The Proceedings of the 2016 Equine Chapter Meeting at the ANZCVS Science Week

7 July - 9 July 2016
Gold Coast International Hotel
Gold Coast, Queensland, Australia
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The Equine Chapter would like to acknowledge the Scone Equine Group for sponsoring the ANZCVS Equine Membership Award.
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EFFECT OF TRAINING ON CARDIAC FUNCTION, UPPER RESPIRATORY TRACT AND MUSCLE DISORDERS

Sponsored by Austvet Endoscopy and Miatech Diagnostic Imaging Specialists
The use of heart rate and lactate analysis to assess fitness

David Evans
BVSc PhD
Adjunct Associate Professor, School of Animal and Veterinary Science - Charles Sturt University
Director, Evans Science Pty Ltd, www.evansscience.com.au

Regular analysis of results of fitness tests can address important questions. How has fitness changed with training, racing, or rest periods? Is the horse training regularly at intensities that are appropriate for the physiological demands of competition? How does the horse’s fitness compare with other horses? Could a history of poor performance be explained by inferior findings in a fitness test?

Fitness testing necessitates accurate measurement of velocity of the horse, coupled with physiological or other measurements during and/or after the exercise test. Until recently this objective was only been possible during treadmill exercise tests, which facilitate accurate prescriptions of duration and speeds of each step in the test, as well as precise timing of physiological measurements or blood collections. Significant correlations have been found between racing performance and both heart rates and blood lactate concentrations during and after treadmill exercise tests (Evans et al., 1993).

Fitness assessments with heart rate analysis typically study HRs during slow, medium and high speed exercise. Ideally, maximum heart rate (HRmax) should be measured to enable calculation of velocity (V) at which the horse achieves HRmax. VHRmax represents the velocity at which, despite an increase in velocity, there is no further significant increase in HR. It therefore estimates the speed at which any further increase in horse speed will need to rely much more on anaerobic ATP resynthesis. VHRmax varies greatly between untrained horses, and it increases with training in most horses. HRmax changes little in a 3-4 month training programme. Therefore the increased VHRmax due to training is mostly attributable to an improved cardiac stroke volume (SV) (Evans and Rose 1998).

Measurements of HR during fitness tests provide an estimate of maximum aerobic capacity. It is likely that events of more than 90 secs duration rely more on aerobic energy production than on anaerobic energy production. It is important to note that HR findings alone will have a limited capacity to predict future racing performance. Racing ability will be influenced by a horse’s
acceleration, its 400-600 metre sprint speed, and other factors not measured by HR assessments. It is also notable that myocardial performance during an individual race may be very different to cardiac function at lower speeds on a treadmill.

Accurate GPS systems now facilitate studies of the relationship between velocity and heart rate (HR) during field exercise. This technique has been used to describe changes in fitness with high speed training in two year old Thoroughbred racehorses (Vermeulen and Evans, 2006). Results have also been significantly correlated with past Thoroughbred racing performance (Gramkow and Evans, 2006). However, evaluation of HRs during racetrack exercise can be complicated by horse behaviour. Excitability, fear and anxiety can invalidate HR results. Results in all horses will be invalid in horses that “pull” during the gallop, or do not get an adequate warm up. HRs will also be influenced by track conditions.

Resting blood lactate concentration in the horse is approximately 1–1.5 mmol/L. At low exercise speeds (trot and slow canter) this value does not change greatly from the resting value. At moderate speeds lactate begins to accumulate in “fast twitch” muscle cells and diffuses into blood. Accumulation of lactate in blood occurs most quickly when the work speed is faster than that at which blood lactate is approximately 4 mmol/L. The exercise speed at which blood lactate is 4 mmol/L approximates the speed at onset of accumulation of blood lactate (OBLA). Accumulation of lactate at faster exercise speeds is associated with higher blood adrenaline concentrations and recruitment of higher percentages of fast twitch muscle fibres for energy production.

Many studies of horses trained on both treadmills and on racetracks consistently demonstrate that training results in lower blood lactate concentrations at the same work speed. The fitter horse is able to work at higher speeds without rapidly accumulating blood lactate. Measurements of $VLa_4$ also enable comparisons of relative stamina between horses. However, $VLa_4$ measurements have the disadvantage of requiring several blood collections during the treadmill exercise test. In a one-step treadmill exercise test, blood lactate concentration 3 minutes after a two minute gallop on a treadmill was correlated with past racing performance in thoroughbreds (Evans, Harris, and Snow, 1993). This approach has been successfully used in busy commercial horse training environments. However, considerable errors can occur if hand-held lactate analysers are used to assay lactate in equine whole blood collected during or after exercise tests. These errors are attributable to haematocrit values of greater than 50% (Evans and Golland, 1996).
Blood lactate measurements after field exercise are not advisable for routine assessments of fitness in horses. The fitness test is not sufficiently standardised, and small variations in speed or distance of the gallop can have large effects on the post-exercise blood lactate concentration (Davie and Evans, 2000).

References

Exercise and equitation effects on upper airway function

Samantha Franklin
BVSc, PhD, MRCVS, Dip ACVSMR
University of Adelaide

Since the advent of overground endoscopy a number of factors have been identified as influencing upper airway function. For the majority of horses, upper respiratory tract (URT) collapse only occurs, or is at its most severe during peak exercise. However there are occasions when URT collapse appears more severe at slower speeds or during the immediate recovery period. Other factors such as rider or driver interventions, tack modifications and excessive head and neck flexion may also induce or exacerbate dynamic airway collapse. It is important to note that many of these factors may occur concurrently, for example when pulling up at the end of the gallops the horse will slow and at the same time might show concurrent poll flexion and mouth opening, making it difficult to separate these factors.

Exercise effects:

Recent studies suggest that the type of exercise test that is undertaken may affect the ability to make a definitive diagnosis of URT collapse and hence it is important that exercise tests are appropriate and tailored specifically for the individual horse. For racehorses, it is particularly important that exercise tests are sufficiently strenuous to replicate racing conditions whereas, for sport horses, exercise tests should be sport-specific (Allen et al. 2011).

Dynamic airway collapse commonly occurs during strenuous exercise. Inspiratory airway pressures become more negative at higher speeds and hence the collapsing forces to which the upper airway dilator muscles are exposed increase as exercise intensity increases. Fatigue of the URT musculature may also be involved and it is acknowledged that continuation of exercise to the point of fatigue is often necessary for URT obstructions to become evident in some horses.

In some cases, URT obstruction may be seen with changes in exercise intensity. In particular, nasopharyngeal collapse (incl. palatal instability, dorsal displacement of the soft palate, pharyngeal wall collapse) may be observed as the horse is pulled up following strenuous exercise. The reason for this is unclear and may be related to changes in upper airway function, such as changes in breathing strategy or relaxation of the pharyngeal musculature, or related to other factors such as changes induced by the rider or driver. The significance of URT collapse that occurs as the horse is slowing is
unclear. However, Priest et al. (2012) reported that horses that showed dorsal displacement of the soft palate (DDSP) after racing had slower times than unaffected horses.

**Effect of head and neck flexion:**

In sport horses, dynamic URT collapse occurs at lower exercise intensities than in racehorses. In these horses a number of other factors may play a role. In particular head and neck position appears to greatly affect URT function. Van Erck, (2011) examined 129 sport horses and reported that induction of URT obstruction or exacerbation of collapse was associated with head and neck flexion in 90% of horses. A number of studies have investigated the changes that occur in the upper airways as a result of alterations in head and neck position. Petsche et al. (1995) showed that head and neck flexion results in increased inspiratory impedance during exercise. It was proposed that this occurs due to increased compliance of the airway walls, which allows the soft tissues to bulge and consequently reduce the pharyngeal diameter. This has been confirmed by radiographic and endoscopic studies, which show that head and neck flexion causes a reduction in the dorsoventral diameter of the nasopharynx and changes its cross-sectional shape, in resting horses (Cehak et al. 2010). In susceptible horses the increased compliance of the pharyngeal walls may lead to further dynamic collapse during exercise.

Dynamic nasopharyngeal collapse is the most common finding associated with excessive head and neck flexion. However, cases of dynamic laryngeal collapse (including uni- and bi-lateral arytenoid and vocal fold collapse, axial deviation of the aryepiglottal folds and epiglottic retroversion) have also been observed (Allen et al, 2011).

**Factors associated with the bit & bridle:**

Factors associated with the bit (including: mouth opening, tongue withdrawal, oral pain and excessive salivation) have been suggested to play a role in the development of palatal dysfunction (Cook, 2002). However, at present, there is a lack of evidence to support these claims and whether or not the use of a “bitless bridle” might reduce the incidence of palatal dysfunction.
Opening of the mouth has been suggested to compromise the oro-palatal seal and contribute to palatal instability. As a result, the use of a crossed noseband is frequently recommended in an attempt to prevent this. Again, this theory requires further investigation.

Tongue retraction has, for many years, been implicated in the development of palatal dysfunction. The widespread use of the tongue-tie aims to prevent this caudal retraction and is also thought to pull the hyoid apparatus and larynx forward. However, the evidence regarding the efficacy of the tongue-tie is conflicting. Only one small study has attempted to perform endoscopy with and without the tongue tie in place and, in that study, DDSP was observed in 4 out of 6 horses exercise with a tongue tie in place (Franklin et al. 2002).

Rider & driver interventions:

More recently, rider and driver interactions have been implicated in the development of URT collapse. Van Erck (2011) reported that the use of spurs, changes of gait or short turns had a significant affect on the stability and morphology of the upper airways. It was suggested that these interventions interrupt the normal rhythm of ventilation and hence may exacerbate any functional instability of the airways. Priest et al (2012) also reported that driver interactions might be important in the development of URT collapse in Standardbred racehorses.

In conclusion, it is clear that a number of external factors may be implicated in the development of dynamic airway collapse in the horse. It is important to carefully observe the horse during overground endoscopy in order to relate events occurring within the URT to external factors.

References:

Diagnosis and management of muscle disorders affecting performance horses

Joan Norton
VMD DACVIM

University of Queensland, School of Veterinary Science, Gatton, QLD.

Muscle disorders in horses, whether acute or subclinical can have a significant impact on the performance of an elite athlete. Recognition, diagnosis and proper management of these cases are paramount to the successful athletic career of these patients. The first portion of this talk will cover the common, an uncommon myopathies and neuromuscular disorders that we encounter. These include polysaccharide storage myopathy (PSSM) and recurrent equine rhabdomyolysis along with idiopathic and Australian stringhalt, shivers and hyperkalemic periodic paralysis (HYPP) and atypical myopathy. The clinical signs and pathophysiology will be discussed and appropriate biochemical and genetic diagnostics will be covered. The different locations and technique for obtaining muscle biopsies will be demonstrated. The second portion of the talk will centre on the treatment of both acute episodes of rhabdomyolysis as well as long term management of subclinical myopathies. Management of the pain, inflammation and secondary renal insults as a result of acute myopathy involve analgesia, muscle relaxants and ensuring adequate hydration and diuresis. Long term management of horses with diagnosed or suspected myopathies include high fat and low carbohydrate diets along with a strict and consistent exercise regime.
Notes
Hypoxic training in Thoroughbred Horses

Allan Davie, Li Wen, Andrew Cust, Rosalind Beavers, Tom Fyfe and Shi Zhou

Southern Cross University, School of Health and Human Sciences, Lismore, NSW, Australia.
Tianjin University of Sports, Tianjin Key Laboratory of Exercise Physiology and Sports Medicine, China.
Ballarat Equine Veterinary Centre, Ballarat, Victoria, Australia.
Pulford Air and Gas, Sydney, NSW Australia.

The quest for effective training methods that result in optimal performance outcomes is a continuing area of interest in both human and equine fields and in accordance with this, hypoxic training methods have been the focus of considerable scientific investigation within the human field for many years.

Hypoxic training refers to training in an environment with reduced oxygen concentration at normal barometric pressure. The fundamental concept behind hypoxic training is that the concentration of oxygen in the inspired air is reduced from 20.9% to varying levels. As the energy cost of work does not change, then to do the same work under hypoxic conditions, the body needs to adapt to compensate for the reduced availability of oxygen. In the acute stages of exposure this is achieved by breathing faster to increase availability of oxygen and increasing heart rate to speed up the delivery to muscles.

At the molecular level, intermittent training in hypoxia in human athletes has been shown to result in an up-regulation of the regulatory subunit of hypoxia-inducible factor-1 (HIF-1α) (Hoppeler Klossner Vogt 2008; Zoll Ponsot Dufour et al. 2006). Further as a consequence of this up-regulation of HIF-1α, the level of mRNAs for myoglobin, vascular endothelial growth factor, and glycolytic enzymes such as phosphofructokinase, together with mitochondrial and capillary densities, increased in a hypoxia-dependent manner (Zoll Ponsot Dufour et al. 2006).

Since early 2000 there has been a growth in studies looking at the effects of various types of altitude training, such as living high training low, living low training high, and living high training high, on metabolic, biochemical and mRNA expression adaptations. In addition to the potential benefits in endurance performance from hypoxic training, research has also suggested benefits to anaerobic exercise performance, via improvements in muscle buffering capacity (Gore Hahn Aughey et al. 2001) and glycolytic enzyme activity (Katayama Sato Matsuo et al. 2004).
Traditionally the hypoxic state was achieved by taking athletes to altitude. However, purpose built chambers in which the percentage of oxygen can be lowered thereby exposing them to a hypoxic environment similar to that experienced at altitude, but at normal barometric pressure. The application of the concept of hypoxic training to the Thoroughbred horse is new and the availability of hypoxic chambers has made it possible to conduct well-controlled trials on horses. The results of our preliminary work have shown that training in hypoxia did provide additional changes in mRNA expression in comparison to normal training.

References:

RESEARCH SESSION

Sponsored by International Animal Health Products and The University of Queensland
Carpal injury in Thoroughbred racehorses: a comparison of conventional radiography and CT imaging

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The carpus is anatomically complex and even when a full series of radiographs are obtained it can be difficult to evaluate the presence and extent of injury since the carpal bones overlap considerably. Computed tomography (CT) has become available and offers the clear advantage that regions of interest can be evaluated without superimposition of structures. Furthermore, CT imaging is able to detect a smaller decrease in bone mineral density than conventional radiographs, meaning that more subtle bone lesions may be detected.

