medical History

The most common communication between veterinary colleagues in the pre-purchase exam is a call or email requesting prior medical history on the horse presenting for the prepurchase examination. The veterinarian who has previously examined this horse for the seller must then request permission from the seller to forward on any medical records or imaging. Not uncommonly, the seller is asking the veterinarian to limit or edit the prior medical history. This undoubtedly puts the seller's veterinarian in both an ethical and legal conflict, in addition to straining the relationship with the seller should the veterinarian refuse to edit the medical record. This dilemma must be resolved with the seller before records can transfer. Otherwise, the seller's veterinarian must respond back to the buyer's veterinarian, indicating that the records will not be forthcoming. Often, the buyer's veterinarian will contact the seller's veterinarian and discuss the matter "off the record." Remember, however, this does not absolve the veterinarian's ethical and legal responsibility to the requests of the seller, and it is rare that "off the record" discussions remain that way, particularly if lawyers become involved. Care, meticulous documentation, and impeccable communication with all parties, will usually see you through this predicament.

Communicating Pre-Purchase Results

The second most common communication between veterinarians regarding a pre-purchase examination, usually results after the veterinarian has failed a horse and indicates the presence of a lameness or a specific radiographic finding. In this case, the seller's veterinarian may be contacted for either prior radiographs, or to give an opinion regarding potential concerns for the horse's future athletic performance. Not uncommonly this can put the veterinarian of both the buyer and the seller at odds over differing opinions for their respective clients. The best way to avoid this is to have fully documented the problem during the pre-purchase examination, and if necessary, reach out for additional expert veterinary opinions prior to getting the seller's veterinarians involved.

For example, consider that the buyer's veterinarian noted a Grade 2/5 right front lameness while the horse was circling right on a firm surface during the pre-purchase examination. Ideally, the veterinarian would have video recorded the lameness, adequately documented the lameness in the record, and potentially, assessed the horse with a quantitative lameness device. Such thorough documentation should resolve the majority of the "he said, she said" arguing that sometimes follows a failed pre-purchase exam.

Another conflicting situation may arise from a radiographic finding for which the buyer's veterinarian deemed the horse unsuitable for purchase. If the buyer's veterinarian is not confident in his/her ability to assess whether this radiographic finding will limit the horse's ability to perform its future job, it is advised to consult with a colleague or a radiologist for an additional opinion. This second opinion should also be documented within the record and may defuse a future argument between parties.

II. CONCLUSION

In summary, a methodical, well-documented clinical examination accompanied by adequate diagnostic imaging and if necessary, the second opinion of a specialist veterinarian, are crucial components of a pre-purchase examination. This attention to detail and thoroughness will drastically improve communication between both the buyer, seller, and the veterinary colleagues who represent them respectively.

ACKNOWLEDGMENTS

Declaration of Ethics

All information gathered for this paper was in accordance with the AVMA Principles of Veterinary Medical Ethics.

Conflict of Interest

There are no financial interests or conflicts of interest to be addressed.

Applications of Objective Lameness Measurement in the Pre-Purchase Exam

Mark R. Baus, DVM

Author's address — Grand Prix Equine, 434 Main Street South Bridgewater, CT 06752; e-mail: mbaus@grandprixequine.com

Take Home Message: Inertial sensors have been used as an objective method of measuring equine lameness for over a decade and their use by veterinarians continues to grow. However, even among those veterinarians using it for lameness evaluations, there is reluctance to use it for pre-purchase examinations. This paper will look at the best way to integrate this technology into the prepurchase examination to produce useful information and protect veterinarians in the process.

Until recently, the equine veterinarian was limited to subjective methods of detecting and measuring lameness. The detection of lameness relies on many factors: asymmetric movement of the head, the hike of the pelvis, the unequal sounds of the affected limb or the unusual movement of a lame limb. This subjective identification of lameness is well-suited for the experienced veterinarian and serves most practitioners well. It had served the author so well that it was difficult for him to understand how three sensors attached to the horse could possibly be more accurate. But they are. They provide reliable, quantitative data which can be particularly helpful in a prepurchase examination.

The conventional lameness scale from one to five is a timehonored method of scoring lameness but is fraught with uncertainty.¹ One person's grade two lameness is another person's grade three or grade one. For the purpose of a prepurchase exam, the difference between a grade one lameness and a grade two lameness will determine the outcome of a buyer's purchase decision but, in fact, is a subjective and variable method for describing a gait abnormality.

Body-mounted inertial sensor systems (BMISS) have been commercially available since 2009. The most widely used commercially available system is the Equinosis Q, also known as the Lameness Locator® co-developed by Dr. Kevin Keegan^a at the University of Missouri. For the sake of this discussion, the Equinosis Q will be the system reviewed and is the system used by the author. The Equinosis Q uses an accelerometer placed on the head and the pelvis, and a gyroscope placed on the right front pastern. The head and pelvis sensors measure vertical movement on the midline of the horse. Vertical movement of the head and pelvis are considered the most sensitive indicators of lameness.² The gyroscope on the right front limb simply acts as an event marker, detecting movement of this limb and the movement of each other limb.

The horse can be evaluated at the trot in hand or under tack, in straight lines and in circles, and following flexion tests. It is important to note that the validation studies and establishment of reference ranges for the system were based on straight line data collections of at least 25 strides. Modifications to data collection and interpretation of data must be made for evaluating horses on a circle, under saddle, or following flexion tests.

Signals from each sensor are transmitted to a handheld tablet and algorithms analyze the data to produce a report which describes the limb or limbs involved, the amplitude of head and pelvic movement asymmetry in millimeters and the timing of asymmetry in each stride determining if the lameness is either a push-off or an impact lameness.

A report generated by the Equinosis Q contains a read-out of each trial. At the end of the report is an AIDE (Auto Interpretation and Degree of Evidence) statement. An AIDE statement is generated stating the amplitude or amount of lameness into mild, moderate and severe categories. The report also describes the degree of certainty of the evidence and is based on the standard deviation relative to its mean measurement. The higher the standard deviation, the weaker the evidence. The AIDE affirms the reliability of the evidence into three groups: weak, moderate, or strong. It is important for the practitioner to understand why a trial might yield weak evidence and seek to make corrections for a repeat trial. Although experienced practitioners using the Equinosis Q do not rely on the AIDE statement, a buyer who sees the report will. It is necessary that the practitioner understand the data from each trial and translate the findings and the AIDE statement to the buyer.

There are numerous reasons why practitioners do not use BMISS that are worth addressing as they represent either a misunderstanding of what the system does or how it works. There may also be an underlying fear that the technology somehow replaces the skills and expertise of the veterinarian rather than enhances them.

- A practitioner may not trust the accuracy of BMISS nor do they believe it is more accurate than their own ability to detect lameness
- The findings from the inertial sensors may not agree with the practitioner's findings
- It takes additional time to conduct each trial
- The Equinosis Q costs between \$17,000-20,000

These are significant reasons for choosing to not use BMISS so the advantages are critical. It is important to understand that the results of the Equinosis system have been validated in accuracy, repeatability, and sensitivity in multiple peer reviewed studies.³⁻⁶

Time is critical when examining lame horses. A thorough lameness exam takes time, time that the equine practitioner has little of. In the author's experience, sensors can be applied in less than three minutes. The tablet and program can be booted up and operational in less than two minutes. Each trial takes less than two minutes. In less than 7 minutes, a trial providing valuable information can be gathered for the lameness examination. A trained technician is invaluable in operating the Equinosis Q efficiently and can operate the software while the veterinarian is performing their normal lameness evaluation (Fig. 1). The use of BMISS actually saves time, especially when evaluating subtle lameness cases and performing diagnostic nerve blocks.



Fig. 1. Analyzing an Equinosis Q report after a trial.

The cost of the system is not insignificant. However, used regularly and charged appropriately, the system will enhance cash flow for most practitioners. The author generates enough revenue using the Equinosis Q to pay for the system in one year of use.

It is one thing to use BMISS for lameness examinations but using it for pre-purchase examinations is quite another. Until the veterinarian arrives for a pre-purchase exam, there is perfect alignment between the seller and the buyer of a horse. By the end of the examination, this alignment is often frayed. Veterinarians examining horses for potential buyers have always had control over how a horse's way-of-going was described and systems such as the Equinosis Q makes that more difficult since it may provide information that conflicts with the veterinarian's findings.