The aim of this study was to compare the diagnostic value of conventional radiography to that of CT in horses with either 1) third carpal bone slab fracture, or 2) lameness localised to the mid carpal joint and inconclusive radiographic findings. We hypothesised that conventional radiographs often fail to demonstrate the extent of bone pathology in horses with carpal lameness.

To date, we have compared the radiographs and CT images from 18 age matched control horses, 50 horses with carpal slab fractures, and 16 horses with carpal lameness and inconclusive radiographic findings. In fracture cases, CT revealed a range of pathology within C3 not evident on radiographs including comminution, fissure lines, and vertical or Y-shaped lucencies, subchondral bone lysis and complete fracture when incomplete fracture was suspected. In addition to C3 fracture, CT commonly detected lesions elsewhere in the carpus and in the contralateral carpus, some of which were not evident on radiographs: dorsal chip fractures, palmar fragments, incomplete slab fracture and lytic defects. Of the cases with carpal lameness unexplained by radiographic findings, CT enabled diagnosis of a range of lesions including subchondral bone lysis, deep vertical linear or Y-shaped lucencies, small incomplete fractures of C3, and chip fractures in atypical locations within the carpus.

CT imaging is of particular value in the evaluation of horses with MCJ lameness and inconclusive radiographic findings, and in cases of C3 slab fracture. Radiographs often underestimate the extent of bone injury present in horses with C3 slab fracture. In addition, in horses with C3 slab fracture, CT imaging of the other carpus is warranted as bilateral bone injury is not uncommon and often goes unrecognised on routine radiographs. CT can be performed relatively quickly under general
anaesthesia (20-40 minutes additional anaesthesia time), immediately before arthroscopic surgery. Information obtained from CT imaging is of value in surgical planning and contributes to prognostic information.
Thymic hyperplasia in an Arabian colt following chronic peri-oesophageal abscessation and resultant cardiac compression

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Abstract:

True thymic hyperplasia has been reported sporadically in the human literature as an immunological rebound phenomenon following immunosuppressive treatment or disease. There are limited accounts in domestic species, mainly following vaccination, and thymic hyperplasia has not been a recognised condition in the horse to date. This report details a case of true thymic hyperplasia in a 10 week old Arabian colt diagnosed on histopathology from Tru-cut biopsy samples. The colt developed pulmonary stenosis caused by compression from a suspected cranial mediastinal mass following a month long history of hospitalisation for treatment of traumatic peri-oesophageal abscessation and fistulation. Diagnostic imaging of the cranial mediastinum was indicative of a thymic mass, and histopathology confirmed the mass was normal thymic tissue. The colt was treated with a tapering dose of corticosteroids which led to involution of the hyperplastic tissue and removed compression on the pulmonary artery. Thymic hyperplasia could be an unrecognised physiological syndrome in horses undergoing chronic inflammation, which was only identified in this case due to its mass effect on adjacent mediastinal structures.
The variability and influence of animal and environmental factors on exhaled breath condensate hydrogen peroxide and leukotriene B₄ in horses.

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Background:
Inflammatory airway disease (IAD) is a common cause of poor performance,¹ coughing, and abnormal pulmonary function in horses.² Conventional diagnostic methods for IAD (e.g. endoscopy, tracheal aspirate [TA], broncho-alveolar lavage [BAL]) are invasive, do not represent pulmonary function and are not suitable for frequent disease monitoring. Analysis of biomarkers in exhaled breath condensate (EBC) is used in human medicine for the assessment of the lower airways, and such methods may represent advances in the non-invasive diagnosis and monitoring of IAD in horses. Hydrogen peroxide (H₂O₂) and Leukotriene B₄ (LTB₄) are useful EBC biomarkers for the assessment of several lung conditions of humans, including asthma.³⁴ There are few published reports of EBC biomarker variability and validation for the assessment of pulmonary disease in horses.⁵ The objectives of this study were to assess the variability and influences of animal, environmental and disease factors on EBC H₂O₂ and LTB₄.

Materials & Methods:
Ten and 20 horses were used for investigation of H₂O₂ and LTB₄, respectively. From each horse, EBC was collected at 8am, 12pm and 4pm on day 1 and at 12pm on the following 2 days. A randomised crossover design was used to assess the influence of environmental factors on H₂O₂ and LTB₄. Collection time was standardised to 15 min and ambient temperature and relative humidity were recorded. All EBC samples were stored at -80°C until analysis. After EBC collection on day 3, each horse underwent respiratory tract endoscopy, TA and BAL. Six horses in the H₂O₂ group and 11 in the LTB₄ group were diagnosed with IAD by BALF cytology.² LTB₄ concentrations were determined using mass-spectrometry⁴ and H₂O₂ concentrations using flow injection analysis with fluorescence detection.⁶

Data was analysed using linear mixed models and significance was set at P<0.05
Results:
There was minimal within- and between-day variation in LTB4 within and between horses. LTB4 was not influenced by environmental, animal or disease factors. Large within- and between-day variation in H2O2 within each horse and large variability between horses was present. There were significant relationships between ambient temperature (P<0.001), time of EBC collection (P<0.001) and feeding within 1 hour of EBC collection (P=0.005) with H2O2 concentration. When accounting for the aforementioned relationships, there were no significant differences in H2O2 concentration within and between animals or between horses with and without IAD.

Conclusion and Clinical Importance:
While EBC LTB4 concentration is stable and displays minimal variation within each animal, it does not appear to have discriminatory capabilities for detection of IAD. EBC H2O2 concentration is significantly associated by ambient temperature, time of EBC collection and feeding status however, IAD did not evoke biological nor statistical significant differences. As such, neither parameter appears to represent a useful biomarker for detection of IAD.

References:
Cardiac Troponin levels in a pony with Avocado toxicity

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Introduction

Ingestion of the Guatemalan varieties of avocado plant in equids causes cardiomyopathy. There are few case studies in the literature detailing the clinical course of toxicity, and associated Cardiac Troponin I levels have not been documented.

Case History

A one year old female miniature horse was initially examined for colic. At the time of examination, she had evidence of distributive shock, pyrexia, hypoproteinaemia (TP 33g/L), and an irregular tachyarrhythmia with variable pulse strength. History revealed exposure and possible ingestion of a non-fruiting Hass avocado tree (*Persea americana var guatemalan*), which was removed on day two. Further diagnostics were not undertaken until day six following Hendra Virus infection exclusion via PCR on day five. Hospital admission and intensive care treatment also occurred on day six. The arrhythmia was undetectable by day three. Cardiac Troponin I was sampled on days 6, 49, 70, 98 and 154.

Clinical Outcome

Treatment included intravenous fluids, anti-inflammatories, parental nutrition and benazepril. Hospital discharge occurred on day nine with an intermittent tachycardia, which continued until day 98. Elevations in Cardiac Troponin I levels were evident at day 6 (0.172ug/L), continued till day 49 (15.2ug/L) and normalised by day 70 (0.010026ug/L).

Relevance to Clinical Equine Practice

This case documents the previously unreported duration of time and extent of changes in Cardiac Troponin I levels that may occur with ingested avocado plant induced cardiomyopathy.
Equine herpesviruses (EHVs) are common respiratory pathogens in horses and other equids, which are responsible for serious health, welfare and financial consequences worldwide. The clinical importance of alphaherpesviruses is well established however the consequences of gammaherpesvirus (GHV) infection remain undetermined given their frequent detection in clinically normal horses. Recent studies have indicated an association with GHVs infection in horses with several respiratory conditions including inflammatory airway disease and equine multinodular pulmonary fibrosis. Both of these conditions reflect a T-helper (Th) type 2 response rather than an (anticipated) Th-1 cytokine mediated antiviral response.

This study aimed to determine the prevalence, and any association between equine respiratory herpesviruses EHV1, -2, -4 and -5 infection in horses with and without clinical signs of respiratory disease. Cases were those horses that were presented for exclusion of equine influenza virus (EIV) that exhibited signs of respiratory disease including pyrexia, nasal discharge, and/or coughing during the 2007 Australian EIV outbreak in Victoria, which remained free of EIV and included clinically normal horses that had been screened for regulatory purposes. Samples were placed in viral transport media and subsequently stored at -80°C. Quantitative PCR was performed on nasal swabs using primers specific for EHV1, -4, -2 and -5.

The odds of EHV-5 positive horses demonstrating clinical signs of respiratory disease were twice that of EHV-5 negative horses (OR 1.99, 95% CI 1.25 to 3.16). Horses infected with EHV-2 made up a smaller proportion in the diseased group (18/120, 15.0%) compared to those without disease (61/249, 24.5%, P=0.042). The odds of disease in EHV-2 positive horses were approximately half that in EHV-2 negative horses (OR 0.54, 95% CI 0.31 to 0.97).

Fifty of the 83 horses (60.2%) shedding EHV-2 were also shedding EHV5, however there was no greater likelihood of EHV5 detection in these horses compared to those without detectable EHV-2 (199/324, 61.4%; P=0.90).

The dual infected horses were no more likely to exhibit signs of disease (14/46, 30.4%) than those shedding EHV-2 alone (4/33, 12.1%; P=0.063) or EHV-5 alone (71/176, 40.3%; P=0.24).
Logistic regression showed no interaction between EHV-2 and -5 shedding on clinical signs of respiratory disease ($P = 0.41$).

No quantitative difference between mean loads of EHV shedding between diseased and non-diseased horses was able to be detected.

The clinical significance of respiratory gammaherpesvirus infections in horses remains yet to be determined, however this survey adds to the mounting body of evidence over the last decade incriminating EHV-5 with equine respiratory disease processes.
Overground endoscopy in 311 Thoroughbred racehorses: findings and correlation to resting laryngeal function

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Objective:
To compare laryngeal endoscopy findings at rest, immediately prior to overground endoscopy (OGE) findings.

Methods:
Records of signalment, presence or absence of respiratory noise and examination findings for horses undergoing OGE at Randwick Equine Centre between 2010 and 2014 were reviewed. Video recordings from OGE were reviewed and abnormal laryngo-pharyngeal function recorded of horses during exercising examinations.

Results:
Of the total examinations, 311 were reviewed. One or more dynamic upper airway obstructions (DUAO) were found in 249/311 horses. 17/92 horses ≥ 4 years old compared to 7/89 horses ≤ 2 years old were found to have an uncommon DUAO. No other obstruction category was statistically correlated to age. Males (colts and geldings) were found to have arytenoid cartilage collapse (ACC) in 123/210 cases in conjunction or separately with vocal fold collapse (VFC) in 111/210 cases. Females were found to have intermittent dorsal displacement of the soft palate (DDSP) in 25/101 cases. Resting laryngeal function grade 4 (Lane1) was found in 121/311 of the study population and 92/210 of males. Association was found between horses with lesser standing arytenoid abduction to dynamic ACC and greater standing arytenoid abduction ability to DDSP. Abnormal respiratory noise was positively associated to the presence of DUAO.

Conclusions:
Multiple DUAO, along with abnormal exercising respiratory noise was found to be extremely common. The specific DUAO was positively correlated with age and gender. Resting arytenoid function assessment was found to be correlated with different DUAO.
Acknowledgements:

The authors would like to thank the veterinarians, owners and trainers that made this study possible. JA Davison, JM Lumsden and BJ Ahern contributed to the study design, data collection, data analysis and interpretation and manuscript preparation. RC Boston contributed to data analysis and interpretation. J Leutton, I Bayliss, C Elliott, V Locke, R Perez, R Salz and N Pagan contributed to data collection.
Temporal variation in gene expression, histopathology and biomechanical properties in an ovine model of flexor tendinopathy

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Introduction:

Flexor tendinopathy is a common pathological condition in humans and animals. Despite extensive research, the pathophysiology of tendon injury and the mechanisms involved in tendon healing are still poorly understood. While often considered a 'localised' injury, recent evidence indicates that in the short term (6 weeks post-injury) pathological changes are distributed widely throughout the tendon, remote from the lesion itself. This widespread pathology may predispose these tendons to reinjury and poor patient outcomes. In cases of flexor tendinopathy, whether these widespread changes persist throughout the healing process is unknown. This aim of this study was to document the gene expression, histopathological and biomechanical changes that occur in an ovine flexor tendinopathy model during the 16 week period following injury.

Materials and Methods:

Twenty-one Merino wethers were divided into three groups (n = 7). Eighteen sheep underwent a partial transection of the superficial digital flexor tendon in the hindlimb while 1 sheep in each group underwent a sham operation without transection. The opposite superficial digital flexor tendon was used as a non-operated control in each sheep. The 7 sheep in each group were euthanased at 8, 12 and 16 weeks after surgery, respectively, and the tendons harvested and regionally sampled for gene expression, histologic and biomechanical analysis.

Results:

Mixed regression modelling was carried out to determine the effects of surgery, time and spatial position on each outcome (gene expression histopathology, and biomechanical modulus of elasticity in compression). Pairwise and group comparisons were also created between cut and control tendons, and within each group at each time point. Significance was set at P < 0.05.

Overall, surgical injury was associated with a decrease in gene expression for aggrecan, decorin, fibromodulin, the tissue inhibitors of metalloproteinases (TIMPS 1,2 and 3), and collagen I and collagen II (P < 0.05). There were increases in gene expression for collagen III, lumican and matrix metalloproteinase 13 (MMP13) (P < 0.05). Over time there was a decrease in the gene expression of collagen III and MMP13, but all three elevated genes (collagen III, MMP13 and lumican) remained
regionally high in comparison to controls for the duration of the study (P < 0.05) Time had no effect on the expression of decorin, but decorin expression levels adjacent to the lesion remained low for the duration of the study (P<0.05). An increase in TIMP3 was observed with time (P < 0.05). There were regional effects, with biglycan, lumican, ADAMTS5, MMP2, MMP13 and collagen III showing decreased gene expression with progressive distance from the lesion site (P < 0.05). Conversely, the expression of collagen I was shown to increase in the regions remote from the lesion site (P < 0.05). Histologically, operated tendons had higher pathology scores than controls, but this difference was more prominent around the injured region (P < 0.05). A ‘chondroid’ phenotype was observed with increased cellular rounding and marked proteoglycan accumulation. The histologic appearance of the tendon did improve with time, but pathological changes in cellularity, vascularity, proteoglycan accumulation and collagen fibre alignment were observed during the study period and did not improve with increasing time post-injury (P < 0.05). Biomechanically, surgical injury had a significant effect on tendon stiffness (in compression) (P<0.05), with transected tendon being less stiff than controls but this effect was weak overall and only prominent at 8 weeks post-transection.