Once a veterinarian notes that a horse is "lame" at a prepurchase exam, buyers head for the door, sellers start screaming and the veterinarian is widely vilified for killing yet another sale. So where is the threshold for pronouncing a horse "lame"? Instead of "lame", many veterinarians use alternatives such as "weak", "stiff", "short" or "a bit off" to describe findings from the pre-purchase examination. Van Weeren⁷ suggested that the term "lame" be reserved only "for horses deemed unfit to compete". This interpretation wrongly assumes that lameness is a disease and not merely a symptom. Lameness is only a proxy measurement for disease and is not the disease. Horses can and do perform with lameness, but it is the nature of the underlying disease that will determine if they should perform at a specific level.

Whether it is a routine lameness examination, a baseline wellness evaluation, or a pre-purchase examination, the veterinarian will determine the significance of any lameness that is visualized or measured. With the help of the BMISS, it must be determined if the identified lameness is primary, secondary, or compensatory. It is therefore important that the veterinarian remain in control of the evaluation and not simply be led by the data.

The key for acceptance of BMISS for purchase exams is managing the prospective buyer's expectations. If a buyer understands the advantages of using this technology to assess a prospective horse's gait, their acceptance tends to be favorable. So how does the veterinarian get buyer acceptance for using this technology to evaluate their horse? As a starting point, it is important that prospective buyers understand that lameness is a common symptom so it must be accepted that some degree of lameness is likely to be determined during the examination. The author uses the term lameness liberally to explain his findings during and after the pre-purchase exam, so using BMISS coordinates well with that since it, too, will often identify some degree of lameness.

The Equinosis Q program established thresholds for head and pelvic movement asymmetries indicative of lameness that are deliberately low and based on a wide population of horses of various breeds, age, and use. In the front limbs, this threshold is 6.0 mm of Diff Max and Diff Min for the front limbs and for the hind limbs, it is 3.0 mm for the Vector Sum of Diff Max and Diff Min for the pelvis. For the author, lameness in a front limb is often not recognized until it reaches 12 to 14 mm or 4 to 5 mm from the hind limbs. These thresholds are critical measurements, but each veterinarian will determine their own threshold based on their experience, the intended use of the horse, and the clients risk-taking ability.

Rather than establishing a threshold for pronouncing that lameness is present, it is much clearer to simply measure the amount of lameness (or asymmetry) and assess its importance in the context of other clinical findings and imaging information such as radiographs and ultrasound examination.

Conducting the Evaluation with a Body-Mounted Inertial Sensor System

The Equinosis Q is suitable for in-hand examinations, but the author performs all pre-purchase examinations under tack. There are several important things to remember when using the Equinosis Q during a pre-purchase examination:

- To save time, pre-enter the horse's information into the Q program.
- While tacking up the horse, only apply the head bumper and sensor under the bridle or halter; do not apply the pelvic sensor or the right front pastern sensor bandage until conducting a trial because the occasional horse reacts negatively to the pelvic attachment or the right front pastern wrap.
- Because consistency of movement is more erratic prior to a warm-up, conduct a Q trial after the standard soundness examination to allow the horse a chance to stabilize their musculoskeletal system.
- Before conducting the Q trial, the visual soundness exam findings should be discussed with the prospective buyer or their agent. This will provide the buyer with the veterinarian's findings independent of the sensor trial.
- Although trials with the Equinosis Q may be conducted in circles, and in some scenarios may offer additional or clarifying information, it is best to conduct trials in straight lines. Trials in circles require significantly more interpretation and it is more difficult to explain the normal variances that occur in circle-trials.
- Attach the right front pastern sensor and the pelvic sensor and conduct the trial. If the examination is performed under tack, the rider should trot without posting and remain sitting.
- A repeat trial is often necessary to achieve the most accurate and meaningful information.
- Send the report generated by the Equinosis Q to the buyer along with all information generated at the time of the pre-purchase examination.

How the Equinosis Q results are discussed with the prospective buyer or their agent is critical. It is important to discuss the correlation of the examining veterinarian's findings with the Equinosis Q measurements and why there might be a discrepancy. It is also important to point out the strength of evidence of the Equinosis Q trial as determined by the standard deviation of each trial. High standard deviations are an indication of high stride-to-stride variability and, therefore, reduce the confidence in the evidence of lameness in a limb. The veterinarian needs to understand this potential variability and how to assess it.

If lameness is noted in both a front limb and a hind limb, it is necessary to opine on which limb is the primary source of lameness. It may also be necessary to determine if the secondary lameness is compensatory to the primary lame limb or if it is a true, but less important source of lameness compared to the primary lame limb.

The most difficult situation encountered with BMISS is when the measurements from a lameness trial contradict the veterinarian's findings (Fig. 2). To clarify this scenario, the veterinarian needs to explain the discrepancy. In the author's experience, if the sensors are applied correctly and the variability of the data is adequately low, the Equinosis Q is likely correct which can make this explanation a humbling one. This discrepancy may be clarified if the clinical exam is conducted in circles and the O trial is conducted in straight lines. It may be necessary to visually examine the horse for lameness a second time, palpate the noted limb more thoroughly for abnormalities or conduct additional imaging. It is also recommended to rerun the Q trial if there is disagreement between the veterinarian's findings and the Q measurements. It is necessary for veterinarians using the Equinosis Q to have a reasonable amount of experience with this system before using it for pre-purchase examinations.



Fig. 2. The Equinosis Q report for a pre-purchase exam showing mild RF and RH lameness although the horse did not show lameness visually.

As noted earlier, it is important to put the findings from BMISS into context for a buyer. If a front limb shows a mild lameness, the veterinarian might scrutinize the navicular radiograph more critically. If a hind limb shows no lameness but has radiographic changes in the lower hock joints, those changes will have less meaning. If a front limb shows a push-off lameness and the horse has sloping pasterns, the veterinarian may elect to ultrasound the suspensory apparatus.

The information from BMISS is just that: information. Prospective horse buyers want as much information as possible from the pre-purchase examination and, more importantly, they need the examining veterinarian to summarize this information in a way that allows the buyer to make an informed purchase decision. Veterinarians who use this device as an adjunctive tool will find that it promotes the best interests of the horse and the potential buyer in a way that complements the routine prepurchase exam.

REFERENCES AND FOOTNOTE

- 1. Lameness Exams: Evaluating the Lame Horse, <u>https://aaep.org/horsehealth/lameness-exams-</u> <u>evaluating-lame-horse</u>.
- 2. HH Buchner, et.al. Body centre of mass movement in the sound horse. Vet J. Nov 2000, p. 225-234
- 3. Keegan KG, Kramer, J, Yonezawa Y, et.al. Assessment of repeatability of a wireless, inertial sensor-based lameness evaluation system for horses. *Am J Vet Res* Sept. 2011;72(9):1156-1163.
- 4. McCracken MJ, Kramer J, Keegan KG, et.al Comparison of an inertial sensor system of lameness quantification with subjective lameness evaluation. *Equine Vet J* May 2012;44(6):652-656.
- 5. Leelamankong P, Estrada R, Mählmann K, et. al, Agreement among equine veterinarians and between equine veterinarians and inertial sensor system during clinical examination of hindlimb lameness in horses. *Equine Vet J* 2020 Mar 52(2):326-331.
- Bell RP, Reed SK, Schoonover MJ, et.al. Associations of force plate and body-mounted inertial sensor measurements for the identification of hind limb lameness in horses. *Am J Vet Res* 2016;77(4):337-345.
- 7. van Weeren PR, Pfau T, Rhodin M, et.al. Do we have to redefine lameness in the era of quantitative gait analysis? *Equine Vet J* 2017;49(5):567-569.
- a. Equinosis, LLC, Columbia, MO 65203.