**Conclusions and Clinical Relevance:**

The study provides an improved understanding of the tendon environment post-injury. The pattern presented is one of an early ‘peak’ of pathology, with widespread chondroid changes throughout the tendon, that, over time, progressively shows some improvement, characterised by localisation of the changes associated with the histology and gene expression abnormalities around the region of injury. Despite a gradual reduction, localised collagen III levels remained high for the duration of the study and are likely to reflect the production of tendon tissue with suboptimal biomechanical properties. The presence of regionally low decorin with persistently high lumican and MMP13 expression in comparison to control tendons is of interest and may provide targets for novel therapies in the post-acute period. Further studies evaluating the long-term behaviour of the tendon post-injury (6-12 months or longer) are warranted to provide additional insights into the process of tendon healing and reconstitution.
Relationship between reference point indentation of the calcified metacarpal articular surface, training history and subchondral bone microstructure of Thoroughbred racehorses

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Introduction: Palmar/plantar osteochondral disease (POD) and third metacarpal/-tarsal condylar fractures are considered fatigue injuries of subchondral bone (SCB) and calcified cartilage due to repetitive high loads. In combination with adaptive changes in SCB in response to race training, the accumulation of SCB fatigue is likely to result in changes of joint surface mechanical properties.

Aim: To determine the spatial relationship and correlation of calcified articular surface biomechanical properties with microstructure and training history in the distal palmar metacarpal condyle of Thoroughbred racehorses.

Methods: Third metacarpal condyles were examined from 31 Thoroughbred horses, including untrained horses and horses in or resting from race training, with micro-computed tomography (micro-CT; SkyScan 1172). Hyaline cartilage was removed and reference point indentation (RPI; BioDent™ Hfc) mechanical testing of the calcified articular surface was performed. The association between indentation distance increase (IDI), an inverse RPI measure of toughness and micro-CT and training variables were assessed using a mixed-effects general linear model. Statistical significance was set at P<0.05.

Results: Untrained horses had higher IDI than horses that had commenced training (P<0.0005). Death as a result of musculoskeletal fatigue injury was associated with higher IDI (P=0.016). The micro-CT variables connectivity density and trabecular pattern factor were positively (P=0.001) and negatively (P=0.001) correlated with IDI respectively.

Conclusion: Commencement of race training is associated with increased toughness of the calcified articular surface in horses. Horses suffering catastrophic musculoskeletal injury have reduced metacarpophalangeal joint calcified articular surface toughness consistent with accumulation of bone fatigue more widely. Measures of SCB connectivity may be more important determinants of resistance to failure of the calcified articular surface than the volume of SCB.
Acknowledgements: Funded in part by a University of Melbourne Veterinary Hospital research grant and Racing Victoria Limited.
Comparing the effect of generic honey and two different grades of Manuka honey on the healing of equine distal limb wounds


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Introduction

Wounds on the distal limb of horses are common and often involve extensive tissue avulsion and contamination that preclude primary closure and necessitate healing by second intention.\(^1\) Topical wound medications have been used to enhance second intention healing in equine distal limb wounds with varying success.\(^2,3\) Honey derived from the Manuka bush (\textit{Leptospermum scoparium}) is known to have antibacterial,\(^4\) and immunomodulatory effects.\(^5\) Recent studies using a surgical wound healing model have shown beneficial effects of UMF20 Manuka honey on the healing of equine distal limb wounds.\(^6,7\) This study was designed to compare the effects of two different grades of Manuka honey (UMF20 and UMF5) with a commercially available, generic multi-floral honey on second intention wound healing in the distal limb of horses.

Materials and methods

Two full thickness skin wounds (2.5 x 2.5 cm) were created on the dorsomedial aspect of each metatarsus in 8 Standardbred horses. Wounds were bandaged overnight and then photographed on day 1 before treating each wound with one of four treatments; UMF20 Manuka honey, UMF5 Manuka honey, generic multi-floral honey and untreated control. The bandages were changed daily and the treatment applied for 12 days, after which treatment was stopped, bandages were removed, and the wounds were left open to heal. The wounds were photographed and the wound area calculated on day 1, then weekly until day 42. Time to complete healing was recorded. Overall wound healing rate (cm\(^2\)/day) was determined by dividing the wound area on day 1 by the total days to complete healing.

Results

The mean area of all wounds on day 1 was not different. During the 42 days following wound creation, the mean wound area was only different on day 21 where wounds treated with UMF 20 Manuka honey were smaller than wounds treated with UMF 5 (p=0.031). All other comparisons were not statistically significant. The overall healing rate was not different between treatment groups. However, wounds treated with UMF20 Manuka honey healed faster (90.78 days) than
generic honey (100.30 days; p=0.02) and untreated controls (101.36, p=0.01). There were no other differences.

Conclusions

Treatment of wounds with UMF20 Manuka honey reduced overall wound healing time compared with wounds treated with generic multi-floral honey and untreated controls.

References

Preliminary investigation into oral esomeprazole in the horse

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Introduction:
Esomeprazole has potential for treatment of equine gastric ulcer syndrome (EGUS). The objective of this study was to investigate the pharmacodynamics of oral esomeprazole in horses.

Materials and methods:
Intra-gastric pH was measured in two regions on six adult horses fitted with percutaneous gastrotomy (PEG) tubes. Median intra-day gastric pH (medpH) and the percentage of time gastric pH was greater than 4 (%tpH>4) were measured for a 23 hour period each day. Day 0 was considered baseline. A stabilised esomeprazole formulation was administered on days 1-5. Two dose rates (0.5 and 2.0 mg/kg/d) were studied under two dietary conditions (free choice hay or high grain/low fibre (HG/LF)) in a cross-over design. Differences between the groups were assessed using generalised estimating equations. MedpH and %t>pH4 on day 5 were compared to day 0 using paired t-tests.

Results:
The %tpH>4 was higher on day 5 versus day 0 in both regions on the HG/LF diet at both doses and on the hay diet at 2 mg/kg/d (p<0.015). MedpH was higher on day 5 versus day 0 in both regions on the HG/LF diet at 2 mg/kg/d and at region 1 only on the hay diet at 2 mg/kg/d (p<0.002). There was an effect of diet and dose on %tpH>4 and medpH (p<0.001) in region 1. In region 2 there was only an effect of dose on %tpH>4 and medpH on the HG/LF diet (p<0.019).

Relevance to clinical equine practice:
Esomeprazole warrants further investigation as an alternative treatment for EGUS.
SUBCHONDRAL BONE INJURY

Sponsored by International Animal Health Products and The University of Queensland
Cutting edge review of subchondral bone injury

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Subchondral bone injury is of major importance for athletic horses. A survey of new cases admitted to a large UK referral hospital found that 45% involved subchondral bone pathology.

In general when discussing subchondral bone, it is the calcified cartilage, the subchondral bone plate and the underlying trabecular bone that is referred to. However, in the athletic horse the demarcation between the subchondral plate and trabecular bone at sites of high load becomes less clear. This is because subchondral bone adapts to race training by increased subchondral plate thickness, thickening of trabeculae and filling of trabecular spaces. It has been proposed that this densification increases the stiffness of the bone but investigations of subchondral bone material properties show the mechanical properties are complex.

Subchondral bone injury is characterised by microcracks at the calcified cartilage articular surface which propagate into the subchondral bone plate. Focal bone resorption is accompanied by surrounding extension of densification with subsequent collapse of the articular cartilage into the subchondral bone resulting in loss of joint surface congruity.

Epidemiological data on risk factors for subchondral bone injury in racehorses is complex and contradictory, however accumulation of high speed work over a career and rapid accumulation of high speed work appear to be important contributors.

Imaging of subchondral bone is challenging given its high density and the overlaying of surrounding bones. Scintigraphy is highly sensitive for subchondral bone injury but does not give accurate information on its severity and therefore the prognosis. Three dimensional imaging such as CT and MRI provide the most information about the subchondral bone but experience with both these advanced modalities have revealed some limitations.
The effects of exercise related to catastrophic injuries in Thoroughbred racehorses

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Catastrophic injuries and their corresponding pre-fracture pathologies are a major cause of wastage in Thoroughbred racehorses. Pre-existing pre-fracture pathology is recognised in multiple catastrophic fractures: proximal phalanx, metacarpus/tarsus, proximal sesamoids, carpus, humerus, scapular, tibia, pelvis and vertebrae. Depending on the anatomical location, the following pathologies can be identified: microfracture, cortical or subchondral bone resorption, subchondral bone necrosis or sclerosis, and periosteal or endosteal callus formation.

Bone is a dynamic structure that adapts to the strains placed on it. Exercise regimes are one of the many factors that can alter these strains and subsequent bone adaption. Ideally, this bone adaption results in a structure that facilitates racing and training at high-speed. There is a delicate balance between accumulated microdamage and its repair. The ability to repair the microdamage is related to both the rate of accumulation of damage within bone tissue and the rate of repair of microdamaged bone tissue (1). Consequently, both the exercise event that initiated damage and the exercise events during the bone tissue repair period are likely to play a role in development of complete fractures. The relationships between the accumulation of exercise, exercise intensity, and propensity for fracture are probably complex because in some scenarios, remodeling may also be inhibited by a high-strain environment (2). Thus, there may be optimal exercise strategies that induce strains that will induce bone adaptation and prevent excessive bone resorption and degradation of material properties (3).

Epidemiological studies focusing on exercise are largely biased by population (United States, UK or Australia), population bias (post-mortem or imaging diagnosis), anatomical location (which can limit study power) and the exercise intensity that is analysed. Most Californian studies focus on the retrospective analysis of recorded high-speed events (races or workouts) associated with their comprehensive post-mortem database of catastrophic injuries (4). However, UK prospective studies have indicated the importance of lower intensity exercise has on fracture incidence (5). The complexity of exercise intensity is demonstrated by high-speed exercise history studies that have indicated that the greater accumulation of high-speed exercise in defined periods of time may be protective (6), whereas other studies have observed an increase in the risk of musculoskeletal fatality (7). In a study of catastrophic scapular fractures (4), both circumstances were found to be
pertinent to catastrophic scapular occurrence, when horses were divided into subsets with the inclusion or exclusion of horses with >10 high speed exercise events without a lay-up. Comparisons in this study between racehorse breeds (TB and QH, which race and exercise very different distances) provide evidence to support the theory that timing of exercise events is important. Furthermore, periods of inactivity and lay-ups have also been linked to some fracture sites (3, 4).

The identification of exercise risk factors associated with different catastrophic fracture sites should help guide training regimes and to identify individual at risk horses. Identification of these at risk horses would allow the use of advanced imaging diagnostics or, to allow racing regulators to modify the horses training regime (ie. spell) to reduce catastrophic fracture fatality rates.

References

Subchondral bone microdamage accumulation in the distal metacarpus of Thoroughbred racehorses

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Introduction: Microdamage accumulation leads to subchondral bone injury and/or fracture in racehorses and an understanding of this process is essential for developing strategies for injury prevention. We aimed to quantify subchondral bone microdamage in the subchondral bone of the third metacarpal bone of Thoroughbred racehorses at different stages of the training cycle.

Methods: Metacarpal bones from 46 racing Thoroughbred horses were examined with micro computed tomography (µCT) to detect calcified microfractures, and light microscopy to quantify bulk stained microcracks. Racing and training histories were obtained for comparison with microdamage data.

Results: Subchondral bone damage was observed in all bones with at least one method. Microcrack density was higher in association with age ($P<$0.025), greater duration of the current training period at the time of sampling ($P=$0.037), and BV/TV in the parasagittal groove. Calcified microcracks in the parasagittal groove were only associated with apparent bone mineral density across the whole condyle ($P=0.019$).

Conclusions: Fatigue damage in the distal cannon subchondral bone is highly prevalent in Thoroughbred racehorses and appears to accumulate throughout a racing career and during each individual training period in many horses.

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Notes
Computed tomographic findings of carpal pathology prior to carpal arthroscopy

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Computed tomography’s rapid image acquisition rate and ability to provide multi-planar images that provide high detail bone morphology, lends itself to being a very useful diagnostic modality prior to carpal arthroscopy under the same general anaesthesia. CT prior to arthroscopy has been utilized at the University of Melbourne Veterinary Clinical Centre on cases with lameness localized to the mid-carpal joint that have: clinical signs that are more severe than which the radiographs would typically indicate, or, to aid surgical technique or fixation. CT has added 20-40 minutes to the total anaesthetic time. Image review is performed whilst the horse is being positioned on the surgery table and aseptically prepared. CT has characterized subchondral pathology, fragments and fracture configurations that were either not appreciated or ill-defined on radiographs. Intra-articular contrast enhancement or vascular contrast enhancement techniques have not been utilized, thus subchondral defects highlighted on CT correlate to overlying cartilage pathology identified during arthroscopy. However, CT is unable to identify cartilage wear lines or intra-articular ligament tears that are identified on arthroscopy. CT findings give the surgeon confidence in debriding cartilage erosions and degenerate bone. CT has been useful in determining incomplete fracture line morphology that has been used to determine the feasibility, landmarks, risks and potential success of utilizing lag screw fixation. CT has been useful to document and communicate with the client the degree of subchondral bone damage associated with mid-carpal joint pathology. This has resulted in recommending a longer lay-up from training (4-6 months from training) than the conventional 3-month recommendation. Whilst CT information has been used to guide prognosis, the severity of findings has not been directly correlated with a successful return to racing, as some cases with severe pathology that have been hypothesized to have a poor prognosis, have successfully returned to the racetrack, albeit with the aid of intra-articular therapy.
DISTAL LIMB LAMENESS AND LAMENESS PANEL

Sponsored by Hallmarq
Distal limb lameness: pitfalls and challenges

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Distal limb lameness is extremely common. In the front limbs, it is the most frequent cause of lameness. It is also prevalent in the hind limbs although often overlooked due to difficulty in examining and perceived risk of injury. Because it is so common, the equine lameness diagnostician devotes an enormous amount of time evaluating the distal limb. It would seem logical, therefore, that clinicians would be exceptionally skilled at distal limb lameness. However, affected horses often have few, confusing, or no discernable physical or gait characteristics that undeniably pinpoints lameness to the distal limb. To further confound evaluation, the distal limb is a complicated anatomical area involving numerous soft tissue and bony structures, any of which are prone to injury in the performance horse. Equally problematic, imaging of the distal limb can be inconclusive and difficult to perform and interpret. Despite its prevalence, accurate diagnosis of distal limb lameness is a real challenge.