Evaluation of the Off-Track Thoroughbred for Their Second Career

Jeffrey Berk, VMD, MRCVS; Anna Ford, Program Director of New Vocations

Author's address — PO Box 11067, Lexington, KY 40512-1067; email: jtberk5@aol.com

he use of Thoroughbreds for a variety of equine activities has spawned an increase in the number of individuals and organizations locating and providing retraining opportunities for these horses once they have been retired from racing. Most of these groups' function under the umbrella of the Thoroughbred Aftercare Alliance (TAA), a 501(c)3 non-profit which accredits, inspects, and awards grants to approved organizations to retrain, retire, and rehome Thoroughbreds using industry-wide funding. Since 2012, the TAA has granted more than \$24.5 million to accredited aftercare organizations and 13,700 Thoroughbreds have been retrained, rehomed, or retired by those organizations. Currently, 82 organizations with approximately 180 facilities hold TAA accreditation. One such organization is New Vocations, founded in 1992 and now the nation's largest racehorse adoption program. New Vocations mission statement is "To stand in the gap for non-competitive often injured racehorses providing a peaceful environment and skilled hands to assist in their development as pleasure mounts. To place these horses in experienced loving homes that will continue their education so each has a skill and therefore, a future". Anna Ford, the executive director of New Vocations, will join me in giving an overview of the process of evaluating each individual for a second career, starting with her initial evaluation and then the veterinary evaluation utilizing the history and previous diagnostic imaging as well as the physical examination and appropriate diagnostics. The same protocol is followed for each horse. The purposes of the initial physical examination are listed below.

- Assess whether there is any detectable level of lameness
- Determine the relevance of any previously diagnosed injuries
- Discover any undiagnosed injuries
- Assess any behavioral problems which may impact a second career

This will form the basis of the initial plan for the horse, and in each case follow-up will determine the discipline(s) available for each individual horse and the rate at which training should proceed.

There are many challenges regarding aftercare of racehorses. In terms of initiatives that could improve the current situation, there are several options to consider. First, an important owner education piece would be to help the buyer to understand that, when he or she buys a yearling at public auction in order to race that individual, that person becomes a steward of the welfare of that horse. Almost all Thoroughbreds are conceived with the intent to become racehorses or bloodstock to be purchased at public auction for that ultimate purpose. Buyers are only responsible for the cost of the maintenance of the horse as long as they own it and race it, but when it leaves their ownership they are responsible to transfer the horse to its next career in the best condition possible. Dr. Patty Hogan, in a seminar at Saratoga in August of 2017, commented on three primary situations that should prompt a trainer and owner to consider retiring a horse from racing.

- The horse does not exhibit a level of talent that would make it competitive
- The horse sustains a serious injury which is likely incompatible with future racing
- The horse has chronic, progressive issues which will (or already have) become performance limiting

This third situation has been termed the "One Last Race" syndrome. In the case studies that will be presented, there will be clear examples of this, and its effect on the future suitability of these horses for other athletic pursuits.

An opportunity to address this third situation would be mandatory continuing education for trainers at the racetrack, emphasizing the importance of early identification of clinical signs related to conditions which could be addressed with appropriate veterinary diagnosis and therapy (including rest) to allow the horse to either continue a racing career or transition to a second career. Many of the clinical issues identified in the preliminary examination of the New Vocations horses are advanced, and severely limit the opportunity for a higher level of athletic pursuit. What the stewards (trainers and owners) of these horses don't realize is that by continuing to train and racehorses that are declining in their performance, they are limiting that horse's opportunity for adoption. Jumping, eventing, dressage, and other disciplines require a level of soundness that cannot be attained by a horse with chronic and / or degenerative issues.

Horses are not retired from racing when they're performing well. In an Australian study,¹ the following objective was stated: "Significant proportions of horses leave the Australian Thoroughbred and Standardbred racing industries, which has ramifications for both the economic sustainability and the public perception of racing. The aim of this study was to quantify potential horse wastage, describe the destinations of exiting horses and identify risk factors for horses going to these destinations". The results of the study indicate that the total horse exit rates for the 2002-2003 official race year were 39.7% for Thoroughbreds and 38.7% for Standardbreds. The factors listed as the reason for exit from racing are below

- Poor performance / slow (36.5% Thoroughbred [TB], 35.2% Standardbred [SBD])
- Illness / injury (31.0% TB, 27.1% SBD)
- To breed (9.4% TB, 10.1% SBD)
- Unsuitable temperament / behavior (6.4% TB, 6.4% SBD)
- Other (16.8% TB, 21.2% SBD)

The study concluded that improved behavior training and early identification of the causes of poor performance could assist in reducing wastage. Thus, the aforementioned need for educational efforts directed toward trainers and owners.

Case studies will form the bulk of this presentation, detailing the history, clinical presentation and diagnostic work-up (including imaging), treatment (if applicable) and follow-up including adoption status and post-adoption performance. There are instances in which the adopted horse does not work as intended, and this will be addressed also.

Reference

1. Thomson PC, Hayek AR, Jones B, et al. Number, causes and destinations of horses leaving the Australian Thoroughbred and Standardbred racing industries. *Aust Vet J* 2014 Aug; 92(8):303-311.

Exploring Legal Pitfalls of the Pre-Purchase Exam

Kit Miller, DVM; Jeffrey Berk, VMD, MRCVS; Mike Meuser, Esq; and Mike Casey, Esq

Authors' addresses — 120 Nichols Road, Brewster, NY 10509 (Miller); PO Box 11067, Lexington, KY 40512-1067 (Berk); 271 West Short Street, Lexington, KY 40507 (Meuser); and 3151 Beaumont Centre Circle, Ste 200, Lexington, KY 40513 (Casey). Contact mail: jtberk5@aol.com

For sport horse practitioners, pre-purchase examinations are a particularly important service in which veterinarians play the role of clinician and advisor in the decision to purchase a particular horse. These transactions are frequently both financially and emotionally significant for the buyer, and the decisions are, in large measure, contingent on the veterinarian's clinical expertise and understanding of the specific discipline or industry for which the horse is intended. Pre-purchase examinations are an opportunity for clinicians to provide highly valued information that, in time, can help to develop and nurture a strong doctor-client relationship. Conversely, prepurchase examinations have the potential to make that bond more tenuous should the outcome, for whatever reason, be perceived as unsatisfactory. Pre-purchase examinations that result in unsatisfactory outcomes may have legal repercussions. It is from that perspective that we will be examining numerous case studies and their outcomes. There are numerous legal issues pertaining to pre-purchase examinations that will be discussed as we examine the case studies, including conflict of interest, confidentiality, scope of examination, professional negligence, fraud, breach of fiduciary duty, and administrative liability.

From a business perspective, a thorough pre-purchase examination can be a significant source of revenue provided the veterinarian is appropriately compensated for his or her time in performing the clinical examination, acquiring and interpreting the images, and communicating with clients. It is particularly important when performing pre-purchase examinations to have a complete understanding of the client's objectives in purchasing a horse. Horses may be purchased for pleasure, athletic endeavors, and investment purposes, and the client's goals in owning a particular horse should guide the nature and extent of the examination. Most of the pre-purchase examinations are performed on horses intended to compete at some level of athletic activity. In addition, many of the clients have a professional trainer. It is the responsibility of the trainer-not the veterinarian-to advise the purchaser on price and on the physical ability or suitability of the horse or its prospective owner and rider. These variables should have been discussed and agreed upon before the veterinarian becomes involved in the transaction, and the pre-purchase exam should be performed in an effort to establish whether the horse is physically capable of performing at the intended level of athletic activity. Pre-purchase examinations are frequently performed on horses that have already had extensive athletic careers and have, as a consequence, acquired some degree of wear and tear. An important and often difficult feature of prepurchase examinations is the ability of the veterinarian to form and convey an opinion as to whether the nature and extent of specific exam findings are likely to prevent a horse from continuing to perform at the intended level for an acceptable period of time. Being able to formulate such an opinion requires clinical experience, a thorough understanding of the discipline in which the horse will compete, and a complete understanding of the buyer's expectations. For example, a client may be willing to purchase an experienced equitation horse knowing full well that horse may have a prior injury or some degree of degenerative joint disease, because the horse is known to be safe and reliable and will be competitive at specific events. For such buyers, a horse's reliability and safety may be acceptable tradeoffs for durability, and it is important for veterinarians to have that understanding to offer effective and appropriate advice. There are a multitude of ways of performing the actual clinical examination. It is important for practitioners to develop their own routine that is thorough, repeatable, and appropriate for the horse's intended discipline or use.