Anatomy

For the purpose of this topic, distal limb lameness will include fetlock, pastern and foot regions. The bones in the distal limb include the distal third metacarpus/metatarsus (MCIII/MTIII), the proximal sesamoid bones (PSB), the proximal phalanx (P1), the middle phalanx (P2), the distal phalanx (P3), and the navicular bone (NB). The synovial structures include the metacarpo-/metatarsophalangeal joint (MCPI/MTPJ), the proximal interphalangeal joint (PIPJ), the distal interphalangeal joint (DIPJ), the distal digital flexor tendon sheath (DFTS), and the navicular bursa. Robust collateral ligaments and fibrous joint capsule tissue support these articulations. Numerous soft tissue structures are associated with and within the bursae, in particular the deep digital flexor tendon (DDFT). Other soft tissue structures within the distal limb include the distal branches of the suspensory ligament (SL), distal sesamoidean ligaments, and the branches of the superficial digital flexor tendon (SDFT). During exercise, extreme hyperextension and flexion occurs in the distal limb. These forces are particularly large during the loading phase of stride and structural injuries ensue due to chronic repetitive or high monocyclic forces on the limb.

Innervation of the distal limb is primarily from the medial and lateral palmar/plantar nerves. In the front limb, the medial and lateral palmar metacarpal nerves originate from the proximal lateral palmar nerve and become superficial just distal to the button of the second and fourth metacarpal...
bones. In the hind limb, the medial and lateral plantar metatarsal nerves originate from the tibial nerve and transverse similarly just distal to the splint bones. Diagnostic analgesia of these nerves is referred to as low palmar (front) or plantar (hind) analgesia. The “condylar block” refers to anesthesia of only the palmar/plantar metacarpal/metatarsal nerves. As the medial and lateral palmar/plantar nerves descend into the digit, they are renamed the palmar/plantar digital nerves and anesthesia of these nerves is referred to palmar/plantar digital nerve block (PDNB). Innervation to the dorsal aspect of the pastern and foot is due to the dorsal branch of the palmar/plantar digital nerves.

Clinical Examination

Often, clinical signs are not obvious or specific for distal limb injuries. However, this should not preclude the clinician’s careful and systematic visual and tactile evaluation of the distal limb. Structures should be palpated with the limb in a weight and non-weight bearing position. Special attention should be given to the foot and its size, shape, heel length, toe length, and hoof pastern axis should be noted. Front feet are generally round or circular in shape whereas hind feet are more triangular. Subjective assessment of the digital pulses and the presence of heat within the hoof capsule should also be noted. Joint effusion and assessment of passive range of joint motion should also be performed. Systematic application of hoof testers is essential in the front limbs and should not be overlooked when assessing the hind limbs.

Next, the horse is evaluated in motion, i.e. the lameness examination. The typical distal limb lameness is accentuated during the weight bearing phase of stride. It is important to evaluate affected horses on different surfaces and when appropriate with a rider. Specific lameness characteristics are highly variable; affected horses may have a typical “head nod”, carry the limb wide (abduct the limb), and/or be more lame with affected limb on the outside of the circle. Also confusing is response to distal limb flexion. This is particularly confusing in the hind limb where many horses with upper limb injuries “flex positive” to distal limb (fetlock) flexion.

Diagnostic analgesia is the best way to authenticate the source of pain to the distal limb. However, techniques have limitations and can add to misinterpretation of clinical exam findings. Traditionally, the PDNB was believed to anesthetize only the palmar/plantar one third of the foot including structures of the navicular apparatus. In reality, the nerve block desensitizes most of the foot. Experimental studies have demonstrated that PDNB not only alleviates pain in the navicular apparatus and palmar foot but also pain in the DIPJ and the sole. The PDNB should be performed
near or distal to the proximal margins of the collateral cartilages to avoid partially anesthetizing the PIPJ. Low volumes (1.5 mls of local anesthetic) and lameness re-evaluation within 10 minutes are also helpful to prevent inadvertent PIPJ analgesia. PDNB is particular challenging in the hind limb where most clinicians prefer to pick up the leg to perform this block which invariably results in anesthetic deposited fairly proximal to the collateral cartilages, mid pastern region, juxtaposed to the plantar PIPJ. Despite accurate and timely PDNB technique, proximal infiltration of local anesthesia occurs in many cases. Therefore soft tissue structures in the palmar/plantar pastern and bone pain in the pastern should also be included as possible sources of pain in distal limb lameness alleviated with PDNB. Intra-articular DIPJ anesthesia provides analgesia to the DIP joint and the palmar/plantar digital nerves which results in additional analgesia of the navicular bursa, the NB, and the sole. Analgesia of the navicular bursa does not alleviate pain from the DIPJ but will ameliorate pain originating from the navicular bursa, NB and its supporting structures, and solar toe pain. Intra-synovial analgesia of the distal DFTS is likely to desensitize only structures within the sheath. Abaxial nerve block may alleviate pain in the foot, pastern and/or fetlock region and is the least helpful in isolating the foot as the source of pain. Low palmar/plantar analgesia should eliminate pain from the entire distal limb and fetlock region. In the front limbs, this block is usually performed after distal limb blocks. In the hind limbs, it is often justifiable to start with low plantar analgesia especially when the horse has few or no abnormal physical abnormalities. If the severity of the hind limb lameness is markedly improved or abolished following low plantar analgesia, it is best to repeat the examination on a separate day and begin blocking more distally. Proximal diffusion of anesthetic is inevitable with low palmar/plantar analgesia which further complicates this technique.

**Imaging**

Radiology remains the gold standard for imaging the distal limb and provides useful information about the bony structures. Proper positioning, adequate views, and good quality radiographic technique are absolutely essential. Radiology of the front feet is relatively routine and commonly performed. On the other hand, imaging of hind feet can be difficult due to technical challenges and the hind foot is often overlooked as a source of pain which further adds to the omission of imaging. Removal of the horseshoe, debris within the frog, and abnormal sole is highly recommended so that imaging artifacts are minimized. For the foot, 5 standard radiographic views include lateromedial, dorsopalmar/plantar, dorso 60° proximal palmaro-/plantaro-distal oblique (DPr-PaDiO), palmaro-/plantaro-proximal to palmaro-/plantaro-distal oblique (PaPr-PaDiO), dorso 45° latero 60° proximo-palmaro/plantaromedial oblique (lateral wing view), and dorso 45° medial 60° proximo-palmaro/plantarolateral oblique (medial wing view). Additional radiographic views include
dorsolateral-palmaromedial oblique (DLPMO) and dorsomedial-palmarolateral oblique (DMPLO) views of the DIPJ and PIPJ. In the fetlock, lateromedial, flexed lateromedial, dorsopalmar-/plantar (DP), DMPLO, and DLPMO are standard. Special radiographic projections such as “down angled DLPMO” (dorsal 45° proximal 45° lateral – palmar/plantar distal medial oblique), flexed DP, and 125° DP may be necessary to elaborate specific area of interest. Osseous abnormalities are not uncommon especially in middle or older aged athletic horses and should be correlated with clinical examination findings. Radiographic abnormalities associated with the NB continue to be debated.

The main application of ultrasonography is identification of tendon or ligament injuries. Advantages over advanced imaging include excellent patient tolerance, non-invasive imaging, and real-time capability to assess adhesion formation between structures. The size, shape, echogenicity, fiber pattern, and surrounding inflammatory reaction of the soft tissue structures can be determined. Ultrasound is operator dependent and the operator should have a clear understanding of the anatomy and sound-tissue interactions. Recognition of artifacts and/or normal variations is critical to obtaining diagnostic images. In the foot, imaging through the frog (transcuneal approach) can facilitate identification of pathology of the distal aspect of the NB apparatus although is difficult to perform even with experience. In the foot, the main disadvantage is the inaccessibility to image the NB, its immediate surrounding soft tissue structures, and the distal aspects of the collateral ligaments of the DIPJ. In horses with lameness alleviated following PDNB and/or abaxial nerve block, soft tissue injuries within the palmar pastern region should be included in the differential list of pathological conditions and therefore ultrasound imaging is indicated. Sonographic imaging of the DFTS is performed to identify involvement of SDFT, DDFT, and other structures within the fetlock canal. Associated soft tissue structures of the MCPJ/MTPJ should also be assessed. Static and dynamic evaluation is recommended to identify adhesion formation and joint surfaces. Ultrasound imaging of the proximal suspensory ligament may also be necessary in horses with proximal diffusion of anesthetic following low 4-point block.

Nuclear scintigraphy can be extremely helpful in identifying stress-related bone injury typified by focal increased radiopharmaceutical uptake (IRU). IRU predominately reflects increased osteoblastic activity due to increased bone turnover. It can be used to ascertain the current status of known radiographic abnormalities and/or pursue diagnosis in horses with negative or equivocal radiographs. It can also be used to corroborate functional information gained from MRI or CT. As with radiography, proper image acquisition is essential. A minimum of two orthogonal images is recommended. Additional images such as solar images of the feet, flexed images, and/or images
obtained from the medial aspect of the distal limb are also employed for complete evaluation. In the
distal limb, IRU associated with the distal palmar/plantar fetlock is a common finding in racehorses.
Mild to moderate distal fetlock IRU can be the result of normal increased bone metabolism of the
MCIII/MTIII during active training or may be associated with early maladaptive stress remodeling;
distinction between normal training response and abnormal pathological response can be difficult.
As with other imaging, scintigraphy can also produce false-negative results and bone pathology
cannot be ruled out in horses that lack IRU in the distal limb. This is particularly problematic for
horses with low grade, chronic lameness.

The greatest strength of computed tomography (CT) is the detailed evaluation of bone structures. It
is the ideal imaging modality to accurately characterize fractures of the distal limb and particularly
useful to identify subchondral remodeling. The addition of contrast medium within a joint or
intravascularly improves the ability to detect soft tissue injuries. Its advantage is rapid image
acquisition (much faster than MRI), 3D reconstruction imaging, and detection of very subtle osseous
density differences. CT does not provide information regarding bone activity or bone fluid
accumulation. And, small tendon and ligament injuries are difficult to identify. Standing CT imaging
acquisition cannot be easily done routinely.

Magnetic resonance imaging (MRI) is very useful for detecting pathology within the distal limb. This
modality can identify abnormalities that are not detectable using other imaging modalities because it
allows examination of both bone and soft tissues with detailed anatomical resolution. It may also
provide some physiological information. The now widely used modality has been instrumental in our
current understanding of injury to the NB apparatus. Numerous MRI studies have demonstrated that
injuries to the NB apparatus are often complex involving the NB and one or more of the supporting
soft tissue structures such as the collateral sesamoidean ligament(s), distal sesamoidean ligament
(impar ligament), and the navicular bursa. Primary injury to the distal DDFT is considered a separate
condition by some clinicians; however, can also be identified in horses with “navicular disease.”
Hyperintense (high) signal intensity in fat-suppressed images within the medullary cavity of the NB
has been associated with NB degeneration. MRI is most useful when a source of foot pain cannot be
identified with other imaging modalities. Subchondral bone and soft tissue injuries in the pastern
and fetlock regions are also readily identified with MRI.

Arthroscopic evaluation of the synovial structures in the distal limb can also be a very effective
diagnostic and therapeutic tool. This technique allows direct visualization of the synovial structure
including articular surfaces, collateral ligaments, and intra-bursal tendons. Since cartilage is not readily visible with radiology, ultrasound, CT, and all but very high field (≥ 3 Tesla) MRI, arthroscopy is the diagnostic tool of choice for assessment of early joint disease. Fetlock joint arthroscopy is very common especially in racehorses with traumatic bone fragmentation (bone chips) and sport horses with developmental bone disease. However, the DIPJ, PIPJ, DFTS, and navicular bursa are also amenable to being explored with the arthroscope.

References
What MRI has taught us about radiographic interpretation of the equine distal limb

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Magnetic Resonance Imaging (MRI) of the equine distal extremity is increasingly common in equine practice (MA Smith 2015), with many regions having access to a referral centre with either a standing low field, or a low field magnet requiring general anaesthesia. For many years, radiographic examination of the distal limb was the mainstay of diagnostics for horses that had lameness localised to the distal extremity. There is much published comparing the results of MRI and radiography in the horse (M Biggi and S Dyson 2010, S Dyson, R Pool et al. 2010, M Biggi and S Dyson 2011, S Dyson, T Blunden et al. 2012, M Biggi, T Blunden et al. 2013, M Biggi and S Dyson 2013, R Parkes, R Newton et al. 2015) as well as correlating these with post mortem and histological findings (S Dyson, T Blunden et al. 2008, A Blunden, R Murray et al. 2009).

With the advent of and improvement in digital radiography, we are able to obtain extremely high quality high resolution radiographs of this region. Additionally, with the post processing available we are able to alter exposures to view both soft tissues and bones in the same image (SM Puchalski 2008).

Both MRI and digital radiography are prone to artefacts that can obscure a diagnosis, or even lead one to a mis-diagnosis (M Spriet and A Zwingenberger 2009). Attributing clinical significance to radiological changes of the navicular bone in particular has been a challenge faced by equine practitioners for many years (S Dyson 2011), and MRI has been especially helpful in this region (M Biggi and S Dyson 2010, M Biggi and S Dyson 2011).

This talk will outline commonly encountered clinical diagnoses obtained with MRI, that are also apparent on high quality digital radiographs, and discuss image acquisition, and technique to maximise the diagnostic potential of both these modalities.