The physical examination is the most important part of the prepurchase evaluation. This is especially the case in the examination of an older horse with a proven record of performance. Though there are no industry guidelines, the physical examination of a horse is relatively standard. It routinely includes an evaluation of the horse's health status, including its eyes, heart, and lungs. It may include routine bloodwork to further evaluate the horse's condition. The physical examination should include investigations specific to the intended purpose of the horse. In the case of a sport horse, careful evaluation of the musculoskeletal system, including palpation of the neck, back and distal limbs to assess the horse for signs of arthritis, trauma, or previous injury. In addition, the examiner should evaluate the horse for evidence of prior medical procedures, including surgeries such as colic, arthroscopy, or neurectomy. Though many colic surgery scars are easily identified by simple palpation, evidence of prior arthroscopy or neurectomy can be very obscure or nearly impossible to detect. In the case of a horse being purchased for breeding purposes, a thorough reproductive evaluation is appropriate and evaluation of the musculoskeletal system of much less importance.

The same is true for ancillary testing such as lab work and imaging. The extent of the radiographic evaluation should be appropriate for the horse's intended use. Additional modalities, such as survey ultrasounds and upper airway endoscopy, should be made available and performed based upon the results of the clinical examination and the clinician's opinion as to the relevance of the information to be acquired. In contrast to the Thoroughbred (TB) industry, the sale of show horses is completely without industry standard or guidelines. At public auctions, at which most TB racehorses are bought and sold, the scope of the pre-purchase examination, both the clinical exam as well as the radiographic evaluation, are regulated by the sales company, and all horses at a particular sale are subject to the same examination. In the show horse industry, no such standard exists. This is often a source of confusion for the buyers, most of whom are not industry professionals and often wholly reliant on the counsel of their representatives in the transaction, their trainer, and their veterinarian. In contrast to the public auction setting, the scope of the examination and the number and type of images acquired in evaluating a show horse for pre-purchase are determined by the buyer and his or her trainer and veterinarian.

The area of greatest variation is the number and type of diagnostic images acquired by the veterinarian when performing the show horse pre-purchase examination. While it is important for a buyer to be made aware of the available options, many show horse clients are unfamiliar with equine anatomy and have difficulty making these decisions. For many buyers, the decision regarding imaging is based upon cost (today's digital imaging is expensive,) and the recommendations of their advocates in the sale, the trainer, and the veterinarian. Potential problems arise when conditions are undiscovered at the time of the sale and become evident at a subsequent pre-purchase examination. For example, it is becoming increasingly commonplace for radiographs of a horse's neck and back to be included as survey images in a prepurchase evaluation. It is not, however, standard. The scenario has arisen, in which a veterinarian performed a pre-purchase examination on behalf of his or her client and acquired the images he or she felt appropriate. At a subsequent pre-purchase examination, a different veterinarian may elect to take additional images or perhaps image a part of the horse's anatomy, such as the neck or the back, omitted by the original examining veterinarian. Such additional images may reveal a finding that directly impacts the subsequent sale. This scenario happens frequently in the case of horses that are purchased in Europe to be resold in the U.S. The typical European prepurchase show horse examination includes fewer radiographs than in the U.S. Many veterinarians have experienced the scenario of a client purchasing a horse in Europe and being unable to sell the horse in the U.S. because of an imaging flaw or irregularity that went undiscovered on the original prepurchase examination. It is important to note that these conditions can significantly affect the horse's perceived value, whether or not they are of clinical significance. Veterinarians acquire different numbers and types of diagnostic images in their pre-purchase examinations, with a wide array of findings, and an equally wide range of professional opinions regarding the significance of many of these findings. The outcome of the pre-purchase examination is frequently contingent on the imaging findings, and the lack of consensus increases the incidence of conflicting veterinary opinions. It is a realistic scenario for a client to purchase a horse only to have that horse's perceived value diminish because of a radiograph or ultrasound finding that was not identified on their pre-purchase examination. The finding may be of no clinical relevance, but can be considered to increase risk, with the same effect on the horse's value.

Despite a veterinarian's best efforts, the pre-purchase examination is never comprehensive. To physically examine or image every single feature of a horse that is being considered for purchase would be virtually impossible, not to mention prohibitively expensive. As an example, while it is commonplace to radiograph the navicular bones in the front feet as part of a pre-purchase evaluation, it is far less common to xray the navicular bones of the hind feet. This is because clinical conditions affecting the navicular bones of the front feet are diagnosed far more frequently than in the hind. Though hindlimb navicular bone pathology does exist, it is relatively rare, and radiographs of the hindlimb navicular bones are usually omitted from the pre-purchase examination. The advent of portable digital radiography has enabled the equine practitioner to take diagnostic quality images of a horse's neck and back, and many, though not all practitioners, regularly include these images as part of their recommended prepurchase examination series.

The absence of any examination and imaging standard in the performance of the pre-purchase examination of a show horse puts the advisors to the horse buyer, the veterinarian and the buyer's agent, in jeopardy. Whether or not a show horse is purchased for the express purpose of resale, many buyers have hopes of recouping at least some portion of the horse's value at a point in time. As discussed, a show horse's value can be adversely affected by an abnormal finding on a pre-purchase examination by hampering the sale, or re-sale of the horse. Most show horse competitors are not industry professionals. Nevertheless, the investment in purchasing a show horse as well as the expense of maintaining and competing the horse can be considerable. It can be a very unwelcome surprise for a client to learn that there is an impediment to their recouping at least some portion of that investment.

The goal of all pre-purchase examinations should be to assess the horse's ability to meet the buyer's expectations in the intended discipline, ranging from pleasure use to breeding to athletic endeavor. The scope and focus of the pre-purchase examination should be to assess the horse's ability to perform the intended task. Because imaging is frequently one of the more costly line items in pre-purchase examinations, it is often useful to discuss options and cost estimates with buyers in advance. As with the rest of the examination, it is important to understand and meet the clients' expectations. Invariably, information arises that will be subject to the clinician's interpretation. Scars, radiographic abnormalities, and positive flexion tests are all clinical findings that veterinarians will be asked to interpret to best advise their clients. Potential difficulty lies in the lack of consensus amongst vets and trainers as to the significance of specific findings in predicting the outcomes. There are very few absolutes, and the veterinarian's opinion will likely be shaped over time by clinical experiences. If the veterinarian has uncertainty about specific findings, it is valuable to have resources to consult. Clinicians who perform pre-purchase examinations should be able to consider additional opinions when needed. These are often "mentor" veterinarians who are either employers or colleagues in the industry and are available for additional expertise or simple counsel. It is important to acknowledge that the summaries of most pre-purchase examinations will be the veterinarian's best estimate and that there is often some degree of uncertainty about specific findings. In these instances, it is helpful for practitioners to provide information about the relative risks associated with specific findings and the available remedies in the event of an unwanted or unanticipated outcome. Prepurchase examinations are challenging because they require practitioners to perform a thorough clinical examination and to interpret the findings in a concise and meaningful way. It is an opportunity to provide a valuable service to clients, both professional and amateur, provided the clinician has a thorough understanding of the specific athletic discipline and of the client's objectives. In addition, it is a valuable learning tool because the clinical exam and image findings can be referred to as an individual horse's career progresses.

I. CONCLUSION

Pre-purchase examinations by equine veterinarians play a valuable role in their ability to service clients who buy horses. There is subjectivity involved in the veterinary evaluation of the clinical exam findings as well as the imaging interpretations in a pre-purchase exam. The subjective nature of these evaluations and interpretations, in the absence of any examination or imaging standard and combined with the challenges of effective communication, can result in legal exposure for the veterinarian in cases where the outcome may be perceived as unsatisfactory by the client.

The scenarios in the presentation will illustrate various aspects of legal liability for equine veterinarians performing prepurchase examinations, including the following:

- Conflict of interest
- Confidentiality
- Scope of examination
- Professional negligence
- Fraud
- Breach of fiduciary duty
- Administrative liability