References


Notes
Lameness panel

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A collection of cases will be presented by the members of the imaging panel to generate case discussion amongst conference attendees and panel members.
POOR PERFORMANCE, PROXIMAL SUSPENSORY DESMITIS AND SACROILIAC PAIN

Sponsored by SilverGlide
Clinical Evaluation of the poor performer

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The poorly performing athletic horse is unable to meet the demands of competition. One or more body system(s) break down and the horse is no longer able to perform up to his potential. Return to full function relies on accurate recognition and appropriate treatment of the reason(s) for diminished ability. The fewer the possible factors which contribute to the poor performance the more likely testing will provide an accurate answer. For instance, in a severely lame horse, the most plausible cause for the poor performance is an orthopedic injury and evaluation of the musculoskeletal system is most likely to reveal a definitive answer. However in many instances, the poor performer has subtle or gradual decline in performance with few or no distinct abnormal clinical findings. For these horses, investigation into the cause(s) of poor performance can be a real challenge. This is when real detective work begins.

Clinical Examination

Poor performance testing starts with obtaining a clear and accurate history. A description of presenting complaint(s), the duration, and past and present performance history should be obtained. Any previous surgeries or illnesses should be ascertained and if the problem has improved with treatment. An official performance record such as a race record or other types of competition records should also be evaluated. A detailed physical examination is the next step. A thorough examination of all body systems should be conducted; however, emphasis is usually placed on respiratory, musculoskeletal, and cardiovascular systems.

Physical examination starts with visual observation of the horse during which obvious abnormalities such as joint swelling, muscle atrophy, and/or increased respiratory effort should be noted. The overall conformation of the horse, in particular limb alignment and malalignment, should also be noted. The limbs are examined for signs of heat or pain, in particular the joints, flexor tendons, suspensory ligaments and feet. Auscultation of heart and lungs and palpation of the external laryngeal musculature is also recommended.

Musculoskeletal injury is the most common cause for loss of performance and thorough poor performance evaluation should include lameness assessment. Depending on the nature of the gait disorder, specific exercises (evaluation under tack, jumping, etc.) may also be necessary. Additional testing includes diagnostic analgesia to pinpoint the authentic source of musculoskeletal pain. After
localization of injury, radiography and ultrasonography are the mainstay of imaging. Nuclear scintigraphy is used for “whole horse” evaluation and is particularly useful for horses with inconsistent, subtle or multiple limb lameness. It is the gold standard for early recognition of a stress fracture before catastrophic injury. Advanced imaging such as CT and MRI are very useful for foot and subchondral diseases.

Evaluation of the respiratory tract includes assessment of the head, throat, and lungs. External palpation of the larynx is recommended and atrophy or asymmetry of the laryngeal musculature should be noted. Auscultation of the right and left thorax is performed with and without application of a rebreathing bag. Additional testing includes endoscopic evaluation of the upper airway to assess its form and function. During endoscopy, the nasal passages, pharyngeal, laryngeal and tracheal regions should be assessed. To induce arytenoid movement, the laryngeal mucosal is stimulated with instillation of water through the biopsy chamber of the endoscopy or by gentle pressure with biopsy forceps. Immediately after induction to swallow, maximum abduction and adduction of the arytenoids is assessed. Subjective laryngeal grading system is used.

Cardiac examination starts with auscultation of the heart. Murmurs, dysrhythmias, or other abnormal heart sounds should be identified. The jugular vein should be assessed for patency and capillary refill time should also be assessed. Further testing includes echocardiographic examination which provides useful information about cardiac structure and function. Electrocardiographic (ECG) evaluation is used to assess heart rate and rhythm. Extended monitoring for 24 hours (Holter monitoring) is also used and is especially indicated in the collapsing, fatigued, or ill-defined poor performer.

In horses with suspected neurologic diseases, additional gait and posture evaluations are indicated. Also included are observations of mental status, head position, vision, and muscle symmetry. Ancillary diagnostic aids include cerebrospinal fluid analysis, cervical radiology, myelogram, and/or serology. Other evaluations include serum muscle enzyme assessment, CBC, chemistry profile, and fibrinogen may also be appropriate especially if the horse has a history of past illness. Pulmonary function can be ascertained with forced oscillometry and/or bronchoalveolar (BAL) cytology. A multitude of additional testing is recommended for horses with suspected endocrine, metabolic, or electrolyte abnormalities.

Exercise testing

For horses with clinical signs that are subtle, intermittent, or dynamic, exercise testing may be necessary for the poor performer. Ideally, the testing is completed under conditions that are identical or similar to that of the competition. For example, evaluation is performed where the
ground surface and the horse’s gaits, and speeds are similar to those during its actual competition (e.g., field testing). An alternative method of testing is during treadmill exercise.

Advantages of field testing include evaluation with a rider/driver, in the company of others, and/or over different gradients and obstacles. Lameness evaluation is best performed in the field because treadmill locomotion is quite different than overground locomotion. Certain gaits or maneuvers such as reining spins and dressage canter pirouettes cannot be adequately replicated on the treadmill and are also best evaluated “in the field”. With current sophisticated equipment, field testing with overground telemetric ECG and exercising endoscopy is also feasible.

During treadmill exercise, a multitude of tests can be performed on what is, in effect, a stationary horse. The most common instrumentation includes telemetric ECG recording system, catheterization of a systemic artery (e.g. transverse facial artery) for serial blood gas analysis, a means of measuring core body temperature, and placement of an endoscopy to visualize the upper airway. Facemasks and indwelling catheters for airway pressures can be utilized to assess airflow mechanics; however, are usually reserved for research purposes. Typical treadmill exercise starts with acclimation to the treadmill and associated equipment. The actual exercise test consists of a warm up phase of walking, trotting and moderate canter (or trotting/pacing for Standardbred racehorses) followed by a high-speed test at as fast as the individual horse is capable of sustaining for 1600 to 2400 meters. The exact intensity of the high-speed test is dictated by the temperament, fitness, and ability of the individual horse. In most racehorses maximal speeds will approach 12 to 14+ meter per second. For some horses, the uphill exercise may be appropriate; this is especially true for horses used in competitions that include jumping (i.e. steeple chase, eventing).

Causes of poor performance

Musculoskeletal injury is the most common cause of poor performance in athletic horses. All types of horses are susceptible to lameness and sooner or later, most horses are affected by it. The annual incidence of lameness in the U.S. is approximately 9-14 events per 100 and approximately one half of horse operations report 1 or more lame horses during the previous year. Lameness accounts for approximately 8% of all equine losses annually. Boarding and training facilities are more likely to have lameness compared to ranch/farm, breeding, or personal use stabling. This difference is likely due to exercise intensity and perhaps a greater awareness of lameness.

The second most frequent cause of poor performance is upper respiratory impairment. Exercising abnormal respiratory noise is a common clinical clue associated with upper airway obstruction; however, as many as 30% of horses with intermittent dorsal displacement of the soft palate do not make a noise. Detection of disease is further complicated by the inability to accurately
predict exercising upper airway function based solely on resting endoscopic findings. Therefore, best practices should include exercising endoscopy (overground or treadmill) and there are numerous studies highlighting its merit in the poor performer. Maneuvers that replicate inciting conditions such as enforced head and neck flexion and rapid changes of pace enhance the diagnosis during testing. In the racehorse, palatal dysfunction and recurrent laryngeal neuropathy are the most common exercising obstructive diseases. Both conditions are also prevalent in sport horses and are often induced by equitation. Numerous other upper airway disorders have also been described such as nasopharyngeal collapse and axial deviation of the aryepiglottic folds. Complex dynamic obstructs affect more than 50% of poor performers which emphasizes the importance of exercising endoscopy.

Exercise induced pulmonary hemorrhage (EIPH) and inflammatory airway disease (IAD) are the most common diseases of the lower airway. Clinical signs are often nonspecific, subclinical, or only apparent under maximal exertion. EIPH occurs in most, if not all racehorses. Coughing and/or prolonged recovery from exercise may be noted but often horses have no obvious clinical signs. Rarely horses have post racing epistaxis. More commonly, blood is observed in the trachea during post exercising endoscopic examination. Erythrocytes or hemosiderophages in tracheal or BAL cytology confirms the diagnosis. More difficult, is determining the effect of EIPH on performance.

Signs of IAD include occasional cough, excessive mucous, nasal discharge, chronic poor performance or prolonged recovery from exercise. The effect of IAD is dependent on the level of exercise and the severity of disease. At maximal exercise effort, a relatively mild degree of IAD may result in exercise intolerance. Horses with IAD often have more pronounced exercise-induced hypoxemia (lower PaO₂) at maximal effort. Cytological examination of lower airway secretions confirms the diagnosis. Using the revised American College of Veterinary Internal Medicine recommendations, IAD in horses is diagnosed when the percentage of BAL cells is >5% mast cells, >10% neutrophils, or >5% eosinophils.

The cardiovascular contribution to exercise intolerance can be difficult to determine since affected horses frequently have no, or very subtle abnormalities at rest, while displaying significant abnormalities near maximal effort. On the other hand, a normal horse can have both murmurs and dysrhythmias at rest which disappear during exercise and therefore do not contribute to reduced performance. Cardiovascular causes of exercise intolerance include cardiac arrhythmias, valvular regurgitation, congenital cardiac defects, and myocardial dysfunction. Horses with submaximal exercise expectations can be competitive despite underlying cardiac dysfunction. Therefore, resting and exercising testing is recommended in the poor performer. Normal exercising ECG findings include regular sinus rhythm with no ectopic beats. Maximal heart rate is 220-240 bpm. In the fit horse, heart rate should drop to below 100 bpm within 4-5 minutes post exercise. Abnormal findings
include higher than expected heart rates and dysrhythmia. Atrial fibrillation is the most common arrhythmia. Other arrhythmias include supraventricular and ventricular dysrhythmias. Premature depolarizations are clinically important if >2 isolated premature depolarizations are detected during peak exercise or if multiple (>5) pairs or paroxysms of premature depolarizations are detected in the immediate recovery period. Mitral and tricuspid regurgitation are diagnosed in as many as 50% of racehorses; however, their effect on exercise is negligible unless regurgitation is severe. Mitral insufficiency is the most likely murmur to cause poor performance due to resultant left atrial enlargement and increased pulmonary arterial pressure. Myocardial dysfunction and ventricular septal defects are exceedingly uncommon.

Summary

Given the multitude of body systems that can impede the horse’s athletic function, investigation of the cause(s) of poor performing horse is a real challenge. In horses with obvious abnormal physical exam findings, testing is focused on the injured body system. In horses with vague or ill-defined clinical findings, comprehensive multi-system testing is highly recommended. This is particularly important when the poor performance occurs during exercise. While dysfunction of one body system may be identified as the main reason for exercise intolerance, many horses have complex abnormalities and identification of all problems greatly benefits the horse. For example, performance following prosthetic laryngoplasty may be less than expected if accompanying lower airway inflammation is not recognized and also treated. In summary, comprehensive multisystem testing is recommended because it enhances the clinician’s ability to accurately identify the cause or causes of poor performance.

References

Suspensory desmitis: maximising diagnostic options

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Suspensory desmitis is a common injury in athletic horses. Injury occurs in the front or hindlimb, unilaterally or bilaterally, and any or all anatomical regions of the ligament. Suspensory desmitis at the origin is a diagnostic challenge because affected horses have few or no discerning clinical signs. Diagnosis is further hindered by the number of disease entities that occur in the proximal palmar metacarpal/plantar metatarsal region. For proximal desmitis, imaging modalities are commonly employed; however, interpretation is often confusing especially in the older sport horse. Injury to the suspensory body and the branches may be easier to correctly identify because clinical examination and ultrasound findings are commonly abnormal. However, chronic lesions and concurrent bone pathology often complicates accurate diagnosis. Regardless of the site of injury, authentic identification of clinically significant injury requires attention to and assimilation of multiple diagnostics. Improved understanding of the diagnostic options, what they can and can’t do, enhances accurate assessment.

Proximal suspensory desmitis

Horses with proximal suspensory ligament (SL) desmitis frequently have no localizing clinical signs. Heat, swelling, and edema are transient or absent and lameness is variable. Horses with bilateral injury, especially in the hindlimbs, may have subtle gait abnormalities that are only apparent when ridden or at speed. Lack of impulsion, resistant behavior, and loss of action are frequent complaints. Horses with straight hock conformation and/or hyperextension of the fetlock joints may be predisposed to proximal hindlimb suspensory desmitis and affected horses are chronically lame despite rest. Swelling may result in loss of concave profile along the proximal plantar metatarsus. Proximal injury can occur in the ligament, the proximal palmar metacarpus/plantar metatarsus, or a combination of the two. This complex array of pathological conditions adds to the confusion and complexity of diagnosis.

Perineural analgesic techniques help to localize the site of lameness pain to the proximal suspensory region. Analgesia of the lateral palmar nerve or lateral plantar nerve just distal to the tarsus will alleviate the lameness in the forelimb or hindlimb respectively. However, neither technique is necessarily specific. Middle carpal or tarsometatarsal joint pain may also be alleviated with these nerve block techniques due to local infiltration of anesthetic into the palmar/plantar
outpouchings. Also, prior anesthesia of the distal limb is recommended because proximal palmar/plantar nerve blocks will not selectively anesthetize only the proximal metacarpal/metatarsal region. To further complicate the specificity of localizing proximal suspensory injury, intra-articular analgesia of the middle carpal joint and tarsometatarsal joint may result in partial or complete alleviation of pain in this region.

Ultrasonographic evaluation is complicated by the presence of blood vessels, variation in size and shape of the ligament, and the variable amounts of muscular tissue within the ligament. When present, ultrasonographic changes include cross sectional area enlargement, focal or diffuse areas of hypoechogenicity (Figure 1), core lesions, loss of normal fiber pattern, and periligamentous thickening. The severity of the lesion is assessed by obtaining cross sectional and longitudinal views of the ligament and cross section area measurements. Comparison between the affected and nonaffected limb in the same horse are recommended due to large variation between breeds and individual variation. This is particularly useful in hindlimb injury.

![Figure 1: Transverse and corresponding longitudinal ultrasound images of an 8-year-old Warmblood with lameness localized to the proximal palmar region. Note the focal area of hypoechogenicity (arrows) with the proximal region of the suspensory ligament.](image)

Radiographic examination should be performed to identify concurrent bony lesions. It is very useful in detecting confounding middle carpal joint or tarsometatarsal joint pathology. Subchondral opacity and/or sclerosis of the proximal palmar/plantar aspect of the metacarpus/metatarsus can be noted. Stress fractures are identified as a focal linear radiolucent defect in this region. Endosteal new bone and/or avulsion fractures at the origin are generally not associated with radiographic abnormalities and are more likely to be recognized during ultrasound examination. More commonly, no detectable bony abnormalities are noted in proximal suspensory injury.

Nuclear scintigraphy is normal in the majority of horses with proximal suspensory injury. Increased radiopharmaceutical uptake (IRU) associated with the proximal palmar/plantar metacarpal/metatarsal region can be identified in horses with avulsion fractures (Figure 2) and other stress related bone injuries seen in complex proximal desmitis. IRU during Flow phase (soft tissue)
imaging can enhance diagnosis although false negatives are common. Also, the presence and intensity of IRU is not well correlated with either the severity or duration of the injury.

Figure 2: A, Dorsal and B, lateral delayed bone phase scintigraphic imaging of the carpal region of a 4-year-old Standardbred with focal intense IRU of the proximal palmar metacarpal region.

Even with excellent quality ultrasound, radiographic, and nuclear medicine imaging, the diagnosis can still be challenging. MRI provides more detailed information than ultrasonography regarding muscle fiber detection, ligament size, and heterogeneity. It can also accurately identify adhesion formation between the suspensory ligament and surrounding bony structure(s); a problematic region for ultrasound diagnosis due to artifact of the incongruent bone margins. MRI is the best-suited imaging technique for proximal hindlimb suspensory injury.

**Desmitis of the suspensory body and branches**

In horses with desmitis of the body and the branches of the suspensory, heat, pain, ligamentous enlargement, and lameness are common. Associated fetlock effusion and concurrent distal splint bone fractures may also be noted. Pain is localized following alleviation of lameness after low palmar/plantar analgesia. As with proximal suspensory injury, distal limb nerve blocks should be employed prior to low palmar/plantar nerve blocks to rule out potential distal limb pathology as the source of lameness.

Ultrasonography is the imaging modality of choice. Ligamentous disruptions, enlargements, core lesions, and periligamentous thickening can be identified. Lack of muscle fibers and large vessels in the body and branches facilitate accurate diagnosis with ultrasound imaging. Axial exostosis (“blind splint”) along the second and fourth metacarpal/metatarsal bones can also be identified with careful and comprehensive sonographic evaluation. Similar to injury in the proximal suspensory ligament, radiography is utilized to identify concurrent bony lesions. Splint bone fractures and sesamoid bone fractures can contribute to desmitis of the body of the suspensory ligament. Dystrophic mineralization of the ligament can also be identified. Fibrous adhesion between the body and the small splints is best imaged with MRI.

**Degenerative suspensory ligament desmitis (DSLD)**
DSLD is characterized by bilateral chronic recurrent lameness, painful and enlarged suspensory ligaments, dropped fetlocks (Figure 3), prolonged periods of recumbency, and reluctance to move. Horses with bilateral hindlimb degenerative suspensory desmitis may tread, constantly shifting weight between affected limbs. The condition occurs sporadically in many breeds, usually older, and broodmares. Peruvian Paso and Andalusian horses may be at risk and often are affected in all 4 limbs. It has also been infrequently identified in horses with proximal hindlimb suspensory desmitis and straight hock conformation (Figure 4). Ultrasonographic evaluation reveals progressive enlargement and fiber disruption of the entire suspensory apparatus.

Figure 3: Hyperextension of the hind fetlock joints when walking in a 12-year-old Warmblood with progressive degeneration of the suspensory ligaments.

Figure 4: Degenerative suspensory desmitis and straight hock conformation.

References


Management of proximal suspensory desmitis in the performance horse

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Proximal suspensory desmitis (PSD) is a common condition of sport horses, in particular dressage horses (RC Murray, SJ Dyson et al. 2006). Prior to treatment being commenced, it is vital that an accurate diagnosis is made, which is often a challenge in and of itself (SJ Dyson 2003). The techniques used to obtain such accurate diagnosis are beyond the scope of this abstract, and are covered by other speakers at this conference. Clinical signs vary between the condition seen in the front limbs, and that seen in the hindlimbs, and also depending on whether the condition is chronic, acute or acute on chronic.

In the forelimb, PSD often presents as an acute lameness most obvious with the affected limb on the outside of the circle (S Dyson 2011). Some horses may show almost no lameness, except when being worked under saddle. Especially in acute cases of PSD, the condition most often responds to a period of rest and controlled exercise. In the author’s experience this period of rest can often be relatively short, especially in minor acute injuries. The author recommends box rest with daily walking to graze for a period of between 1-4 weeks (depending on the severity of the lameness and injury), followed by saddle walking and trotting guided both by clinical improvement, and the results of serial ultrasound examinations. In more chronic cases, and those with more severe injuries, other treatments may be needed to improve clinical outcomes. These include the use of shockwave (OM Crowe, SJ Dyson et al. 2004), injection with regenerative medicine products such as platelet rich plasma (N Romagnoli, R Rinnovati et al. 2015) (A Spadari, G Ricciardi et al. 2010), cultured bone marrow derived mesenchymal stem cells (C Marsh, RK Schneider et al. 2012), bone marrow aspirate concentrate (A Rosenbrock, R Jacobi et al. 2004, MS Hall, JR Vasey et al. 2013) and desmoplasty/fasciotomy on its own or in combination with the above (CA Hewes and NA White, II 2006). In spite of their common use in clinical practice good objective evidence for the use of regenerative medicine products in this condition is lacking.

Suspensory desmitis in the hindlimb presents with a wide variety of clinical signs, ranging from acute unilateral hindlimb lameness, to loss of performance and difficulty completing certain tasks or movements (D Marneris and SJ Dyson 2014). Unlike PSD in the forelimb horses with hindlimb proximal suspensory desmitis often do not respond to conservative treatment with box rest (S Dyson 2011). Treatment for these cases involves similar techniques to that outlined above, for the
forelimb. However, in some horses due to compression and degeneration of the lateral branch of the plantar nerve (F Toth, J Schumacher et al. 2008), surgical intervention may be required and can carry an improved prognosis compared to conservative treatment alone (S Dyson and R Murray 2012).

This presentation will aim to discuss the available treatments, and the quality of the evidence behind their use, as well as outlining the author’s approach to the treatment of this troublesome condition.

References

Sacroiliac/pelvic pain – evaluation, diagnosis and treatment

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Pelvic pain is an uncommon cause of hind limb lameness. Clinical signs of horses with pelvic and hip injuries are variable and non-specific and associated with a myriad of other causes of poor performance. Horses with sacroiliac pain also present with varying clinical exam findings. Historical information combined thorough physical assessment of the entire pelvic region enhances the diagnosis. As with other causes of decreased athletic ability, gait and neurologic evaluation are also recommended to rule in or rule out pain from the pelvis region. Equally challenging, imaging of the pelvic structures is problematic because of the horse’s anatomy and limitations of equipment. Horses with bonafide pelvic pain may benefit from directed therapy.

Physical examination of the pelvis

Clinical examination starts with obtaining a good working history. For racing horses with pelvic stress fracture, a common historical complaint is acute severe unilateral hindlimb lameness after breeze or race. The lameness is transient and resolves within 1-2 days. Few discernable physical exam abnormalities are noted and nuclear scintigraphic evaluation is recommended in any horse with suspected pelvic stress fracture prior to resuming strenuous exercise. Pelvic injury in the mature non-racing athletic horse is an uncommon cause of lameness except when associated with traumatic event such as a fall, rearing over backwards, or being cast in a stall.

Physical examination of the pelvis region is performed in a comprehensive and thorough fashion. Solid working knowledge of pelvic anatomy is paramount. Due to the large muscle mass, only the bony extremities of the pelvic girdle can be appreciated. Horses with pelvic fractures often have structural differences between right and left hemi-pelvis. In horses with fracture of the pelvic bones, ventral displacement of the fracture will be noted. Comparison to the normal side while standing behind the horse or via critical observation from side to side is recommended. Inspection of horses with fractured tuber ischii often identifies focal depression and/or loss of normal contour along the caudal margins of the pelvis. Evaluation of pelvic muscle mass should also be done. Muscle atrophy in the pelvic region is very common in horses with pelvic limb lameness or in horses with equine protozoal myelitis as well as horses with underlying pathology of the pelvic region. It is important to identify loss of muscle mass but equally important to correlate it with other clinical examination findings. Muscle tone in the tail and anus should be also be evaluated. Flaccid paralysis
of the rectum, anus, vulva, and tail may be noted in horses with sacral fractures.

Fractures of the ischium and pubis are uncommon and affected horses frequently have a history of falling or rearing over backwards. Focal swelling and pain over the tail head and/or deviation of the tail to one side may be appreciated. With chronic injury, muscle atrophy and a resultant depression at the site of injury may also be noted. Another differential in the acute severely hind limb lameness is fracture or osteoarthritis of the acetabulum. Injured horses have may hop on the affected limb or have extremely short protraction when ambulating. Horses with chronic coxofemoral joint pain may prefer to canter rather than trot and/or move on three tracks.

Rectal examination may be helpful in detection of injuries within the pelvic canal. The integrity of the pubis should be carefully examined. Any loss of contour and/or pain along the internal surface of the wing of the ilium and ventral border of the sacroiliac joint should be noted. Obvious abnormal rectal findings in horses with pelvic fractures include loss of bony continuity, sharp bony edges, or soft tissue bulges due to hematoma formation at the fracture site. Gentle rocking of the pelvis in a side-to-side fashion may facilitate the identification of fracture(s) or crepitus.

Other maneuvers include palpation of the pelvis girdle while simultaneous auscultation of the region is performed. Gently rocking the pelvis side-to-side and/or direct palpation of the lateral pelvis while the horse is walking may also facilitate identification of crepitus in horses with pelvic fractures. The trochanteric bursa is located between the greater trochanter of the femur and the tendon of the middle gluteal muscle. Inflammation of the bursa and/or its surrounding musculature may be painful during focal palpation and/or manipulation of the region. Because the coxofemoral joint lies just deep to the bursa, differentiating pain from the joint vs. bursa can be challenging.

**Physical examination of the sacroiliac region**

Sacroiliac pain is the result of osteoarthritis, iliac wing stress fractures, or desmitis of the sacroiliac ligaments. The clinical significance of sacroiliac joint pathology is difficult to determine since many presumed normal horses have degenerative changes similar to horses with known sacroiliac pain.

Acute sacroiliac injury is usually the result of a series traumatic incident like a fall or starting gate incident. Affected horses may be lame and have localized pain and swelling along the tuber sacrale. Horses may exhibit plating, a gait characterized by crossing over each hind limb, with foot placement close to midline as if trotting on a tight wire. Clinical signs of chronic sacroiliac pain are non-specific and varied. Affected horses are frequently categorized as poor performers. Failure to engage hind limb, overall lack of impulsion, poor hind limb action, and lameness are common complaints. Ridden exercise often worsens the abnormal gait.
The paired dorsal sacroiliac ligaments (DSIL) can be palpated in the croup region as two cord-like structures spanning from the dorsal aspect of the tuber sacrale and extend caudally to insert on the dorsal spinous processes of the sacrum. Firm pressure along the ligaments may be appreciated in horses with injury of the DSIL. Manipulation of the sacroiliac region may elicit a pain response in horses with pathology.

The overall conformation of the tuber sacrale should also be assessed. Sacroiliac instability or subluxation is commonly identified clinically as dorsal displacement of the affected tuber sacrale. The resultant unilateral or bilateral prominences are often called “hunters’ or jumpers’ bumps”. However the clinical significance of this physical examination as a sole finding is nebulous at best; only 5% of confirmed cases of sacroiliac disease have pelvic asymmetry. In horses with atrophy or asymmetry of the gluteal musculature and/or generalized loss of topline, the tuber sacrale may also be prominent and usually not a primary site of pain. Firm ventral pressure to the dorsal aspect of the tuber sacrale is variable and inconsistent in horses with and without underlying pathology in this region. The exception are horses with acute tuber sacrale fractures which are almost always reactive to palpation and will often suddenly collapse in their hind limbs in response to pressure.

Gait examination

After thorough physical examination, the horse should be assessed while exercising. Initially, the horse is evaluated in-hand, on a loose rein, on a flat surface. The horse is walked and trotted in straight lines, similar to the traditional lameness evaluation. Any lameness should be noted and investigated. Horses are then evaluated while walking and trotting in circles. Assessment when moving in a small figure “8” pattern may also be useful. Horses with decreased suppleness and/or spasm may have difficulty turning. Loss or lack of lateral bending through the topline may be another indicator of underlying thoracolumbar pain and may help to differentiate between horses with pelvic pain. Some horses with sacroiliac pain and/or stress fractures of the ilium develop a very close hind limb gait or “plaiting.”

Gait evaluation continues while the horse is lunged and/or ridden to the right and left at a walk, trot, and canter. Ill-defined gait abnormalities such as loss of hind limb impulsion, unable/unwillingness during collected work, difficulty with downward transitions especially canter to trot, and “bunny-hopping” are common complaints in horses with sacroiliac pain. Other complaints include tail swishing, bracing against the bridle, heavy on the forelimbs, and unwillingness to go forward. On occasion, affected horses may appear lame, exhibit a disunited gait, or even rear when ridden.
As with other musculoskeletal abnormalities, diagnostic analgesia assists in authenticating the site of pain. Hindlimb lameness should be thoroughly investigated. Intra-articular anesthesia of the coxofemoral joint can be performed blindly or via ultrasonographic guidance. Anesthesia of pain originating the sacroiliac region can also be diagnostic. Techniques for injection from a cranial approach are recommended. Caudal approached should not be used due to risk of diffusion of anesthetics to surrounding nerves, vessels, and other vital structures.

**Periarticular sacroiliac injection technique:** Horses are restrained and should stand squarely in both hindlimbs. To inject around the *right* sacroiliac joint, an 18 gauge 6 inch spinal needle is inserted slightly axial and 2 cm cranial to the *left* tuber sacrale. The needle is directed in a slightly caudal direction toward the cranial aspect of the *right* greater trochanter along the medial aspect of the *right* ilial wing. The needle is advanced until bone is encountered at the caudomedial aspect of the *right* sacroiliac joint region (figure 1).

![Figure 1: Periarticular injection of the right sacroiliac joint](image)

**Ultrasound-guided sacroiliac technique:** Cranial and caudal injections are advocated by some and ultrasound-guided injections facilitate accurate deposition of medications. For the cranial approach, the ultrasound probe is placed just cranial to the ipsilateral tuber sacrale, 5-7 cm abaxial to midline, perpendicular to the cranial rim of the ilium. The dorsal aspect of the iliac wing is clearly imaged as a hyperechoic line. The needle is inserted cranial to the probe and directed caudally ventral to the ilial wing until bone is encountered. Injection is performed at this location. For the caudal approach, the probe is positioned caudolateral to the ipsilateral tuber sacrale. The probe is angled in a craniolateral-caudomedial oblique plane; perpendicular to the caudal rim of the iliac wing. The needle is inserted caudal to the probe and directed cranially and ventral to the iliac wing. Injection of diagnostic analgesia is not recommended using the caudal approach due to potential diffusion around the sciatic nerve resulting in hind limb paresis.
**Neurologic evaluation**

Since many horses present for poor performance and/or ill-defined gait abnormalities, neurologic assessment should also be performed in horses with suspected pelvic pain. Gait abnormalities such as lack of co-ordination in the hind limbs, weakness, stumbling, or an overall disconnect between the front and hind limbs can be observed in horses with neurologic deficits, sacroiliac pain, and/or caudal pelvic pain. Signs of weakness, loss of proprioception, and/or ataxia may include scuffing of the toes, hypo- or hypermetria, pivoting, circumduction of a limb, and/or loss of balance. Any neurologic deficit should be thorough investigated as part of the comprehensive assessment of these horses.

**Diagnostic imaging**

Nuclear scintigraphic evaluation of the pelvic region is very useful for identifying fractures, stress fractures/reactions, bone remodeling associated with osteoarthritis of the coxofemoral joint, and overall symmetry of anatomy. Dorsal, lateral, caudal, and dorsal oblique views are recommended in horses with suspected pelvic pain. Increased radiopharmaceutical uptake (IRU) at focal site along the cortical margins is the hallmark of a stress fracture. Unilateral muscle atrophy, radioactive urine, soft tissue attenuation, and motion can complicate or hinder adequate imaging.

Ultrasonography can be performed percutaneously or per rectum. It is useful for identifying fractures of the ilial wing, ilial shaft, tuber coxae, and ischium. Discontinuity of the pelvic surface and surrounding anechogenic muscle (hemorrhage) are noted in affected horses. Acetabular rim fractures, joint effusion, osteoarthritis, and/or subluxation of the coxofemoral joint can also be identified. The dorsal sacroiliac ligaments are readily imaged however complete evaluation of the sacroiliac joint is not possible due to anatomy. As with other ligament/tendon abnormalities, sonographic findings should be correlated with clinical examination findings. Transrectal ultrasound facilitates evaluation of the internal bony surface of the pelvic girdle and the ventral sacroiliac ligament and joint margins.

For horses with suspected pelvic fractures, ventrodorsal radiographic images obtained with the horse in dorsal recumbancy under general anesthesia can be diagnostic. In the adult horse, right and left imaging is necessary due to the large size of the pelvis. Abdominal viscera and ventilation blurring can impede radiographic interpretation. Radiographic techniques in the standing sedated horse have been described however safety concerns for the horse, the handlers, and the equipment are paramount considerations. In the standing horse, a dorsal 50° proximal medial-ventral lateral oblique image can be used to assess the integrity of the tuber coxae.
Conditions of the pelvis and sacroiliac region

Pelvic fractures

In racing horses, diagnosis of pelvic stress fractures is focal IRU along the cortical margins of the pelvic bones. Diagnosis can also be made via ultrasound by identification of bony remodeling and/or loss of normal bony contour. Stress fractures along the wing(s) of the ilium are the most common. Affected horses have acute transient lameness immediately after strenuous exercise. Recommendations include 2 months of stall rest followed by 2 months of small paddock turn out. Prognosis is excellent for horses with stress fractures of the ilium unless unrecognized. Stress fractures can lead to catastrophic fracture; post mortem racetrack studies reveal chronic bony remodeling at the sites of complete fractures which is indicative of prior bone stress remodeling.

Other fractures of the pelvis are usually the result of direct large impact traumatic events. Affected horses are often acutely severely lame. Horses with displaced fractures have loss of normal pelvic bone and in the chronically affected horse, muscle asymmetry. Abnormal physical examination abnormalities, including rectal palpation, assist in the diagnosis. Comprehensive ultrasonographic evaluation and bone scan imaging is also helpful. The mainstay of therapy for pelvic fractures is rest. Complete fractures of the pelvis require longer convalesce; stall rest for a minimum of 3 to 4 months may be necessary. Adult horses with fractures of the acetabulum have the poorest prognosis for return to athletic function although some affected horses may become sound enough to retire to pasture. Intra-articular corticosteroids may be beneficial for associated coxofemoral osteoarthritis although most horses are chronically affected prior to diagnosis and therefore response to treatment is often fair at best.

Sacroiliac joint pain

Sacroiliac joint pain is the result of osteoarthritis, iliac wing stress fractures, or desmitis of the sacroiliac ligaments. Sacroiliac instability or subluxation is commonly identified clinically as dorsal displacement of the affected wing of the ilium. The clinical significance of sacroiliac joint pathology is difficult to determine since many presumed normal horses have degenerative changes similar to horses with known sacroiliac pain. The most common clinical signs reported in affected horses include poor performance, lack of impulsion, and/or mild chronic hindlimb lameness. Plating (affected limb placed close to midline) and tenderness to palpation may also be appreciated. Diagnosis is complicated by the inaccessibility of the joint and imaging limitations and is often a diagnosis of exclusion. Therapeutic and/or diagnostic periarticular sacroiliac injections followed by resolution of clinical signs confirm the diagnosis.
For horses with acute sacroiliac injury, box stall rest and systemic NSAIDs are indicated during the initial treatment period. For chronic injuries, physiotherapy exercise without a rider may be beneficial. Non ridden exercises that encourage and/or maintain muscle development of the back and gluteals such as work with a Pessoa apparatus, exercise via long lines (driving in hand), and water treadmill exercise may also be beneficial. Shockwave therapy and local injections with irritants or corticosteroids may also be beneficial, albeit usually short lived. Acupuncture and chiropractic manipulations are non-traditional approaches that are also used although evidence based support for these modalities is lacking. Some horses may have improvement in performance or lameness but may not return to previous level or consistent exercise. Recurrence is common.

**Dorsal sacroiliac desmitis**

Desmitis of the dorsal sacroiliac ligament (DSIL) is one of the differential diagnoses in horses with sacroiliac pain. Injury of the DSIL is the most common soft tissue injury in the sacroiliac region. Horses with sacroiliac pain exhibit similar clinical signs to those noted in horses with bone or joint pathology in this region. Ultrasonographic evaluation should be included as part of the comprehensive evaluation of horses with sacroiliac pain. DSIL desmitis is characterized by enlargement of the ligament, disruption of the normal fiber architecture, and/or hypoechogenic areas. Associated enthesiophyte formation on the tuber sacrale may also be noted. Acute DSIL injuries can contribute to sacroiliac joint instability however; the clinical significance of chronic desmitis is controversial. Management consists of stall rest and anti-inflammatories during acute injury. Intralesional injections with platelet-rich plasma or stem cells have been advocated by some clinicians although evidence based studies are lacking. Physiotherapy, controlled exercise, and other site-directed therapies as described for sacroiliac pain may also be beneficial.

**Muscle spasm, strain and tears**

Muscle strains and injury in the pelvis region can result in focal soreness, overall stiffness and poor performance. For horses with psoas muscle injury, pain may be appreciated during rectal palpation of these muscles. Swelling, sometimes severe, in the medial thigh region may be due to gracilus muscle injury. In horses with hind end lameness, secondary muscle injury may occur due to the resultant altered gait. Primary muscle injuries mostly occur during activity, either ridden or during turnout. Inciting causes are extremely variable and often not conclusively identified. Preceding events may include a traumatic event such as a fall or overuse of an undertrained muscle. Ultrasonographic abnormalities in acute injury include hypoechoic areas within the affected muscle.
and loss of normal muscle fiber striation. Focal hematoma may also be noted in severe tears especially along fascial planes. Chronic changes include regions of hyperechogenicity and occasionally mineralization. IRU in pelvic muscle(s) may be noted during bone phase nuclear scintigraphic evaluation. Elevation in serum muscle enzymes analysis is rare. The aims of treatment are repair of muscle damage, minimization of scar tissue formation and restoration of muscle function. Adequate rest, non-steroidal anti-inflammatory drugs in acute injury and controlled exercise are recommended. Physiotherapy such as massage, electrical stimulation, laser, therapeutic ultrasound, and passive stretching may be beneficial during the rehabilitation process.

References

POOR PERFORMANCE, NECK AND BACK PAIN

Sponsored by Austvet Endoscopy and Miatech
Diagnostic Imaging Specialists
Poor performance panel

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A collection of cases will be presented by the members of the imaging panel to generate case discussion amongst conference attendees and panel members.
Neck pain is an uncommon cause of poor performance in athletic horses. A detailed clinical examination (including physical, lameness and neurologic evaluations) and good quality imaging is recommended for accurate diagnosis. Treatment(s) are directed at an authentic source of pain and/or clinical problem.

Clinical Signs and Examination

The most common clinical signs of neck pain include general neck stiffness, lack of flexibility during bending manipulations and abnormal head carriage. Unwillingness to work on the bit and/or resistance in a certain head position when ridden is also a frequent complaint. Affected horses may have a history of trauma, such as a fall or collision with another horse or solid object. A cervical lesion should be considered in horses with unilateral forelimb lameness that cannot be localized to the limb. Subtle hindlimb ataxia, stumbling or loss of hindlimb propulsion may reflect compression of the cervical spinal cord.

Physical examination begins with visual assessment of the neck conformation, posture and position of the neck relative to the head and withers. Any patchy sweating area may reflect local nerve damage. Muscle atrophy and/or sites of pain during palpation should also be noted. Neck flexibility can be rudimentarily assessed with “carrot stretches.” A carrot or other enticing food is used to encourage the horse to flex its neck to the right and the left caudally to the withers and the hock. Between the front legs and above the bridge of the nose, neck extension and flexion in the forward direction is also assessed with “carrot stretches”.

After static assessment is complete, dynamic neck mobility is assessed. The horse should be observed in hand, while lunging and, if indicated, while ridden. Implementation of various bits, bridles, side reins, etc. are indicated if clinical signs are related to certain head and neck positions. Rider complaints such as difficulty bending in one direction, a jerky head and neck movement or neck stiffness should be thoroughly investigated. While these ill-defined complaints may be due to neck pain, they may also be an avoidance and/or protective mechanism in horses with lameness. Diagnostic analgesia of the limb(s) should be performed in horses with unilateral lameness (especially forelimb lameness) and/or horses with abnormal head or neck carriage, since abnormal neck posture and/or gait may reflect a primary lesion elsewhere. Neurologic assessment is indicated.
especially when ataxia, proprioceptive deficits and/or stumbling are observed. A combination of historical findings, clinical evaluation and imaging provide strong evidence of neck pain. In horses with radiographic evidence of osteoarthritis of the dorsal cervical articular process joints (APJ), clinical significance should be confirmed with intra-articular analgesia.

**Imaging**

Radiology: Lateral images of the neck (from the poll to the withers) require at least 5 well-positioned exposures which are best performed with a large radiographic cassette. Accurate positioning of the head and neck is critical because any rotation makes it difficult to interpret radiographic findings, especially the dorsal cervical APJs. In the caudal neck large exposures are necessary especially in Warmblood or other large breed horses.

Nuclear Scintigraphy: Nuclear scintigraphy is relatively insensitive at detecting neck lesions. In normal horses increases in radiopharmaceutical uptake (IRU) is associated with the fifth, sixth, and seventh vertebrae compared to the more cranial vertebrae. Also, the dorsal axis is a common site of IRU in normal horses. Ideally right and left lateral scintigraphic images are obtained and compared. Conformational abnormalities, such as abnormal angulations or enlarged dorsal cervical APJs, may be noted with or without IRU.

Ultrasound: Sonographic assessment of the neck is indicated for swelling, painful muscles, nuchal ligament abnormalities and nuchal ligament bursitis. Ultrasound-guided dorsal cervical APJ injections for diagnosis and therapy of joint pain can also be performed.

**Clinical Conditions and Treatment**

**Insertional desmopathy of the nuchal ligament**

Affected horses are resistant to rein pressure and unwilling to lower and flex the head. Bony remodeling along the caudal aspect of the occipital bone at the site of insertion of the nuchal ligament is noted. However, as many as 85% of Warmbloods have bony remodeling and therefore may be an incidental radiographic finding in this breed. Nuclear scintigraphy is helpful when IRU is localized to the area, but is frequently negative. Critical sonographic assessment can be diagnostic but is challenging. Diagnosis is confirmed following elimination of significant reduction of clinical signs after infiltration of local anesthetic. Treatment consists of local infiltration of corticosteroids which may need to be repeated. Exercise without poll flexion for 2-3 months should also be encouraged. Shockwave therapy may also be beneficial. Most, but not all, affected horses respond favorably to treatment.
Nuchal ligament bursitis

Affected horses have prominent swelling in the poll and abnormal head carriage. Ultrasonographic evaluation confirms the diagnosis by visualization of fluid distension within the nuchal ligament bursa and synovial thickening. Often numerous amorphous hyperechoic densities are noted floating in the fluid distended bursa. Radiographic evidence of soft tissue mineralization and bony remodeling can also be appreciated. The cranial (atlantal) nuchal bursa and/or the caudal nuchal bursa may be affected. Focal IRU can also be noted during scintigraphic evaluation. The cause for the bursitis is unclear. Older literature suggests an infectious etiology such as *Brucella* sepsis in horses with “poll evil.” Nonseptic inflammatory process has been recently suggested. Nuchal bursoscopy is preferred over surgical resection. Intrabursal corticosteroids may be beneficial, but often results in short-lived response.

Osteoarthritis

Radiographic evidence of osteoarthritis of the dorsal cervical APJs has been implicated as a cause of neck pain or stiffness and forelimb lameness. However, approximately 50% of clinically normal horses have some degree of bone remodeling of the C5-6 and C6-7 dorsal articulations. Therefore, the clinical significance of osteoarthritis of APJs can be difficult to determine by radiographic evaluation alone. As with other neck pain causes, clinical signs include neck stiffness, reluctance to work on the bit or general poor performance. Unilateral forelimb lameness is an infrequent clinical sign in horses with arthritis between the fourth cervical and first thoracic vertebrae. Large amounts of new bone formation, due to arthritis, can encroach in the vertebral canal resulting in compression of the spinal cord and hindlimb ataxia and weakness. Therapeutic and/or diagnostic intra-articular dorsal cervical facet joint injections followed by resolution/reduction of clinical signs confirm the diagnosis of neck pain.

Cervical facet joint injection technique: Using ultrasound guidance, the dorsal APJs are located just dorsal to the caudal extent of the transverse processes which are the most dorsolateral bony structures of the neck. The joint space is identified as an anechoic gap and the articular processes form a characteristic “chair” sign. Using aseptic technique a 20 gauge 3.5 inch spinal needle is inserted at a 30° angle to the skin surface, cranial to and in the same plane as the ultrasound beam. (Figure 1) A properly placed needle causes a hyperechoic shadow. (Figure 2) Joint penetration is confirmed by aspiration of synovial fluid.
Figure 1: Drawing of ultrasound-guided ABJ injection technique

Figure 2: Ultrasound image of the C6-7 articulation. A spinal needle (arrows) is directed toward the joint space.

References

In the athletic horse, back pain is a common cause of poor performance. Common complaints in affected horses include ill-defined or undesirable gait and performance abnormalities. Diagnosis is difficult because the signs are vague and horses that appear sensitive to palpation of the back may not necessarily have pain in the thoracolumbar region. Equally difficult is adequate imaging of the back and determining the clinical significance of those findings. Treatment modalities are plentiful but most therapies lack evidence based proof to support or refute their efficacy. Identification of authentic causes of back pain is very challenging.

Anatomy

In the horse, the thoracolumbar vertebral column contains 18 thoracic, 5-6 lumbar vertebrae and 5 fused sacral vertebrae. The mechanical functions include protection of spinal cord and nerve roots, support for weight bearing and soft tissue attachment, and maintenance of movement for flexibility and locomotion. The vertebral bodies and intervertebral disks are located ventrally and the associated dorsal spinous processes (DSP) extend dorsally. Similar to the cervical vertebrae, the articular process joints (APJ) create bilateral synovial articulations along the dorsal cranial and caudal margins of the vertebral bodies. Compared to the neck, thoracolumbar APJs are small and less mobile. Connecting soft tissues include short and long spinal ligaments and the spinal muscles. The nuchal ligament continues as the supraspinous ligament in the thoracolumbar region and inserts on the summits of the DSPs. Dense interspinous ligaments provide stability to the thoracolumbar vertebrae. The epaxial and hypaxial muscles lie dorsal and ventral, respectively, to the transverse processes of the vertebral bodies. These muscles are innervated by dorsal and ventral branches of the spinal nerves and provide spinal and lateral flexion.

Clinical Examination

Assessment of a horse with back pain starts with obtaining a clear and accurate history. The
A detailed physical examination is the next step. The purpose of the clinical examination is to determine if abnormalities exist in the back and to determine a suitable way of diagnosing underlying pathology. The cause of back pain can be difficult, at best, to pinpoint. Many times the diagnosis is by eliminating other possible conditions. Therefore a comprehensive musculoskeletal examination of the entire body and limbs is always indicated. Other examinations include an assessment of the neurologic system. Assessment by a behavior specialist or another professional rider/trainer may also beneficial for horses that lack the temperament and/or athletic talent for its intended use.

Visual observation of the back at rest include assessment of conformation in particular, lordosis or kyphosis, should be noted. Reportedly, short backed horses are more prone to bone injuries and long backed horses to soft tissue injuries. Muscle asymmetry and atrophy should be noted. Also, evidence of white hairs along the withers or saddle region can also be clues for sites of

description of presenting complaint(s), the duration, and past and present performance history is essential. A common complaint of a horse with a long-standing back problem is alteration in behavior and temperament. For example, affected horses may be difficult to catch, unwilling to walk to the ring or stand still for mounting. Information regarding tack changes, in particular saddle and pad, and rider/trainer changes should also be obtained. Another common complaint is difficulty or reluctance to lie down, rise up, and/or roll. Sometimes, the farrier will complain that the horse is “difficult” for shoeing/trimming the hind feet.

Most affected horses are not overtly lame but have primarily complaint of poor performance. They may exhibit general decline in the quality of their gaits, unwillingness to jump especially for combination or grid work, lack of impulsion, or resistance during collection work. Affected horses may be stiff, lack flexibility when ridden but appear free and flexible in the paddock. Often times, owners will complain that horses resent brushing across their backs sometimes by kicking or biting at the owner. Generally sourness when being saddled is another common complaint. Characteristic “cold backed” horses will often brace and/or ventrally sink in their middle back when the saddle is positioned and the girth is tightened. Riders will also complain that horses resent being mounted by moving away from the mounting block, hunch up their back, pin their ears, swish their tails, or walk with a stiff and stilted gait immediately after mounting.

Other historical complaints include kicking out, bucking, or overall unwillingness to go forward. Sometimes, the riders are able to pinpoint specific movements during which affected horses are more likely to exhibit clinical signs. For example, the horse may buck when asked to canter or refuse an oxer jump or resist collected dressage movements. Other times, general ill defined, inconsistently consistent changes in gait and behavior are noted.
previous trauma or ill-fitting tack. Overall impression of “good” vs. “poor” topline should also be noted. A poor topline despite good, consistent training is a common finding in horses with back pain. In comparison, a horse without back pain frequently has a good well-muscled topline even in competition or not.

Palpation usually starts at the withers and ends at the sacral region. Firm, but gentle, pressure is applied with fingertips along the musculature to the right and left of midline. Horses with muscle soreness may exhibit guarding or splinting in anticipation of palpation. Occasionally, horses will pin their ears, swish their tails, kick, or bite. Skin sensitivity is not a reliable indication of back pain but prolonged fine muscle fasciculation or spasm is an abnormal response and may indicate underlying pathology.

After thorough physical examination and palpation, evaluation of gait is performed. Horses are evaluated while walking and trotting in circles. Assessment when moving in a small figure “8” pattern may also be useful. Horses with decreased suppleness and/or spasm may have difficulty turning. Loss or lack of lateral bending through the topline may be another indicator of underlying thoracolumbar pain. Any lameness or neurologic deficits should be noted and investigated. It is uncommon for horses with overt unilateral lameness to have primary back pain. Gait evaluation continues while the horse is lunged to the right and left at a walk, trot, and canter. Affected horses may exhibit loss of hind limb impulsion, difficulty with downward transitions especially canter to trot, “bunny-hopping”, and/or dragging the hind feet; although these gait abnormalities are not pathognomonic. Applying pressure across the withers and saddle region may facilitate observation and identification of sites of soreness.

Ridden gait evaluation is also important. The horse should be observed when saddling, girth tightening, and mounting. Abnormal signs include grunting, teeth grinding, tail swishing, extreme ventral extension of the spine, and/or buckling of the hindlimbs. The horse’s gait should be assessed once the rider is mounted. Affected horses may have an exaggerated shorted stride even at the walk. The horse is then ridden at the walk, trot, and canter. Comparison of gait with the rider in sitting position vs. jumping position (half seat) may also be helpful. Horses with thoracolumbar pain may resent contact with seat, collected movements, and/or changes of pace especially downward transitions. Tail swishing, bracing against the bridle, heavy on the forelimbs, and unwillingness to go forward are common complaints. On occasion, affected horses may buck or rear when ridden. It is important to determine if this is a behavior issue, a response to poor training, or due to underlying pain.

Local infiltration of local anesthetic solution is very helpful to authenticate the back as the site of pain. Seven to ten mls of mepivacaine are injected between or along the side of the DSPs in
regions of interest. Ideally as few sites as possible are blocked which enhances the specificity of injury location. Response is assessed in 15-20 minutes and best assessed while ridden.

Imaging

Imaging of the back is essential to determine underlying pathology. Radiologic evaluation can be performed in the sedated standing horse. The horse should stand squarely. Large plates and high powered x-ray generator facilitates accurate imaging. At least 5 lateral exposures are necessary to assess the thoracic and lumbar spine. Radio-opaque markers help to correlate clinical examination findings with radiographic findings and vice versa. Additional 20° oblique images are useful to assess thoracic intervertebral articulations.

Ultrasound of the epaxial muscles, supporting soft tissue structures, APJs, and transverse processes of the vertebrae can also be performed. The supraspinous is thinner and wider in the saddle region and narrower and thicker in the lumbar region. Great variability in normal echogenic appearance confounds evaluation. Nuclear scintigraphy provides assessment of current bone activity. Increased radiopharmaceutical uptake (IRU) associated with the DSPs increases the likelihood that a lesion is clinically relevant. However, IRU does not equal pain and may merely represent a physiological response to bone stress. Also, lack of IRU does not rule out significant lesions and/or back pain.

Causes of back pain and treatment

Impingement or over-riding DSPs

Impingement of the DSPs aka “kissing spines” is a well-recognized disorder of the equine back. The most common locations are between T10 and T18. Remodeling, narrowing or loss of interspinous space, and sclerosis are the radiographic characteristics. Nuclear scintigraphy can identify active bony remodeling or insertional desmopathy of the supraspinous ligament. However, overriding DSPs can be found in horses performing satisfactorily with no clinical manifestations of back pain. Therefore imaging should be combined with a good clinical examination including response to local analgesia.

There are multiple treatment options for overriding DSPs. Medical treatments include local perispinal or interspinal injections of corticosteroids and/or Sarapin and acupuncture. Modification
of the training program and short term rest may also be beneficial. Physiotherapy directed at strengthening the epaxial musculature such as “carrot stretches” and/or controlled exercise in a water treadmill may facilitate muscle development. Other therapies include extracorporeal shockwave therapy and mesotherapy. Surgical resection of one or more dorsal spinous processes has been successful in some horses that do not respond to medical therapy. Interspinous ligament desmotomy is a promising novel new surgical treatment for affected horses. Prognosis is variable, but generally considered poor for the chronically, severely affected athlete.

**Osteoarthritis of the thoracolumbar intervertebral articulations**

Affected horses may have swelling, pain, atrophy, or spasms in the thoracolumbar muscles. Limited flexibility and/or stiffness through the back can also be observed at rest and during exercise. Poor quality gaits, lack of hindlimb impulsion, reluctance to work, and bucking are also common. Commonly, 2-5 facet joints are affected, usually in the caudal thoracic and cranial lumbar spine. Radiographic changes such as sclerosis, periarticular bony remodeling, and narrowing of the joint space are the most frequent radiographic lesions. Lateral oblique views of the spine provide comprehensive evaluation of the joints. Local infiltration of local anesthetic solution around the facet joints is technically challenging but can facilitate accurate diagnosis if performance improves after blocking. As with arthritis in other joints, local and systemic anti-inflammatory treatment combined with exercise modification is indicated.

**Stress fractures of the vertebral body**

In a post-mortem study of Thoroughbred racehorses, 50% of specimens had evidence of vertebral stress fractures characterized by focal periosteal proliferation and incomplete fracture lines. Although a common postmortem finding, clinical prevalence is significantly lower. Albeit rare, vertebral laminar stress fractures have been identified using nuclear scintigraphy. Physical exam findings include nonspecific signs of back pain, poor performance, hunched-up lumbar spine, and poor hindlimb propulsion. Stress fractures are managed with 2 months of stall rest followed by 2 months of small paddock turn out.

**Spondylosis**

Spondylosis is a degenerative disease of the vertebral joints that produces large osteophytes that eventually bridge the ventral vertebral bodies. Affected horses may have restricted back mobility and exhibit ill-defined signs of thoracolumbar back pain. Radiography and nuclear scintigraphy aid in the diagnosis. Treatment options are very limited and restricted to exercise modification or career change.
Fracture of the DSPs in the withers ("Fractured withers")

Fractures of the dorsal spinous process of T4 to T9 are commonly the result of falling over backward. Swelling and sensitivity to palpation are noted in the acutely affected horse. Movement may be restricted and horses exhibit a base narrow stilted gait. Radiography and occasionally nuclear scintigraphy confirm the diagnosis. Most horses respond well to long term rest. Bony sequestrum is uncommon. The resultant flattened appearance may be cosmetically unpleasing to some owners and may necessitate a specially fitted saddle pad.

Supraspinous ligament injury

Injury to the supraspinous ligament is uncommon. Jumping horses may be over-represented and injury may be more prevalent in elite athletes. Sonographic signs include ligamentous thickening, focal hypoechochogenicity in acute injury, and hyperechogenic foci in chronic injury. Insertional desmopathy is identified by irregularity of the bony contour of the summits of the dorsal spinous processes of the vertebral bodies. However, ultrasonographic abnormalities can be appreciated in horses without clinical signs of back pain especially between T14-T17. As with other abnormal imaging findings, correlation between pathology and clinical signs is paramount for definitive diagnosis. Radiology and nuclear scintigraphy are helpful for identification of associated bony pathology such as avulsion factures, enthesiophyte formation of the dorsal spinous processes and/or to rule in osseous causes of back pain. The mainstay of management of supraspinatus ligament injury is rest. In acute injuries, anti-inflammatory therapy is also beneficial. After resolution of clinical signs, hand walking and periodic ultrasound examinations (every 8-10 weeks) are indicated until sonographic appearance has improved and/or resolved. During the rest period, physiotherapy is directed at strengthening the epaxial musculature. “Carrot stretches” and/or controlled exercise in a water treadmill may facilitate muscle development. Other therapies include intralesional platelet rich plasma, intralesional stem cells, extracorporeal shockwave therapy, mesotherapy, and local infiltration of corticosteroids.

Long term studies regarding the efficacy of various therapies and prognosis have not been reported. As with other ligamentous injuries, recurrence and complete resolution of clinical signs in chronic injury is not uncommon.

References
